A study of views of Facebook users on the role of haptics in social network systems

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Abstract

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The research area relates to mediated interaction and people's activities in social network systems of the Internet. There are various systems available in the Internet for mediated social interaction. The context of this research is limited to voluntary and free-time based social interaction and maintenance of personal relationships. The purpose is to clarify the role of haptics (the sense of touch) as a part of activities of social network systems.

Since the question is about social interaction occurring at free-time and concerning mundane matters, it makes sense to think about means for enriching the interaction with more affective, playful, supportive, and interactive ways, although people are already able to adapt and use the prevalent text-based interaction in various ways. Also, increasing mobile use of social network systems creates new contexts and challenges to be faced for making mobile use fluent. In addition, mediated interaction creates new affordances for communicating and being in contact with others. Because of changing behavior and new interaction contexts, there might be needs for additional and alternative means of interaction. Mediated haptics might be a viable alternative since the sense of touch is an important part of physical interpersonal interaction and has a role in making interaction more affective and personal.

The subject is future oriented. The results of the user study are based on knowledge of contemporary technology and usage of social network systems, which presumably will develop in parallel with development of haptic solutions. Consequently, this research serves as an initial overview on the subject at this moment of time when Facebook use has achieved mass use, and only a few haptic solutions are commercially obtainable.

The research concentrates on Facebook and similar social network systems. A user study was conducted in order to clarify views of users on usage of haptics. A semi-open questionnaire was selected as the method. As a part of the questionnaire, three different scenarios involving haptics were provided to the participants for evaluation.

Based on the results obtained, it could be concluded that Facebook is not used in such a way that would benefit much from haptics. At least, users are not yet ready for bigger changes and are relatively satisfied with the current usage. However, the user study together with theoretical analyses revealed potential usages of haptics in the future and matters to be considered in designing haptic solutions. In addition, different development paths are proposed for inclusion of haptics: one as an enhancement to messaging and another associated with interaction in 3D environments and gaming.

Keywords: social network system, haptics, mediated social interaction, Facebook.

Contents

1 Introduction

The Internet use has changed from primarily unidirectional publication of relatively static content to more dynamic information exchange and social interaction. Ordinary people are able to start writing blogs, a kind of diaries, which users produce and publicly share with others in the Internet. Users are also able to share photos and videos using applications such as Flickr, Picasa Web, or YouTube. In addition to content sharing, the Internet provides means for mediated collaboration and collective activities. Wikipedia is an example of collectively produced content in the form of online encyclopedia. This new way of using the Internet is being called Web 2.0 (O'Reilly 2005).

Nowadays, social interaction has become an important usage of the Internet systems. The first forms of social interaction were various online communities and newsgroups in which any user could join in to (anonymously) converse with others. One of the first well-known online social networks, the Whole Earth 'lectronic Link (WELL) established by Rheingold, was created in 1985, and it was based on a computer mediated conference system and e-mails (Rheingold 2000).

Facebook is a commonly used social network system. It offers a variety of possibilities for social and playful interaction, maintaining friendships, and presentation of self, among other things. The idea of Facebook is to create and build an own network of friends and acquaintances. It is usual to exchange context dependent information about personal matters and mundane events, which may "expire" relatively soon after short discussions. Another form of interaction of Facebook is chatting, which consists of relatively simultaneously and mutually exchanged brief messages. Furthermore, Facebook makes it possible to use various applications and perform different operations if one wants to spend more time on Facebook. Other popular social network systems, at the moment, are MySpace, Twitter, and LinkedIn. One of the latest initiatives is Google Buzz.

It can be said that Facebook has achieved mass use, and people are relatively well accessible and available via Facebook, at least in some geographical areas. According to statistics collected by The Nielsen Company (2010) from ten countries in February 2010, the growth in the amount of social network users compared to the previous year was nearly 30% globally. Facebook was the mostly used system (52% of users), which was visited 19 times and used

almost six hours per month per person. (The Nielsen Company 2010.) The amount of Facebook members reached 500 million in July 2010 (Mashable Infographic 2010).

Characteristics and availability of means of mediated interaction, and how it is used by people, create and provide opportunities for increased social interaction. People have adopted new technology, and new ways of communicating have been developing. Increased use of mobile devices creates affordances for social interaction in any idle time independent of place. For instance, according to statistics provided by Facebook (2010), more than 150 million users use Facebook via mobile phones, and those users are twice as active Facebook users as other users.

Social network systems are typically based on (text-based) messaging technology. They include characteristics from near real-time instant messaging to less frequently exchanged e-mails. The phenomenon that people started using social network systems (and the Internet in general) via mobile phones together with emergence of IP based data communication, have brought services of the Internet and telecommunication networks closer each other. This enables transferring and mixing of usage practices and norms, or even interoperability or integration of different systems.

New types of input devices have become available providing means for users to use gestures and movements in user interfaces. This is realized especially in game systems such as Wii video game console from Nintendo (Wikipedia contributors, Wii). In addition, touch screens have become common in mobile phones and computers although only a few of the devices have touch feedback implemented. One of the latest new devices is the big screen iPad device from Apple (Apple Launches iPad) having a multi-touch user interface implemented. In addition to touch, also position of the device can be utilized by applications.

Haptics is a concept covering both the sense of touch and kinesthesis. With haptics, it is possible to explore objects, feel shapes and surface material, or sense touch in the skin. Humans use aids of haptics for performing actions (e.g., feeling the environment) and touching others. As already mentioned, technology is evolving to apply the sense of touch and kinesthesis to human computer interaction. Since the sense of touch is one of the important senses belonging to human social interaction, there are and have been research efforts for clarifying the availability and role of the sense of touch in mediated interaction. For instance, whether mediated touch corresponds to physical touch, whether mediated touch is able to

evoke emotions, or which kind of usages would be suitable for haptics in mediated contexts, have been under research.

With regard to social network systems, applicability of haptics as a part of multimodal solutions could be investigated for clarifying the role of haptics as an additional, alternative, or complementary modality in mediated social interaction. For instance, whether text-based interaction, lacking visual and auditive cues, could be enhanced or enriched with haptics is worth considering. It is also worth clarifying if there are other completely new usages or contexts for utilizing haptics, such as having a better support or alternative means for silent communication or mobile use. Furthermore, it goes without saying that haptics is important in 3D activities and virtual environments.

Although it is possible to find potential usages of haptics in social network systems, it is still an open question, whether people are willing to take haptic solutions into use, and what would be the prerequisites for usage. Or, is it even acceptable from the users' point of view to remotely touch others? Or, how would they think of using haptics, for instance, are there specific contexts and situations, or specific purposes of use? Still an additional question is, which kind of problems or possibilities people see in using haptics? Are covering the cuelessness of and adding richness to text-based interaction good enough reasons for using haptics?

Touching others has been relating to physical interaction, which is different from mediated interaction in interaction participants, publicity, and simultaneity. A good question is how people see haptics in that kind of the context, remembering that touching in the physical context is an inseparable part of human interaction. For instance, do people consider touching too intimate, intrusive, or even strange to be used in mediated interaction. One possibility is that people would like to keep touching only as a part of physical interaction.

The questions mentioned above are addressed in this research, which concentrates on clarifying views of users on the role of haptics in the future mediated interaction and social network systems of the Internet. The stereotype system is Facebook or a similar social network system. The clarification covers, how users of the current social network systems view the need for or the interest in haptics, which kinds of use they see as potential usages of haptics, in which contexts haptics could be utilized, and which are important matters to be considered with haptic solutions. Emphasis is given to social and playful interaction, affective

matters, and maintaining personal friendships. The use context is voluntary and free-time based participation.

The content of this thesis consists of two major parts. First, theoretical background is being described, and after that the user study is described. The *theoretical part* covers definitions of concepts, descriptions of characteristics and theories of mediated interaction, descriptions of social network systems, an introduction to haptics and a description of state of the art of research of haptics, an introduction to some related research, and a discussion of future views of mediated interaction. The *user study part* covers discussion of objectives, and descriptions of the implementation of the user study and research material. After that, results are discussed based on the objectives and the theories. Finally, the research process is evaluated, and potential future research topics are proposed.

2 Mediated social interaction

In this section, forms and characteristics of mediated social interaction are described in order to introduce core terms and concepts related to mediated interaction, and give an understanding on the diversity of means of interaction offered by the Internet and telecommunication networks. In addition, reasons for using social interaction systems are discussed in order to get an idea on the affordances mediated interaction offers in comparison to face-to-face interaction. Finally, descriptions of social network systems, Facebook and Google Buzz, provide outlook to the current characteristics and usage of them. Also, the places of Facebook and Google Buzz among different forms of mediated social interactions are briefly discussed.

2.1 Forms of mediated social interaction

Different forms of interaction on the Internet can be classified by *synchronicity*, the degree of *anonymity*, used *media types* or *target audience*. They also vary in the degree of *mutuality*, and how long exchanged information remains *valid*. In terms of synchronicity, interaction may vary from simultaneous (or synchronous) to asynchronous. Asynchronous interaction makes it possible for the user to interact independent of time. It also provides time to think, and a better control over responses and presentation of self. (E.g., Baym 2002; Joinson 2003; Hankonen et al. 2007.) The target audience may vary from public to a restricted set of recipients. The set of recipients may be restricted to a group's members, a contact network of a person, or case by case selected persons for communication. The participants of interaction may be anonymous, for instance, by using alias names, or alternatively, use their real names. (E.g., Baym 2002; Joinson 2003.)

The media type may vary between text, voice, video, and graphics, text being prevalent in the Internet use (e.g. Hankonen et al. 2007). Live picture, a form of video media type, is able to convey non-verbal cues and resembles closely face-to-face interaction, which is considered to be the *richest* form of interaction (e.g., Joinson 2003). In addition to media types mentioned before, there are blogs of data, like pictures or video clips, used for sharing content. Language in text-based communication may resemble written and/or oral forms. Also, for instance, characteristics of interaction, speed needed for responding, and user input capabilities affect language, e.g., leading to short forms of language (Baym 2002).

Östman (2008) defined a new concept, life journal (*elämänjulkaiseminen*), denoting the convention of publishing mundane, life related content in the Internet to public audience. According to Östman, the characteristics of published content (or life journal) are that it is fragmented, covering various themes related to life and self; quite superficial and incomplete; constantly updated in near real time; based on real life occurrences; and targeted to public audience. The life journal may contain several types of media from text to audiovisual. The proportions of media types vary depending of the motives of publication, which stem from *self-assessment*, *narrative performance,* and *playful social interaction*. The self-assessment strives for identity building and maintenance of internal self-image. The narrative performance covers self-presentation to others so that publications reflect how a person wants to be seen by the others. The person is able to control his or her public self-image by deciding which matters to reveal and which to hide, and with which groups or ideologies to identify. The social aspect covers expectations of others as readers, commentators, or co-players. It has playful properties, and targets for amusing, being interesting, and engaging others. (Östman 2008.)

Various forms of mediated interaction can be found from the Internet and telecommunication networks. One possibility is to classify them using the classification based on motives of publication as Östman (2008) did. For instance, according to Östman (2008), playful and social elements are emphasized in Facebook use, picture galleries are well suitable for narrative performance, and text-based diaries are suitable for self-assessment. Another way of classifying them could be to use categories such as *light-weight interaction*, *deep interaction*, or *activity-based interaction* (as done in Table 1). The light-weight interaction covers task-oriented and ordinary use, which appears as short mutual discussions of mundane and context-dependent matters resembling conversations and speaking (cf. the characteristics of life journal by Östman 2008). Examples of typical forms of the light-weight interaction are chat, instant messaging, and short messaging. Since the interaction relates often to a specific situation, exchanged information may not remain valid long after the interaction. The deep interaction may appear deeper from the affective or the content point of view. From the content point of view, it could mean better thought out and longer texts resembling writing. Examples of typical forms of the deep interaction are blog writings, e-mails, and discussion forums, the blog being a relatively creator oriented way of sharing information whereas the others are more interactive. The activity-based interaction would cover spending time, being

engaged in as a hobby, or performing various actions. See Table 1 for a more detailed collection of typical forms and properties of mediated social interaction.

Table 1. *Forms of mediated social interaction.*

Form / Property	Audience	Anonymity	Synchronicity	Directio-nality	Validity
Deep interaction					
blog	public	identifiable	asynchronous	one-way	saved
e-mail	defined	identifiable	asynchronous	mutual	saved
discussion forum	group	anonymous	asynchronous	mutual	saved
Light-weight interaction					
short messaging	defined	identifiable	asynchronous	mutual	expires
chat, instant messaging	defined	identifiable	synchronous	mutual	momentary
FB feed and status upd.	contact network	identifiable	asynchronous	mutual	expires
Activity-based interaction					
virtual environment	group	anonymous	synchronous	mutual	momentary
FB application	contact network	identifiable	asynchronous	mutual	expires

Note that the table does not contain a comprehensive list of forms of interaction. Note also that the purpose is to describe typical properties of different forms for distinguishing them. In reality, the properties are not that clearly fixed but depend on implementation and usage.

Next, affordances of mediated interaction will be discussed, and after that two existing social network systems will be described.

2.2 Reasons for using social interaction systems

From the user study point of view, it is good to understand reasons for the increased use of mediated social interaction, and how use of media affects physical contacts. There are certain affordances in mediated interaction that make it possible for people to interact more. For instance, in some situations social interaction systems may offer a more appropriate context for interaction than the offline one since others with which to interact are not physically nearby. Secondly, it is easier to arrange time for interaction because of the time and place independent nature of mediated interaction. Especially, asynchronous interaction enables integrating interaction timeframes with other tasks since communication is possible in shorter periods and during any idle time. For instance, there is no need to change one's physical

location in order to communicate, and interaction may occur in multiple brief sessions. Even for synchronous interaction, it may be possible to find others online almost any time because of the bigger amount of available relationships, such as relationships to people who are geographically distant. (Wellman & Gulia 1999; McKenna & Green 2002.) There are also a number of other reasons, but since they are not directly related to the usage of social network systems, like Facebook, they are not discussed more.

There have been arguments that mediated interaction would take time from or replace face-to-face meetings. Ellison et al. (2007) noticed that usage of social network systems does not necessarily take time from offline interaction but helps keeping contacts, especially during life changes, after which ordinary offline interaction is no longer possible. Mediated interaction is also used for maintaining and complementing offline relationships, or negotiating time for face-to-face meetings (e.g., Wellman & Gulia 1999). Boase and Wellman (2006) found corresponding results when they collected and compared results of a number of empirical studies of offline and online relationships. Their conclusion was that Internet use does not take time from other social activities but fosters offline contacts with friends as well as enhances neighbourhood relationships. The time may rather be off from consumption of traditional media, such as TV, especially, when the Internet is used for social purposes and not, for instance, for entertainment. (Boase & Wellman 2006.)

2.3 Social network systems

In the context of this thesis, *social network systems* are considered as means for mediated social interaction in the Internet that support people's social activities with friends and acquaintances. The social activities may include personal network creation, interpersonal interaction, and sharing personal details or events of everyday life, among other things.

Facebook and Google Buzz are described as examples of social network systems. Facebook was selected since it is one of the most used social network systems at the moment (The Nielsen Company 2010), and it contains a versatile set of typical features and forms of mediated social interaction. Facebook is also the prototype system regarding the user study. Criteria for selecting Google Buzz were that it is a new approach in which deficiencies of concurrent systems (evaluated by Google) have been addressed, and it can be said to have been built on a different basis than Facebook, namely messaging (especially, e-mail). Google

Buzz is not used in the user study as such, but it provides outlook for likely areas of development of social network systems in the near future, which will be considered as input to and in evaluating results of the user study.

Facebook (FB) is rich in features and functions, and it has support, for instance, for self-presentation, contact network building, short discussions and commenting, media sharing, and various small applications. For being active, it is enough to do rapid status updates and commenting. Alternatively, a person may spend more time with different applications and conversations with others. Facebook can be accessed using mobile phones or computers. Some of the users may access Facebook even several times a day (The Nielsen Company 2010).

The sharing and interaction mostly occur within a contact network of one's acquaintances. The audience is more or less known by the user. The personal network usually contains friends that have been originally met offline. In addition to his or her own contacts, the user is also, at least to some extent, connected to networks of his or her contacts. (Beer & Burrows 2007.) Ellison et al. (2007) found, in their research of Facebook use of students, that Facebook was used to maintain both the old contacts (e.g., the former school friends) and the contemporary offline relationships. They also found that Facebook was especially suitable for the maintenance and the formation of weak ties, which broaden the availability of different resources offered by one's contacts. With regard to creating and maintaining strong relationships, Facebook was important as well. (Ellison et al. 2007.)

The basic structure of Facebook consists of a *user profile*, which serves as a node of a wider contact network, where all user-related information is linked or actions are taken. The node includes a user-specific *wall*, in which the user is able to publish (or post) his or her own status information or news. Alternatively, the contacts of the user are able to write entries to the wall. The wall serves as a platform for conversations enabling the others to comment or take part in a started conversation. The news feed specific wall, on the other hand, shows a collection of postings and activities taken by the contacts of the user. In addition to dynamically updated information, the user profile contains more static information, such as a collection of information about demographics, hobbies, preferences, and profile photos. Facebook also provides a place for sharing photos.

The small, embedded *applications* include, among other things, different informal tests (e.g., testing personality traits or intelligence), possibility for digital gift exchange, likeness comparisons, or games. The poke feature enables users to nudge, or contact and interact with the others using the corresponding actions. The mode of operation and the meaning of a poke are left for the users to define (Wikipedia contributors, Facebook Features).

The *group* feature makes it possible for the user to join in a group to support or promote an ideology, or even create a group based on a shared interest. For more private interaction within a restricted set of contacts, Facebook offers a simple *e-mail* type of application or possibility to synchronous *chat* discussion. Facebook also provides real-time *presence information*, which indicates whether the contacts of the user are online or offline in order to make synchronous contact attempts more likely to succeed and providing the feeling of presence of the others. (*See Using Facebook and Wikipedia contributors, Facebook for more information about the Facebook platform*.)

