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***Specific Programme 'Cooperation'***

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### **D7.3.1- User Requirements**

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U	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
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**DELIVERABLE SUMMARY SHEET**

Project Number: 213349

Project Acronym: 3DPHONE

Title: All 3D Imaging Phone

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**Short Description:**

This deliverable makes a user analysis including different user classes, user profiles and use case scenarios after presenting some important design principles of user interface and user interaction. Most important scenarios are chosen as the use case scenarios in this part. Lastly, the requirements for mobile users are categorized such as software, hardware, UI, performance, etc. and labeled as 'must', 'should' and 'may' according to their level of importance.

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## 1 Introduction

To develop a new system, the first step is to identify the users and understand the user requirements correctly. Knowing user's expectations and needs for a mobile 3D phone will facilitate the development of a better system.

First of all, the following limitations, specific to mobile phones, should be considered during the development:

- Low power consumption
- Limited display size
- Limited input modalities
- Limited computational power
- Limited memory
- Limited data transmission rates

A good user and requirements analysis is essential since user's expectations should not be ignored while considering the above limitations for mobile phones. So, possible user groups should be examined carefully. Due to the wide range of the possible users, usage should be simple and intuitive enough for the users with basic knowledge; however it should satisfy the needs of a complex user at the same time.

This document is to provide some important requirements to satisfy the users' expectations from this phone. It contains important design principles, user profiles, some possible tasks and application scenarios, and a categorization of user requirements.

### 1.1 Terminology

**'Must'** means that the item is an absolute requirement.

**'Should'** means that there may exist valid reasons in particular circumstances to ignore the item, but the full implications must be understood and carefully weighed before choosing a different course.

**'May'** means that item will be considered, but further examination is needed to determine if the item should be treated as a requirement.

## 2 Design Principles

In this section, some widely accepted design principles of user interface and user interaction are explained. Taking these principles into account while designing new user

interfaces and interaction techniques, will provide ease of use. These design principles are prepared by the help of the resources [3], [6] and [10].

## 2.1 UI Principles

The user interface of the applications should obey the following principles:

**The aesthetics principle:** The design should provide a good look & feel to the user, by using the color appropriately and following the contrast rules.

**The structure principle:** The design should put the related things together and separate the unrelated things, differentiate dissimilar things and make similar things resemble one another.

**The simplicity principle:** The design should make simple, common tasks simple to do, communicating clearly and simply in the user's own language, and providing good shortcuts that are meaningfully related to longer procedures.

**The visibility principle:** The design should not overwhelm users with too many alternatives or confuse them with unneeded information.

**The feedback principle:** The design should keep users informed of actions, changes of state or condition, and errors or exceptions that are relevant.

**The tolerance principle:** The design should be flexible and tolerant, reducing the cost of mistakes and misuse by allowing undoing and redoing, while also preventing errors wherever possible. Also, the error messages should be in plain language.

**The reuse and consistency principle:** The design should reuse internal and external components and behaviours to maintain the consistency, thus reducing the need for users to rethink and remember.

**The context & navigation principle:** The interface should be structured so that, at any given point, users can identify where they are in relation to the supported options and functions.

**The help & documentation principle:** Help and documentation should be easy to search and explanatory.

**The learnability & flexibility principle:** Mechanisms should be available to speed up the interaction for expert users; the system should satisfy both inexperienced and experienced users.

**The personalization principle:** User defined display options should be available.

## 2.2 Interaction Principles

**Easy interaction:** The way that the user interacts with the phone should be easy and familiar to the user. Due to the rapid development in the sensor technology, new gestures will be determined. These gestures should be easy to use and also familiar to the user.

**3D interaction:** Since the most important feature of this phone is being 3D, a person should interact with his device and applications in 3D.

**Being handheld:** A mobile phone must be handheld. Also, it would be better to allow most of the operations using one hand.

**Avoiding unintentional commands to the phone:** Since within this project new interaction types and gestures will be used, there is a possibility of giving commands to the phone without intention. That is, if movement of the phone will be an input for the phone, there should be precautions that will prevent the phone to be interrupted by every motion.

## 3 User Needs Analysis

As it is mentioned before, the first step should be to identify possible users and their needs, during the development of a new product. This section provides a detailed analysis of possible users. The following questions are answered in this part:

- Who will use this phone?
- What will they do using this phone?
- Why will they use this phone?

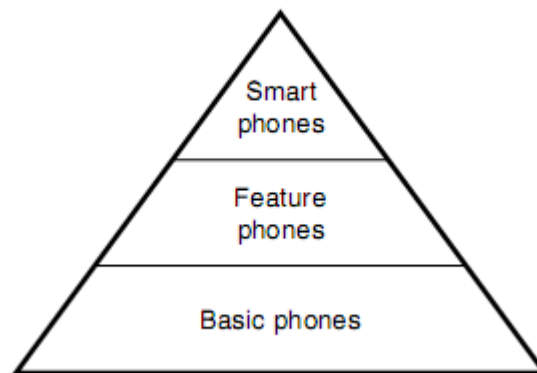
While giving answers to these questions, user classes, some use cases, scenarios and tasks are analyzed in detail.

