Development of a Natural User Interface for Mobile Music Players

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Mobile phones have been used as portable music players for a long time now. There is a growing interest in the use of haptics, NUIs (Natural User Interfaces) and gamification (game like mechanics) in the mobile applications but, unfortunately, there are no music players that implement one or more of these concepts effectively. The success of aforementioned design philosophies has created an interesting opportunity for me to develop an application and test how the use of these concepts could increase user satisfaction and provide an overall better and natural experience.

I developed a small music application for Android phones that used a wind chime metaphor for a music player application. The beads hanging by the threads played music when touched and provided visual and auditory feedback. The whole interaction felt more interesting and real than WIMP based interfaces commonly used in other music players.

The user testing reveals that the majority of the users liked the new interface more as the experience was more natural and engaging. The results demand more research into this area and development of a better prototype.

Key words and terms: real life metaphor, touch gestures, haptic feedback, mobile phones, music player, NUIs, gamification.

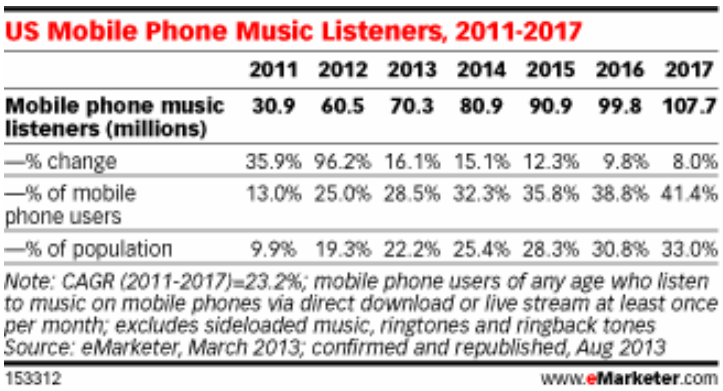
Contents

1. Introduction

Many people enjoy listening to music. In consequence, it is hardly surprising that since the introduction of the original Sony Walkman in 1979 portable music players have gained huge popularity over the years as a music listening medium.

Five years after Sony Walkman, people were thrilled to see yet another portable music player called Discman from Sony in 1984 which used disks as the new music medium. No significant progress was made in the industry until 1998 when a Korea's Saehan Information System released the world's first digital portable music player [Tai, 2010] called MPMan F10.

Currently, rather than using dedicated portable music players, users are increasingly listening to their music via a built-in music player on their smartphones [eMarketer, 2013]. Figure 1 shows a massive increase in the numbers in the recent years.



US Mobile Phone Music Listeners, 2011-2017

	2011	2012	2013	2014	2015	2016	2017
Mobile phone music listeners (millions)	**30.9**	**60.5**	**70.3**	**80.9**	**90.9**	**99.8**	**107.7**
—% change	35.9%	96.2%	16.1%	15.1%	12.3%	9.8%	8.0%
—% of mobile phone users	13.0%	25.0%	28.5%	32.3%	35.8%	38.8%	41.4%
—% of population	9.9%	19.3%	22.2%	25.4%	28.3%	30.8%	33.0%

Note: CAGR (2011-2017)=23.2%; mobile phone users of any age who listen to music on mobile phones via direct download or live stream at least once per month; excludes sideloaded music, ringtones and ringback tones
Source: eMarketer, March 2013; confirmed and republished, Aug 2013

153312 www.eMarketer.com

Fig 1. Music goes mobile as more smartphones users stream songs

This increase is not surprising as the mobile phones have become a personal companion for every user and the growth in the field of haptics has made it even more interesting [Immersion, 2011]. It is worth noting that the graphical fidelity of the mobile phone applications has become pleasing overtime as well. The shiny buttons, interesting animations and responsiveness has increased a lot.

The word haptic originates from the Greek verb hapto-to touch- and therefore refers to the ability to touch and manipulate objects. The haptic experience is based on

tactile senses, which provide awareness of the stimuli on the surface of the body [Mihelj and Podobnik, 2012].

With the development of touchscreen phones such as the Motoral A1200, HTC diamond, Samsung Smart F520 etc, new user interaction techniques have appeared. Such devices make use of touch gestures as the means of input data to allow for much easier user interaction; for instance, pinching gesture for zooming into photos and flicking fingers across the screen to move objects. Several user studies on mobile games show that user satisfaction has increased greatly with the use of advanced haptics [Ullrich, 2005; Wei et al., 2008].

The mobile phone users desire a friendly looking, highly interactive and a naturally controlled interface. Such an interface is easy and comfortable to use for the users. Since the advent of the mobile phones the graphical interface has improved a lot. The animations have become better and the graphics quality is sharper and clearer. There seems to be no noteworthy innovation in the interaction techniques used in the applications or in their design philosophies.

Typically we are able to use objects easily if they are familiar to us. Using real life metaphors is one way to make a friendly and easy interaction take place. Natural User Interfaces (NUI) is a related concept. NUIs allow us to design products that are more "natural" to touch and feel [Wigdor et al., 2011]. This can be achieved with or without a real life metaphor. For example, Microsoft Kinect [Kinect, 2014] is used in many applications to accept voice commands and visual cues. Moreover, TUIs (Touch User Interfaces) are used in many devices like tablets, smartphones and many others. This type of interface is very popular because it is the most intuitive type of NUI [Ogiela and Hachaj, 2015].

Although the majority of smartphones supports touch/tilt input and tactile feedback, these are not really used in the music players as the core interaction technique nor has it impacted on the look and feel of the music players. In fact, almost all music players have a standard look and feel i.e. a plain list of songs often accompanied by artists' or albums' graphic. However, if music players were to integrate haptics, NUI concepts and a visually pleasing interface, the attention of the users would be better engaged and it would result in a richer emotional experience. Over the years, the experience has been becoming more "personal but not dear".

We have all the technology available to us to create a visually pleasing music application for mobile phones that uses tactile feedback and implements game mechanics and NUI concepts.

In this thesis I explore the above mentioned concepts in detail and highlight their potential in the said area. I will also show that how there are almost no music applications available to use that implement these concepts. Afterwards I will propose my own solution which will provide for a unique and engaging music experience on mobile devices.

This thesis consists of seven chapters. In Chapter 2, I briefly describe the efforts done so far involving haptics, use of game mechanics, NUIs, real life metaphor and music. Then in Chapter 3, I propose my own system explaining the concept and possible interaction techniques used in it. In Chapter 4, I describe the development of a prototype which will be useful in drawing the conclusion of my research. In Chapter 5, I conduct user testing and compare the user satisfaction level compared to a reference mobile music player. In Chapter 6, I draw conclusions and state future possibilities for my research. Chapter 7 provides a summary of the entire thesis.

2. Background

Efforts to create visually pleasing, natural and close to real life interfaces and interaction techniques have been in progress for a long time. Similarly, vibro-tactile feedback, motion and position sensors have been in use in mobile phones for years. Mobile users find the use of haptics more intuitive, engaging and informative than simple touch gestures [Immersion, 2011]. Furthermore it makes perfect sense to use them with music players. The use of a visually pleasing and natural interface, game like mechanics, haptics and sensors will only make the experience easier, more enjoyable and personal.

Moreover, I will go over the related concepts such as NUIs, real life metaphor and Gamification and discuss in detail and explain how they can be crucial in the development of a portable music player. Nonetheless these topics are essential to my research and play a crucial role in the development of a successful prototype.

2.1 Sensors and haptics Available in Mobile Phones

I look at some of the sensors used in smartphones which can be incorporated in a music player.

These sensors measure acceleration forces and rotational forces along three axes. This category includes accelerometers, gravity sensors, gyroscopes, and rotational vector sensors. These sensors measure the physical position of a device. This category includes orientation sensors and magnetometers. Most modern mobile devices running Android, IPhone and Windows have these sensors.

Older phones have standard inertial haptic actuators and newer phones have Piezoelectric (piezo) or ceramic haptic actuators (HD haptics). Essentially they all produce vibrations but HD haptics create high definition vibrational effects on phones. HD haptics lets users feel more discernible vibration effects which result in an overall compelling and satisfactory experience [Rao, 2012].

2.2 Related work in Haptics

Shoogle [Williamson et al., 2007] is a novel, intuitive interface for sensing data within a mobile device, such as the presence and properties of text messages or remaining resources (see Figure 2). It is based around active exploration: devices are shaken, revealing the contents rattling around “inside”. Inertial sensing is used for a completely eyes-free, single-handed interaction that is entirely natural.