When comparing the forms of mediated interaction in Table 1 with Facebook interaction, it appears that Facebook mainly provides means (or at least is used) for, but is not limited to, the light-weight interaction and the asynchronous type of activities. Also, the group feature and the e-mail in Facebook may provide relatively similar means of interaction as the discussion forums and the e-mail in Table 1. According to the classification of Östman (2008), Facebook is mostly related to the playful social interaction, but has also characteristics of the narrative performance. Some of the Facebook functions, like personality tests, likeness comparisons, and the possibility to get feedback from acquaintances to any postings and actions, also provide means for the self-assessment.

Google Buzz is one of the most recently launched social network systems. Within developing Google Buzz, Google has tried to address deficiencies of concurrent social network systems by providing an easy way of defining the publicity level, namely the set of recipients of a buzz, and a mechanism of filtering messages based on their importance. They also enabled embedding and fast use of multiple media components as well as use of integrated contact information and inbox of messages (or buzzes) with other applications, like Gmail. Google also paid attention to mobile use by providing a specific user interface to mobile phones and integrating map or location information with Google Buzz. (Wikipedia contributors, Google Buzz.) In comparison to Facebook, Google Buzz seems to offer rather a platform for

messaging and conversations than a platform for various activities and applications or a window for everyday life episodes. Also, the network of contacts is not equally well visible.

When comparing the forms of mediated interaction in Table 1 with Google Buzz, it appears that Google Buzz mainly provides means for, but is not limited to, the deep interaction and the light-weight interaction.

This section provided an introduction to characteristics, forms, and systems of mediated social interaction. Next, the concept of haptics and its utilization as a part of mediated social interaction will be discussed.

3 Research of haptics and mediated interaction

The concept of haptics and mediated haptic interaction are explained in this section together with a discussion on the state of the art of mediated haptic research. Many research efforts related to mediated haptic interaction have included prototypes, some of which are briefly described in this section. Since one of the roles of haptics in mediated social interaction could be to provide means for more affective interaction, research results on the relation of touch and emotions are also introduced. Additionally, it is discussed how haptics could be utilized as a part of multimodal forms of mediated social interaction. Furthermore, certain theories of mediated interaction are briefly described, and the role of haptics in mediated social interaction is discussed based on the theories.

3.1 Haptics and emotions in unmediated interaction

Haptics denotes the sense of touch, through which a human can detect pressure, vibration, position, movements, temperature, and pain stimuli. The concept of haptics includes both the *cutaneous* and *kinesthetic* systems. The skin's receptors and nerve endings of the cutaneous system can be stimulated by mechanical, electrical, vibrotactile, and temperature actuators. The kinesthetic system relates to movements and limb positions. With haptics, humans are able to actively explore and manipulate objects of the environment or touch other people. For instance, humans are able to feel shapes, firmness, and surface material of objects, or perform actions. (Srinivasan & Basdogan 1997; Haans & IJsselsteijn 2006.)

With **touch**, a human expresses his own state of mind, his feelings towards another, and feelings about a relationship. It is used to establish contact and intimacy. With touch, the relationship or the touched party can be influenced, i.e., aroused, calmed, or compliance for a request can be increased (Patterson 1986). Touch is also very subjective and defines "the physical, social and emotional boundaries of our identity" (Thayer 1986, 8). For that reason, touch may evoke unpleasant emotions, and it may be felt as intrusion to the personal space.

Touch is important in human interpersonal interaction. When touch is used as a part of interaction, it usually has a mutually known meaning. It is a part of the symbol system of communication. The meaning of a specific touch cannot be necessarily derived from the touch

itself but contextual information, like spoken statements or situational cues, are needed for giving additional information for the interpretation. Touching someone induces the recipient to respond with feedback. (Jones & Yarborough 1985.)

Jones and Yarborough (1985) studied meanings of touches in mundane interaction. They grouped individual touches to seven groups: *positive affect touches*, *playful touches*, *control touches*, *ritualistic touches*, *hybrid touches*, *task-related touches,* and *accidental touches,* each group subdivided into different categories. The positive affect touches are associated to communicating positive emotions in order to support, express gratitude, or signal togetherness. The control touches relate to attention-getting or directing the other's behaviour. The ritualistic touches consist of greetings or touches related to departure. The task-related touches are used, for instance, for accomplishing a task whereas the accidental touches occur unintentionally and are meaningless. (Jones & Yarborough 1985.)

Interpersonal touches in physical contexts are limited to interaction between two persons nearby. However, in a mediated context, touch can be shared among multiple persons. The mediated context enables *transformed* haptic communication. (Bailenson et al. 2007.) In addition to interpersonal interaction, the sense of touch is essential for perceiving and interacting with the environment, and performing mundane tasks such as handling of objects effortlessly (Robles 2006).

Emotions are an essential part of rational human performance like thinking and decision-making. Emotional experience is an internal affective state, which is not revealed to others automatically, but may be detected by physiological measures. What is revealed is emotional expression, which may be recognized by others, for instance, from facial expressions or voice inflection. In addition to one's own emotional reactions, it is possible to stimulate feelings of others. Researchers have classified emotions in different ways: either to discrete categories or defined them with continuous dimensions. (Picard 1995.)

Hertenstein et al. (2009) studied the relation of touch to expressing and identifying emotions. Participants of their study were allowed to use the whole body of a person for expressing emotions by touching. In the experiment, they used all the combinations of dyads of both the genders, being strangers to each other. They managed to discover eight distinct emotions such as anger, fear, happiness, sadness, disgust, love, gratitude, and sympathy related to specific tactile behaviour. They also found that there were no differences between males and females

in interpreting emotions whereas there may be differences in expressing them. (Hertenstein et al. 2009.)

3.2 Mediated haptics

While the previous subsection concentrated on the concepts of haptics and emotions in general and from the physical interaction perspective, this subsection concentrates on introducing corresponding research in the mediated context, and concepts or matters related to the mediated haptic interaction system.

Social touch and emotions in mediated haptic interaction

Haans and IJsselsteijn (2006) defined the concept of *mediated social touch* to denote humans remotely touching each other using haptic feedback mechanisms. (See Jones and Yarborough (1985) for different types of touches.) Social touch enables, among other things, personal and intimate communication. In research, it has been an open question whether mediated social touch corresponds to unmediated one. Haans et al. (2007) found partial support for the correspondence, but more research is needed.

Bailenson et al. (2007) studied if emotions can be expressed and recognized through mediated social touch. Their study indicated that even extremely degraded cues, produced by a simple device of two degrees of freedom, were enough for conveying emotions. Salminen et al. (2008) also studied emotional responses to haptic stimulation and found that "even simple haptic stimulation can carry emotional information" (p. 1555). They also acknowledged that there is not yet enough research available for mapping haptic stimuli to the corresponding distinct emotions.

Although touch is an important part of social interaction, using it in mediated interaction may create an *uncanny effect*. The uncanny effect occurs when an object is simultaneously both familiar and foreign resulting in uncomfortable and strange feelings. The uncanny valley hypothesis of Mori (1970) is related to human perception and emotional responses to human-like robots. When the human likeness is high, but not exact, a person has negative feelings towards the object. (Mori 1970.) Similarly, mediated social touch as a likeness of physical touch may easily be sensed as artificial and uncanny because of potentially imprecise devices, imperfect realization, or the lack of pervasive actuators. Reiner (2004) offers an additional

theoretical perspective to this by thinking about the co-operation of cognitive, sensory and motor systems of humans. She proposes that the correct meaning of haptic sensation is not achieved if haptic stimuli do not match with the past haptic experiences stored in sensory memories. For this reason, the environment or the touch may feel alien. Reiner also reminds that haptic stimuli do not need to be ”perfect”, in the sense that the cognitive system of humans is probably able to compensate incomplete perceptions, provided that minimal key cues are received with the haptic stimuli.

A challenge with mediated haptic interaction might be that people are not used to the conscious and cognitive use of haptics, which may be required if haptics are added as a part of mediated interaction. Although interpersonal touching is often cognitively controlled by adults (Thayer 1986), is intentionally used for achieving goals and influencing others (Patterson et al. 1986), and has a meaning (Jones & Yarborough 1985), people may use touch automatically (e.g., Prytherch & Jerrard 2003) without being able to mimic its use in mediated interaction. Usage may be difficult especially in cases in which people need to be able to transfer unmediated use to mediated use of different realisation. This is not an issue with media types like live picture or audio since the mediated and unmediated uses are relatively similar.

Next, components of mediated haptic interaction system are described in addition to giving an overview of available devices for haptic interaction.

Mediated haptic interaction system

Mediated haptic interaction involves humans to explore or act with the environment provided by computer software, and interpret sensory information received via haptic interfaces. It also involves devices capable of generating and displaying that sensory information (stimuli), namely haptic feedback, via their haptic actuators to humans. (E.g., Srinivasan & Basdogan 1997.) *Haptic feedback* consists of either interaction with haptic properties of tangible and physical objects (cf. Ullmer & Ishii 2000) or active generation of haptic stimuli by haptic devices. The former type of interaction is called *tangible interaction* whereas the latter *haptic interaction*. (Note that this research concentrates on the haptic interaction.)

Interpersonal mediated haptic interaction can be realized by devices and systems capable of producing haptic stimuli, which can be sensed as single taps, different vibrations, or thermal changes (Raisamo et al. 2009). Devices and systems may have been specifically designed for

certain purposes, but there are also commonly applicable devices, which can be used with various applications. One such common purpose haptic display for computers is the ground-based Phantom device, which can produce force feedback in 3D space and enables operation in at least three degrees of freedom (Massie & Salisbury 1994). There are also touch screens that can produce good quality force feedback (Raisamo et al. 2009). The haptic interface may also be body-based, which means using haptic displays as wearable.

One of the drawbacks related to the deployment of haptics for the purposes of mediated interaction has been the lack of proper usable and affordable actuators and the lack of possibility for several participants using different devices and systems to attend the same interaction (e.g., Raisamo et al. 2009). In order to gain a sufficient user base, the haptic solution should be general enough to be suitable for multiple purposes, in other words, it should be device and system independent. Raisamo et al. (2009) foresee that rather than desktop solutions, mobile devices equipped with more advanced haptic actuators will bring haptics in mundane use. An example of such a realization is Luk's et al. (2006) mobile device prototype based on the piezoelectric technology. In addition to vibrotactile stimulation, the technology enables perception of small shapes and textures (e.g., Luk et al. 2006).

Mediated social touch in Facebook use is discussed in the following by considering differences of mediated and unmediated social interaction and the state of research and technology.

Mediated social touch in Facebook use

Intimacy, privacy, simultaneity, and mutual interpersonal interaction are related to physical social touch. These may become issues because of the relatively public nature of Facebook interaction. Although the interaction may occur between people who usually know each other beforehand, strengths of relationships vary. Additionally, the context of multiple recipients and the asynchronous type of communication differs from in-person interaction. On the other hand, since online and offline meetings complement and alternate with each other in people's mundane lives, it could be assumed that having a possibility for as similar means for interaction as possible would be beneficial. However, when considering the state of research and technology of haptics, in general, it could be assumed that at least the first haptic solutions may not be suitable for the most advanced forms of mediated social touch. More detailed discussion about the potential role of haptics in Facebook interaction follows in the subsequent subsections and sections.

3.3 Haptic prototypes

In this subsection, different prototypes that might give ideas on potential usages of haptics in mediated social interaction and social network systems are briefly introduced. Some of the prototypes are examples of haptic-only interaction while some include also other modalities in addition to haptics. Most of the prototypes involve dedicated physical devices. In general, some researchers (e.g., Haans & IJsselsteijn 2006) have criticized these research efforts because they are based on assumptions of haptic effects or the metaphor of mediated social touch rather than basic research of mediated haptics. It has also been noticed that they do not provide systematic basis for utilizing the results in other settings (Raisamo et al. 2009). Anyway, they provide views of researchers on potential usages of haptics and (at least) targeted user experiences. The prototypes are referred to later with discussions of usages of haptics, for instance, within scenarios created for the user study.

inTouch (Brave & Dahley 1997), **HandJive** (Fogg et al. 1998), **White Stone** (Tollmar et al. 2000), and **Shaker** (Strong & Gaver 1996) are prototypes for haptic-only silent communication in which users interact simultaneously and are able to feel actions of each other in real time. The interaction occurs using specific devices designed for the prototypes. While all the prototypes are aimed at providing the sense of social presence, inTouch and HandJive are designed for more active and playful interaction whereas the two latter systems are meant for providing a feeling of connectedness.

The **HandJive** prototype is targeted especially for people in isolated and silence demanding contexts like at school or in meetings. The handheld device, designed for the prototype, provides asymmetric interaction for users by enabling manipulation of (discreet) positions of two balls connected to a centre part. The users are able to sense manipulations of each other as orthogonal movements. In the user tests, Fogg et al. (1998) discovered that simple matters may be “fun” in isolated and silence-demanding contexts, and even simple devices are capable of providing complex interactions. They also found out that haptic skills were fast to learn and users considered haptic interaction compelling. They also believed that people would invent their own ways of using the device. (Fogg et al. 1998.)

ComTouch (Chang et al. 2002) and **Contact IM** (Oakley & O’Modhrain 2002) are examples of multimodal prototypes using haptic feedback as a part of synchronous and asynchronous

communication, respectively. Capabilities of ComTouch are integrated to a mobile phone to be used as an additional modality to voice communication. Contact IM is based on the idea of throwing a visually and haptically perceivable virtual ball to the other party. (Chang et al. 2002; Oakley & O'Modhrain 2002.)

There are also different systems and solutions developed around the **haptic icons** concept. A haptic icon (or *hapticon*) is a haptic correspondence to the visually perceived emoticon, which denotes a graphical or string representation of an object or a notion. The icon design can be based on either a direct intuitive association to the meaning or so that the meaning must be learned (Enriquez & MacLean 2003). Rovers and van Essen (2004) developed a framework for Haptic Instant Messaging (HIM) in order to supplement text-based messages with the hapticons aimed at providing more emotional and intimate content, or strengthening expression. The hapticons can be added by special devices or using the text-based symbols of the emoticons, which will be displayed by means of haptics. The HIM framework supports different devices such as joysticks, mice, touch pads, or other devices supporting haptics. Although mechanisms for using the hapticons are available, the correspondence between the emoticons and the hapticons is still unexplored. Additionally, it is not clear, what should trigger displaying the hapticon(s), for instance, a user's action to read the message or an explicit activation. (Rovers & Essen 2004.)

Luk et al. (2006) conducted an experiment of capabilities of humans to discriminate haptic patterns (or haptic icons) varying by different properties of haptic stimuli. They used the haptic actuator of their own design based on the piezoelectric technology. Luk et al. managed to discover salient parameters of haptic stimuli to be varied in order to produce various distinguishable haptic patterns. (Luk et al. 2006.)

A prototype related to ritualistic touches (cf. Jones & Yarborough 1985) is **Tele-Handshake**, which enables people to shake hands and feel simultaneously each other in a virtual environment using the Phantom device. The haptic sensation is carried over the Internet in the prototype. (Alhalabi & Horiguchi 2001.)

3.4 Multimodal interaction

Multimodality makes human interaction natural and rich. Multimodal interaction involves possibility for multiple input and/or output modalities from which the haptic modality may be

one, which can used as a complementary or an alternative modality. The benefits of multimodality include enhanced perception (cf. Srinivasan & Basdogan 1997, 401) and understanding of received information (cf. Jones & Yarborough 1985), and context aware or selective use of modalities. (Raisamo et al. 2009.) A further benefit of multimodality is the possibility to overcome limitations of human perceptual capabilities by sharing load to multiple modalities. Haptics is especially suitable for controlling perceptual load in that its use normally requires less attention and it operates relatively automatically (Prytherch & Jerrard 2003). For that reason, haptics could be utilized as an unobtrusive background channel used in parallel with the main communication channel (e.g., Nardi et al. 2000; Luk 2006). Multimodality also enables, for instance, mapping haptic input to visually detectable stimuli, like colours (Bailenson et al. 2007).

Multimodal interaction has not yet gained success in mediated social interaction (e.g., Herring 2004; Raisamo et al. 2009). Raisamo et al. (2009) believe that interest in multimodal systems will increase when more expressive haptic feedback will be available in mobile devices. Also, perception and operation in virtual environments will be significantly improved if haptics is provided as a complementary modality (Reiner 2004). Potential text-based and vision-based forms of interactions are collected in Table 2 as a basis for a discussion on the role of haptics as a part of multimodal interaction. These forms are addressed one by one in the following.

Table 2. *A collection of text-based and vision-based forms of mediated interaction.*

Synchronicity/ Medium	**Text**	**2D vision**	**3D vision**
Synchronous	chat; instant message	live picture	3D virtual or augmented environment
Asynchronous	text message	still picture; video clip	3D objects

The role of haptics in **synchronous text-based interaction**, like chat and instant messaging (e.g., the Facebook chat), could be to provide a background channel for controlling and structuring interaction, or providing other non-verbal cues. In addition, invitation to a chat session or turn taking during an interaction could be realized by haptic means, for instance, by throwing a haptic ball to another person like in the Contact IM system by Oakley and

O'Modhrain (2002). Haptics could also be used for creating an indication that the other person is writing a chat entry, thus avoiding simultaneous writing. In multiparty interaction, a participant could ask for the floor using haptics. Haptics could also contribute to the sense of social presence (which is discussed later more) or be used to get the attention of others. A reason for using haptics would be to release limited perceptual resources from the already overloaded visual channel.

The role of haptics in **asynchronous text-based interaction**, like the status-related or group conversations of Facebook, could be to provide either a complementary or an alternative modality in forms of simple haptic-only messages or haptic icons included in text. Haptics could provide means for expressing oneself in a more creative way and possibly, at least in some contexts, more efficiently, quickly, and naturally than with text. Haptics could also contribute to making interaction more interesting, spontaneous-like, playful, or supportive.

When considering benefits haptics could bring to interaction mediated by **2D vision**, interaction mediated by the webcam might be complemented with some of the ways described in connection to the synchronous text-based interaction above. However, in general, the benefits of haptics could be assumed to be lesser with already "rich" live picture. On the other hand, support of haptics in 3D contexts would be highly beneficial.

In **3D** virtual environments (such as a potential 3D wall or group space in Facebook), haptics would serve as a complementary modality to vision by providing means to sense the environment and possibly the presence of others. It would also help performing operations and actions in the environments. In 3D augmented environments, augmented objects could include haptic properties in addition to other media, like vision. The asynchronous type of 3D visual objects, which could correspond to potential 3D gifts or any shaped objects of Facebook, could also have perceptible haptic properties like firmness, shape, and surface material.