### 3.1 User Classes

The rapid advances in the graphics and display technologies increase both the demand for mobile phones and the expectations for these phones. Today, a mobile phone is not just a phone. It is used as calendar, address book, camera, radio, TV, media player, web browser, etc. at the same time. 3.3 billion mobile phone subscriptions are reported by 2007[8]. By 2010, it is expected that there will be as many mobile phone users in the world as toothbrush users [1]. Even today, an increasing number of countries, particularly in Europe, have more mobile phones than people. Also, according to the data from Eurostat, the European Union's in-house statistical office, Luxembourg had

the highest mobile phone penetration rate at 158 mobile subscriptions per 100 people (158%) [7].

Fig.1 shows the three types of phones according to [5]. Basic phones are very limited in terms of their processing power and physical screen size. This class allows only the simplest of 3D applications because of their limited CPU performance. Feature phones, on the other hand, offer sufficient programming interfaces for most multi-media needs and 3D graphics. The last category, high-end smart phone, can be considered as mobile computers. This category includes large, sharp, and vivid color displays, powerful processors, plenty of memory, and full-blown multimedia capabilities. Some of the latest devices also incorporate dedicated 3D graphics hardware. Considering the desires of the people, it is expected that future mobile phone users will be from the top category.



**Fig.1:** Three phone categories. Smart phones are more powerful than feature phones or basic phones, but there are more basic phones than either feature phones or smart phones. [5]

The intended 3D Phone will be specialized on 3D. That is, it will have a special display, graphical infrastructure and software that are aimed to give a realistic 3D feeling to the user. Among the phone categories, we can classify it under the smart phones and the information specific on smart phones are important for our analysis. Some statistical results from [9] report that 59% of US smart phone users are male and 35.1% of smart phone users have a household income of \$100,000 or higher, by 2008. Additionally, the distribution of the smart phone users according to their age is given as follows:

- 10.4% are ages 18-24
- 29.0% are 25-34
- 24.5% are 35-44
- 18.2% are 45-54
- 13.0% are 55-64
- 4.9% are 65+

It can be seen that people between the ages 25-34 form the biggest group of smart phone users, and male users are slightly more than female users. However, the remaining group of users should not be underestimated. Moreover, present smart phones shift to feature phone group in a few years. Upon this information, the mobile phone users form a heterogeneous distribution over the people from many aspects such as age, gender and economical status. Also, education level, which is an important factor to be able to use the full functionality of a mobile phone, changes over a wide range. Satisfying the needs of such a wide range of people is a challenging task. Therefore, the requirements of these users should be analyzed carefully.

### 3.2 User Levels

Level	Knowledge	Abilities
1	Novice	Make and receive calls, use basic functions of contact list
2	Basic	+ Basic functions (Messaging, taking photos, basic settings (date, tone...))
3	Average	+ Calendar, music, web browsing, advanced settings (Bluetooth, call, message)
4	Advanced	All features of the phone

### 3.3 User Profiles

Name	Level	Age	Job
Ayşe	1	50	Housewife
Burhan	2	55	Manager
Esra	3	15	Student
Erhan	3	40	Instructor
Asli	4	29	Project Manager
Bertan	4	22	Engineer

### 3.4 Use Cases

This section provides the requirements from an application-based viewpoint. A user should be able to do the following tasks by using this phone:

#### 1 Call-Answer

The most important feature of a phone is making calls and answering incoming calls. Being the core application of a phone, an incoming call must be able to interrupt all other applications. It should be very easy to make calls to an intended person.

#### 2 Contacts

A user should be able to view and manage contacts easily. Finding an intended contact should be simple. There are ways to achieve this already, such as lastly called contacts, mostly called contacts etc. Adding, deleting, editing and grouping contacts are some of the required functions of the phone related to contact management. Another contact related requirement is that it should be accessed through many applications. Whenever a name or number is found it should be easily added or searched in contacts.

#### 3 Calendar

Mobile phones are often used for personal information management purposes. As a result, calendar applications have more importance especially for advanced users. A user should be able to view contents of his calendar through an efficient user

interface and easily manage them. Categorizing events and assigning reminders to them is another required function of the calendar.

#### 4 Mail / SMS

SMS usage is a very important feature of mobile phones for years. Furthermore, e-mails are also controlled by mobile phones with the increasing usage of the Internet on mobile phones. As well as the basic message related functions like sending, reading and editing them; advanced functions are likely to be necessities like searching and filtering messages.

#### 5 Media related

The cameras and displays of mobile phones are developed significantly and more developed camera and display technologies are expected from the 3DPhone project. Therefore, there should be applications to use and manage these media related functions. It should be possible to view, add, delete and edit media files, sending and receiving them and grouping them as we do in PC's. Other than those management related requirements, there are usage related requirements. A user should be able to play a music or video file, change album properties, take photos, make video conferences etc. In short, many of the functions that can be performed in a PC are expected from the phone.

#### 6 Map

Map and navigation related applications are very useful for mobile phone users. There is a correspondence between the terms, map and mobility and the usage of a phone for navigation related functions is becoming an important requirement of mobile phones as GPS systems are used in them.

#### 7 Entertainment

Mobile phones are also used for entertainment purposes. Playing multimedia files and games are the most important activities in that field. Also game applications are the ones that can give 3D feeling to user. So, playing games is also a required function of a mobile phone, especially a phone with an extensive 3D display and interaction capabilities.

### 3.5 Detailed Task Analysis

The scenarios and tasks that are explained in this section are only representative scenarios to better understand the user's expectations. A selected subset of these scenarios will be implemented on the 3DPHONE prototype.