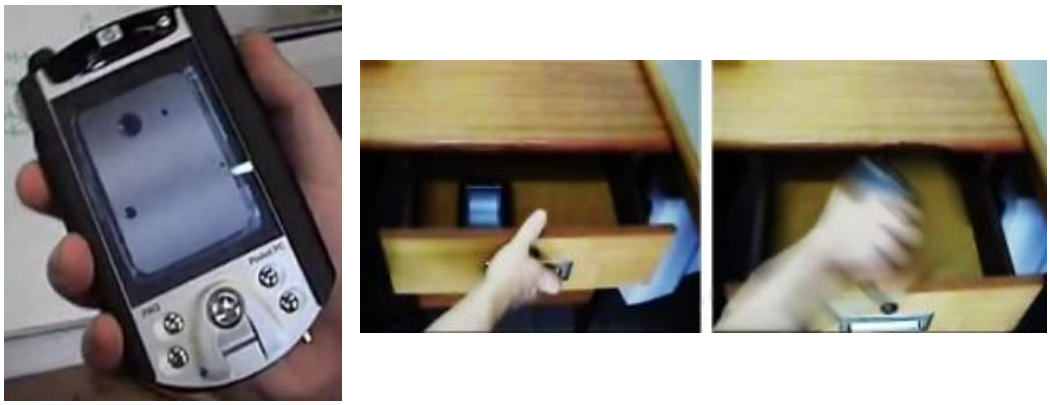


Fig 2. Shoogle. Newly arrived messages become balls and the phone can be shaken to know how many messages there are. This can be done without having to look at it.

The Immersion MOTIV [Immersion, 2012] development platform (SDK) integrates haptics into Android and provides haptics with quality and precision (see Figure 3). It is already used in at least 200 million phones including the Samsung Galaxy series and new smartphones from Nokia and LG.

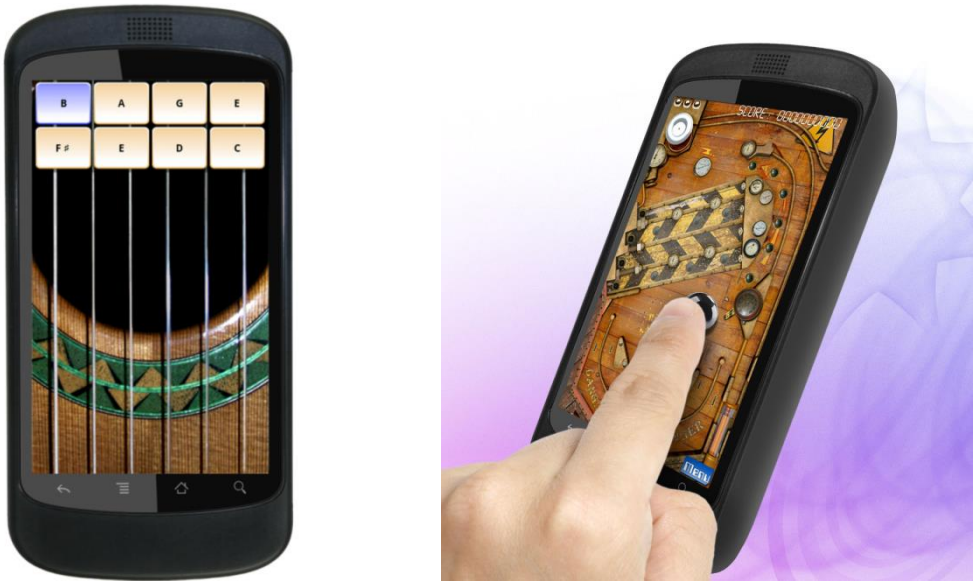


Fig 3. The following Android applications are using the MOTIV haptics framework.

Feel What You Hear is a music player application for Samsung Behold II which works on Android 1.5 (see Figure 4). It uses the TouchSense 3000 haptic effect system by Immersion [ref4] developed by [Baillie et al., 2011].

In this application a method of previewing audio is presented in the form of a haptic preview. The preview is used to enable users to "feel" the track they want to select, thus saving them from having to remember how the track sounded and having to look at the screen, before actually playing it.

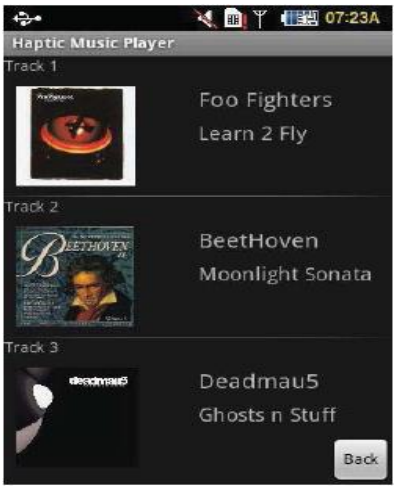


Fig 4. Feel What You Hear Interface

The results show (see Figure 5) that users enjoyed the combination of audio and haptic feedback and that users would very much like to see this type of sensory collaboration being incorporated into their own mobile device.

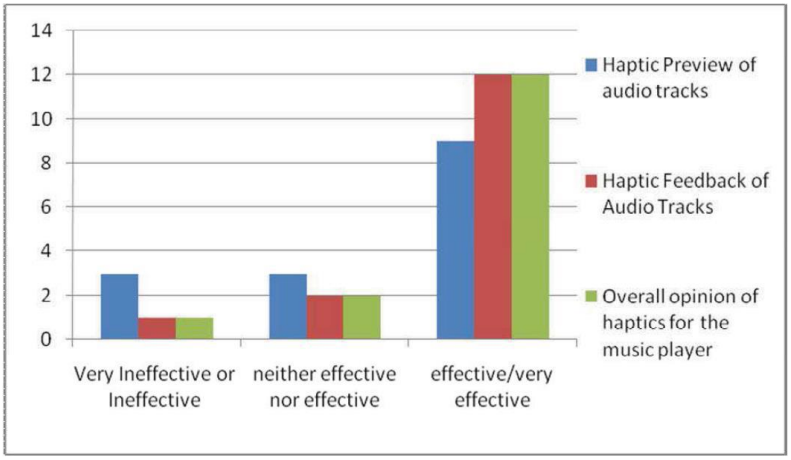


Fig 5. User Feedback chart on “Feel What You Hear”

Auto Haptic [Auto Haptic, 2012] is an application featured in Samsung Galaxy SIII smart developed by the Immersion Corporation [Immersion, 2012]. It automatically generates haptic feedback by monitoring the given audio track. It gives the ability to create custom ringtone vibrations.

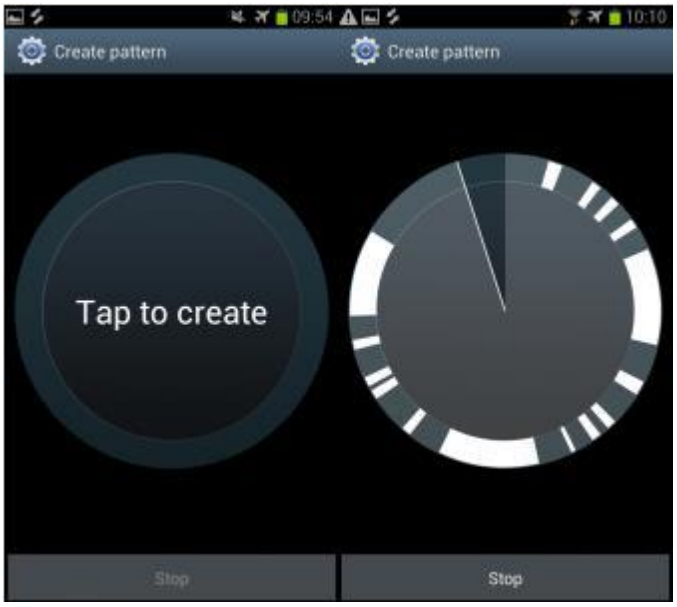


Fig 6. In Auto Haptic the user taps the circle to create unique vibration patterns.

Auto haptic is used in many applications nowadays. One more example is an Android game called Cut the Rope [2014]. In this game, auto haptic physics effects play an important role. The aim is to get the dangling candy into the mouth of a cute hungry creature. One can feel the candy swinging, how it drops and the rope is cut and how the creature munches on the candies.

The related work shows that a lot of research and effort has been made towards developing usable and fun haptic and motion based devices. While many different applications exist, none of them is an audio or music player which utilizes the above mentioned techniques as its core mechanic. One area which is seriously missed in existing music players is a user interface which provides an intuitive and interactive haptic experience.

2.3 The Gamification of Music Players

Gamification is a concept in which game design elements are incorporated into non-game applications or contexts. It is used to promote desired behaviors using game mechanics and dynamics [Deterding et al., 2011]

The concept was introduced in the early 2000s, but it did not get much attention until as late as the second half of 2010. This concept is applied in two ways: firstly to increase the acceptance of games in daily life [Schell; Helgason, 2010; Chatfield, 2011] and secondly to improve the non-game products with game design elements such as

look and feel, reward system and intensity [Zichermann and Cunningham, 2011; Flatla et al., 2011].