So far, this section has been concentrating on research of haptics and haptics as a part of mediated multimodal interaction. Next, research of mediated interaction of the Internet will be discussed.

3.5 Mediated interaction in the Internet

There are various theories developed for explaining behaviour of humans in mediated social interaction of the Internet. The basic assumption of computer mediated communication (CMC) is that characteristics of media, for instance, a low bandwidth for conveying information or limited availability of modalities, affect interaction. Many of the early theories have explained consequences of behaviour by missing modalities or anonymous participation. It has been thought that physical interaction, having basically all the modalities and unlimited information available, is the richest possible form of communication in which vision and audio are the most common modalities.

Interpersonal interaction involves both *non-verbal* and *verbal* parts. The verbal part is conscious and cognitive in nature involving a certain directly stated meaning on what is being communicated using a language. The non-verbal part can be said to complement the verbally conveyed message. It covers, among other things, facial expressions, gestures, physical proximity, appearance, tone, and spontaneous reactions, which means that it has an important role in mutual understanding of messages being conveyed and in structuring the dialog. (E.g., Haans & IJsselsteijn 2006.)

The **cues-filtered-out** approaches of CMC are based on the assumption that mediated interaction lacks, depending on the medium, non-verbal cues, for instance, visual and audio cues, instant reactions, and physical presence, leading to impersonal, more superficial, and task-oriented communication, among other things. On the other hand, it has been noticed in later research that the richer the medium the more emphasis is given on physical attributes, like appearance and environment, which in turn may distract other aspects of interaction. (Baym 2002; Joinson 2003; Hankonen et al. 2007.)

Making mediated interaction richer would mean (according to the media richness related CMC theories) that additional modalities, for instance, live picture mediated by the webcam, would be taken into use. Although devices and systems of the Internet are capable for enabling use of richer modalities, they are still underutilized in social network systems. This might imply that people are not willing to take richer media into use, or there have still been technical or usability reasons to avoid using. Alternatively, people might prefer asynchrony or silent media. There may also be other reasons for using less synchronous media, like using the

best way of reaching the other party, or keeping interruptions and the amount of contact attempts in control.

The **social information processing theory (SIP)** is, on the other hand, based on the assumption that participants of mediated communication adapt their interaction according to the characteristics of the medium. For instance, when non-verbal cues are missing, people adapt verbal communication for complementing the missing cues and achieving goals of communication. (Walther et al. 2005.)

There are certain solutions applicable for overcoming the issues related to the missing non-verbal and contextual cues in asynchronous text-based interaction, namely the smileys or the emoticons. They are often embedded in messages for indicating emotions and intentions related to the message. In addition to the emoticons, missing cues are compensated by linguistic and typographic means, for instance, by using a more descriptive language or varying the style of language. (E.g., Hankonen et al. 2007.) For instance, the results of the content analysis of text-based mediated interaction of a professional group showed that the portion of socio-emotional content was about 30 percent despite the fact that members of the group did not know each others otherwise (Rice & Love 1987).

The view of the **rational actor approach** is based on choices of people rather than technological determinism. For instance, the used medium is selected based on the message being conveyed and the goals of communication. It may even be rational to select a less social and personal medium, or to select a medium, the benefits of which are bigger than its drawbacks, namely to select a medium, the capabilities of which to fulfil the communication goals surpass the potential negative (social) effects. Furthermore, it seems that people tend to avoid using an inappropriate medium for communication needs. It is also up to the user to decide how to use the medium. For instance, when purposely selecting a medium having negative social effects, the user can take actions to minimize the effects. (Markus 1994; Baym 2002; Joinson 2003, 51-52; Hankonen et al. 2007.)

In general, technology defines limits and possibilities for mediated interaction, but as Markus (1994, 146) states “however advanced our communication technologies may become … their effects will always depend, at least in part, on how people understand these technologies and choose to use them”.

What would be the role of haptics in light of the above described theories and discussion? Haptics could provide an additional modality for interaction bringing it, at least in theory, one step closer to the (rich) physical interaction – still keeping in mind that many of the matters associated with missing non-verbal cues are not significantly related to haptics but are rather either visually or auditorily sensed. On the other hand, haptics might be used in a transformed way for compensating the missing cues. One more matter to notice is that it may be shortsighted to target *only* to similar interaction as what face-to-face interaction provides since there are different needs and goals (cf. the rational actor approach). In addition to providing the additional modality, haptics could provide an alternative channel for communication (cf. the rational actor approach), expressing oneself (cf. the SIP), or providing different kinds of presence information (which will be discussed more next).

Presence and awareness systems are mentioned by several researchers (e.g., IJsselsteijn et al. (2003); Reiner 2004; Haans & IJsselsteijn 2006; Luk et al. 2006; Harboe et al. 2008; Nardi et al. 2000) in relation to haptics, sociability, or mediated communication. Since Facebook has also the presence feature, it is worth discussing.

On one hand, the concept of presence is considered to be a spatial matter, denoting a sense of being in a mediated environment (rather than the physical one), or being able to naturally interact in that environment (e.g., Biocca et al. 2003; Reiner 2004). On the other hand, presence is considered as "a sense of being with another in the virtual environment" (Biocca et al. 2003, 460). The former presence concept is called *spatial* (or *physical) presence* whereas the latter is called *social presence*. (Biocca et al. 2003.)

It is thought that the sense of social presence is high in interpersonal interaction of the physical context. In mediated contexts, the sense of social presence can be achieved, for instance, by having a mental representation of others (denoting psychological involvement) or a feeling of being with others (e.g., experiencing co-location and awareness of others). Perception of social presence may be enhanced, for instance, by linguistic means by varying the style of writing in text-based communication. (Biocca 2003; Hankonen et al. 2007.)

Awareness systems provide unobtrusive means for the users to stay in touch and gain a feeling of connectedness without explicit communication needs. There are both affective and practical benefits of awareness systems, such as a person may discover when another person is available for communication, or have a feeling of company or relationships. (IJsselsteijan et

al. 2003.) For instance, Harboe et al. (2008) discovered in their studies related to social mobile TV that when a person was able to see that there are others online, it enhanced the feeling of social presence and awareness of others, and inspired to contact.

One of the application concepts, designed by Luk et al. (2006) in their studies on haptics, was based on the idea of using haptic patterns for indicating presence information as background information. A matter to consider with the device implementation is that the haptic solution of Luk et al. (2006) required actions from the user to have skin contact, which might be unavailable whenever (presence or other) notifications arrive.

In addition to using haptics for providing awareness and connectedness information, other (symbolic) communication independent usages of haptics could be to use haptics in chat for enhancing the sense of social presence. For instance, haptic patterns used in the background could create an impression that the other party is still present in the chat session or could be used to give more immediate feedback to the other party before being able to reply with text. In virtual environments, haptics could be used for enhancing feelings of both spatial and social presence.

4 Related research

Since this research is proposing a new modality, previously relatively unused in mediated social interaction, to be adopted ordinary use, it is relevant to address behaviour of people in the face of technology paradigm shifts and the question of acceptance of new technology. Furthermore, the subject of adopting haptics in mediated social interaction relates to bringing technology to use that is currently related mainly to the physical context. It is not only a matter of technology deployment but it may affect the prevalent behaviour with unforeseen consequences, which is briefly discussed as well. In addition, new ways of communication afforded by new technological solutions, namely instant messaging, are introduced.

4.1 Processes related to technology paradigm shifts

The adaptation process related to technology paradigms is described in order to get an understanding about the phases and timeframe needed before a new technology achieves mass use. It also explains, why people behave in a certain way in face of technology paradigm shifts, and helps understanding which kind of participants should be searched for the user study. Moreover, it describes how products of high technology are brought to the market.

The *technology adoption life cycle model* depicts how different sets of people respond to technology paradigm shifts, which require them to change their present behaviour. The model divides people into the following categories based on their adaptation style and speed: innovators, early adopters, early majority, late majority, and laggards (aka sceptics). There are also different phases that each new product undergoes during the adoption life cycle.

The *innovators* (aka technology enthusiasts) and *early adopters* (aka visionaries) are the first users of new products. They have influence on the future success of the product. Although these early users have accepted and adopted the product, the majority may still hesitate. The *majority* categories constitute two-thirds (2/3) of the population. They require proofs of usefulness and effectiveness of the product and wait for to be sure that the product is mature, comprehensive, and reliable enough before acquiring it into use. The early majority starts acquiring the product at the same time. After that, the users could be kept satisfied with the product by accommodating it according to preferences of the users. However, the market starts to be ready for offering a new product, although there is no need from the users' side for

the new paradigm shift. The bigger the paradigm shift shock is the slower the phases go forward while the bigger the improvements are the faster technology adoption is. The *late majority* consists of conservatives, which take the product into use as late as possible (under duress). (Moore 2005, 13-130, 136.)

Basically, there is no need for including haptics in mediated social interaction since people are used to interact with the currently available relatively simple mechanisms (e.g., Herring 2004). When taking into account the process and user behaviour related to technology paradigm shifts, which assumingly occur when use of the Internet is enhanced with haptics, people may not be ready for bigger changes at the moment. Especially, when keeping in mind that a critical mass of users is needed for making a social network system operational (e.g., Preece 2000). Thus, the added value perceived by users should be high and deployment as effortless as possible. In any case, it can be anticipated that it takes time for more advanced haptic solutions to achieve mass use.

4.2 Technology acceptance theories

Several models have been defined for information technology acceptance. The models define determinants and moderators for intention to use and usage. Venkatesh et al. (2003) collected the (eight) models together, compared them and developed a unified model, *unified theory of acceptance and use of technology (UTAUT*), covering the existing models. They ended up with four *direct* determinants of acceptance and usage: *performance expectancy*, *effort expectancy*, *social influence,* and *facilitating conditions*. The moderators were gender, age, experience, and voluntariness.

The effort expectancy denotes the degree of ease of use or needed effort for starting to use a system, for instance, whether the system is easy to learn, perceived to be easy to use, or use of the system does not take too much time. The effect of the effort expectancy is stronger in case of females, older ages, and with limited experience. According to the UTAUT definitions, the other determinants than the effort expectancy should not be very significant in voluntary and non-task related (Facebook) use. (Venkatesh et al. 2003.)

On the other hand, the facilitating conditions, such as the existence of technical facilities, might be relevant because of new actuators needed for haptics. Also, the social influence

determinant might (at least indirectly) effect since use of haptics in Facebook requires that also others start using it. The performance expectancy might relate to a person's belief of finding haptics useful and a more efficient way of interacting. The effect of the performance expectancy should be stronger in case of males and young ages. Still another determinant, which might effect, but which was not considered as a *direct* determinant in the UTAUT, is the *attitude toward using technology*. It relates to feelings and attitude toward use, such as whether the system is pleasant and enjoyable to use, liked or not, or good or bad idea.

Bruner and Kumar (2005) studied the effect of the *hedonic determinant* (i.e., enjoyment and fun) and the attitude toward using technology on consumer acceptance of handheld Internet devices. They found out that in consumer contexts the hedonic determinant affected the attitude of using devices more than the usefulness determinant. They also found that the determinants affected the attitude which had effect on the intention of use. The research also revealed that making a device easy to use is an important way of improving the hedonic aspect of device use. (Bruner & Kumar 2005.) Liao and Tsou (2009) studied the perceived playfulness determinant in SkypeOut use and found that the attitude towards using technology was more influenced by the perceived playfulness than the usefulness or ease of use determinants.

Lazy user theory of solution selection, developed by Tetard and Collan (2009), is based on the principle that the intersection of needs and state of the user define a set of alternative solutions from which the user selects the one that demands the least effort. The effort is estimated by the user, and it may cover matters such as needed time, money, or mental or physical work. Correspondingly, when a person is making a decision whether to switch to using an alternative solution, there are costs, like costs of investments, learning time, change resistance, and critical mass needed for using the solution. This means that the new solution should bring significant benefits in comparison to the replaced one. There are ways of reducing the switching costs such as paying attention to transferability of knowledge, ease of learning, and ease of memorizing the use of the new solution. (Tetard and Collan 2009.)

When applying the lazy user theory to use of haptics, minimizing costs related to taking a new haptic solution into use and using the solution should help in adoption. For instance, if the costs of investments, such as costs related to devices and learning, could be thought to be divided to various purposes of use, the benefits of taking a haptic solution into use in one system would not have to be so big in order to cover the costs. This would mean that the

efforts spent for potential device investments, learning, or developing principles of use were commonly applicable to various usages, also to other than Facebook use.

So far, processes, models, and challenges related to acceptance and adoption of new technology have been introduced and discussed. Next, new kind of behaviour facilitated and inspired by instant messaging will be described.

4.3 Consequences of new technology

In addition to problems related to adoption, use, or acceptance of changes in the face of new technology, people may fear losing privacy, freedom, or control if technology will gain a more important role in our lives, which might be the case with pervasive computing systems. For instance, sensor systems make it possible for technological solutions to reveal matters a person wants to keep private, or they may even make wrong interpretations. There are also risks that a technological solution will be misused or used against the person's will. (Manuel 2003.) Similar concerns were brought out with the smart home concept, such as the ability to maintain control by humans as well as uncertainty on automatic interpretations and actions taken by technology. Also, capabilities to configure or bypass technology were needed (Edwards & Grinter 2001).

Experiences gained from research on smart homes might give more concrete ideas about which kind of acceptance, adoption, and deployment related challenges may arise when routines or physical behaviour will be changed or augmented by means of advanced technology. A matter to consider is how well people are able to understand the functionality of new technology since familiar kinds of physical affordances may no longer be available (Edwards & Grinter 2001). This relates to mediated haptics in that haptics as physical interaction provides much better physical and visual affordances (or cues) of the touched party than, for instance, asynchronous text-based interaction. The originator of a mediated haptic message is neither able to see the context and state of the touched party nor reactions of the other.

Another matter is that new technology typically causes unpredictable social consequences, changes to routines, or creates new kinds of behaviour. During the process when new technology is being accommodated to ordinary use, its original purpose of use changes as well. (Edwards & Grinter 2001.) Accordingly, it can be anticipated that usage develops when

mediated interaction is enhanced with haptics, and people start using it. Note that this was also suspected by the developers of the HandJive prototype (Fogg et al. 1998). Because interaction using social network systems differs from physical interaction, it still increases the need for accommodating use and calls for new ways of using. Another question is, which kind of consequences the adopted use of mediated haptics would have to physical interaction, for instance, whether it decreases the amount of physical interaction, changes the way of using touch in interpersonal interaction, or creates new ways or contexts for touching.

Based on Leppänen's (2001) experiences, people take two-fold attitude to technological solutions of the smart home concept. They are both enthusiastic and have fearful feelings for new technology. They acknowledge that technology develops, and originally even strange inventions may become ordinary. They are also ready to adopt new technology that brings clear benefits. People acknowledge that there are both benefits and drawbacks related to technology, for instance, keeping home as a private place and having connections outside. It also became apparent that people see face-to-face meetings very important, but did not necessarily anticipate losing them because of technology. They also preferred to have more time for family and friends in which (they thought that) technology might help. People also wanted to control their lives, which means disallowing technology either to define their actions or perform supervision to the detriment of privacy. (Leppänen 2001.)

4.4 New ways of communication

Interpersonal communication is not only information exchange but also consists of different actions like interaction initiation, selection of media and the form of interaction, reaching the interaction partner, and negotiation of interaction time. Nardi et al. (2000) conducted a study of informal communication behaviour at a workplace in which instant messaging was used for the communication. They managed to discover new ways of communication facilitated by affordances of instant messaging. They found that instant messaging was an immediate, quick, and easy way of exchanging brief messages any time with co-workers and friends without causing inconvenient interruptions to the other party. Connections to the others were active during a day for intermittent messaging. They were also aware of presence of each others, which created a feeling of connection and closeness with the other persons without a need for exchanging any information. Presence information (cf. Poikselkä et al. 2004, 375-

382), associated to contacts of buddy lists, was also used to find out when a person might be available for communication. (Nardi et al. 2000.)

Nardi et al. (2000) noticed that instant messages were exchanged in parallel with other activities or interactions. They were used for reaching other persons or negotiating suitable meeting times. It was acceptable for the recipient to delay responding and keep the received messages as a reminder. Nardi et al. also noticed that participants were doing media switching during a communication, namely using the best set of media for the given purpose and the context. (Nardi et al. 2000.)

It seems that the way of using instant messaging (like in the study of Nardi et al. 2000) might cover potential application areas for haptics. Similar kind of communication style or pattern might be seen in Facebook use when people exchange comments related to status updates or have a chat connection. The main differences are that the status updates are (often) more asynchronous, less dialog based, and more participants are attending. Haptics might, for instance, be utilized in keeping in touch with others without exchanging information, or maintaining awareness, connectedness, and presence information of the others. It could also be utilized for enhancing the sense of virtually being in the same environment (like getting feelings of door openings and closings as in Nardi's et al. (2000) study). Haptics would also be a suitable way for communicating in the background seamlessly (without disturbing interruptions) in parallel with other actions. In addition, haptics might be used for sending brief messages (e.g., greetings), making contact attempts, or reaching others.

5 Future

Since this research area relates to future usage of social interaction systems and the role of haptics in it, it is essential to consider future views of technology development, the Internet, and social interaction systems in order to anticipate trends of how usage develops, and consider the role of haptics based on that. First, future views from different perspectives are introduced. After that, characteristics of future mediated social interaction are derived and discussed based on the future views.

5.1 Future views

It seems that text-based interaction will have a major role in mediated social interaction also in the near future. For instance, Herring (2004) discusses her views of the future trends of computer mediated communication. She thinks that now when people have become familiar with the currently available CMC systems, they are satisfied with them without seeking any major changes and innovations. She also sees that *text-based* systems will still dominate, although technology enables richer multimedia systems. For instance, relatively familiar and natural media components for mediated interaction, such as video and voice, are underused and untapped in the Internet use. The users rather value relatively constant and simple systems suitable for ordinary interaction. Herring predicts that there will not be need from the users to adopt new technology paradigms or manners of use, but *technology integration*, *enhancements to ordinary use,* and *trusted identity* are the next topics to concentrate on. (Herring 2004.)