### 3.5.1 Calendar

#### Scenarios

**Scenario 1: User: Erhan Level: 3**

Erhan uses calendar application to keep track of birthdays of the people he cares about. When he intends to make a new birthday entry on 27th November and opens the month view of calendar application, he realizes that he entered his daughter Esra's birthday as 23rd November while it's 13th in fact. So he decides to correct it and he selects the incorrect event and edits it as 13th November. Then, he enters the birthday of his friend, Abdullah on 27th November. While he is adding, he selects "Birthday" as the type of the event and enters his birth year and he sets a reminder in order to remind Abdullah's birthday one day before.

**Scenario 2: User: Asli Level: 4**

Asli uses the calendar to manage her daily business related and personal activities. After a monthly regular meeting with her project members, they decide an educative journey for their test team in America that is intended to take 2 weeks. So she cancel all of the meetings with the test team for two weeks starting from July 14 by selecting all the events labeled as test team between 14th and 28th of July and deleting them.

- She selects one of the events labeled as test team, chooses the option show only the events of the same type.
- She selects all events and deletes them.

During the meeting they have also modified the meeting dates with the application development team. Bertan is a member of application development team and he has applied all the modifications about the meeting dates directly on his mobile phone. At the end of the meeting Asli synchronizes her calendar with Bertan's calendar about the events related to application development team.

After the meeting since all the events are determined for a month, Asli tries to find 3 consecutive days for a short holiday by looking at her calendar in monthly view. She realizes that there is a planned appointment with an intern that prevents her to find 3 consecutive appropriate days. She directly calls the intern in the calendar view without going to contacts menu, postpones the appointment and reflects the change to her calendar. Lastly, she adds the holiday event of 3 days period.

#### Tasks

- View, add, delete, edit, synchronize events

### 3.5.2 MMI – Application switch

#### Scenarios

**Scenario 3: User: Erhan Level: 3**

Erhan is intended to call his project partner at 14:00. He looks at his phone and realizes there is still 10 minutes to wait. He decides to check his calendar entries for the upcoming week. He selects the calendar application and opens it. After controlling his calendar entries he returns to main screen of the phone, opens contacts application and makes the phone call to his partner.

#### Tasks

- View, select, open the main applications
- Support viewing the currently running applications and changing the focused one
- Show time, date and upcoming entry of the calendar or events of the day

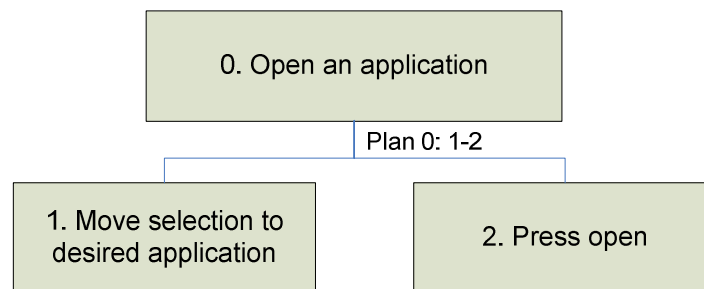


Fig. 2: HTA diagram for opening an application using MMI

### 3.5.3 Address Book

#### Scenarios

**Scenario 4: User: Asli Level: 4**

Asli and Zeynep are newly friends. Asli wants to add Zeynep's contact information into her contact list. When she clicks "New Contact" option from the contact application menu, a warning message appears that the cell phone is out of memory. So Asli decides to delete some of her contacts in order to add Zeynep into her contact list. So while viewing contact list, she deletes some of the contacts that she wants.

#### First way of addition:

After deleting some of her contacts, she opens new contact window and starts to enter Zeynep's name, surname, company, job title, work phone, mobile phone, fax number, e-

mail, birthday and her group “Friends”. In addition to this, she wants to put her picture. First she thinks that Zeynep’s picture is already in her cell phone so she clicks “Add Existing Thumbnail” and looks for the picture in the gallery. However, none of the Zeynep’s pictures are in her cell phone. So she exits from the “Add Existing Thumbnail” menu and she clicks “Add New Thumbnail”. Camera starts and Asli takes a photo of Zeynep. After that Zeynep asks whether some people on Asli’s contact list have the same birthday with Zeynep. Asli opens the calendar application and chooses the 7<sup>th</sup> March in order to see birthdays.