Gamification is predicted to take over many aspects of our daily life [Schell; Chatfield, 2011] and it is pertinent to the fields of software development and HCI.

Although there are no noteworthy music applications that utilize the visual dynamics of Gamification, nwplyng [nwplyng, 2014], available for both iOS and Android, utilizes the reward system (one of the aspects of gamification) and has been claimed to be the "First Music App with Gamification" by its developers (see Figure 7).

By identifying and sharing music, the application lets users progress through its reward system and earn badges which allow them to unlock music albums.

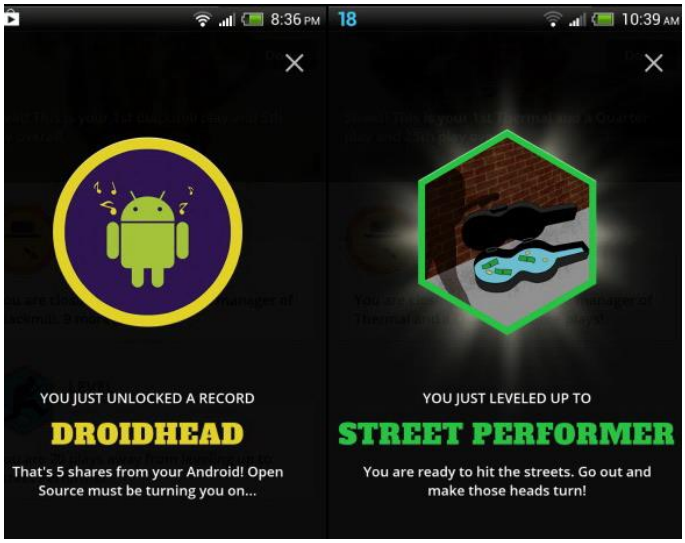


Fig 7. The user has achieved the DROIDHEAD badge and is half way through the STREET PERFOMER badge.

A second example is of the Viggle [Viggle, 2014] that rewards a user for watching television (see Figure 8). A user checks in while watching their favorite TV shows, shares them via social media sites and the application rewards them with points that can be used to buy electronics and gift cards from a number of retailers.

Fig 8. The Viggle application explaining how the points can be used.

There are barely any music applications for mobile devices that apply the look-and-feel aspect of Gamification. One of them is the 3D Music Player [3D Music Player, 2011] for Android that does everything the same way other applications do except it depicts songs as 3D cubes that can be touched to play music (see Figure 9). The rest is the same as an everyday music player. A playlist consists of 3D cubes that can be scrolled through via touch gestures.

Fig 9. The 3D Music Player while playing a song.

Another example is Player3D Music Player [Player3D Music Player, 2011] for Android that does the same as stated in the first example except that it utilizes a 2.5D image bearing the song's artist and the title which react to touch gestures (see Figure 10).

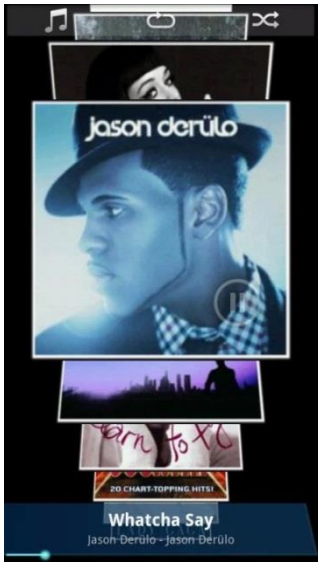


Fig 10. The Player3D Music Player while browsing through songs.

We have noticed that Gamification is already in use and its aspects, other than look-and-feel, are already in present in many applications. In our proposed system I will focus more on the look-and-feel aspect of gamification.

2.4 User Interface Metaphors

Generally, a metaphor is a thing considered as representative of some other (usually abstract) thing [Brown, 1993]. In the context of user interfaces it can be restated as: "A device for explaining some system functionality or structure by asserting its similarity to another concept or thing already familiar to the user" [Barr,2003].

We use metaphors to reason and understand the world around us. It is only natural that we try to understand our interaction with computers using metaphors. Metaphors can trigger familiarity and emotions. They can motivate users.

An example of a real life user interface metaphor is the Windows 7 trash bin. When a user deletes something it goes into the bin and it seems full (see Figure 11). The trashed items can be retrieved or discarded permanently making the trash bin look empty.

Fig 11. TheWindows 7 Trash bin: In its full and empty state.

Another example is of the Windows XP desktop (see Figure 12). The metaphor is quite good as we have a lot of objects on our real life desktop. A real desktop provides easy access to objects that are placed on it. Similarly, the Windows desktop contains shortcuts that allow access to different programs.

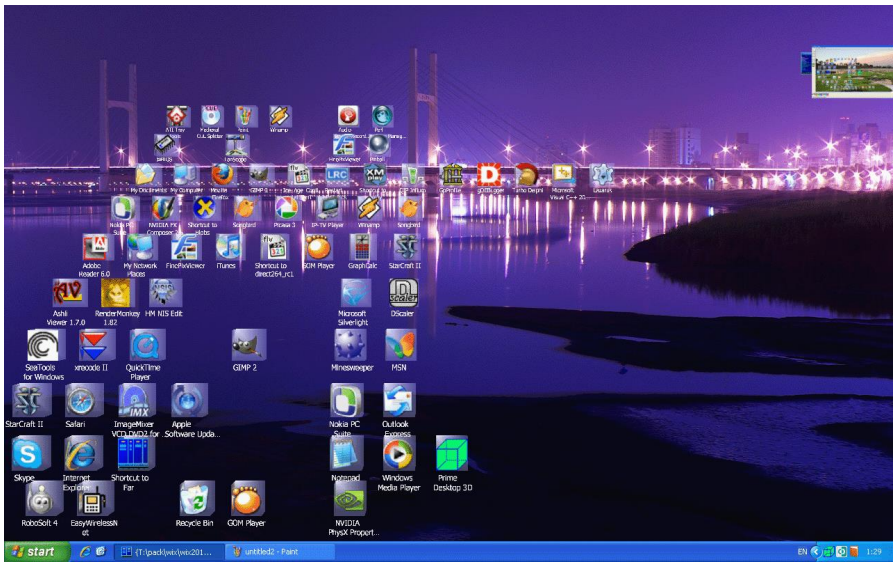


Fig 12. A Windows XP desktop with shortcuts on it.

In the Trash bin example we can neither take the items out by hand nor is any graphical representation shown when an individual item is taken out. Basically, there are only two graphical states, empty and full.

In the desktop example, the desktop does not look like a real world desktop! The concept is there, but the representation is a vertically flat surface with two dimensional objects on it.

Most metaphors used in applications are graphically poor and are partially realized. They do not exhibit most of their inherit attributes. There is no denying that when implemented properly they can be very powerful and improve the user experience

2.5 Natural User Interfaces

Most often the term “natural” is considered to mean mimicry of the “real world”. Natural User Interface is a design philosophy that enables an iterative process to create a product that is considered “natural” in the way users interact with and feel about the product [Wigdor et al., 2011].

NUI can be created with other modalities but in this thesis I will use gestural interaction as sensory and a real life metaphor as a visual modality.

The objective of NUIs is to provide easy to learn, intuitive interactions related to natural and everyday human behavior, hiding the complexity of human machine interfaces [Broy and Rümelin, 2012]. A NUI may make use of real world objects for metaphors.

NUIs employ one or more of the following ways to interact with the system: Touch, gesture and speech recognition, gaze tracking and brain machine interfaces.

On the other hand, the output NUI modalities include visual output which is rich and can present a large amount of information in a short time. Audio-visual feedback provides more intuitive and natural interaction for general users [Izquierdo, 2003].

Two recent applications provide good examples of NUIs. One of them is Etronika [Etronika NUI Banking, 2011] which provides a natural user interface that allows users to navigate through the online banking application using voice commands and gestures. This application uses Microsoft Kinect [Kinect, 2010] to track the movements of the user.

Another noteworthy example is of Kinectimals [Kinectimals, 2011] which is a game for the Microsoft Xbox 360 game console which allows the gamers to interact with cute animals using voice commands and motion gestures. The game became quite popular among children. This game uses Microsoft Kinect to recognize the user’s gestures.

Most applications claiming to implement NUI use body gestures and voice commands as input. Almost all of them ignore the visual interface (output modality) which is supposed to look and feel natural and implement some real life metaphor.

Perhaps Kinectimals is the most realistic example as it utilizes real life metaphors (animals with realistic graphics) and the interaction is done using hand and body gestures.

We should keep in mind that while designing NUIs we should fit the metaphor to the functionality, not the other way around [Saffer, 2005]. I did not find any working examples of NUIs for mobile devices.