Correspondingly, one of the most recent social network systems, Google Buzz, is mainly a messaging system rather than a system offering means for "rich" interaction in terms of modalities. Google tried to address deficiencies of the current social network systems when developing Google Buzz. They provided solutions for users to *define target audience*, *filter messages,* and easy *use of multiple media components*. They also paid attention to *mobile use* and *technology integration*. (Wikipedia contributors, Google Buzz.)

Moreover, Nardi et al. (2000) noticed that text-based messaging provided enough variety for different informal communication needs. They also noticed that the other means of communication would have been more interruptive, time consuming, and required more

formalities than the instant messaging system. They also noticed that the way of using instant messaging lowered threshold to contact. For instance, it was normal to send a brief greeting to others without expectation of (instant) response. People also wanted to have control when to respond, which would not have been possible in the case of phone calls or video connection. Affordances of the instant messaging system made it possible for these kinds of *new communication behaviours and principles* to develop. (Nardi et al. 2000.)

A more general view of the future of the Internet, the next development steps after the Web2.0, has been proposed by O'Reilly and Battelle (2009). What might be relevant from the viewpoint of haptics is that O'Reilly and Battle believe that utilizing *sensor provided information* increases. They also believe in exponential growth of use of the Internet, which will be considered as a network of different devices and applications operating together with each other. The proper *interoperability* requires some sort of standardization or other agreements in the area of social networking. O'Reilly and Battelle also talk about *augmented reality* systems and taking the user's *context* and actions into account in using the Internet. (O'Reilly & Battelle 2009.)

It seems that the role of augmented reality systems and *3D* video solutions will increase. There are already 3D televisions available for 3D movies. Also, for instance, Google Street View (cf. Wikipedia contributors, Google Street View) provides 3D views of geographical places. The augmented reality systems are able to provide additional information of visually perceived real world objects based on contextual information and objects identified using pattern recognition techniques (O'Reilly & Battelle 2009).

Amor (2001) sees *pervasive computing* as the next generation computing mechanism after the internet computing. He describes pervasive computing as follows: "many devices serve many people in a personalized way on a global network" (Amor 2001). It means that instead of one device, computing will be *distributed across multiple devices* embedded in physical things and having *more intuitive user interfaces*. Computing will become more invisible and adaptive to *a context of use* and *personal preferences*. In addition to devices, also data, applications, and networks become more pervasive, for instance, in terms of *interoperability*. Pervasive computing is closely related to the concept of *augmented reality*. (Amor 2001.)

Raisamo et al. (2009) predict that *use of haptics* and *multimodality* will increase with mobile solutions becoming available, for instance, based on piezoelectric technology. Moreover,

researchers have recently developed a new prototype where the skin can be utilized as an input device. The solution is based on the idea that sensors are able to recognize locations of tap touches in the skin, and those taps are used to control the device that is connected, for instance, using Bluetooth technology to the sensors. The skin may also serve as a surface for displaying, for instance, menus and buttons. (Harrison et al. 2010.) Although this kind of skinput system does not serve as a haptic actuator, it represents a *new kind of user interaction technique,* like also touch screens, and game controllers based on, e.g., positions and movements. This might suggest that the role of the traditional user input devices, the keyboard and the mouse, will diminish. Whether and how it affects text-based interaction is a good question.

5.2 Discussing potential future trends

Based on the research and the future views described so far, potential characteristics of future mediated social interaction, especially those in which haptics might be involved, are summarized in the following.

First of all, it seems that mediated social interaction will be more and more *context-aware and situation-specific* in that the way and means of interaction depend on the context or the situation at hand. The context might relate to environmental conditions, goals of interaction, available technology and "free" modalities, means to get access to the other parties, available times for interaction, or preferences of the communication partners. For instance, technology is selected from media best fit to a given context, and altering media during interaction is possible. Interaction periods and time spent for interaction also vary context dependently within and as a part of mundane life events, and interaction may occur in parallel with other interactions or activities. Conditions and situations vary also because of mobility, for instance, in some contexts, quiet, unobtrusive, and seamless interaction is either required or preferred (cf. the smart home material by Edwards and Grinter (2001, 263)). Some contexts may set requirements to input technique, for instance, use of touch or voice might be more appropriate than keyboard typing. In general, interaction technology should be readily available when needed and in the way needed.

Secondly, it seems that there will be a bigger role for systems enabling the users to silently keep in touch and maintain a feeling of connectedness, awareness, and presence of others. Dynamically updated information exchanged automatically with others can create a sense of a

mentally perceived virtual space. The connection may be alive all the time in the background. These kinds of systems are already available as integrated with other communication means, like the presence feature integrated with a chat system or Facebook.

Thirdly, it seems that use and availability of *augmented reality systems* and *3D virtual environments* will increase over time, which might also appear as increased use of multimodal systems in general. Instead of text, these systems are highly visual, and addition of haptics would bring significant benefits.

Still an additional characteristic of the future mediated social interaction would be to be able to maintain *control over own privacy and activities*. This means, for instance, ability for people to keep their own standards of when to interact or respond to contact attempts so that means of interaction are at hand, but they do not disturb or create obligations to take actions. Privacy also relates to controlling information overload or contact attempts (e.g., by filtering mechanisms), and having control over one's own information sharing, especially the information derived automatically by sensory systems.

6 User study

In this section objectives and scenarios for the user study are discussed. In addition, an overview of the current system environment and technologies related to use of social network systems is provided. The overview is important in terms of giving an understanding of the experience of the participants of the user study.

6.1 Research objectives

As already discussed, haptics is a new modality to be considered to be taken into the Internet, mediated interaction, and social network system use. According to the touch theories, touch has an important role in social interaction. However, it is still generally unclear how well mediated social touch is able to resemble physical social touch (see Subsection 3.2), or how the sense of touch could be utilized in mediated interaction, which differs from physical interaction. There are clear benefits in including haptics in remote operation environments (e.g., Srinivasan & Basdogan 1997; Reiner 2004), but the need for and the role of haptics as a part of mediated social interaction is still an open question. One of the objectives of this research is to clarify opinions of users of social network systems on haptics use, whether they see a need or are interested in taking the new modality into use in the future. The user study concentrates on Facebook, a popular social network system offering a versatile set of means for mediated social interaction.

Facebook is a system used for mundane interaction by ordinary people. Users have had time to develop norms and adjust usages according to their need and goals. A question is if they are ready to change the usage and adopt haptics? Based on the technology acceptance theories and the lazy user theory (see Subsection 4.2), it could be assumed that haptics should bring major benefits in order to cover the adoption costs related to new investments, learning, and other efforts needed for the change. Which would be the usages and the contexts in which haptics could either bring added value or overcome the current solution of using Facebook? For instance, is Facebook able to provide good enough means for sociability or expression of emotions? Or, are there features of Facebook which would benefit from haptics? Could haptics enhance or enrich some specific forms of interactions or actions in Facebook? Are there contexts in which usage of Facebook is difficult or even impossible?

An additional research tasks is to clarify how strange the idea of extending mediated interaction with haptics previously considered to be related only to physical interaction feels? Are people ready for remote touch, even though mediated interaction has been compared to face-to-face interaction and blamed for lacking cues available only in the face-to-face context (cf. the cues-filtered-out approaches of CMC)? If touching others is not wanted, a further question is whether haptics is suitable to be used otherwise, for instance, for expressing oneself, triggering emotional reactions in others, enhancing the feeling of presence, or utilizing it in task-related use.

Usage of the instant messaging system in Nardi's et al. (2000) study resembles closely at least some usages of Facebook. Instant messaging has been able to provide affordances that have created new ways and principles for communicating. Examples of the new ways include, among other things, silent messaging providing only awareness information and a feeling of connectedness with others; intermittent way of communicating; and exchange of brief informal messages even without any particular reason. Including haptics to social network systems might correspondingly provide new affordances or be related to these kind of the new ways of interaction already happened with the instant messaging. One of the research tasks is to clarify opinions of users on silent messaging and the role of haptics in it.

Predominantly text-based interaction has earlier been considered to be impersonal, unsocial, and suitable only for simple task-oriented use (cf. the cues-filtered-out approaches of CMC). This is mainly because of missing non-verbal, e.g., social and physical, cues expressed in face-to-face interaction either visually or auditorily. On the other hand, the SIP theory (Walther et al. 2005) proposes that people take actions to adapt interaction within limitations of media, and for instance, compensate missing cues with richer linguistic expressions. Additionally, Facebook interaction mainly consists of narrative performance and social play (cf. Östman 2008). There is a need for people to make their publications as interesting as possible and differentiate because of a number of messages (Östman 2008). Since touch is a way of expressing and conveying emotions, one of the usages of haptics in mediated interaction might relate to extending means of expressing oneself and making the interaction more personal. One of the research tasks is to clarify opinions of users on usage of haptics as a part of text-based interaction.

The future views, discussed in Section 5, indicated augmented reality systems being one of the promising areas of development. Also, game consoles have adopted more and more haptic

features, and there are already virtual reality systems (e.g., Second Life, PlayStation Home, and The Sims) although without support of haptic feedback. A question is whether there is any more interest in using virtual environments for meeting and spending time with others, when mediated social interaction of the type exemplified by Facebook is available. Would support of haptics increase interest in virtual environments? One of the research tasks is to clarify opinions of users on usage of haptic-enhanced virtual environments for social interaction purposes.

A more general question is which kind of terms and requirements people set in order for them to adopt haptics and consider it useful enough to use? After getting more information about contexts, purposes, terms, and how people would like to use haptics, it is useful to think about which kind of matters should be considered in designing haptic solutions, and which would be the most important characteristics of haptic solutions included in social network systems.

6.2 System environment

Figure 1 gives a high level depiction of the networks and possible devices of users involved in mediated social interaction of the Internet. The devices are either mobile phones or personal computers connected via the internet protocol (IP) based networks to other users' devices or network servers. Haptic actuators may be embedded in devices or be separate peripherals having connection to the devices. Different potential ideas of haptics capable actuators are indicated with filled colour in the figure.

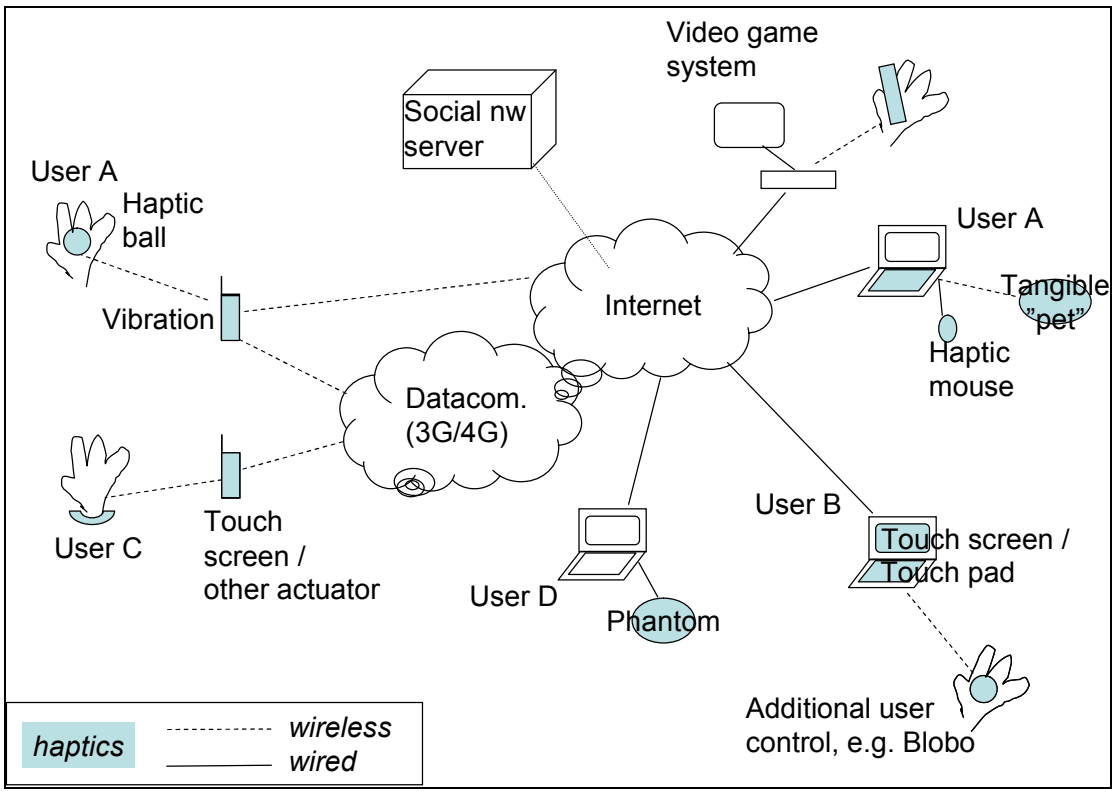

Figure 1. *A logical depiction of the system environment with potential haptics capable actuators.*

The present support of haptics in **mobile phones** is *mainly* limited to vibrating alarms and notifications of, e.g., an incoming call, and touch screens without haptic feedback. Position and movement information of the device may also be provided by the most advanced phones for applications. The Internet connection is made available via WLAN or data communication network. Bluetooth technology is often available for wireless connection with other devices. The more advanced mobile phones typically have a camera enabling video calls in addition to photographing. With regard to services and applications, different messaging systems, such as SMS and e-mail, are used for asynchronous communication. Chat and instant messaging with the presence feature are available for synchronous interaction, but the audio connection is still prevalent. Also, various means of interaction offered by the Internet are available.

Support of haptics in **personal computers** is limited to (multi-gesture) touch pads and touch screens. In addition to the touch pads, the mouse is a commonly used user control device. The Internet connection is typically realized using fixed data communication connections (e.g., ASDL) or WLAN. Peripheral devices can be connected with USB, HDMI, WLAN, or Bluetooth. The computers may have a webcam for video calls. With regard to services and applications, people use e-mail and other means provided by the Internet for asynchronous

interaction. Chat and instant messaging systems of the Internet are used for synchronous interaction in addition to voice over IP calls.

In addition to the touch screens and the touch pads, there are also other haptic actuators commercially available, but they are rarely acquired by ordinary users. For instance, the Phantom device (Massie & Salisbury 1994) or similar user controls may be used with desktop computers for operating in 3D environments. Moreover, there are also haptics capable mice available and other more specific user controls for gaming purposes. In Figure 1, the tangible pet and the haptic ball resemble Hapticat (Yohanan et al. 2005) and Blobo (Lahtiniemi 2009), respectively. *Blobo* is a physical soft ball, which can be used as a game console. It is used to control games or small applications executed in a Bluetooth connected device like a computer or a mobile phone. The ball has sensors for movement, rotation, magnetic fields, and pressure. (Lahtiniemi 2009.)

6.3 Scenarios

This subsection describes various scenarios on how haptics could be utilized in social network systems. The scenarios are derived from outcomes of the discussions of the theoretical part of this thesis, especially the future views of Section 5 and multimodal interaction of Subsection 3.4, and are based on, but not limited to, the Facebook paradigm. The scenarios are used in the user study.

Adding an additional dimension (3D) and haptics to social network systems

One possible scenario for extending social network systems with new ways of interaction and more activities to spend time with is to add the third dimension. In Facebook, the user profile (or a selected part of it), consisting of personal details, status updates, data feeds, and various discussions, could be modelled as 3D spaces to make them a kind of personal rooms. In a similar way as the current use of Facebook enables contacts of the user to access and operate on the user's wall, the other users could visit the 3D personal rooms. In addition to the currently performed actions, the visiting users could, for instance, interact with a user's virtual pet, give a 3D gift, or even meet a 3D avatar of another person (provided that the other person is online at the same time) for interaction. The contact networks themselves could also be visualized in the 3D space. This solution is depicted in Figure 2 as the user profile (UP) boxes having connection to the user profile boxes of others.

Spending time in various chat groups or virtual environments, where people are able to join in to converse, meet others, and take actions, is a form of mediated social interaction. A haptic-enhanced 3D environment would enable various new possibilities to spend time together as well as provide enhanced sense of spatial presence and social presence. For instance, users could join in to play 3D and haptic-enhanced games, touch others through avatars (e.g., knock on shoulder, hug, or shake hands), co-operate, or take some other actions. Modellable objects could be utilized in collective actions or co-operation in order to encourage interaction (cf. the study of collective content by Olsson et al. (2008) and the concept of the social object by Engeström (2005) or MacLeod (2007)). This solution maps to the virtual environment (VE) box in Figure 2.

An alternative for the haptic actuator would be a Phantom-like desktop device (Massie & Salisbury 1994), which is capable of producing force feedback needed for exploring, feeling, and manipulating objects in a 3D space. Force feedback would also be generated when avatars touch each other. For enabling mobile use, handheld devices could be equipped with haptic feedback, at least for feeling simple shapes and surfaces (cf. Luk et al. 2006). Additionally or alternatively, other user controls could be designed. For example, a physical correspondence to the virtual pet could be designed being something similar to the Hapticat (Yohanan et al. 2005). Also, user controls of game consoles could be enhanced with haptic feedback of good quality. For instance, an elastic ball like Blobo (Lahtiniemi 2009) enhanced with haptic feedback could be used for manipulating objects or otherwise used in activities. A user could, for instance, throw a haptic virtual ball to some of his contacts, like in the Contact IM system (Oakley & O'Modhrain 2002), in order to get them to respond or react. Or, the ball would be used for creating and modelling the 3D avatars or the virtual 3D gifts like in the DO-IT system (Murakami et al. 2005). These additional user controls would be connected through a Bluetooth or similar connection via a computer or a mobile phone to the Internet. The suggested user controls can be found in Figure 1.

Given various different devices of users and mobility, all the users may not have the possibility for operating in the 3D space. This means that the most important Facebook features should also be accessible in the 2D context. For instance, the personal rooms should still be available in the 2D space. However, there could be separate 3D activity rooms for getting together, and these rooms would require 3D-capable devices. Also, some of the 3D objects could be replaced by figures or animations in the 2D space. In addition, the system

could provide a possibility to send ready-made 3D gifts to those who are able to receive it, or throw the virtual ball through a GUI instead of using a haptic actuator.