#### **Second way of addition:**

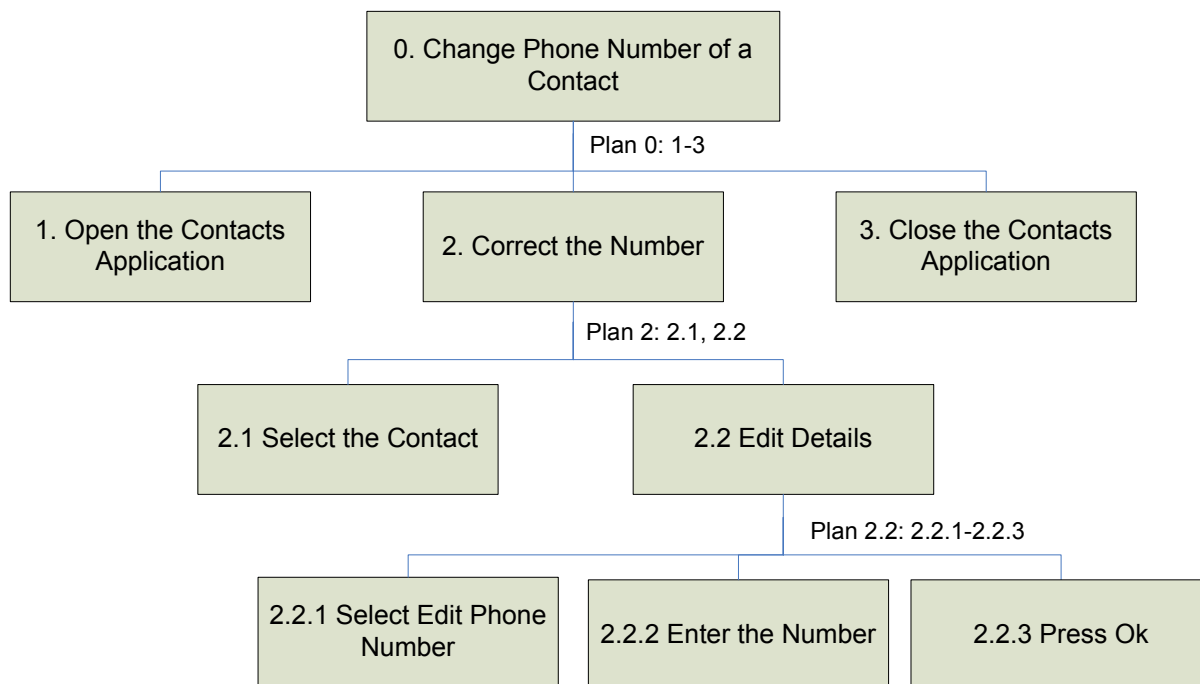
After deleting some of her contacts, Zeynep sends her contact card including her name, surname, company, job title, work phone, mobile phone, fax number, e-mail, birthday and picture via Bluetooth. After data transfer, Asli saves contact card into “Friends” group. After that Zeynep asks whether some people on Asli’s contact list have the same birthday with Zeynep. Asli opens the calendar application and chooses the 7<sup>th</sup> March in order to see birthdays.

#### **Scenario 5: User: Ayse Level: 1**

Semra lives next door to Ayse. Ayse already has Semra’s phone number in her contact list. But Semra changes her phone number and informs Ayse to correct her number. So, Ayse wants to find Semra’s details in her contact list and then edit her phone number. She opens her contact list and searches for Semra. When she finds the contact, she edits the number.

#### **Tasks**

- View, add, delete, edit, synchronize, group contacts



**Fig. 3:** HTA diagram for changing phone number of a contact in the address book

### 3.5.4 Map Viewer

#### Scenarios

**Scenario 6:** User: Bertan Level: 4

Erhan is on a vacation with his family and they are going to see the waterfalls in Antalya. When they arrive in Antalya Erhan decides to check their route from the map on his phone. He chooses to see the touristic places around. Then he locates the waterfalls and by zooming out, he confirms that they are on the right road. Then, he realizes something that he did not realize when he decided their route on the huge printed map. The restaurant they went last year is very close to them and, although, they need to change their route a little, it seems it will not make a big difference. He realizes this when he sees the small icon on top of the restaurant which means that they had taken photos there. Also, they need to have a rest at some place. So, he decides to change their route so that they will visit the restaurant they loved.

#### Tasks

- Search for a location in the map
- Find the route to a location
- View the important places (restaurants, theaters, etc.) in a given location