2.6 Use of haptics, Gamification, a real life metaphor and NUIs in a music player

While we may not be sure of the success of audio, visual input and their use in the context of NUIs and mobile phones, haptics would nevertheless be a practical choice. haptics combined with audiovisual feedback provides a rich experience resulting in high user satisfaction [Rao, 2012].

According to a study conducted by the Immersion Corporation [Tactile Feedback in Mobile, 2011] the vast majority of users (about 90%) prefer HD haptics in mobile devices. Furthermore, according to the study, the users thought that the applications that utilized HD haptics made the experience more engaging (see Figure 13).

	Pinball			Frozen Bubbles		
	Prefer HD Somewhat/ Much More	**No Preference**	**Prefer No Haptics** Somewhat/ Much More	**Prefer HD** Somewhat/ Much More	**No Preference**	**Prefer No Haptics** Somewhat/ Much More
Overall Gaming Experience	76%	5%	19%	55%	19%	26%
Gaming is More Engaging	75%	14%	11%	66%	17%	17%
Will Make Me Play Better	63%	26%	11%	40%	40%	20%
Purchase the Game at an Acceptable Price	70%	9%	21%	43%	38%	19%

Fig 13. Preferences for HD haptics vs. No haptics in Pinball and Frozen Bubble Games.

It would be interesting to see how NUIs and gamification concepts can be utilized in a mobile music player. These concepts allow for providing a natural, pleasing and

user friendly experience for the users. Both concepts are a seriously missed opportunity in mobile music players and I did not find any suitable example that used those concepts. I plan to implement these concepts in my prototype.

The use of real life metaphor is probably the most important aspect of my thesis. It is interesting to note that piano applications and games based on piano playing are a success on mobile devices. A piano application essentially looks and acts like a real piano and, in most cases, in addition to visual and audio, provides haptic feedback. In the light of the applications reviewed I conclude that a music player which utilizes haptics, gamification, a real life metaphor and NUIs will be extremely engaging for users.

It should be noted that WIMP (window, icon, menu, and pointing device) interface [Heathcote, 2003] is the most dominating interaction technique used in mobile phones and computers. WIMP interface is so now so familiar that most of the users that it may be difficult to understand that other models for a user interface are also possible [Kumar, 2005].

3. SongBeads - The Haptic Music Player

As we have seen in the previous chapters that a music applications that implements NUIs, gamification and a real life metaphor makes sense and would be welcomed in a music player for mobile phones and maybe preferred over the application based on WIMP graphical interface.

The name of my proposed solution is SongBeads and this name will henceforth refer to the application in most instances. This chapter will help understand the meaning behind the name.

3.1 The Concept

My suggested music player application will consist of a real life wind chime having threads with colorful soft beads representing songs (see Figure 14). The beads will bear the title of the song. A bead can be touched to play music. As the beads are touched and moved, the music is played and various combinations of vibrations will be produced.

The concept of a wind chime is very natural and primitive. It is natural to think that when dangling objects are moved or touched they produce sounds.

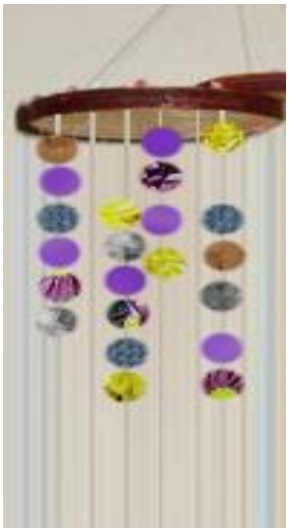


Fig 14: Early concept of SongBeads – my proposed music player

When in playlist creation mode, a user will see two threads at close range; one on the left and one on the right (see Figure 15). The left thread will contain all the songs, in the form of beads, from the phone memory. The right thread will be empty. A user will touch and drag or flick a song bead on the right and it will be added to the new thread. Each song bead will bear the song's title and the artist's name.

One can browse the playlist by stroking the beads up or down on the thread. The beads will roll realistically giving a nice haptic feedback.

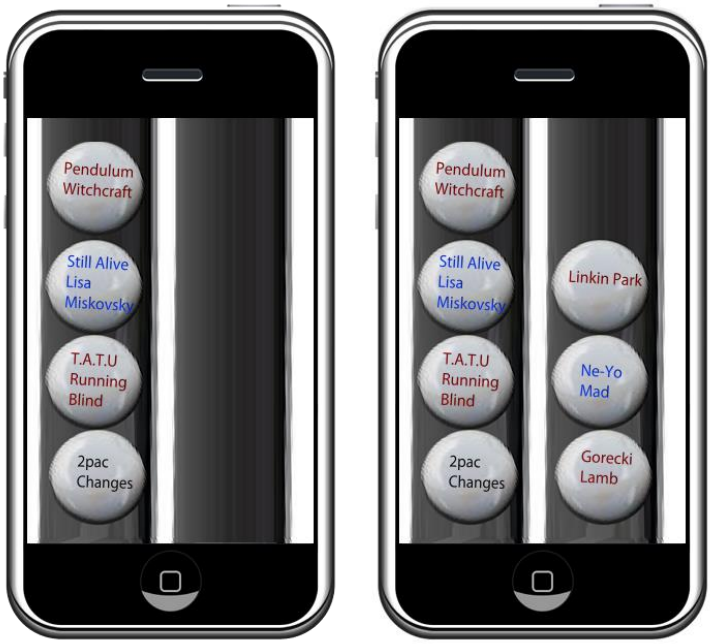


Fig 15: The SongBeads are added to the new playlist on the right hand.

3.2 The Playlist

One can select a thread (playlist) from the main view by tapping it twice so that it comes up into close range. The selected thread will come into full view and take up the entire screen (see Figure 16). SongBeads can be removed from the playlist by tap-holding one and wiggling it until it breaks away from the thread, giving an appropriate haptic feedback.

Fig 16. The playlist

3.3 The Song

A song bead can be played by tapping it twice, which will bring it into close up (see Figure 17). The bead will contain music in the form of energy that starts pouring out and splashes around giving off pleasing visual effects. Appropriate haptic effects will be produced as well.

Fig 17: To the left, a song is just starting to play, to the right, almost 70% of the song's energy has drained and it will end soon.

In order to stop the song one must tap the bead once. To keep the song playing in the background and to go back to the thread, one must simply double tap to exit the close up view.

To forward the song a user will swipe two fingers on the screen either from bottom to top or from right to left and the energy will drain from the song bead. Swiping two fingers from left to right or from top to bottom will fill in the energy, rewinding the song.

The concept includes almost all the important aspects of a real life metaphor, NUIs, gamification and haptics. The design is not the final representation of the product. I suspect challenges in many areas of its development. It is quite possible that not all of the concepts will be implemented in the final implementation.

4. Implementation

My music player prototype SongBeads uses Android platform. I used gdx library which allowed me to work with 2D graphics. I was using Android version 4.4.4.

All the interactions are performed using a single tap apart from adding songs which requires a user to tap and hold a song bead until it is added to the new thread. The application uses camera technique which allows the users to move the perspective up or down.

The main interface looks like wind chime and 18 SongBeads are loaded onto 3 threads with 6 on each one (see Figure 18). Every bead had the artist's picture, album and the song name on it. An empty thread was kept for adding more beads, i.e., to create a new playlist. For this prototype we are loading only a limited number of songs.

Fig 18: SongBeads - main interface.

4.1 The Playlist (thread) view

The playlist (thread) view is a close up of the wind chime. A user taps on any thread or any of the beads hanging by a thread and the wind chime zooms into a close up. As seen in the left hand site of the Figure 19, the first playlist is in the middle of the screen. At this point a user can tap and play a song bead or scroll through the songs by sliding the finger on the thread.

When a user moves his finger on the thread we actually move their perspective. So our camera which is essentially user's perspective is moved and the user can scroll to see any song they like.

Furthermore, in order to create a new playlist, the user taps on the empty thread and they can see a long thread with all the 18 songs on it. The user can tap and hold a song bead and it is automatically added to the new thread. This is shown in the right hand side of the Figure 19. It is interesting to note that when moving the thread, containing all the songs is moved, I actually move a second camera that I put in place. If at any time the user wants to go back, he can tap on the background and the camera will zoom out taking them away from the playlist view.