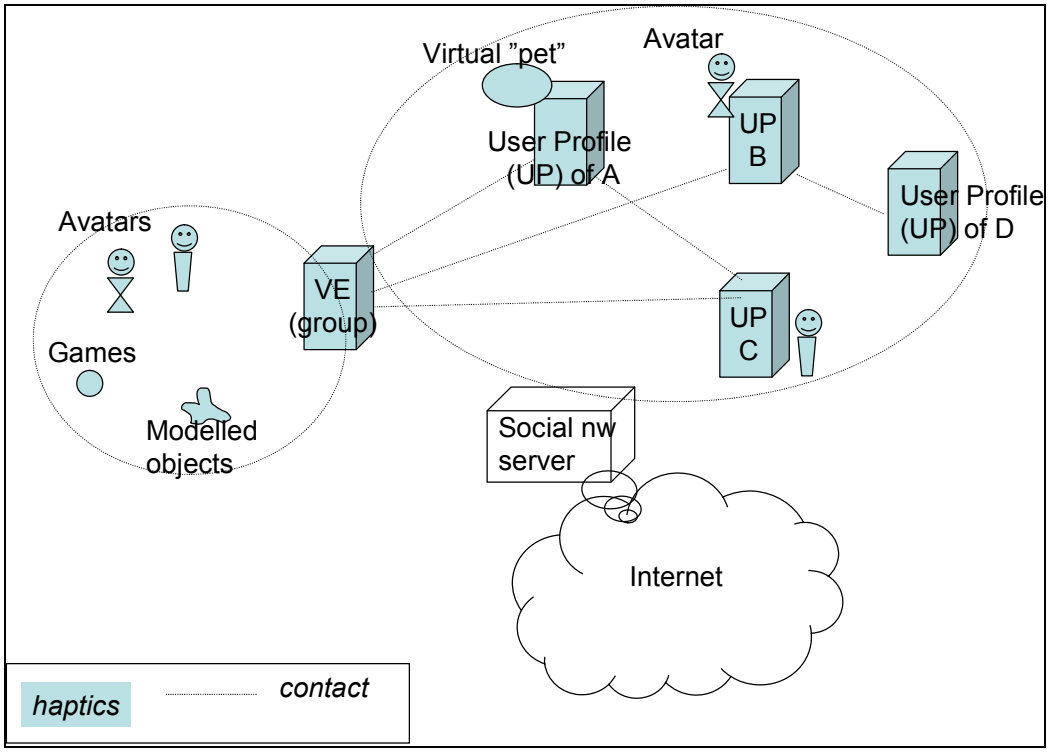

Figure 2. *A logical depiction of internal elements of a social network system, e.g., Facebook, enhanced with haptics as described in the scenarios.*

Enhancing mediated social interaction with capabilities for silent messaging

Wearable type of haptic actuators could be designed for extending social network systems with the sense of connectedness and social presence, and for enabling more affective communication. For instance, a bracelet, a wrist clock, or a ring could be used as actuators of affective, intimate, or playful haptic messages, or as actuators of notifications of events, actions, or received messages. The received signals could be sensed as taps, vibrations, colour changes, or changes in temperature. The sensation could vary depending on the sender, the type of the message, or the content of the message. There could also be different parts of the bracelet dedicated for different contacts, namely the bracelet might simultaneously show information or greetings from a couple of contacts. Or, the ring could be dedicated only to one person. The actuators could also have a simple system enabling the user to respond or send haptic signals to others. The sending of simple messages could be, for instance, based on pressure, tapping, or patting the actuator.

This solution would enable interaction especially in contexts in which the actual device is not at hand, but is nearby; or, when environmental factors are not suitable for interaction with the other modalities. The solution could also be used in parallel with other activities, and is suitable for serving as a background channel for signalling connectedness. It should also be noted that there are a limited number of haptic-only messages, the meaning of which can be distinguished and remembered. On the other hand, the solution does not restrict users to agree mutual meanings of haptic stimuli.

The actuator would have a Bluetooth or similar connection to a mobile phone or a computer, which conveys signals to the recipients. Haptic messages would be conveyed in real-time whenever the user is in touch with the actuator. For privacy reasons, use and received haptic stimuli should be configurable by the user. There are haptic prototypes implemented (at least partly) for these kind of purposes like inTouch (Brave & Dahley 1997), White Stone (Tollmar et al. 2000), and Shaker (Strong & Garver 1996).

Enriching text-based interaction with haptics

The haptic icons (e.g., Enriques & MacLean 2003) could be used for adding haptic stimuli to text-based messages, for instance, status feeds of Facebook. The haptic icons would either enrich the accompanied message or serve alone as messages. The recipient could use a computer's haptic mouse pad (or a mouse) or a mobile device's touch screen (or another available haptic display) for sensing the haptic icons. The idea of the haptic icons should be relatively simple and easy to understand because of the resemblance to the smileys.

Extending synchronous interaction with haptics and non-verbal cues

Participants in simultaneous interpersonal interaction, like chat, could utilize a haptic-enhanced touch screen as an additional communication channel. The touch screen would be used, for instance, as a drawing tablet for finger tip drawing or conveying simple symbolic signals during a conversation. The tablet tapping could serve as an invitation and an alert in the recipient side for a communication. The recipient could feel the haptic signals through his or her haptic device, and see and feel the drawings in the screen. Care must be taken in the final design since the users might end up simultaneously using the same channel for input and output, especially when the other user is tapping while the other is drawing, causing potential disturbances to the communication. This may be avoidable by designing haptic signals so that

some actions occur in the background whereas the main communication happens in the foreground (cf. Luk et al. 2006).

7 Research implementation

This section concentrates on describing the implementation of the user study. First, feasibility of different methods is compared. After that, the questionnaire, the target groups, and the material collection process are described.

7.1 Evaluation of feasibility of methods

By nature, the research area is future-oriented and related to anticipated experiences of users, namely how end users consider the role of haptics in social network systems when good enough devices and means of realizing haptics become available. This requires that the users participating in this research are able to think creatively, reflect their current usage of social network systems to the future, be open to technology development, and imagine experiences caused by haptic stimuli in interaction.

Since the researched subject does not have a specific, well-formed theory in the background, it is not appropriate to formulate specific and very detailed hypotheses for studying the issue but keep the research tasks relatively open. Due to the nature of the research problem, it was quite obvious to select a qualitative research method instead of a quantitative one. Another possibility would have been to use methods of futures research (e.g, Niiniluoto 1999).

Alternative methods for conducting qualitative research exist: an open or a semi-open questionnaire, a combined group trial and interview based method, observation of the current use, or a discussion among a focus group either online or offline.

The observation method was rejected because of the fact that the method was neither able to reveal users' views on haptics (but only the current way of behaviour) nor reasoning behind certain behaviour. It would also have led to a limited target group. There were also ethical reasons, such as involuntary and identifiable participation together with a personal and restricted network of contacts, for not choosing observation as the method. There would have been benefits of the method as well, like possibility to have relatively authentic material of ways of interaction, but still a large responsibility of interpretation of aspects behind interaction and transferring the current interaction manners to the future use of haptics would have been left to the observer.

When successful, a guided online focus group discussion might have been a good way of approaching the problem since the discussion would have been held in the Facebook context, and the participants could have got support from each others' statements and been able to develop one's thoughts further. However, it would have required a number of active persons to take part in the discussion in a certain period of time, and it was anticipated that people had not enough time and interest in the subject.

An offline trial and interview based method was considered because the research area would certainly benefit if the participants had real experiences on how usage of haptics is sensed and felt. The problem with arranging the trial was that there was no corresponding context, namely devices and applications, available. And, even if the context were available, the offline context (providing co-presence and visual information from others) would not yet correspond to the target context. Furthermore, a one-time trial would cause limitations in the experiences since there is no time for learning or use patterns and policies to develop. There would have been a possibility to arrange the trial with Blobo (Lahtiniemi 2009) or another advanced game console, but their use reflects turn-based human-computer interaction with a group of people co-present at the same locale rather than remote social interaction between users. Also, the applications would have been games instead of communication oriented tools of the Internet. This means that the participants should have been able to transfer the experience gained in the trial to the social network system context. The offline group interview after the trial might have provided some help with the transfer task.

The selected method was the semi-open questionnaire. It was selected in order to get more in-depth answers and avoid restricting the answers as far as possible. One reason for selecting the questionnaire method was the possibility to get material from people with varied demographics, and regardless of physical location, time, or other limitations. People were also able to participate anonymously and voluntarily.

The following aspects should be noticed in case of studying haptics and affective matters in that they may affect the results especially when the questionnaire is used as a method. First, it can be anticipated that participants do not have prior experience of using haptics, especially haptic feedback, in mediated social interaction. It might be difficult for participants to imagine without trying themselves or having personal experience how haptics is sensed and how it affects the interaction. Or, which kind of possibilities there could be to use haptics, or

how important haptics is as a part of social interaction (cf. Jones & Yarborough 1985; Robles 2006). Secondly, haptics and affective matters are personal experiences that have effects on the possibility for generalisation of the results, especially in the case of qualitative research with limited amount of participants. Thirdly, haptics and affective sensations may not be straightforward to cognitively formulate or express. Or, even recognize their important role as a part of behaviour or actions (cf. Prytherch & Jerrard 2003). Consequently, participants are given descriptions of use scenarios and other additional information for gaining an understanding on capabilities of haptics.

Scenarios are used in *futures research* for describing the state of future matters and development. They can be used to stimulate thinking and discussion, or in communication of potential future views. It is also possible to involve users in development or evaluation of scenarios. A future state is developed based on the current state, understanding of trends of development, or common behavioural patterns, among other things (Niiniluoto 1999). Since forecasting is uncertain, a range of alternative scenarios are provided. A recommendation for the optimal amount of scenarios is between two and four. (May 1996.)

7.2 Questionnaire

The questionnaire of the user study consisted of five parts (see Appendix 1). The first two parts covered background information about demographics and the current social network use. The rest of the questionnaire focused on clarifying the role of haptics and matters related to it.

The **current social network use** section of the questionnaire contained questions like which social network systems the participant uses and the activity level of the participant in terms of the frequency of use, the amount of contacts, and the user role. The alternatives for the user role were *active / conversation initiator*, *responding based on other's input,* and *follower*. Their nearest correspondence to the social technographics ladder (Forrester Research 2008), classifying consumers based on the way of using social technologies, would be *creators*, *critics* and *spectators, or joiners*, respectively. The corresponding roles, identified by Blanchard and Markus (2004) based on the activity levels of users, were *leaders* (as facilitators), *participants*, and *lurkers*. Baym (2002) classified users as *heavy users*, *light users*, and *lurkers*. The section also asked participants to indicate the used devices (*computer* and/or *mobile phone*), purposes of use, and their use pattern (*short visits*, *long sessions*, or

both). The rest of the questions covered the future development needs and suitability of Facebook for social interaction and expressing emotions.

The part of the questionnaire concerning **haptics** was formulated so that the participant was first given open questions to be answered in order not to restrict the range of thoughts. The open questions concerned the future development and social interaction of the present Facebook, and the role of haptics in social network systems. After that, short and simplified descriptions of three different use scenarios were given. The purpose of the use scenarios was to increase understanding and give ideas how haptics could be utilized in social network systems. The last part of the questionnaire consisted of multiple choice questions focusing on some key matters, such as the characteristics of haptic solutions, the contexts of use, and the purposes of use, for ensuring that they got covered. The last part was also intended for participants who, for some reason or another, did not answer to the open questions. The very last question gave the possibility for the participant to provide any feedback or further input. The questionnaire was provided both in English and Finnish.

The amount of **scenarios** was limited to three. The scenarios used in the questionnaire were created based on the scenarios in Subsection 6.3. The principles of describing the scenarios were that they should be so simple that they are fast to read and easy to remember and compare, but still understandable and descriptive enough. The scenarios were planned to cover as broad a range of ideas as possible. They varied by the synchronicity, duration of a session, the role of haptics, the haptic actuator used, activities of Facebook, the use context, the target user group, and the degree of mobility. The descriptions were left partly incomplete in order to leave room for the participants' own thinking. For instance, technical details, descriptions of exact sensations, and purposes or contexts of use were not given or were given only on a high level of abstraction.

The exact descriptions of the scenarios are found from the questionnaire (see Appendix 1). Regarding the duration of a session, one of the scenarios, the third one, was intended for long sessions when the user wants to spend time whereas the other two were for shorter interaction. All of the scenarios can be used for synchronous interaction, but the second one enables also asynchronous use. Basically all the scenarios might be suitable, although depending on the implementation, to be used by mobile devices and desktop computers, but the third one is the most applicable to the desktop context and the first one to the mobile device use.

The first scenario was purely based on the touch modality requiring a new wearable item. It also complements or is an alternative to the current forms of interaction offered by Facebook. The scenario was created based on the earlier introduced scenario *Enhancing mediated social interaction with capabilities for silent messaging* in Subsection 6.3. The potential target groups could be couples or family members, teens, or females.

The second scenario relates to the earlier introduced scenario *Enriching message-based interaction with haptics* in Subsection 6.3. The scenario requires least changes to the current system and usage. It could be assumed to be the most obvious development step of haptic-enhanced Facebook, especially when considering the future views on the potential convergence of messaging systems and the text-based interaction remaining prevalent. On the other hand, it may provide the least added value and be thus considered a bit boring. In general, this scenario fits to all kinds of messaging, e.g., messaging originated from telecommunication and e-mail standards. The potential target group could be any user, and this would be a scenario for mass use.

The third scenario, based on the *Adding an additional dimension (3D) and haptics to social network systems* scenario of Subsection 6.3, resembles virtual environments, and may be considered as science fiction or at least outside the core features of Facebook. On the other hand, Facebook is also used for longer sessions and this could be seen as a new development path to them, especially, if the convergence of different social network systems is seen probable. This scenario also relates closely to the development of game consoles and convergence with them. The potential target group could be heavy computer users (geeks spending time with and investing in high technology) and people playing games.

Other possible use scenarios would have been, among other things, the 3D personal profile (for more information, see *Adding an additional dimension (3D) and haptics to social network systems* of Subsection 6.3) and the haptic-enhanced screen sharing (see *Extending synchronous interaction with haptics and non-verbal cues* of Subsection 6.3), but they were left out in order to keep the number of alternatives limited.

7.3 Target groups

In general, the target group of the user study was people using social network systems of the Internet. In order to increase concreteness and get focused on social network systems of

certain types, the questionnaire was mainly directed to Facebook users without excluding users of other corresponding systems. The goal was to select users having positive attitude towards social network systems since the research tasks were not related to potential existential issues of the current systems, namely whether they make sense to use or not, but potential use of haptics. Furthermore, the goal was to have participants with long experience of social network systems, experience of haptics, experience of different user control devices (i.e., used in games), and/or knowledge of technology development possibilities (i.e., computer expertise).

According to the technology adoption life cycle model, the candidates who are best able to think about future outcomes are innovators and early adopters (Moore 2005), which were also targeted in this research (the selection process being described later). The goal was also to include participants having both the heavy user (aka initiator) and the light user (aka responder) role in Facebook use. It could be anticipated that the heavy users have a key role in controlling the way of using Facebook. On the other hand, the light users might reveal matters that need to be improved in order for them to become more active. The target group was not limited to certain nationality or age. Both genders were covered.

7.4 Material collection process

The first version of the questionnaire was sent to four persons for getting preliminary answers and comments. The purpose was to test that the questionnaire was understandable. After the test, the questionnaire was made available on Facebook. It was published on the wall of my personal profile and on the wall of a group consisting of Hypermedia students in the University of Tampere. Additionally, a link to the questionnaire was distributed via e-mail to most of my Facebook contacts (about 30 persons) and students of a Haptic User Interfaces course in the University of Tampere. In order to balance age distribution of the participants, one person, representing the age group 16-21 years, was asked to distribute the questionnaire further to some of her contacts. (Note that according to Mashable Inforgraphic (2010), 38% of Facebook users are from the age group 16-24 years.) The participants were also encouraged to distribute the questionnaire further to their own contacts, reflecting snowball sampling.

The questionnaire was available for answers during February 2010. The survey was based on anonymous participation and no contact information was collected.

8 Research material

Research material consists of participant input received via the questionnaire from 25 persons. There were three participants that did not answer to open questions. Research material is introduced by themes in the following subsections. The raw material of the open questions was analysed by first aligning terminology of answers of each theme. After that, the answers were combined to (subgroups and) groups that were created based on the answers. The answers of the closed questions have been counted by using the whole material or by specific classes of the answers. For instance, the amount of answers has been compared with regard to user roles, age groups, genders, nationalities, or devices used. In the following subsections, the (first) number in parentheses, e.g., "(5)", indicates the amount of participants who have expressed a specific view in the user study. The second number in parenthesis indicates the total amount of participants, e.g., "(11/25)" means 11 out of 25 participants have expressed the view being discussed.

8.1 Demographics

The questionnaire was answered by 14 males and 11 females. (Note that according to Mashable Infographic (2010), the gender balance is quite equal among all the Facebook users.) Ages of participants varied from 16 to 60 years (see Figure 3). (According to Mashable Infographic (2010), over 87% of Facebook users belong to that age range.) Most of the participants were Finnish (20/25). The others were from Norway, Germany, France, Mexico, and USA. The level of computer experience was high: 18 professionals, 6 heavy users, and 1 having some experience. Knowledge and experience of haptics were limited since only 5 indicated having good knowledge while 8 had none. The rest had some experience on, for instance, touch screens.