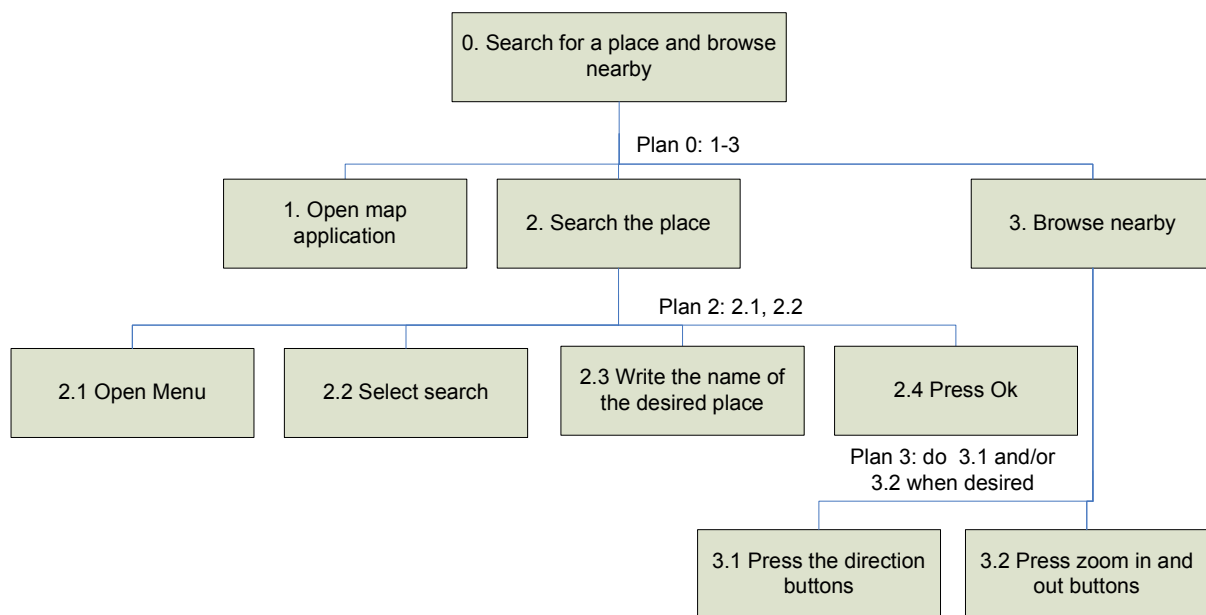


Fig. 4: HTA diagram for searching for a place in the map viewer

### 3.5.5 Gallery

#### Scenarios

##### Scenario 7: User: Esra Level: 3

Esra looks at the photos that she has taken at the last weekend in the concert of her favorite singer to select one of them to be background of her phone. Before selecting a photo she creates an album as “Concert Photos” and moves related photos under this album. She starts looking at the photos in the album and she sees that unintentionally she has taken the photo of her friend Ezgi when she is very close to her favorite singer. Esra sets this photo as the background. She selects the edit photo option and marks her friend Ezgi by sketching. After the modification she sends this photo to her friend by adding a comment “Look, whose photo I have taken yesterday :P”.

##### Scenario 8: User: Burhan Level: 2

Burhan usually uses his mobile phone’s camera to take pictures of his family on special occasions. Each time, he takes quite a number of pictures, however, he is not used to transfer these photos to his PC and he keeps all the photos on his phone. So, he wants to group and label his photos on his phone. He enters the photos section of the Gallery. Photos are grouped according to their dates so that photos that are taken in a period of time will be in the same group and each group has the date taken as its label. Then he selects a group of the photos to change their label. A panel to enter text appears at the bottom of the screen and Burhan enters “My daughter’s birthday 2007” as the label. Then, he selects this group

and another group he named before as “My wife’s birthday 2007”, and groups these groups under a new label “Birthdays”, so that he can find birthday photos more quickly later.

**Scenario 9: User: Bertan Level: 4**

Bertan watches his favorite TV series on his mobile phone while he is in the way to his hometown for a holiday. He stops the player since he did not understand the last sentence, rewinds a little, listens again and he notices that there is a reference to one of the previous episodes. He immediately opens the directory of the TV series. Looks at the thumbnails of episodes and guesses the referenced episode and opens it. Quickly scans the scenes and finds the referenced scene, while watching it he is called, and the player stops automatically. He answers the call and makes the conversation. After that he goes on watching the old episode and understands the referenced topic. He returns to where he has stopped in the last episode and continues watching.

**Scenario 10: User: Esra Level: 3**

Esra loves to listen to music on her way to school every day. So, she keeps a music library on her mobile phone. On the bus, she chooses one of the playlists she prepared and starts to listen to the songs. A few minutes later Ceren, a friend of her, calls and the music pauses. Ceren asks something about the course they are taking together. After their talk, the music continues from the previous point. At the last stop of the bus, Esra’s close friend Busra gets on the bus and sits next to Esra. Esra takes off the earphones and starts to talk to Busra. Busra sees the cover of the album of the song that is playing on Esra’s phone and asks the name of the vocal of the band. Esra does not know, but she also wonders and chooses the “Get Artist Info” and the phone connects to the internet and retrieves information about the band. Now they both know the name of the vocalist.

## Tasks

- View, add, delete, edit media files
- Send, receive media files
- Group the files to folders
- Add, delete, play, pause, rewind, forward media files
- Add, delete, edit, shuffle, repeat playlists
- View and edit properties of albums etc.