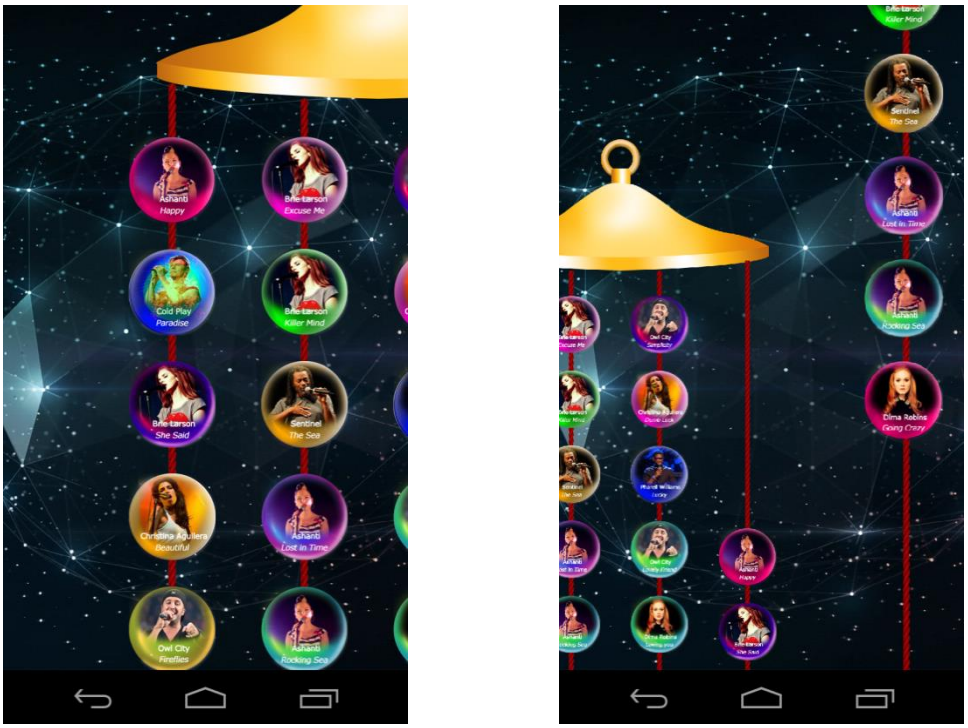


Fig 19. SongBeads – on the left, playlist view with SongBeads, on the right, new playlist mode.

4.2 The Song View

While in the playlist view a user can tap a song bead and the song will come into a close up. The song bead is colorful and it contains artist's picture which makes up the entire bead. The song bead also has the artist's name and the album name written on it (see Figure 20).

As the user taps a song it starts to play and a light green circle starts to appear from the center of the song bead. One can pinch the circle inwards to go back in time and pinch it outwards to go forward in time. When the circle reaches the edges of the song, the song finishes playing. If the circle is reduced to a dot, the song starts from the beginning. Furthermore, a single tap pauses the song and another tap again plays it.

To give it an interesting look, I used some particles in red color which were bound in a circular shape. They would move when the song would play and stop moving when the song was paused.

If at any time the user wanted to go back, he could tap on the background and the camera would zoom out to the thread view. A further tap on the background would zoom out further and show the entire wind chime.

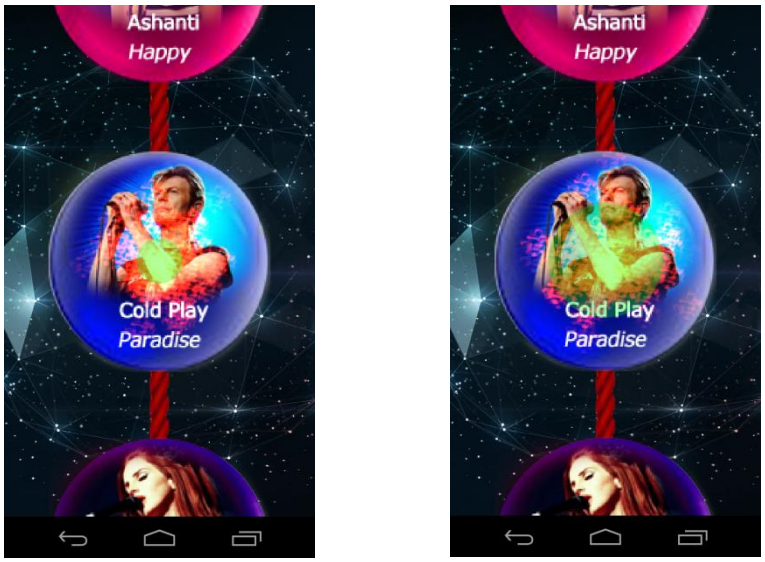


Fig 20. SongBeads – on the left; the song is just beginning to play, on the right; the song is almost halfway through.

4.3 Technical problems and changes in implementation

Due to technical challenges there were a few changes that had to be made in the final product.

Lack of haptics: The biggest change was that I could not incorporate haptic effects into the application. That was probably the only major change from the planned implementation.

My initial idea was to use haptic effects to a greater extent but due to lack of time towards the end of development I decided not to include them. Since in our testing we will test our application against another music player which also lacks haptics, I am confident to assume that had I used haptics effects, the experience would be even more enjoyable. This opinion is based on Section 2.2 of this document where we had established that the use of haptics is liked by the users in music applications.

Tap-hold rather than drag and drop: When in new playlist mode, I had planned users will drag and drop beads from the thread, which contained all song beads, to the empty thread. Due to lack of time and skills, it was not done. Instead a user would tap and hold a song bead from the parent thread until that song is added to the new (empty) thread.

This change may affect user satisfaction level and it also takes us a bit further from our metaphor and NUI concept.

Song energy effect: In my initial concept defined in Chapter 3, I had proposed that the beads were full of song energy and as the song progressed in time the energy would be released and it could be seen hovering around the song bead. We would also notice that the song bead had become hollow. The energy could be pushed back into the song bead to go back in time.

The idea described above was phenomenal and it appealed to the mind as we will see it in the next chapter as well. However, due to lack of skills and time, I decided to leave it out and used a static energy effect which would not leave the bead and the timing would be controlled by pinching the green circle in and out as described in detail in Section 4.2.

Without doubt this missing feature would impact on the user satisfaction level and believability of our real life metaphor.

5. User testing and evaluation

As soon as I had developed a fairly stable and testable version of SongBeads, I set out to test it. I decided to do the testing at the premises of the university. The details of the test process are available in Appendix 1.

5.1 Setup and participants

I decided to compare our system against another fairly popular audio player from Android app store. The player I used was called "Music Player for Android" [Music Player App, 2014]. That music player is fairly popular and has over 10 million downloads. The version of the player I used was 4.1.0.7.

My aim for testing was not efficiency or how fast the application was but how well the user metaphor made sense to the users and if it felt pleasant for not.

The subjects were contacted through social media marketing and personal invitation. They signed up using an online sign up form and booked their time slots.

Eleven subjects participated in the testing. Four of them were females and seven were males. Almost all of them were students and a couple of them were employed. Their ages were between 20 and 35. Six subjects stated they were beginners or average users of mobile music players and five subjects stated they had good or excellent with music players.

The subjects were seated in a comfortable room of the usability lab at the university and were shown how to use both music applications. Once they understood they were given some tasks to perform on both music players like creating a playlist, playing songs and testing the song controls. After the testing, the subjects were asked to fill in the user satisfaction forms. Afterwards, the users were interviewed as well to get their feedback and future expectations.

5.2 Results and statistical analysis

The following are the results from the user satisfaction form. The result data is shown as a question followed by user choices available for that question. Every user choice has a numeric ratio result under it showing how many users picked that choice for SongBeads and the reference application.

The numeric ratio result is shown as (number of times SongBeads was picked) / (number of times the reference application was picked).

5.2.1 User Satisfaction Form results

1. How easy it was to create a playlist?

Very easy	Easy	Quite OK	Quite difficult	Very difficult
3/1	7/2	1/6	0/2	

2. How easy it was to control a song?

Very easy	Easy	Quite OK	Quite difficult	Very difficult
3/5	2/5	6/1		

3. How pleasant was the song view?

Very pleasing	Quite pleasing	Quite OK	Quite displeasing	Very displeasing
4/0	5/1	2/8	2	

4. How pleasant was the entire application?

Very pleasing	Quite pleasing	Quite OK	Quite displeasing	Very displeasing
1/0	8/2	2/8	0/1	

5. Did you feel any sense of reward/accomplishment after creating a playlist or controlling a song?

A lot	Yes	Quite OK	No	Not at all
	5/0	5/4	0/5	1/2

6. How much sense the application metaphor makes to you? (Is that how a music player should look and feel?)

A lot sense	Good sense	Quite OK	Less sense	No sense
2/2	7/3	1/5	1/0	0/1

7. Would you like to use this player once it is completely polished?

Of course!	Yes	Maybe	Not sure	No
2/0	6/5	2/3	1/3	

The most important statistics are shown in Table 1. The choices the subjects selected are under the column “Choice selected”.