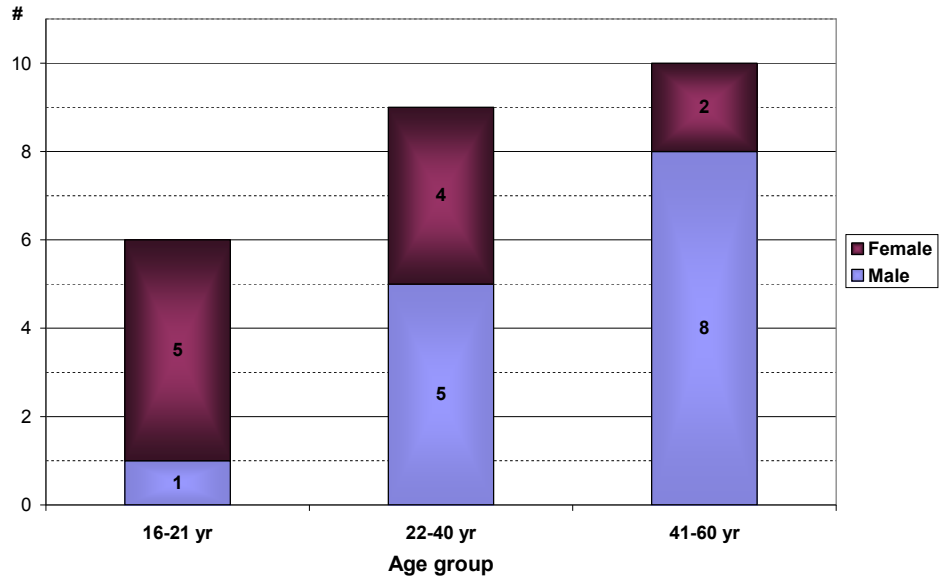

Figure 3. *Division of genders by age groups.*

8.2 Current Facebook use

All participants were Facebook users, and some of them also used other social network systems. Most of the participants were active users of Facebook since 19 of them used it daily and 16 of them indicated having more than 80 contacts (which was the maximum alternative). (According to Facebook (2010), the average amount of contacts is 130.) The self-reported roles of participants varied from heavy users (10) to light users (11) and followers (4), see Figure 4. All participants used Facebook with the computer, but 11 of them also with the mobile phone. The Facebook use pattern varied so that 11 participants used it for short visits, 2 for long sessions and the rest for both the type of sessions.

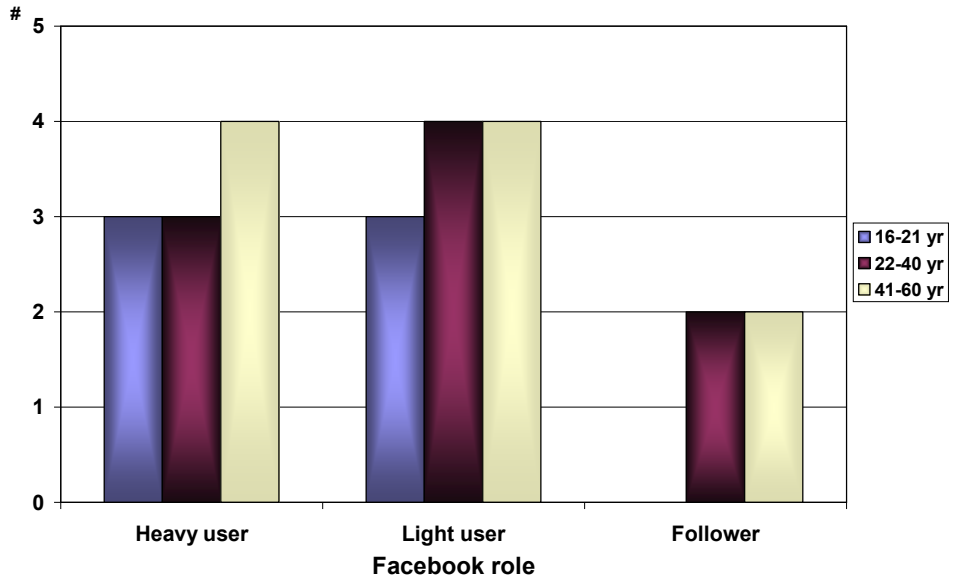

Figure 4. *Division of Facebook roles by age groups.*

The most common purposes of Facebook use were *social interaction* (13), *sharing one's own news and information* (11), *spending free time and refreshing* (10), and *maintaining friendships* (9). All given choices were selected and the least selected purpose was *seeking or giving support* (1). The purposes of use by the heavy users (10), were *social interaction* (9), *sharing one's own news and information* (7), and *transferring or getting information* (5). The light users (11) selected *maintaining friendships* (5), *spending free time and refreshing* (5), and *catching up* (4). (See Figure 5 for more information about the answers of the heavy users and the light users.) The participants of the other nationalities than Finnish (6) mostly selected *maintaining friendships* (4) and *social interaction* (3).

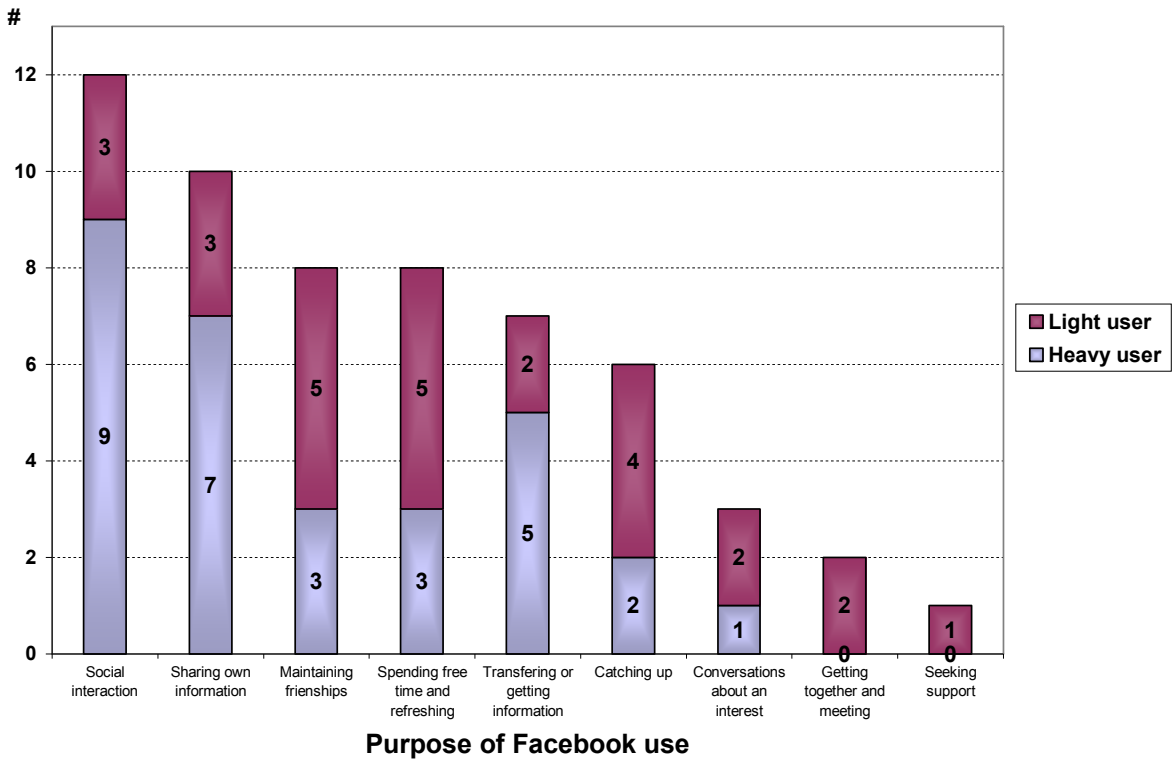

Figure 5. *Purpose of Facebook use by the user role of the heavy user and the light user.*

When the participants (25) were asked to assess the suitability of Facebook for social interaction, 16 of them agreed on that Facebook is either well or very well suitable for social interaction. None were of the opinion that Facebook is not at all suitable, and 5 slightly disagreed. Among the heavy users (10), only 1 indicated dissatisfaction while 8 were satisfied. The corresponding figures for the light users (11) were 3 and 5. When the participants were asked to assess the suitability of Facebook for conveying emotions, 10 of the participants agreed that Facebook is either well or very well suitable for conveying emotions whereas 8 of them had the opposite opinion.

Those who answered to the open question of what is missing from social interaction were looking for non-verbal means of communication, additional modalities, better means of expressing oneself, synchronous interaction, means for filtering and emphasizing information, more in-depth information, capability to restrict the set of recipients, privacy, usability improvements (e.g., ease of use and clarity), and improvements to accessibility.

8.3 Facebook development

When the participants were asked for views on the next major development steps of social network systems, they saw usability aspects (e.g., reorganization of the graphical user interface), convergence and co-operation of different systems providing mediated interaction, addition of modalities, restrictions of recipients, means for filtering information, security, and versatile means for expressing oneself as targets. One of them also saw that social network systems would expand their scope to more professional use if trust issues related to identities were improved.

In more detail, *the convergence and co-operation of different systems providing mediated interaction* consisted of either clarity of roles of different systems or convergence of different social network systems; convergence of messaging and social network systems; capability to transfer information between systems or combine information of different systems via external interfaces; and single sign-on. *The versatile means of expressing oneself* consisted of needs for having "a more 'human' way" of interaction; an easy way of adding contextual and mood information; and diversity means for different kinds of interactions, like a means for restricting the recipients in order to have deeper interaction.

8.4 Role of haptics

When the participants answered how haptics could be utilized in social network systems, the following matters came up in the open questions. Some of the answers indicated that haptics is not necessary in Facebook use. Some of the answers indicated that haptic solutions could be available for visually impaired or blind users for communication with audio and shapes. Some saw use of haptics in different notifications as an alternative to audio and visual signals, for instance, to be used as an indication when a contact becomes online or of an incoming message. It was also proposed that simple haptic messages could be available for use as well as a possibility to reply to them. Haptics was also considered to be used like the smileys and the emoticons, for instance, "a pulsating heart icon, a warm smiling face, or a cold sulky face" (non-literal transl.) were mentioned as examples. Gaming was also mentioned as a potential target for haptics.

Some of the participants believed that, in general, haptic feedback will be available in user interfaces and supported by devices. Some of them saw that the desktop system (or game console systems) would be easiest to augment with more advanced haptic actuators. Also, mobile phones have already moderate support for haptics, and they could be enhanced with additional, but quite simple, usages of haptics.

It was mentioned that haptics could make the interaction more natural and personal, but the solution should be kept simple. Furthermore, it was stated that haptics could be utilized for affective actions, like giving a hug. It was also preferred to have a clear separation between physical and mediated interaction. One pointed out that haptics could be utilized in contexts in which it is not practical to use the keypad.

There were also specific ideas on how haptics could be utilized. One of the ideas was to enhance mediated social interaction with touch screen sharing. Another idea was to indicate quality and depth of relationships with haptics based on the idea that intensity of haptic feedback reflects the strength or importance of the relationship.

As a part of the current Facebook activities, the participants thought that haptics could be utilized in the chat, games, simple and basic messages, status postings, the poke feature, notifications, and applications.

8.5 Scenarios

The exact descriptions of the scenarios are found from the questionnaire (see Appendix 1). From the scenarios, the 2nd scenario, involving haptics as a part of text messages, was rated the most interesting (11) and worth implementing (10). The 3rd scenario, involving the hapics-enhanced 3D room for getting together and spending time, was seen relatively interesting (8), but only 3 saw it worth implementing. The first scenario, providing silent messaging and the feeling of social presence, got some support from both the interest (5) and the implementation (5) points of views. Quite many of the participants (7/25) were of the opinion that none of the scenarios were worth implementing.

When selections of the participants by the different roles of Facebook use were compared, the results were similar. The same applied to selections of Finns versus non-Finns. When selections between females and males were compared, it appeared that males were mostly

(7/14) interested in the 3rd scenario whereas females were mostly interested in the 2nd scenario (7/11). On the other hand, males selected the 2nd scenario worth implementing (8/14) whereas only 2 females thought so. When selections were compared between the age groups, they were quite similar to the results of the whole material.

The **1st scenario** was seen as a use scenario for very close relationships with a limited set of contacts. Some participants were worried about privacy if there are many incoming contact attempts. In general, the scenario was considered simple, fast, unobtrusive, social, and fluent. Some considered it as an alternative to Facebook. Some thought that it provided only a little added value since use of Facebook is already quite fluent. On the other hand, there were also opinions that the solution would fit the Facebook paradigm. In general, participants did not like the idea of having additional devices. A participant mentioned limitations of being able to distinguish different stimuli and their meanings. A participant had an idea that wearable items could operate using energy produced by means of haptics, and by having that kind of a solution would increase accessibility. The younger generation or families were indicated as the main target groups.

The **2nd scenario** was seen as a natural development path to Facebook if haptics were implemented. It was seen the most suitable solution for the current devices, like mobile phones. However, it was mentioned that it should function in computers as well. Some of the comments were similar to the comments on the 1st scenario: the scenario was considered simple, fast, unobtrusive, social, and fluent; and that there are limitations in different distinguishable messages. A couple of the participants commented that the added value is small. A few liked the thought of hapic smileys and the possibility to express emotions with haptics. The scenario was mostly considered to be usable to all.

The **3rd scenario** was seen as a matter of far future or outside the focus of Facebook. However, some participants saw it as a natural development approach in the future. The scenario was also considered as science fiction. A few participants perceived it similar to some of the already existing virtual reality systems, but providing more realistic experiences. The scenario was considered to provide more new features and versatility than the other scenarios. Some of the participants commented that this kind of use required new accessories and control devices (which was seen as a problem), and that the solution was best suitable to desktop use. There were also doubts on producing haptic stimuli of good enough quality.

The 3rd scenario was, in many answers, compared to physical face-to-face meetings and seen as an alternative to them. A comment was, for instance, that "it still wouldn't be able to replace real contact of humans" (orig. English). Some of the participants were even a bit afraid of losing physical contacts if they start using haptic-enhanced virtual or augmented environments for meetings. The produced sensation was also considered artificial when compared to physical touch. A participant mentioned that the scenario requires simultaneous use, which is in conflict with the time independent property of mediated interaction. Heavy computer users and game users were indicated as the target user groups because of new investments needed and time-consuming sessions. Also, people living physically far away from friends might use it. It was also commented that the solution would hardly be suitable for mass and everyday use.

8.6 Characteristics, contexts, and usages of haptics

When the participants were asked to select the most important **characteristics** of haptic solutions, *simplicity* (13) and *enriching interaction by complementing other modalities* (12) were mostly indicated to be among the three most important. The next selected alternatives were *mobility* (9) and *no new devices needed* (7). The *richness in functions and new experiences* was the least selected alternative (3 of 25 chose it).

When comparing selections between the different user roles, the light users (11) preferred *simplicity* (6) and *mobility* (5) whereas the heavy users (10) selected *enriching interaction* (6) and *simplicity* (5) most. The answers between females and males were similar although mobility was more important to males. The oldest age group of the participants indicated *simplicity* the most important (8/10) whereas only two of nine (2/9) from the foregoing age group selected it.

The most popular **contexts** for utilizing haptics, with 9 selections, were *context requiring silence*, *noisy and crowded contexts,* and *when want to spend time*. The least selected alternative was *at work and school* with 4 choices. There were no noticeable differences between answers of different user roles of Facebook, age groups, or genders.

The most suitable **usages** for haptics were indicated to be *expressing emotions* (11), *enriching social interaction* (10), and *a new way of doing with others e.g. in virtual environment* (9). The least suitable usages were *comforting or supporting others or myself* (3), *a new way of*

spending time (e.g. manipulating 3D objects or creating touch based messages) (3), and *remotely touching others* (4).

Five of six (5/6) of the non-Finns participants selected *expressing emotions* whereas only six (6/19) Finns selected it, and from the same age groups of the Finns as the non-Finns participants, only two of nine (2/9) selected it. Mostly selected alternatives by the Finns were *enriching social interaction* (8), *enhancing feeling of presence of others* (7), and *a new way of doing with others e.g. in virtual environment* (7). There were no noticeable differences between the answers of either the different user roles or the age groups. In comparing the answers of males and females, males mostly selected *enhancing feeling of presence of others* (6/14) whereas only one female (1/11) selected it.

When the participants were asked how they see haptics in asynchronous or synchronous interaction and one-to-one or multi party interaction, they saw haptics mostly suitable for synchronous one-to-one interaction (14/25). Asynchronous interaction was seen relatively unsuitable to haptics (16/25).

9 Results

In this section, the research objectives and tasks are addressed, and conclusions are made based on the material derived from the user study and the theories.

9.1 Need for and interest in haptics

When thinking about interests in and needs for haptics in social network system use, it appeared that, in general, people currently using Facebook would be relatively satisfied with the current technology and systems in the near future if only minor usability related issues became solved. It seems that people have become used to use social network systems and learnt to overcome potential shortages for being able to express themselves well enough with the current means (cf. the SIP theory, e.g., Walther et al. 2005). This view was supported by the positive results to the questions related to the social interaction of the current system and the answers to the future development steps of Facebook, namely no major changes were mentioned, and remembering that many participants explicitly indicated using Facebook for social interaction. A participant, for instance, stated that "I don't really see any need to improve facebook or cannot imagine ways to do it, i am satisfied with it's current state." (orig. English). (Note that the results also indicate that the participants considered "cueless" text-based interaction social.) It also seemed that the participants of the user study were well aware of the role of Facebook among other social interaction and communication means, which is in line with the rational actor approach (e.g., Markus 1994).

In the following, views of the participants on haptic-enhanced Facebook use are discussed in more detail from the perspectives of interoperability, accessibility, target groups, technology acceptance and adoption, physical interaction, and the future development of Facebook.

Interoperability

What complicates the selection of means of interaction is that there is already now competition and overlap among social network systems without proper interoperability. People need to use and maintain information of several systems without being able to utilize profiles and contact networks created once. This alone disperses mass use, and adding haptics could be assumed to increase the divergence. The unclear roles of available systems make also selection of the best available means for interaction more complex and accessibility of

contacts more difficult. This came up in the answers preferring convergence (between social network systems as well as between social network systems and messaging systems) and better interoperability between systems. For instance, the participants commented that

> There is no single social network system which would cover all the different functionalities. (non-literal trans.)
>
> The next step could be to develop a service that combines all messaging technologies in one place, and every time users write something somewhere they can decide who shall see it. (orig. English)
>
> Facebook should provide a better support for interoperability of different services, e.g. tweets and Picasa, enable common use of contact networks, and single sign-on. (non-literal trans.)

It was also commented that there should be a general haptic solution instead of a Facebook specific solution, although there may appear system specific trials (first), which converge to more general solutions in the future. The convergence, integration, and interoperability issues were also discussed in context of the smart home concept (Edwards & Grinter 2001) and pervasive computing (Amor 2001), mentioned by Herring (2004) and O'Reilly and Battelle (2009), and addressed by Google (cf. Google Buzz 2009).