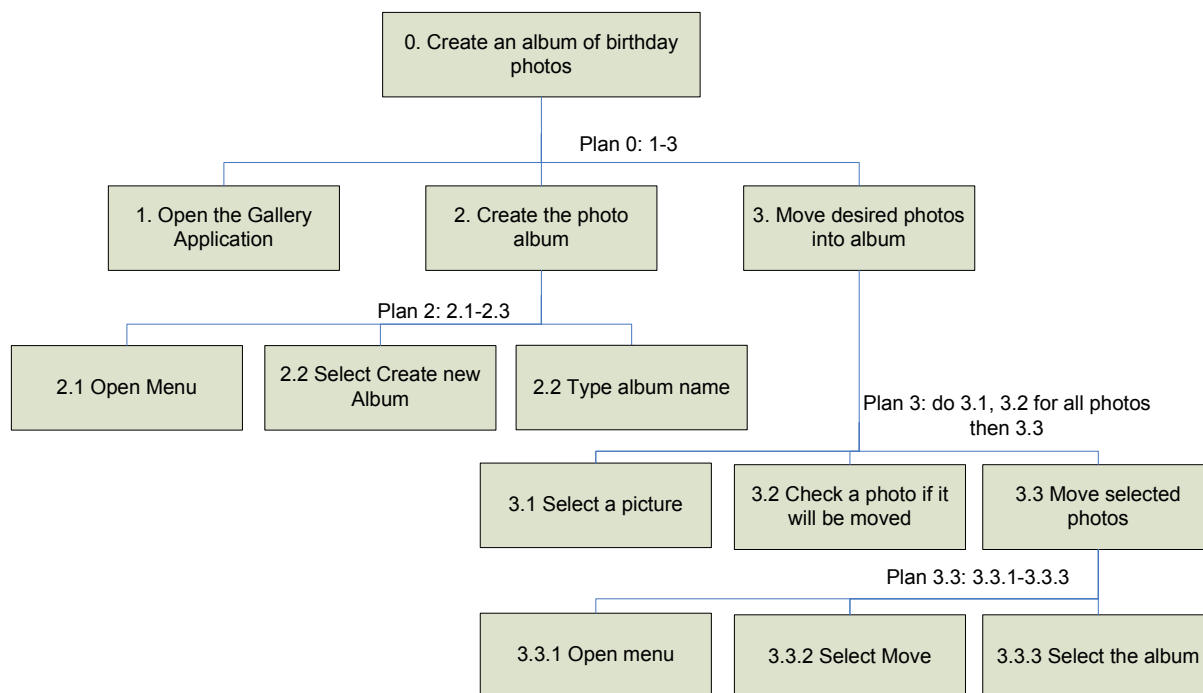


Fig. 5: HTA diagram for creating an album of birthday photos in the gallery

### 3.5.6 Message/Mail Application

#### Scenarios

##### Scenario 11: User: Burhan Level: 2

Burhan wants to send a multimedia message to his friends on Christmas. He opens “Messaging” menu to create a new message. He selects recipients from the contact list one by one and after that, he inserts a picture of him with Santa Claus hat from the gallery to the message body. And then, he sends the message to all his friends.

##### Scenario 12: User: Asli Level: 4

Asli wants to organize her e-mails. She wants to keep her project related mails separately and give them priority. For this purpose, she first creates a folder named “Project” in her mailbox. Then she creates a filter named “project” to automatically download the project related mails to the Project folder in her mailbox. She runs the project filter on her inbox to move the previous project mails to the Project folder. But she is not sure if the filter finds all the related mails correctly. To check if the filter runs correctly, she searches her inbox to find out whether there is a project mail which is not moved to the Project folder, using the search option from the menu. After being sure, she goes to the Project folder and tags some important mails. She also deletes the unnecessary mails. Lastly, she replies one of her colleagues’ mails which asks about the software architecture of a program. She finds helpful

sketching the architecture to visualize it better. So she opens the sketching tool and draws the architecture and then sends this drawing to her colleague.

### Tasks

- Send, read, edit, search, delete, filter mails

## 3.5.7 Video Conference Application

### Scenarios

**Scenario 13: User: Asli Level: 4**

Asli is working for a project that has 7 participants from different countries. One of the participants arranges a video conference about the management deliverables and Asli has to participate. So, she enters the video conference application and calls the conference number and connects to the conference.

### Tasks

- Make, answer video conference calls

## 4 Requirements

This section is the core part of the document as it lists the important requirements of the 3DPhone. These requirements are categorized under the titles Application, UI, Display, Hardware, Software, Media, Performance and Ergonomics. Moreover, all the requirements contain a label as ‘Must’, ‘Should’ or ‘May’ according to their level of importance. For the explanation of these labels, please refer to section 1.1.

### 4.1 Application Requirements

Req. ID	Type	Requirement	Notes
4.1.1	Must	3D property <b>must</b> be used properly.	Applications should give the 3D feeling without distracting the user
4.1.2	Must	Applications <b>must</b> be failsafe.	Failing of an application should not affect the whole system
4.1.3	Must	Memory consumption of the applications <b>must</b> be low.	Consider memory and bandwidth limitations. Typical data for mobile devices: 4 - 64 MB System RAM, 32 MB - 2 GB flash memory, 16 - 32

			bits bus width [4].
4.1.4	Should	Too much content <b>should</b> be avoided.	Consider size limitations
4.1.5	Should	2D rendering <b>should</b> be supported.	
4.1.6	Should	The response for opening and closing applications <b>should</b> be quick.	Big sized applications are loaded slowly; this is not suitable especially for mobile phones where users expect fast usage.

## 4.2 UI Requirements

Req. ID	Type	Requirement	Notes
4.2.1	Must	Proper depth values <b>must</b> be used.	Autostereoscopic displays do not cause eye strain that differs from the eye strain caused by ordinary displays, only if sufficiently small depth values are used [2]. Proper depth values must be investigated for this purpose.
4.2.2	Must	Too fine details <b>must</b> be avoided.	Consider the size limitation. Too many details may not be recognizable on small displays and confuses the user while slowing down the execution speed.
4.2.3	Must	UI <b>must</b> be intuitive and obey the design principles.	See also Section 2 for design principles.
4.2.4	Should	Texts <b>should</b> be readable.	Texts should be on a single depth.

### 4.3 Display Requirements

Req. ID	Type	Requirement	Notes
4.3.1	May	The display <b>may</b> be switchable between 2D and 3D.	The rendering software should be configurable for 2D/3D operation modes.
4.3.2	Should	The phone <b>should</b> support a reasonable resolution.	
4.3.3	Should	Display <b>should</b> provide a good vision in both daylight and indoor environments.	Mobile devices are used in various environments. The display should be visible in those environments.
4.3.4	Should	The display <b>should</b> be 3D in the wider (landscape) mode.	Adding multi-view capabilities to the screen decreases horizontal resolution, which is more tolerable in the landscape mode in which there are more horizontal pixels.

### 4.4 HW and Communication Interfaces

Req. ID	Type	Requirement	Notes
4.4.1	Must	An accelerometer <b>must</b> be available as input sensor.	New gestures will be defined using the accelerometer input.
4.4.2	Must	Bluetooth and GPRS <b>must</b> be supported.	
4.4.3	Should	3GSM <b>should</b> be supported.	
4.4.4	Should	The phone <b>should</b> be equipped with 2 cameras that will be used to take 3D photos and videos.	In order to obtain 3D effect in the photos, at least 2 cameras are needed.
4.4.5	Should	The phone <b>should</b> be equipped with a camera on the front side for optional gesture recognition.	E.g: Head-tracking might be performed using the front camera.