Question	SongBeads	Choice Selected	Reference application
How easy it was to create a playlist?	27%	very easy	9%
	64%	easy	18%
How easy it was to control a song?	27%	very easy	46%
	18%	easy	46%
How pleasant was the song view?	36%	very pleasant	0%
	46%	quite pleasant	9%
Entire application was pleasing	9%	very pleasant	0%
	73%	quite pleasant	18%
Sense of reward/ accomplishment	46%	yes	0%
Application metaphor makes sense	18%	a lot of sense	18%
	70%	good sense	30%
Use this application once finalized?	18%	of course	0%
	56%	yes	46%

Table 1: Highlights of the most important results.

5.2.2 Interview results

The following questions were asked in the interview. They are presented below with brief discussion. There are no quantitative statistics available for that and almost every participant said similar things.

Do you think its interface is interesting and engaging? It is evident from the user satisfaction form that the users liked the user interface. But it was further cleared by their thoughts. The more they discussed it the more sense it made to them. They realized that they actually never thought about the WIMP interface being logical or not, interesting or not, but they just preferred it due to familiarity. The discussion revealed that users definitely liked the user metaphor and found it very interesting. The majority of the users said they thought the interface was much more natural to use.

What are the drawbacks of the application you perceive? Users thought that it would be difficult to show more songs on a single wind chime. They also wondered how it would be possible to have different albums and artists. Once they were explained that I

had planned to use more wind chimes for albums and artists, more threads per wind chime and more songs per thread they realized that everything made sense to them.

Do you have any suggestions on how to improve it? User suggestions were almost the same as I have already mentioned in the future work of this document. Almost all of them argued that SongBeads would look much better and make more sense if it has utilized 3D graphics. They even suggested that it should have real time physics and it should react to touch gestures and act like a real life version of the same concept.

Would you like it even more if it used haptic effects? Since I did not incorporate haptic feedback into the application, this question has to be asked and the results were predictable. All users wanted haptic feedback and they were certain it would make more sense since the future product will be 3D and include real world physics.

5.3 Evaluation

The results are highly satisfying and they show how users welcomed the new concept. Almost in every instance more than half of the users favored SongBeads over the reference application. Next I evaluate the user satisfaction form and interview results in detail.

5.3.1 How easy it was to create a playlist?

Ten of the eleven users said that it was easy or very easy to create a playlist in SongBeads because the interface was very clear. Technically, there was only one user view. Users did not have to deal with any texts along the way, for example, create playlist, add a song etc. The process was simple; they just had to tap on a new thread and a big thread would appear containing all the songs. They would then tap and hold a song bead until it was added to the playlist.

On the other hand, on the reference music player a user would go to all songs and then tap and hold a song until it would pop up a menu with different options on it. From that menu he would then tap “add to a playlist” which would result in an additional pop up asking them whether he wanted to add the song to an existing playlist or create a new playlist. In our instance a user tapped on new playlist which results in an additional pop up where he would give a title to the new list and the song would be added to it.

Without any doubt both experienced and novice users disliked so many popups and sheer amount of complexity involved in the process on the reference application. Some of them used both of the systems again before answering the question to make sure they were right.

Although this question was not as important to us as others because it was a question of efficiency and we were not testing for efficiency. We were testing to see if our user metaphor made sense and how pleasing was the entire idea. But seeing the number of users that found the interface was easier to perform this task shows that when a real life metaphor is used properly it can be efficient as well.

5.3.2 How easy it was to control a song?

It is not surprising to know that almost three times as many users thought the reference application was easier in terms of forwarding and rewinding a song. The reference application used a time seek bar which works with one finger and you can see the time listed in the front of the bar for a precise movement. That player is a popular application and has been in the market for a long time.

On the other hand my design is not complete. It has gone through two iterations only and has been developed by a single person. My early idea was to implement SongBeads with musical energy inside which could be pushed in and out with a single finger gesture. Upon interview it is clear that if one finger gesture is included into SongBeads, users will prefer it over the reference application.

5.3.3 How pleasant was the song view?

Nine of the eleven users thought that the song view, when a song comes into full view with its title and other details, was either quite pleasing or very pleasing in SongBeads compared to eight users who said it was “quite okay” for the reference application.

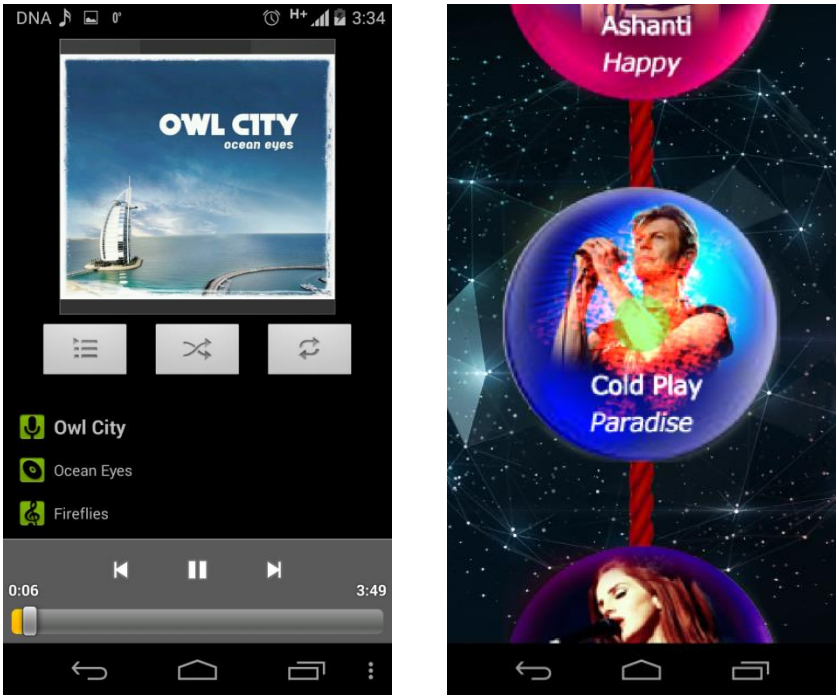


Figure 21. On the left the song view from the reference application, on the right, SongBeads song view.

It seems clear that users liked the song view more in SongBeads because it used big pictures of artists as part of SongBeads themselves and a fiery particles effect was going on inside the beads but from the interview results it was made clear that since the whole application made sense to the users they also liked the song view. The more users thought about it when answering the questions they realized that they liked the simplicity of SongBeads. As seen in the Figure 21, the reference application uses way too many on screen objects and options.

5.3.4 Was the entire application pleasing?

Most users thought that SongBeads was pleasant or very pleasant in its entirety compared to just two users who thought the same about the reference application. As seen in Figure 22, the reference application looks good as well but the fact that users could tap back and keep the whole appliaction in perspective felt very pleasing and natural to them. Users liked the wind chime metaphor and preferred it over the WIMP interface that the reference application implemented.

As many as eight users thought that the reference application design was “quite okay”. As said before the discussion and interview revealed that users were just used to the WIMP interface and it may not be pleasing but it works.

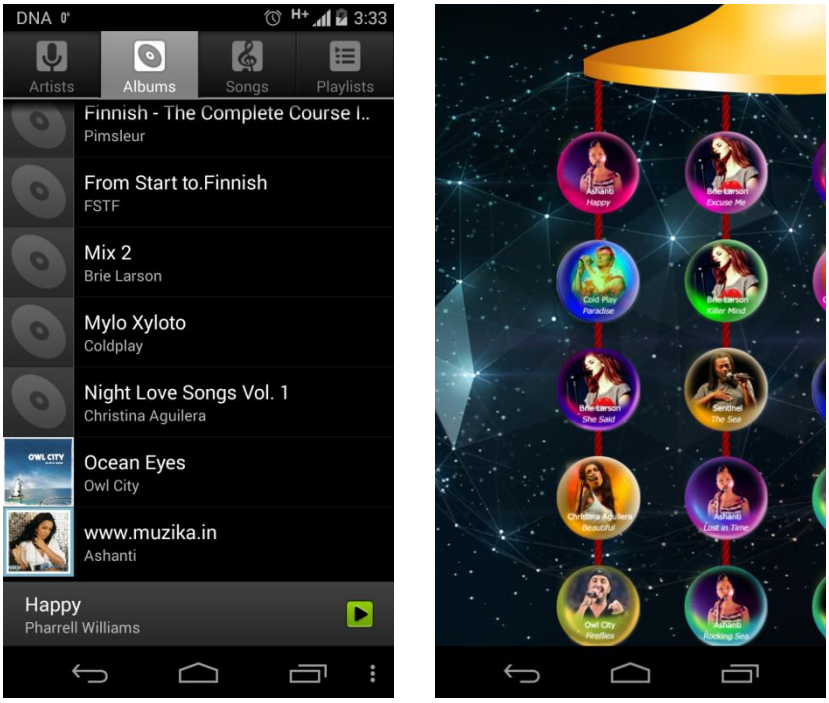


Figure 22. On the left the playlist view from the reference application, on the right, SongBeads playlist view.