Accessibility

In general, accessibility of people via Facebook and other social network systems is relatively good, and the systems have achieved mass and ordinary use. It goes without saying that because of the requirements for new investments and learning, it takes time before a new technology paradigm become accepted and adopted by public (cf. Moore 2005). This was supported by some of the answers of the user study, which pointed out that only the heavy and most interested users would invest in and learn to use the most advanced and versatile haptic solutions, but not an average social network user. Moreover, some participants mentioned that the solution should be available to all in order to become usable.

Target groups

When the participants were asked about the target user group of haptics, and who they saw would need or benefit from haptics, many participants mentioned disabled people or groups with special needs, young people, or heavy computer users. For instance, blind people would certainly benefit from use of the tactile sense. Also, shy or socially anxious people were mentioned as potential users. Based on the answers of the user study, it could be concluded that many of the participants did not see they themselves would use haptics in Facebook.

Some of the participants mentioned that they most probably would try the solution, but did not necessarily believe in continuous use. (See the lazy user theory developed by Tetard and Collan (2009) for a proposal on how people choose media for interaction.) For instance, a participant saw that "continuation of use depends on how easy it is to use*"* (non-literal trans.). This suggests that the haptic solution should bring much added value, for instance, it should provide something that cannot be easily covered by the existing means. Alternatively, the solution should be available without additional effort, for instance, any investment should be made also for other than the Facebook purposes. This relates to minimizing switching costs (cf. the lazy user theory by Tetard and Collan (2009)).

Technology acceptance and adoption

Some of the answers depicted even worry about a technological change anticipated to happen with haptics, for instance, potentially requiring new device investments and bringing more complexity into use. These were addressed in results of the questionnaire: the participants, for instance, selected simplicity over richness in functions and new experiences; anticipated complexity; indicated strongly that haptics is not needed; indicated that they are doing well with the available capabilities; wished convergence and clarity among the current social network system offering; or did not want to have additional devices or make device investments.

This may be due to the fact that people have experienced relatively big technological changes in the past (as also mentioned by Herring 2004) and recently invested into new devices. It is quite natural that they would like to take advantage of the current systems and utilize them in mundane use without investing more resources, like time for learning (cf. Moore (2005, 104-107, 109-111) for the high-tech sector growth model and the main street phase of the technology adoption life cycle from the user's perspective).

Moreover, people may have negative past experiences of changes in computer systems, like added complexity, gigantic applications, and worse end results, which may have slowed use, brought unnecessary features and changes, reserved computer resources, or introduced disturbing display elements. A participant, for instance, mentioned that "features of Facebook may develop to either better or worse direction or may even disappear within introduction of new versions of Facebook" (non-literal trans.).

Still another explanation could be that the participants might not have regarded the benefits of the change to exceed the efforts and investments needed for use (cf. the lazy user theory by Tetard and Collan (2009)). For instance, the following comment from a participant of the user study supports this view: "the solutions should not be too expensive, and they should be good enough to provide real added value in continuous use" (non-literal trans.). Facebook was also seen as a simple and quick tool so both from the effort and the performance expectancies point of view (cf. the UTAUT model by Venkatesh et al. (2003)) or according to the lazy user theory (Tetard & Collan 2009), adoption of haptics would not be very likely. Accordingly, it was noticed in the study of Bruner and Kulmar (2005) that ease of use instead of several "cool features" contributed to the fun aspect of use that further positively affected attitudes toward usage.

Regarding the additional devices, people are used to use general-purpose devices accomplishing various tasks. It may be due to the convention of having device and operating system specific applications and data, which make use of multiple devices difficult. The currently available devices are also relatively complex to configure and maintain. (Amore 2001.) For instance, a participant mentioned that

> Facebook use by the currently available mobile devices is already fluent enough so that added value provided by accessories is not obvious, and that it is more likely to use vibrations of mobile devices for Facebook notifications than accessories. (non-literal trans.)

The results of the user study do not seem to support Amor's (2001) view of multiple distributed devices related to pervasive computing.

The participants also doubted capabilities of devices for being able to produce haptic sensations of good enough quality (cf. the facilitating conditions of the UTAUT model by Venkatesh et al. (2003)). For instance, the participants saw that "Haptic sensations should be of better quality than available by the vibrating devices." (non-literal trans.) and "Haptic solutions and technologies are still too immature." (non-literal trans.). On the other hand, it has been noticed that even simple or incomplete stimuli can be enough to fulfill their purpose (e.g., Fogg et al. 1998; Reiner 2004; Bailenson et al. 2007; Salminen et al. 2008), provided that the stimuli does not feel strange (Reiner 2004). On the other hand, the currently available technology, like vibrating devices, may not attract using haptics for more advanced purposes than currently used (note the hedonic construct of the user acceptance studies, e.g., by Bruner and Kulmar (2005)).

Consequences to physical interaction

The participants were worried about increased use of social network systems taking time from physical interaction. Some of them wanted to keep a clear distinction between physical ("real") and online ("virtual") interaction or at least preferred social touch (or touching others) to be only a part of physical interaction. A participant, for instance, stated that "I think this would be wrong, as I think there should be a real life and virtual life boundary, even when it comes to interacting with friends" (orig. English). Some participants also thought that adding haptics, especially a haptic-enhanced virtual environment or any other appealing components to social network systems, would decrease the amount of physical interaction and actions. For instance, the research material included a comment that "They will make people more addicted to their virtual lives and may forget to keep real friends." (orig. English). However, it could be assumed that those worries relate mostly to use of haptics for mediated social touch or long sessions spent in virtual or augmented environments, which nevertheless may feel more addictive and immersive with haptics.

In general, decreasing physical interaction and increasing mediated interaction are common trends, but it does not necessarily mean that mediated interaction replaces physical interaction. A few research approaches have shown results that mediated interaction may even increase, or at least should not lessen, physical interaction (cf. the subsection 2.2 *Reasons for using social interaction systems* and experiences from the smart home research by Leppänen (2001)). It is hard to believe that haptics alone would remarkably increase usage of mediated interaction or replace physical interaction with mediated one, at least, in the first phases and in mass use. Time used for mundane mediated interaction is hardly affected that much because it typically occurs in short periods, independent of place, and in arbitrary and idle times while being unable to interact in person at those moments. With regard to separating physical and mediated interactions, smart home research has shown that people want to keep (physical) life at home relatively unchanged and react strongly for maintaining physical interaction (Leppänen 2001). It was also noticed that people wanted to use physical interaction instead of virtual one whenever possible (Leppänen 2001, 125), which was also mentioned by the participants of the user study. The participants, for instance, preferred "the old way of meeting at cafes" (non-literal trans.) and said that "remote meetings can be used in case of a physical distance prevents meeting otherwise" (non-literal trans.). They also commented that

> Online communities help to maintain a simple relationship to people. If I want to see or feel them, I would just meet them in person. (orig. English)
>
> [. . .] but for everyday scenarios like meeting up, I think I don't think I'd use it because there's the real world you can meet up in and nothing compares to that. (orig. English)

Conclusion

Given that the participants of the user study were relatively well aware of technological matters and active users of Facebook, and that they showed a relatively mild interest in haptics in Facebook use, it could be concluded that support of haptics may not be among the first or most important development approaches of social network systems from the perspective of the users. The participants did not explicitly mention haptics in the future development views of Facebook either, but implicitly haptics could provide some aids for improving usability and providing enhanced means for expressing oneself, which were mentioned in the user study. Haptics might also provide some aids or alternative means for filtering information (cf. the scrolling and list selection applications of Luk et al. (2006)) and reliably identifying others (e.g., Rovers & van Essen 2004), but haptics is not capable of providing the main solutions. These two latter matters were also brought out by Google (Google Buzz 2009) and Herring (2004) as targets of development.

In order to provide *significant* added value, use of haptics may require new mediated interaction behavior to develop and more versatile and better quality haptic actuators to be available for ordinary use. Alternatively, new innovative and immersive ways of utilizing haptics could be invented for hobbyists. It seems that haptics could provide mostly added value for gaming contexts; otherwise, it could be utilized in smaller scale use. For instance, within the introduction of instant messaging, new ways of interaction were adopted (Nardi et al. 2000), and in a similar way, haptics may provide affordances for new kinds of communication. In addition, haptic actuators to be included in mobile phones or haptic feedback to be available in user interfaces provides a natural path for users to get used to haptics in small steps.

Interest in haptics will be discussed in more detail in the next subsection. In other words, which kind of use of haptics users might find acceptable and would be interested in.

9.2 Utilization of haptics

As characterized by Östman (2008), messages in Facebook are short, simple, talkative (conversational), handling mundane matters, rapidly changing, and light-weight by nature. Some participants of the user study were additionally looking for deeper and longer lasting discussions with a limited set of people. For instance, a participant saw that

> Social network systems will develop to include a more versatile set of forms of interaction, which provide also means for deeper interaction from content and emotions points of view together with a possibility to limit the target audience. (non-literal trans.)

On the other hand, they also wanted to keep interaction simple and fast to access. Additionally, they were looking for better ways of filtering or highlighting some of the received messages because of too many postings (as also brought out by Herring (2004) and Google (Google Buzz 2009). It was also mentioned by some of the participants that a prerequisite for more personal interaction would be to have capability for restricting the target audience (which, for instance, Google Buzz provides). In general, it seems that there are needs for a **variety of forms of interactions** depending on the context and interest (cf. the rational actor approach, e.g. Markus 1994). It does not necessarily mean that one system must support all the forms as long as interoperability of systems is ensured, and the variety does not lead to dispersion of users.

Some of the answers revealed concern with the intimate nature of haptics and being able to keep the personal space, a physical distance to others. For instance, a participant saw that

> People might be scared by the idea of virtual touch senstaions, at least I find it a bit disturbing as a thought. The idea should be presented to the public as something fun and different, not as something to replace real touch sensations, otherwise the idea might seem too 'clinical' and 'spacey'. (orig. English)

Some were looking forward to politely and invisibly decline certain contact attempts already in the current use (cf. maintaining privacy and own control in using technology related to the smart home concept by Leppänen (2001)). Some were concerned over automatically translating real feelings to be attached to messages (a corresponding concern, the 7th challenge, can be found from the smart home research by Edwards and Grinter (2001)). Some anticipated that mediated haptic sensation would be artificial. There were also other suspicions regarding mediated haptics used for the purposes of mediated social touch. So, it

could be concluded that forms and purposes of utilizing haptics should be mainly other than the most personal forms of **mediated social touch**. This view was also supported by the answers to the "suitable usages for haptics" question. However, there was also a differing opinion, for instance, a participant mentioned that "the more natural the communication is the better even if it is mediated by machines" (non-literal trans.).

It is also good to remember that Facebook is mainly used for light-weight and playful interaction with multiple people, so the context is not very supportive of mediated social touch. Because of the public nature of the interaction, people may not even want to be too personal but use other means for deeper interaction, which was also brought out in the answers of the questionnaire (note that this is also in line with the rational actor approach, e.g. Markus 1994). A participant, for instance, stated that "Since most of what is written on Facebook is 'public', I rarely write personal things. And if I have something to say that is private enough to write in a personal message, I rather write an email." (orig. English).

A few participants mentioned **additional modalities**, for instance, live picture and audio, as the next development steps of Facebook. It seems that at least some of the participants would like to make interaction "richer" by adding multiple media components, and at the same time make it more synchronous. At the moment, the most natural way of adding modalities is to provide video and audio, which are already supported by the Internet and devices, but are not yet integrated in Facebook. In other words, it seems that there are no systems in the Internet being able to provide versatile set of modalities, but different systems are offering partly overlapping, different sets modalities. It could be concluded that there might be a need for additional forms of interaction in Facebook, such as simultaneous, multimodal interaction also among multiple people.

Facebook has the **chat** feature for synchronous interaction. Quite many of the participants of the user study indicated that the chat feature might be a potential target for utilizing haptics. It is in line with the answers to the last question of the questionnaire measuring suitability of haptics for synchronous and asynchronous interaction. In the invitation-based chat, the recipients of messages are typically known and restricted, so the chat resembles a context similar to where the participants saw usage of haptics. Consequently, haptics could be suitable for enhancing **synchronous text-based interaction**.

In **(asynchronous) text-based interaction** haptics might provide additional creative means for expressing oneself, differentiate, and making interaction more personal. Haptics could also provide additional means for adapting interaction according to limitations of a medium as proposed by the SIP theory (e.g., Walther et al. 2005). The second scenario of the user study, based on haptic-enhanced messages, was rated worth implementing and the most suitable for Facebook and the current usage. It was also considered interesting and acceptable. With regard to transferability of knowledge (cf. the lazy user theory by Tetard and Collan (2009)), it seems that people like using the smileys, and the participants were looking forward to having haptic effects to (or haptic versions of) them too. The participants, for instance, commented that

> Smileys and emoticons are a fun way to express opinion and feelings in chatting, so taking them futher could be interesting. (orig. English)
>
> I like the thought of smileys! Makes it easier and faster to express emotions. (orig. English)

In general, the participants saw that they could use haptics for better expressing emotions or as a fun way of interacting. Since one third (1/3) of the participants disagreed on the suitability of the current Facebook for conveying emotions, haptics might provide improvements to that. The participants, for instance, mentioned that "text is not always easy and versatile enough for expressing oneself" (non-literal trans.), and that "Facebook is used to stay in touch with your friends but it should be done in a more 'human' way. Posts on walls is not enough any more" (orig. English). The fun or enjoyment aspect was also discovered to be one of the determinants affecting attitude and acceptance of use (e.g., Bruner & Kumar 2005; Liao & Tsou 2009).

With regard to **silent messaging**, related to the 1st scenario, it was considered to be a matter of more personal and intimate interaction having a restricted set of communication partners. The idea of restricting the amount of contacts should not be a major problem since people typically have only four to five frequent contacts (Nardi et al. 2000). A participant of the user study saw that

> Option 1 sounds very cool, but could be a bit annoying after a while. Consider the case when you have tons of friends commenting on your activity and you get notifications in your bracelet all day. If possible to configure for some friends only then will be cool. (orig. English)

Some of the participants of the user study thought that the kind of silent messages could be used to send a greeting or a playful pinch to a close person. (Note that informal greetings were also sent using instant messaging in the study of Nardi et al. (2000).) Many participants mentioned that the poke feature of Facebook could be changed to "real" poke with haptics. See also experiences from the HandJive prototype (Fogg et al. 1998) on context-dependent perception of what is "fun".

According to the touch research by Jones and Yarborough (1985), touch requires contextual information for increasing understanding of meaning of a touch. In the 1st scenario, no additional information was available. A participant of the user study also mentioned the limitations of distinguishable meanings. This means that meanings should be previously agreed either commonly or mutually, or between the actuator and the user depending on the realization. It is also possible that messages are intuitively recognizable or left ambiguous. For instance, Gaver (2002, 478) wanted to bring out that "in conveying information imprecisely, they [the design concepts] suggest that hints and clues about other people's activities may be as affective, and more emotionally satisfying, than more complete information in evoking experiences of connection".

One of the main problems with the 1st scenario seemed to be the additional peripheral needed. The participants might have thought that the main device is able to and available enough for realizing that kind of communication. In other words, they may have been perceiving benefits smaller than efforts needed for taking and using a new peripheral in comparison to using only the main device. Also, even if awareness systems seem to be becoming more common, they are often integrated to be a part of other communication means, like chat or instant messaging systems. For this reason, people may not consider them as independent systems, as was in case of the 1st scenario, and might not have noticed all the utilities they provide.

The almost ubiquitous accessibility and connectedness may not be, in any case, wanted if it creates obligation or expectations to communicate. (Note also that, e.g., Edwards and Grinter (2001, 264) discovered that expectations of people change.) In the smart home research by Leppänen (2001), it was also noticed that people want to be able to disconnect the external world and have privacy at home on need basis. In case of instant messaging, Nardi & al. (2000) discovered that users created such norms of usage that despite active connection between contacts, there was no obligation to act on messages but the messaging occurred in

the background until people had time for it. In the user study, there were some concerns with expectations from others to follow and respond, or how to politely deny contact attempts.

In general, the form of more personal and affective mediated communication with close and strong relationships, whether it relates to awareness or other forms of communication, would be a subject for further thought since it seems that the current social network systems are not necessarily offering affordances for that kind of mediated communication. For instance, Gaver (2002) and IJsselsteijn et al. (2003) talk on behalf of more affective ways of interaction and awareness systems. Haptics might provide aids for that kind of the interaction. Also in the user study, haptics was, in general, associated to affective and personal communication.

With regard to the role of haptics in **virtual environments**, some of the participants of the user study rated the 3rd scenario the most interesting, but indicated the other scenarios worth implementing. This could be due to the fact that the other scenarios require smaller technological changes and less new investments. One of the seen problems was related to being able to have good-quality devices (cf. adoption related to expectation of technology facilities of the UTAUT model by Venkatesh et al. (2003)). Although not explicitly queried in the user study, it somehow seemed that former users of virtual reality systems were no more using those for meeting others since Facebook and other social network systems are currently available for social interaction. (Note that they certainly might be interested in virtual environments for gaming purposes.) However, it seemed that there might be some interest in immersive and more realistic haptic-enhanced 3D virtual environments in the far future. For instance, a participant saw that "The sense of touch in a 3D room could be a fun experience, kind of like the Sims but more realistic." (orig. English).

It could be anticipated that there are two different **branches** for adoption of haptics: one for text-based messaging and another for virtual environments and game consoles. The first branch would evolve to haptic-enhanced messaging for use by computers and mobile phones. The latter branch would evolve to haptic-enhanced 3D environments by convergence of video game consoles, virtual environments, and addition of haptics.

In thinking about other forms of interaction, the first branch would cover also (mostly invitation-based) chat-like interaction enhanced with haptics, and the second branch would cover the join-in type of chat, like chat rooms. Both of the branches could utilize presence and awareness systems. Also, if haptic support is generally available, various separate applications

of social network systems, like Facebook applications, could utilize it. Finally, an additional branch could cover live picture augmented with haptics in the farther future, and possibly lead to a kind of augmented reality system in terms of social interaction.

9.3 Characteristics of haptic solutions

This subsection discusses characteristics of haptic solutions, namely which matters should be considered within involving haptics in social network systems or mediated social interaction. The characteristics listed in the following are not a complete list but derived from this research. The characteristics are grouped to *application (or software) specific*, *usability related*, and *device specific*.