4.4.6	May	MiniUSB and microSD interfaces <b>may</b> be supported.	These interfaces might be helpful for data transfer.
4.4.7	May	Stylus <b>may</b> be supported.	Stylus usage may not be available in 3D.

## 4.5 SW Interfaces

Req. ID	Type	Requirement	Notes
4.5.1	Must	<b>At least</b> OpenGL ES 1.x <b>must</b> be supported.	If OpenGL ES 2.0 is supported, it is not possible to support OpenGL ES 1.x at the same time; since version 2.0 is not backward compatible.
4.5.2	Should	Java, M3G <b>should</b> be supported.	
4.5.3	Should	Installation of native applications <b>should</b> be allowed.	This increases the extensibility of the prototype.

## 4.6 Media Requirements

Req. ID	Type	Requirement	Notes
4.6.1	Must	Video resolution <b>must</b> be lower than any resolution that will cause performance loss.	Taking into account HW display resolution as upper limit; video performance depends on frame rate and resolution.
4.6.2	Must	The data <b>must</b> be coded in a highly efficient format.	taking bitrate and quality into account, considering memory and processing power limitations
4.6.3	Should	3D video playback of stored content <b>should</b> be available.	may require up-/down-sampling to display resolution
4.6.4	May	3D video display of broadcasted content <b>may</b> be available.	3DTV, via DVB, DVB-H, etc.
4.6.5	Should	3D video display of streamed	via mobile phone line, WLAN, etc.

		content <b>should</b> be available.	
4.6.6	Should	3D video recording <b>should</b> be available.	Consider memory and processing power limitations. It may require compression for storage.
4.6.7	Should	Real-time 3D video communication <b>should</b> be available.	most challenging application scenarion taking complexity of compression, rendering, bitrate, resolution into account
4.6.8	Should	Media content <b>should</b> be highly robust against transmission errors.	
4.6.9	Should	Decoding, rendering and display <b>should</b> be fluent at full framerate.	Consider memory and processing power limitations, taking into account complexity of decoding and rendering.
4.6.10	Should	Media content <b>should</b> be processed in real-time with some allowed delay.	some buffering possible
4.6.11	May	Video content <b>should</b> be flexible with regard to different 3D display types.	may require conversion of video content

## 4.7 Performance Requirements

Req. ID	Type	Requirement	Notes
4.7.1	Must	Applications that consume high power <b>must</b> be avoided.	Power consumption limitation
4.7.2	Must	Low memory bandwidth <b>must</b> be considered to prevent slow running, late responding applications.	
4.7.3	Must	Applications <b>must</b> use a limited	for both RAM and mass storage. Typical data for mobile devices: 4 -

		memory/storage.	64 MB System RAM, 32 MB - 2 GB flash memory, 16-32 bits bus width [4].
4.7.4	Should	The bus traffic between memory and GPU <b>should</b> be low.	Compression schemes might be considered.
4.7.5	Should	Complexity of algorithms <b>should</b> be low.	

## 4.8 Ergonomics

Req. ID	Type	Requirement	Notes
4.8.1	Should	Reading 1  The brightness, contrast, resolution and crosstalk of the display <b>should</b> be sufficient to good reading performance in standard inside lighting conditions.	Typical office lighting conditions around 500 lux.  Good reading performance = reading speed comparable to mobile phone display. No excessive cognitive load or frustration as measure by NASA TLX.
4.8.2	Should	Reading 2  The brightness, contrast, resolution and crosstalk of the display <b>should</b> be sufficient to good reading performance in sunny day with clouds.	Outside lighting in a sunny day could be 10000 lux.  Good reading performance = reading speed comparable to mobile phone display. No excessive cognitive load or frustration as measure by NASA TLX.
4.8.3	May	Reading 3  The brightness, contrast, resolution and crosstalk of the display <b>may</b> be sufficient to good reading performance in outside in direct sunlight.	Outside lighting in a sunny day with direct sunlight could be 100000 lux.  Good reading performance = reading speed comparable to mobile phone display. No excessive cognitive load or frustration as measure by NASA TLX.

4.8.4	Must	Image quality 1 Image quality of the 3D user interface <b>must</b> be acceptable.	The test groups should give mean rating of acceptable to the image quality in ordinary phone tasks.
4.8.5	Must	Image quality 2 Image quality of the static 3D photographs <b>must</b> be acceptable.	The test groups should give mean rating of acceptable to the image quality of static three-dimensional photographs.
4.8.6	Should	Image quality 3 Image quality of the 3D videos <b>should</b> be acceptable.	The test groups should give mean rating of acceptable to the image quality of three-dimensional videos.
4.8.7	Must	Viewing angle 1 Viewing angle of the display <b>must</b> be large enough to enable the user to perform ordinary mobile phone tasks without the disappearance of the stereoscopic effect.	The test groups should give mean rating of acceptable related to the stability of 3D in ordinary phone tasks.
4.8.8	Should	Viewing angle 2 Viewing angle of the display <b>should</b> be large enough to enable the user to perform ordinary mobile phone tasks without the appearance of crosstalk or other distortions.	The test groups should give mean rating of acceptable related to annoyance of distortions in ordinary phone tasks.
4.8.9	Must	Eye strain 1 The eye strain experienced in short interval phone tasks <b>must</b> be comparable to ordinary mobile device.	Short interval tasks are 1-2 minute tasks that have pauses of 5-10 minutes in between. In a 40 minute testing of such periodic use of the device the eye strain as measured by SSQ and VSQ sickness questionnaires should be comparable to a mobile phone.