5.3.5 Sense of reward or accomplishment

Five subjects thought that they felt some unique sense of reward or accomplishment when using SongBeads as opposed to none who shared the same thoughts for the reference application. However, almost an equal number of users thought that they had neutral or "quite okay" feelings for both the applications in this regard. The interviews revealed that users did feel they were interacting with a more graphically advanced and engaging application which gave them good feelings.

In post-WIMP world, users are expected to interact through activities rather than simple actions [Beaudouin-Lafon, 2000; Beaudouin-Lafon, 2004]. When subjects manipulated the camera view to locate the beads and threads or when they used song controls or added beads to an empty thread, they felt they were engaged in meaningful and interesting activities rather than performing some simple actions or button presses.

5.3.6 Application metaphor makes sense

It is interesting that more than twice as many users compared to the reference application said that the wind chime metaphor used in SongBeads made "good sense" to them. Those who preferred it was a mixed bag of experienced and casual users. But clearly most novice users preferred SongBeads.

Upon discussion it was revealed that the users who thought that the WIMP interface of the reference application made sense did so because it actually "worked" and they were familiar to similar interfaces for a long time. They also said that it gives the impression of "making sense" but they admitted it did not actually use a real life metaphor nor it made sense when compared to real life.

It should be noted that the majority of the users that preferred the reference player's design were experienced users.

5.3.7 Use this application once finalized?

The findings of this question need some consideration. Seven subjects of the eleven said they would want to use SongBeads as a music application over five who favored the reference music application. The interviews showed that the experienced users who found SongBeads interesting and pleasing still decided to use the reference application because they felt they were more used to that interface and they could work with it more quickly and efficiently. However the same group was hopeful for the future of SongBeads but they were not entirely sure because the wind chime metaphor was not familiar for them. On the other hand most novice users favored the wind chime metaphor and they found it both easier to use and natural.

6. Discussion and future work

In the introduction and background chapters I had introduced haptic feedback, NUIs, user interface metaphor and gamification. All of these topics are very important in creating a functional and user friendly application. I did not find any music application for mobile phones that incorporated all the concepts. While I did find some applications that used haptic feedback and a user friendly interface, I did not find any that used a real life metaphor or gamification.

Keeping the above in mind the main aim for my prototype was to use some aspects of NUIs, user interface metaphor and some aspects of gamification. Since a natural interface and touch gestures are a part of NUIs, as discussed above, I can state that my prototype made use of NUIs as well.

I explain below that to what extent I used the aforementioned topics and how successful my solution was.

6.1 Haptic feedback

It is clear that the use of haptics not only makes sense but is very pleasant for the users especially in mobile phones. We have seen in Section 2.2 and in Figures 5 and 13 that users favor HD haptics over no haptic feedback. For the same reason there was a desire to incorporate haptic feedback into my proposed solution as well.

However, due to project development cycle exceeding the planned schedule, I could not implement haptic feedback into my application. I do realize that it would have resulted in a much better user satisfaction results but the results are already quite remarkable. The discussion with users revealed the same thoughts. It should be noted that the reference player did not have any haptic feedback as well.

6.2 Natural user interfaces

As discussed before, Natural User Interface is a design philosophy that enables us to create a product that is considered “natural” in the way users interact with and feel about the product [Wigdor et al., 2011].

In my prototype I focused on using gestural interaction as sensory and a real life metaphor as a visual modality. Replacing the complex interactions with intuitive interfaces and simple everyday human interactions is also part of NUIs [Broy and Rümelin, 2012]. The user satisfaction and interview results show that users found SongBeads to be natural, easier and simpler to use.

Considering Chapter 2 we can see that we do not find any music application for mobile phones that uses natural interface or hides complexity with easier to use and every day human interaction metaphors. For example, our reference music application places a lot of user interaction objects and other information in its song view. Only experienced users found it easier to use but all the novice users and about half as many experienced users preferred SongBeads.

Furthermore, SongBeads used wind chime user metaphor which felt more natural to the users. The results show that the whole concept made more sense to majority of the users. The reason some experienced users still preferred the WIMP interface which the reference music application used was only due to familiarity. WIMP is a dominating interaction technique in mobile phones, computers and almost every other computing device. In fact almost everyone is used to WIMP interface and most people find it familiar.

The results show that if my prototype will be developed further it can compete with music applications that use WIMP interface. It is also clear that many novice users who may have used WIMP interface before but they did not use a WIMP based music application favored SongBeads which felt more natural to them. It would be interesting to see what would happen if we had more novice participants or children have not become used to the WIMP interface yet.

I also perceive that this application can be quite successful with people who are quite old or too young to fully understand WIMP interface. Since SongBeads does not rely on textual information for its interaction and uses large size graphics, it can be easy for the aforementioned group.

6.3 Real life metaphor

I discussed before how real life metaphors can trigger emotions in the users and make the human computer interaction easier. Many people know about wind chimes and even if they don’t, they can guess that dangling objects will make sounds if they are solid or if they collide with one another. That was the reason that almost twice as many test users said the wind chime metaphor in SongBeads made more sense to them compared to the WIMP interface used in the reference application. Similarly nine of eleven users said that the entire application was pleasing or very pleasing compared to two users who said the same for the reference application. This clearly shows that power of a correctly used metaphor.

I did not find any other mobile music application that used a real life metaphor. We did see that if metaphors are used appropriately they help users become familiar to the application very quickly. User satisfaction results and the interviews revealed that users not only liked and understood the wind chime metaphor but they expected more realistic behavior from it. For example some of them thought of the possibility of having wind blow through the wind chime and make the beads to collide and play a random song. Others immediately understood there can be multiple chimes representing different albums or artists.

Localization is a complicated and expensive process [Esselink, 2000] and it comes with a lot of "cultural localization" issues which are harder to cope with [Khosrowpour, 1997; O'Hagan and Mangiron, 2013]. A huge benefit of wind chime metaphor was the reduction of text based instructions. At the moment, the only text is on the beads bearing the song's information. But users can still identify an artist by just looking at his face on a bead. In many places the user metaphor is speaking indirectly to the user where a textual instruction would be present. For example, when a user sees the empty thread, he realizes it is missing beads (songs), upon touching the thread he sees another long thread by its side which has a lot of beads (songs) which he can bring to the empty thread. This text-less design principle is very powerful. It has the potential to save a lot of localization (translation) efforts which is usually required with WIMP based interfaces.

I think the above mentioned findings are remarkable and they prove that if a metaphor is used correctly it can provide simple interaction techniques for all the complex functionalities and concepts. Although just a prototype, the wind chime metaphor turned out to have a great potential for future research and possible improvements.

6.4 Gamification

In Chapter 2 we saw that the look and feel and reward system aspects of Gamification are already in place in some of the mobile music applications. My focus was to incorporate the look and feel Gamification.

The user satisfaction results show that five users thought that using SongBeads gave them a feeling of being rewarded or accomplishment. The results further show that users enjoyed using the application and felt they were interacting with a real life object rather than an electronic music player. When users put beads (songs) on a thread it feels

as if they are playing a game. The entire application is so colorful that eight of the users said it was quite pleasing compared to two who said the same about the reference application. Although users were not asked directly if they felt like playing a game but based on their response to how pleasing they thought the entire application was and how interesting the user metaphor was, I am confident to state that SongBeads did play out like a game.

It is interesting to note that SongBeads was developed as a game. It uses 2D graphics engine and has two cameras that represent user view. When users are browsing or manipulating the application they are actually changing the camera positions. This is completely different than how most WIMP interfaces are developed and how the reference application was developed.

Based on user interviews and my own ideas about SongBeads' future development, it will actually play like a game and have 3D graphics.

6.5 Future work

Based on the user results and the discussion that preceding discussion I found out that SongBeads has a lot of potential for its future. Some of the most important future concepts are as follows:

Haptic feedback and tilt and motion gestures: We have seen that haptic feedback makes the applications more fun to use and experience more credible. Since my application uses a real life metaphor it would a lot of sense that when beads collide with each other they should produce some sort of haptic feedback. It would also make sense if users were able to title their phones to move, rearrange and shuffle the beads (songs). Furthermore, different haptic feedback effects can be used to identify different threads.

Shake gestures: There is a need to find a way which will allow the application to recognize shaking while the phone screen is locked. This could be useful as one can simply shake the phone, feel some haptic feedback as the beads collide or move along a thread, and be able to shuffle or switch songs without having to unlock the phone first. Many other features can be implemented using the sake gestures. For example when on a thread (in a playlist), shaking the phone along the y-axis will shuffle SongBeads in that thread only. This is a very useful feature since it will be eye-free. In order to select

a song to play from a thread the user can shake the phone up and down (z-axis) and it will play. Doing the same will pause the playing song.