Application specific characteristics

Three kinds of user interaction channels might be needed for an application of mediated haptic interaction: a user input, feedback of the input, and received signals from the other persons. The haptic solution might additionally need to support bi-directional interaction among multiple participants. Also, the users may simultaneously control the same object. The user may also have independent interactions occurring in parallel. (Note that some of these aspects concern only synchronous interaction.) As discussed by Luk et al. (2006), the whole usage of haptics should be designed so that there may be parallel communications in which haptics is involved, for instance, some haptic features may function in the background at the same time with the main haptic-enhanced communication occurring in the foreground. Also, it is good to note that people tend to end up fighting for control if they are allowed to control the same object at the same time (Chang et al. 2002).

There are also different target groups with specific needs, which should be taken into account. For instance, the needs of a mundane user do not necessarily match with the needs of a hobbyist. There are also needs for different forms of interactions like deep conversations, light-weight discussions, and immersive activities.

In addition to aspects of individual users, different capabilities of devices of the other participants should be considered. If some of the users do not have a haptic-capable device or have different devices, the users should still be able to interact as fully as possible. This may require at least some support for cross-modal mappings, usage of commonly known (possibly

standard) solutions, or capability to negotiate the used properties according to the devices or preferences.

Still another aspect to consider is the ability of the user to have control over haptic signals, either sent or received. This relates to the characteristics of mediated interaction allowing the user to make a decision on which kind of self-image to represent to others and having control over published content (e.g., Östman 2008). Although this aspect relates closely to sensory systems, care should be taken also otherwise. For instance, the iFeel_IM prototype, by Tsetserukou and Salvendy (2009), is based on the idea that text messages are automatically interpreted that may lead to inadequate information. Controlling received signals relates to privacy (which is discussed later more). There are also contextual issues to consider like selecting the best possible modality according to the context either automatically or based on user selection. This relates to usage of alternative modalities.

An important consideration relates to privacy. The system should enable configuration of received haptic signals since perception of haptic stimuli is a subjective matter and the recipient may not even prefer to be touched at all by others. There may also be needs for restricting the set of contacts from which haptic messages are being received. Other issues related to privacy are to avoid potential obtrusive and irritating experiences, for instance, because of too many received messages or contextual matters. This may require a kind of a filtering solution. Furthermore, it should be thought what triggers displaying of haptic stimuli, namely whether it is automatically displayed within reception of a message or based on a user's action.

An additional consideration is how the meaning of haptics can be learnt, or how the meaning of a haptic-enhanced message can be mutually understood (if needed). There may be two kinds of solutions: solutions based on intuition or solutions which are based on pre-defined definitions of meanings (e.g., Enriquez & MacLean 2003). A way of enhancing mutual understanding or increasing the amount of distinctive meanings is to use other modalities as supplementary to haptics.

Usability and user experience related characteristics

The quality of haptic solution may be a criterion for use. Haptic stimuli should not be sensed as artificial, uncanny, or naive. When the target is to increase a feeling of immersion and seek rich experiences, the solution should provide versatile and good quality sensations.

Additionally, other modalities, like vision and audio, may be utilized for enhancing haptic sensation if the device is not able to display haptic stimuli of good enough quality (cf. Srinivasan & Basdogan 1997, 401). There are also certain design principles (related to robotics), such as matching appearance and behaviour or fulfilling expectations based on appearance, for decreasing the uncanny effect (e.g., Goetz et al. 2003). These principles could be applied also to haptics, for instance, by not using haptics for such purposes that are not yet possible or mature enough from the technology point of view, or for which users may have prior expectations (cf. Reiner 2003 for the expectations) that do not match with the implementation, as might be the case of the most personal forms of mediated social touch.

A property of usability is simplicity. Since usefulness of haptic solution depends on its suitability for mass use, any complex solution may restrain deployment and usage. The adoption may also be hindered because of required learning effort, expensive investments, or inefficient and complex use, among other things. In general, usage and deployment should be as effortless as possible. In order to surpass the existing means of interaction, usage of the new solution should be more natural, faster, more fun, and more convenient, especially in mundane use.

Another property is the time needed for learning and achieving mass use. Also, fast development of norms and manners of use are important. These can be enhanced by generic, system independent solutions, namely by solutions that can be can be utilized across different applications and devices. Generic systems and usages help utilizing existing skills and knowledge.

Device specific characteristics

Since mediated interaction may involve three simultaneous channels of haptic signals, it should be noted in the design of a haptic device that in case of displaying multiple haptic stimuli at the same time, they may interfere with each other if the channels are the same (Fogg et al. 1998; Chang et al. 2002).

One of the characteristics to be considered is mobility. The solution for everyday use should be portable and mobile so that it can be instantly used any time and place, and in various contexts. Alternatively, the solution might be such that it does not necessarily require involvement of haptics, for instance, haptic elements could be mapped to other media types or

at least be temporarily ignorable. In addition to mobile solutions, there might be need for fixed desktop based solutions for more advanced use and more complex use scenarios.

Another aspect to consider is to provide general solutions so that the user is able to use the same haptic actuator to cover various needs. This means that the haptic actuator should support different applications. Correspondingly, applications may be designed to support different devices, which might require using similar haptic interfaces in various devices. Also, additional devices and peripherals should be avoided, like designing application-specific hardware.

One of the characteristics to consider is the simultaneous use of other user controls, for instance, a mouse or a keyboard in the computer context, or a headset of the mobile device. Also, the haptic actuator should be in touch with skin in order to sense haptic stimuli. In case of a multimodal solution, the user should be able to perceive all the needed modalities at the same time, for instance, to see and sense the displayed items simultaneously, or the device should support cross-modal transformations.

Since haptic solutions might be used in contexts in which the other modalities are not easy to use, contextual aspects should be considered in the design of haptic actuators. The purpose might be, for instance, to support contexts in which the device is not at hand or when it is not possible to see the device. In addition, there might be needs to be able to receive haptic signals when the user is not specially prepared for them, for instance, in case of notifications or other haptic-only messages received in real time.

Other characteristics relate to affordability and ecology. Any costly solution may restrain deployment and usage, especially in mundane mass use. In mobile use, battery and bandwidth consumption requirements may become important criteria for use.

In this subsection, characteristics of haptic solutions to be considered in planning and specifying haptic-enhanced systems of mediated social interaction were collected. The characteristics were derived from this research and were provided in a relatively general level. In order to provide more detailed guidelines or design principles, a specific application should have been assumed as basis, which was not appropriate in the focus of this thesis.

10 Conclusions and evaluation

In this thesis, the role of haptics in social network systems of the Internet, mainly Facebook, was clarified based on a user study in which views of Facebook users was inquired using the qualitative research method, semi-open questionnaire. As a part of the user study, three scenarios of haptic-enhanced mediated social interaction for social network systems, like Facebook, were introduced. The scenarios were developed based on related research and future views of mediated social interaction.

It was found that Facebook users are relatively satisfied with the current usage, and are sceptical of benefits haptics could provide and of taking a new modality into use. There is some interest in using haptic-enhanced emoticons as a part of text-based messaging. Also, benefits of haptics in virtual environments are acknowledged. Haptics is also seen a means for more emotional and personal expression, and more real and natural experiences, but not necessarily for touching others. Consequently, two development paths for inclusion of haptics were proposed: one based on (converged) messaging and another based on virtual operation in social network systems, the former being more likely to happen earlier in the future.

In the following, this research is evaluated based on the criteria of the qualitative research such as *dependability*, *credibility*, *confirmability,* and *transferability* (Tuomi & Sarajärvi 2009, 136-139). Additionally, potential further research tasks are proposed.

Dependability covers potential external and internal aspects affecting the research. Since the material collection of the user study was based on voluntary and anonymous participation, it could be assumed that the participants felt relatively free to give their honest views and opinions, although based on cognitive thinking and prediction instead of real experiences of haptics. On the other hand, the content of the questionnaire may have affected the answers. This may not be such a big issue since open questions were used for giving unlimited possibilities for the participants to answer. Also, because of the future related and relatively unfamiliar researched topic, additional information and hints were probably needed for activating thinking. There was also needs for aligning some of the answers according to specific themes.

An additional external matter of distraction was that more general attitudes, for instance, towards Facebook, mediated interaction, or technological changes, affected answers of some of the participants. This means that some of the comments were not only targeted at use of haptics but were more common. Also, the lack of knowledge and user experience may have made it more difficult to provide answers. An attempt to try to control these latter two issues was made by distributing the questionnaire to suitable target groups. It was seen from the answers, for instance, that the more experience and knowledge a participant had on haptics the less problematic the anticipated technology change was felt, which was reflected as a concentration on haptics instead of the technology change. Correspondingly, heavy users took Facebook as is for the basis of thinking of inclusion of haptics, although they might have had more resistance to changes instead.

Credibility covers matters such as the question of truth, applicability, stability, and neutrality of results, and how well the produced interpretations correspond to the original research material.

Regarding the question of truth and achieving unambiguous results, this research rather produced an understanding of thoughts of users of social network systems on the role of haptics, and potential future development views of the social network systems and mediated social interaction as a by-product. The results on the future role of haptics are based on the contemporary technology and usage of social network systems, which presumably will develop in parallel with the development of haptic solutions. Consequently, this research serves as an initial and temporal overview on the subject at this moment of time when Facebook use has achieved mass use and few haptic solutions are commercially obtainable. The original research material for the overview was produced by so called lead users, which could be assumed to reflect the first likely user group of haptic solutions in the future.

Regarding the question of neutrality, the user study was based on thoughts of users rather than more neutral measurements. The material collection was targeted at people of certain characteristics; otherwise, the participants had a chance to participate relatively freely. The analysing process was based on the answers of the participants, but the researcher bias affected, which answers were addressed and selected in making conclusions or interpreting the answers.

Confirmability relates to evaluation if the results can be reaffirmed by other methods or research results, or whether the reader is provided with enough information for being able to assess the analysing process and possibly making similar interpretations by him/herself.

At the moment, the results have not been reaffirmed by other research methods. For instance, trial sessions, focus group discussions, or methods of futures research could be used as additional methods. Certainly, a possibility for exchanging thoughts and information or having more concrete experience on usage of haptics might provide further insights. From the background point of view, the participants of this research were relatively evenly distributed among the target groups, providing variety in thinking and experiences. For the confirmability reasons, among other things, the questionnaire included some recurring questions of different forms in order to increase clarity. Also, theoretical support was found to some of the results. However, there were no directly applicable theories available for accurately predicting the outcomes beforehand.

When thinking about **transferability** of the results to another context, it could be assumed that the results might be, at least partly, applicable for mediated social interaction in general; although, for instance, public groups of supportive type were excluded that might certainly benefit from haptics. Although the primary paradigm was the social network systems of the Internet, the results could be transferred also to data communication, especially to messaging. Also, the results could serve as preliminary material for future research.

The **further research topics** could be related to different research methods or restricting research tasks to specific ways of using haptics. As already earlier mentioned, for instance, experience in haptics would provide better basis for evaluating usage of haptics. Additionally, eliminating the external matters of dependability, mentioned above, would be essential, although in this research, it was good to get information about them as well. A specific area for deeper research would be activities of virtual environments, like interactive and social games. Alternatively, the research could concentrate on haptic-enhanced chat: which kind of haptic actuators could be used, or how to express one self with haptics. Or, different small applications, like the poke feature of Facebook producing haptic sensations, could be provided to users for use, and the research task would be to follow the development of use patterns, namely how users start using them, which are the best ways of using, and which applications evoke interest. One more research item would be to think about supporting haptics in potential augmented reality systems of mediated social interaction.

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Appendix 1: Questionnaire

QUESTIONNAIRE

This questionnaire relates to Hypermedia studies at University of Tampere (Finland). It is a part of the MSc thesis work studying the role of haptics (e.g. sense of touch) in social networks of the Internet. Facebook (FB) is one of the well-known implementations of the online social networks. You may consider also other similar implementations in your answers even if the question explicitly mentions the Facebook.

The target group of the survey is users of online social networks. The answering takes about 20 min. Answers are handled anonymously and no contact information is collected.

Demographics

Age

Select
- ○ <16
- ○ 16-21
- ○ 22-40
- ○ 41-60
- ○ >60

Sex

Select ○ **Male** ○ **Female**

Nationality

Select ○ **Finnish** ○ **Other** which? [ ]

Computer experience

Select
- ○ Professional / Computer expert (e.g. programming)
- ○ Heavy user (e.g. used at work or school)
- ○ Some experience (e.g. internet use)

Experience (knowledge) of haptics or touch based matters

Select
- ○ Expert/good (e.g. theoretical information)
- ○ Some (e.g. use of displays having touch feedback)
- ○ None

Current social network use

Which social network services do you normally use?
- ☐ Facebook
- ☐ LinkedIn
- ☐ Plaxo
- ☐ Twitter
- ☐ Jaiku
- ☐ Other

Frequency of using Facebook in a typical use period

Select
- ○ At least once a day
- ○ Once a week
- ○ More seldom

Amount of Facebook contacts

Select
- ○ >80
- ○ 30-80
- ○ <30

Your role in normal Facebook use

Select
- ○ Active / conversation initiator
- ○ Responding based on other's input
- ○ Follower

Facebook use pattern

Select
- ○ Several short time visits (e.g. status updates or writing to others' walls)
- ○ Long sessions (e.g. using applications or online chat)
- ○ Varied

Devices used for Facebook
- ☐ Computer
- ☐ Mobile phone

Main purposes of use (select 1-3)

- ☐ Social interaction
- ☐ Maintaining frienships
- ☐ (Virtually) getting together and meeting friends
- ☐ Catching up
- ☐ Discussions/conversations about an interest or hobby
- ☐ Transfering or getting information
- ☐ Sharing own news and information
- ☐ Seeking or giving support
- ☐ Spending free time and refreshing
- ☐ Other

How well Facebook is suitable for social interaction?

1 (poorly) 2 (not so well) 3 (neutral) 4 (well) 5 (very well)

Select ○ ○ ○ ○ ○

Is something missing from social interaction when Facebook is used? Explain.
How much does it matter? Are improvements needed?

How well Facebook mediated interaction is able to convey either your own feelings or your emotions towards othe

1 (poorly) 2 (not so well) 3 (neutral) 4 (well) 5 (very well)

Select ○ ○ ○ ○ ○

Imagine the next major development step of online social networks. What would it be? How Facebook could or should be developed?

The role of touch sensation in future online social networks (e.g. Facebook)

How touch or sense of touch could be utilized in online social networks? You could think about exchanging touch perceived messages, virtually touching with others, or feeling 3D animals, avatars or other 3D objects. ?

In which kind of situations or in which Facebook activities the sense of touch could be utilized? ?

Potential use scenarios

1.

A bracelet, wrist clock, ring or another small wearable item has a wireless connection to your main Facebook device (a computer or mobile phone). The bracelet displays touch based messages or notifications received from friends. The received messages could be sensed as e.g. mild vibrations, color changes or changes in temperature. The bracelet could have different parts dedicated to different friends. You might also be able to send simple responses back to the sender by manipulating the bracelet.

2.

Text based status updates and discussions in Facebook are enriched with icons, like graphical smileys, producing touch sensations. The icons provide users an additional modality for expressing (own) feelings or the tone of a text message. Or, the icons may also serve as unspoken messages linked to pictures or sound. The icons are sensed via different means displaying touch sensations, e.g., a mobile phone producing touch stimuli.

3.

Facebook has a touch enhanced 3D space where people are able to spend time, get together and meet others online. Touch sensations complement the graphical view. The 3D room could enable activities like playing 3D touch supported games, touching 3D avatars of others (e.g., knock on shoulder, hug or shake hands), co-operating or taking any other actions (e.g., virtually drinking a glass of wine or featuring music). The objects of the 3D space can be felt via a mouse or other user controls producing touch stimuli. The device might also be for instance an elastic, flexible and modelable ball.

What's your opinion on the scenarios? Explain. (You may comment all in general or pick some.)

Which of the scenarios did you find the most interesting?

	1	2	3
Select	○	○	○

Explain why?

Which of the scenarios did you find worth implementing (at least with minor changes)?

	1	2	3	None
Select	○	○	○	○

Which kind of problems do you see with them? And how should they be changed so that you could think of using? (You may comment all in general or pick some.)

In which situations (places or contexts) would you think of using them? (You may comment all in general or pick some.)

To which kind of users or usages they might be suitable? (You may comment all or pick some.)

Solution characteristics

Which would be the most important characteristics of a haptic (e.g. touch) based Facebook solution? Select 1-3.

- ☐ Mobility
- ☐ Used as an alternative way of interaction
- ☐ Enriching interaction (by complementing other modalities)
- ☐ Simplicity
- ☐ Richness in functions and new experiences
- ☐ Quality of solution (e.g. touch feedback)
- ☐ Device independency (the same device can be used also for other purposes)
- ☐ Service independency (the same solution can be used also for other purposes)
- ☐ No new devices or equipment needed (operation embedded to the current ones)

Which are the most suitable contexts for utilizing haptics (e.g. touch)? Select 1-3.

- ☐ Contexts requiring silence
- ☐ Noicy and crowded contexts
- ☐ In move
- ☐ At home
- ☐ At work or school
- ☐ When isolated or alone
- ☐ When want to spend time
- ☐ When commuting, e.g., going to work

Which are the most suitable usages for haptics (e.g. touch)? Select 1-3.

- ☐ Expressing emotions
- ☐ Exchanging information (e.g. sending simple meaningful messages)
- ☐ Enriching social interaction (e.g. with non-verbal cues and structuring it)
- ☐ Enhancing feeling of presence of others
- ☐ A mean of being and feeling connected
- ☐ Comforting or supporting others or myself
- ☐ A new way of doing with others (e.g. feeling 3D objects, touching others, gaming or meeting others in virtual environment)
- ☐ A new way of spending time (e.g. manipulating 3D objects or creating touch based messages)
- ☐ Remotely touching others (e.g. to get other's attention or greeting)

How well haptics (e.g. touch) is suitable to the following types of mediated interaction?

	1 (poorly)	2 (not so well)	3 (neutral)	4 (well)	5 (very well)
One to one interaction	○	○	○	○	○
Interaction between multiple people (as in FB)	○	○	○	○	○
Simultaneous (synchronous) interaction	○	○	○	○	○
Assynchronous (people not present at the same time)	○	○	○	○	○

Feedback

Any other comments and input regarding the questionnaire or further ideas.