4.8.10	Should	<p>Eye strain 2</p> <p>The eye strain experienced in intensive medium period tasks <b>should</b> be comparable to ordinary mobile device.</p>	<p>Medium interval task is a task that requires intensive focusing for 5-10 minutes. Examples of such tasks are watching a video or playing a game. In a 40 minute testing of such periodic use of the device the eye strain as measured by SSQ and VSQ sickness questionnaires should be comparable to a mobile phone.</p>
4.8.11	May	<p>Eye strain 3</p> <p>The eye strain experienced in intensive long period tasks <b>may</b> be comparable to ordinary mobile device.</p>	<p>Long task is a task that requires intensive focusing for 30-40 minutes. Examples of such tasks are watching a video or playing a game. In a 40 minute testing of such use of the device the eye strain as measured by SSQ and VSQ sickness questionnaires should be comparable to a mobile phone.</p>
4.8.12	Must	<p>Eye strain 4</p> <p>Eye strain <b>must</b> never, in any condition, exceed the 95 % population limits set in SSQ.</p>	<p>There has been large testing in US military regarding the Simulator Sickness Questionnaire (SSQ). By utilizing this, they have created typical sickness symptom amounts that the users get from flight simulators. These indicate the typical distribution of symptoms. If the mean symptom values from a device exceed the symptoms that 95 % of the test population gets, the symptom levels are very high and alarming.</p>
4.8.13	Must	<p>Physiological aftereffects 1</p> <p>Physiological eye fatigue symptoms of heterophoria and near point of accommodation measurements <b>must</b> not differ</p>	<p>Short interval tasks are 1-2 minute tasks that have pauses of 5-10 minutes in between. Heterophoria refers to the operational efficiency of the muscles moving the eyes and accommodation refers to the</p>

		from ordinary mobile device in short interval phone tasks.	muscles changing the refraction of the lense of the eye.
4.8.14	Should	Physiological aftereffects 2  Physiological eye fatigue symptoms of heterophoria and near point of accommodation measurements <b>should</b> not differ from ordinary mobile device in intensive medium period tasks.	Medium interval task is a task that requires intensive focusing for 5-10 minutes. Examples of such tasks are watching a video or playing a game. Heterophoria refers to the operational efficiency of the muscles moving the eyes and accommodation refers to the muscles changing the refraction of the lense of the eye.
4.8.15	May	Physiological aftereffects 3  Physiological eye fatigue symptoms of heterophoria and near point of accommodation measurements <b>may</b> not differ from ordinary mobile device in intensive long period tasks.	Long task is a task that requires intensive focusing for 30-40 minutes. Examples of such tasks are watching a video or playing a game. Heterophoria refers to the operational efficiency of the muscles moving the eyes and accommodation refers to the muscles changing the refraction of the lense of the eye.
4.8.16	Must	Depth 1  The depth elements of the user interface <b>must</b> be sufficiently large so that the users benefit from them.	The performance and/or user satisfaction must be higher than in 2D.
4.8.17	Must	Depth 2  The depth magnitude of the user interface elements <b>must</b> be sufficiently small so that none of the potential users see the images as double images.	In some references the depth limit has been set to 35 arc minutes of visual angle, but as this depends on the interaction of many parameters (size of the object in depth, other nearby parameters etc), it is not viable to set a single value. However, the 35 arc minutes might serve as a good guidance for larger

			objects.
4.8.18	Must	Depth 3  The depth magnitude of the user interface elements <b>must</b> be sufficiently small so that the use comfort and physiological aftereffects requirements in 5.9.9 – 5.9.15 are satisfied	
4.8.19	Must	Depth 4  Avoid UI graphics that appear for a short time in large depth. If an object appears for a short time (less than 1 second), it should have a small depth value. If large depth value is needed, the depth should increase gradually.	Rationale behind this criterion is the operation of the stereoscopic system: it takes time to perceive objects with large depth, because the user must utilize convergence movements that are slow.
4.8.20	Must	Depth 5  Avoid steep disparity gradients in the user interface, as too steep disparity gradient between two objects cannot be binocularly fused.	Disparity gradient between two objects is defined as binocular disparity difference between objects / distance between the objects. If the gradient value is more than 1.0, the images become difficult to binocularly fuse.
4.8.21	Must	The device <b>must</b> be handheld.	
4.8.22	May	The device <b>may</b> be usable with one hand.	

## 5 Conclusion

Understanding the user's needs and expectations constitutes one of the core parts of the development process, as the success criteria for a product is user centric. In order to

better understand the user's expectations from this phone, this study on user requirements is done.

In this document, important design principles that should be considered during the design of user interfaces and interaction techniques are explained. Then, the most important tasks and use case scenarios are examined in detail. Lastly, the requirements for a mobile 3D phone are listed.

According to this study, possible users of the 3DPhone are formed from a wide range of spectrum. Their high expectations from this phone have to be limited with the limitations of a mobile phone such as small physical size, low memory bandwidth, small storage capacity, and limited computational power. Thus, it is a difficult task to meet the expectations of the users while considering these limitations. For this purpose, the requirements that are listed in this document should be followed carefully.

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