3D wind chime, physics and wind effects: The wind chime will be made 3D so that it can be manipulated even more realistically. The wind chime will have 3D beads as well and it will be able to rotate around its axis. Wind effects will be added as well so that as the wind blows randomly the beads collide and play different songs for a couple of seconds before finally playing a random song. This will require physics to be built into the wind chime. Users will be able to touch the wind chime with a bit of force to shuffle the beads.

Song energy effect and single touch song controls: As discussed before it would make more sense to present the beads having musical energy filled inside them which will be released and float around the bead as the song plays and can be pushed back in with a finger. At the moment it requires two fingers to control the song's timeline. Having one finger to push the energy will make the application easier to use. This concept was discussed with the users and they said it would make the application more believable and engaging.

More threads (playlist) on a single wind chime and multiple wind chimes: At this point SongBeads shows 4 threads on a single wind chime and a limited number of songs on a single thread. As the wind chime will be made 3D it will be able to rotate around its axis and hold more threads. Since there can be more songs than that can fit on single chime, more wind chimes will be made available. Users can swipe left or right to move to a different chime.

Automatic creation of different wind chimes based on artists, albums: Multiple wind chimes will be created automatically upon detecting multiple artists, genres, and albums on a user's phone. Every wind chime head and thread will be assigned a different color to be uniquely identified. Wind chime head can also show an artist's or album's box art graphic.

Users can customize wind chimes: The users will be able to customize chime heads, threads and the background environment. For example they can put a custom graphic

for the chime head or download different chime heads created for SongBeads. Equally so, they can change the background themes, for example a balcony theme where moon is shining and wind blows softly. This will give users a personalized experience.

Online sharing and downloading: Just like any online music library, SongBeads can also have its online server and users can browse, download and share chimes.

A real life wind chime product: A real life product will be made where customers can actually buy a wind chime player with beads on it. They can buy both the wind chime player and the beads or just the beads and use it with a previously owned wind chime player. The wind chime player will use batteries. The player will play songs upon touching beads, shuffle songs when struck or shook hard enough and play a random song as the wind blows. Since the product will be beautiful and customizable with different chime heads, it can become an amazing addition to the interior décor of one's home. Such a product will also be very easy for children, old people and those who stay away from technology.

7. Summary

The use of mobile phones is growing every day and every year. More and more users are using their phones for listening to music [eMarketer, 2013]. While mobile music players have provided an easy access to music they have not offered a pleasing, natural, easy to use and an innovative music experience to the users.

My test results show that there is a great potential for NUIs, gamification, real life metaphors and haptics to be used together to create an engaging music player application for mobile phones. SongBeads has proved that it is not only a successful music player prototype. It is a real life metaphor used correctly. There is no concise blueprint for the post-WIMP world and hence no established design philosophies [Gallud et al., 2011]. My application provides some interesting design principles that can become a building block for that post-WIMP world.

I am sure that if SongBeads is developed further and it improves on the concepts that gave birth to it, it can open interesting research questions. For example, after DOS and WIMP, can such a natural user interface be the next step? If yes, then to what extent? Can we build complete operating systems based on the same concepts?

I think that if we pursue the answers to the above mentioned questions we can achieve interesting results and perhaps develop systems that will revolutionize how we perceive and apply information technology and human computer interaction.

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Appendix 1

1. Introduction – Test Case Plan

The usability of SongBeads will be evaluated against a generic Android Music Player. The goal of the evaluation is to provide the developers with a general evaluation of the ease of use, effectiveness of the real life metaphor and aspects of Gamification used in the application.

This report will briefly describe the application under evaluation and a simple plan for its usability testing.

The participants will be provided with pre-formulated test tasks (prepared so that they will target the issues that are on the focus of the evaluation). In addition, data will be collected with interviews and questionnaires.

According to the ISO-9241-11 standard, the criteria for usability are effectiveness, efficiency, and satisfaction. The following measures will be used to evaluate different aspects of usability:

1. Evaluating effectiveness
    - % of tasks successfully completed
2. Evaluating efficiency
    - Task times
    - Ease of use
3. Evaluating subjective satisfaction
    - Interview results
    - Questionnaire results

2. Description of the Songbeads and its users

Overview of the application and focus of testing

Songbeads is a prototype music player for Android devices developed for my Master's thesis. The application uses a real life metaphor of a wind chime which contains a few threads holding breads. Every bead represents a song and every thread represents a playlist.

The usability test will focus on evaluating the following:

- Navigation of the system

- How easy it is to create a playlist
- How easy it is to control a song using the metaphor, like to play, forward etc
- Level of satisfaction while interacting with the application

User groups

SongBeads is designed for people of every age but given that the prototype does not represent the final product it may not be yet easy enough for a very younger audience. The main user groups are young and middle aged mobile phone users with varying skill levels.

The users will be selected from the university students and staff. Some students who study at a university other than the University of Tampere will be selected as well. Close friends will not be considered to avoid any potential bias.

3. Usability testing

The pilot test will take place on December 2nd and 3rd, from 10 am to 4pm, given that the usability lab is available by then. I will prepare the lab starting from 15 minutes before the participants arrive at 10 o'clock. The usability lab is located in the Pinni B building, room 1067 of the University of Tampere. The location will be pointed out to the participants well in advance in order to avoid any delays.

Technical context

The test will be run on an ordinary Android phone running the 4.4.4 version. The size of the screen is 4.5 inches and the resolution of the screen will be 1280×720. A generic Android music player will be used as well for comparison.

Some training on the new application

Since almost all the android music players use a standard layout, it is easier for users to accomplish tasks due to familiarity. In contrast my application is completely new for the users; therefore they will be given a brief overview of how the controls work.

The following tasks will be done on the reference music player first and then repeated on SongBeads the music player.

Test tasks

Practice task	Play a song from the already existent playlists (threads) for a few seconds and then pause it
Start state	The player's main interface is open.
Rationale	The purpose of this task is to get the user used to the interface.
End state	The user has successfully played and paused a song.
Estimated task time	Less than a minute.

Task 1	Create a playlist and add 4 songs to it.
Start state	The player's main interface is open.
Rationale	The purpose of this task is to test the ease of use and navigation and the efficiency of the controls and the real life metaphor used in the application.
End state	The user has successfully added 4 songs to the list.
Estimated task time	Less than 2 minutes.

Task 2	Add the songs "Cold Play – Paradise" and "Owl City - Fireflies" to the previously created playlist and then play both songs a bit and pause.
Start state	The player's main interface is open.
Rationale	The purpose of this task is to test the ease of use and navigation.
End state	The user has successfully added 2 more songs to the playlist.
Estimated task time	Less than 3 minutes.

Task 3	Play a song from any playlist (thread) and use the song controls: forward and backward
Start state	The player's main interface is open.
Rationale	The purpose of this task is to test the efficiency of the song controls. Also we test how pleasant the song view is for the user.
End state	The user has successfully played and manipulated a song and paused it by the end.
Estimated task time	Less than 2 minutes.

Task 4	Play 3 different songs from different playlists.
Start state	The player's main interface is open.
Rationale	The purpose of this task is to test how easy it is to play songs from multiple playlists.
End state	The user has successfully played and manipulated a song and paused it by the end.
Estimated task time	Less than 2 minutes.

Interview frame

After the usability test, the users will be interviewed. The interview type is a semi-structured interview. The interview will take 5 minutes at most.

The interview will cover the theme listed.

Theme : The user's opinions about SongBeads and its concept.

- Do you think its interface is interesting and engaging?
- What are the drawbacks of the application you perceive?
- Do you have any suggestions on how to improve it?
- Would you like it even more if it used haptic effects?

Questionnaires

A user satisfaction questionnaire will be used. The following user satisfaction questionnaire asks users to choose the answers for both the reference music player and SongBeads music player based on a scale of 1 to 5.

1. How easy it was to create a playlist?

Very easy	Easy	Quite OK	Quite difficult	Very difficult

2. How easy it was to control a song?

Very easy	Easy	Quite OK	Quite difficult	Very difficult

3. How pleasant was the song view?

Very pleasing	Quite pleasing	Quite OK	Quite displeasing	Very displeasing

4. How pleasant was the entire application?

Very pleasing	Quite pleasing	Quite OK	Quite displeasing	Very displeasing

5. Did you feel any sense of reward/accomplishment after creating a playlist or controlling a song?

A lot	Yes	Quite OK	No	Not at all

6. How much sense the application metaphor makes to you? (Is that how a music player should look and feel?)

A lot sense	Good sense	Quite OK	Less sense	No sense

7. Would you like to use this player once it is completely polished?

Of course!	Yes	Maybe	Not sure	No

Collecting and analyzing the data

All the information will be collected with interviews and questionnaires and presented in the forms of tables to be used in the Thesis.