MASTER THESIS

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Universal Design of ICT

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A multifunctional mobile application for people diagnosed with mild dementia

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Preface

Many thanks and appreciation are addressed to the dementia users who participated in the user testing, interviews and the iterations. Their feedback has helped in getting real inputs of how elderly users experience the applications, and contributed in shaping the prototypes from iterations to iterations so that it becomes more suitable for elderly users. Not to forget, numerous thanks and sincere gratitude are addressed to the helpful and kind supervisor, Professor Weiqin Chen. She has been sharing her expertise and valuable knowledge throughout the whole project. Without her assistance, clear guidance and useful suggestions, this research could never be succeeded. Finally, sincere thanks are also expressed to the college, Oslo and Akershus University College of Applied Science for giving the opportunity to study this master degree.

Abstract

With the popularity of mobile positioning navigation application software, these applications provide a lot of help for our lives. But for people diagnosed with dementia, it is easier to lost themselves, so they need a navigation application to improve their quality of life. Many of the current navigation applications have complex interface, cumbersome operating procedures, hug system and a lot of functions, not suitable for people diagnosed with dementia. This study is mainly to develop a suitable mobile navigation application for dementia users. This study uses user-centered method and usability testing methods. This research was conducted through four main phases, which were (1) user requirement study, (2) design, (3) development, and (4) user testing. In the study of user needs, this paper adopts the focus group interview and the semi-structured questionnaire to explore the real needs of users. In the continuous iterative development process, the user was involved in the prototype testing. Through the final user test, we found that users have a great interest in using and learning this application.

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1. Introduction

1.1. Population aging

Nowadays, we are living increasingly depends on a variety of information and communication technology (ICT) devices such as mobile phones and computers, these devices are an essential tool for modern social life. From kids who just learned how to talk to retired old people have some or few experience with ICT devices.

The study report of United Nations (2002) indicated population ageing—the process by which older individuals become a proportionally larger share of the total population—was one of the most distinctive demographic events of the twentieth century. It will surely remain important throughout the twenty-first century. Initially experienced by the more developed countries, the process has recently become apparent in much of the developing world as well. For the near future, virtually all countries will face population ageing, although at varying levels of intensity and in different time frame. And this report also make conclusions as follow:

1. Population ageing is unprecedented in human history, and there are no similar cases；
2. Population aging is universal, is a global phenomenon that affects everyone；
3. Population aging is profound, having significant consequences and effects on all aspects of human life；

Population aging is enduring. In the 20th century, the proportion of older persons continued to grow, it is expected that this phenomenon in the 21st century will continue to exist. From 1950 to 2000, the proportion of older

persons was raised from 8% to 10%, and this percentage will dramatically rise to 21% after first 50 years of 21st .(United Nations, 2002)

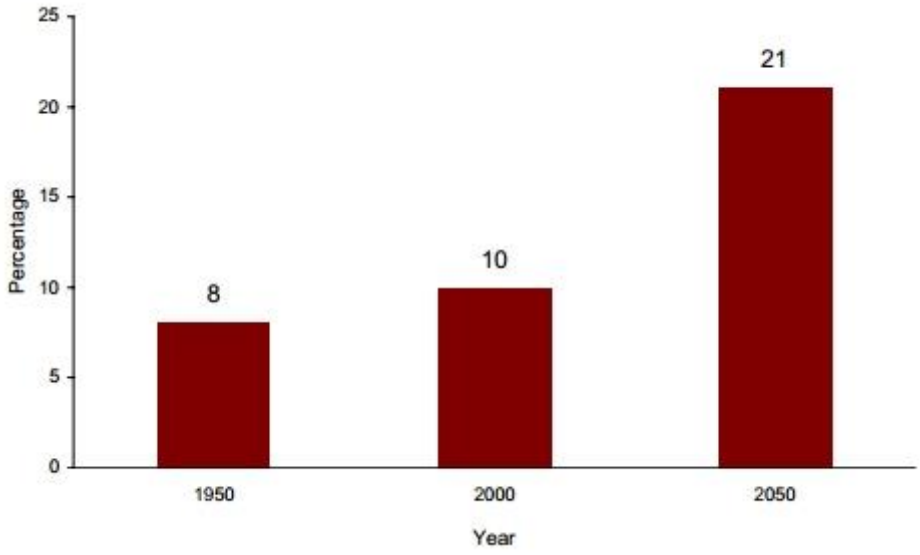

Figure 1.1Proportion of population 60 years or older: world, 1950-2050

Source: United Nation

To be specific, in China, according to the report of *Statistical Communiqué of the People's Republic of China on the 2015 National Economic and Social Development,* by the end of 2015, elderly population was 222 million, 16.1% of the total national population, which means that China entered the aging society(National Bureau of Statistics of China, 2016). In these populations, over 72.42 million old people living alone, more than 6 million elderly people suffering from dementia, the total number of " Disabled Elders" was more than 37 million, daily care for the elderly is no longer just a family problem, it become economic development and social issues that must be addressed. According to China's State Council issued forecasts, elderly people in China will reach 243 million in 2020, in 2025 will exceed 300 million. Aging population began to pick up speed, China entered the aging society. Facing the serious problem of an aging society, the whole society should actively respond to the aging population, accelerating the development of

elderly services, and continuously meet the sustained growth of older persons living, spiritual, medical and other needs.

In the context of global population aging, the global prevalence of dementia has been estimated to reach 24 million, and is predicted to double every 20 years until at least 2040. As the population worldwide continues to age, the number of individuals at risk will also increase, particularly among the very old investigated by (Mayeux & Stern, 2012).

1.2. Dementia

Dementia can be divided into Alzheimer's disease, vascular dementia and mixed dementia of both. According to epidemiological survey, the incidence of dementia in the world for men is 3.05%, for women is 4.82%(Bachman et al., 1992). Dementia is the result of brain atrophy in chronic progressive mental deterioration and personality changes. Dementia is a common disease in clinical, the disease can occur in old age, may also happen in early old age, belongs to a type of degenerative diseases of the nervous system. Dementia is mainly because of the severe damage to the brain organ, to make certain effects on brain function, making it disorder, clinical manifestations is serious damage of language skills, memory ability, comprehension ability, judgment ability and emotional expressiveness, seriously affect the patient's daily life and social skills. As the world population aging faster and people's living standards improve, people's life expectancy is increasing, therefore, the incidence of the disease is increasing, if do not have access to a prompt and effective treatment, the disease will pose a threat to the lives of elderly patients. Due to the prevalence of dementia disease is very high, the duration of the disease will last very long, and it also will cost a lot, so the disease greatly increases the burden on society and families(Mayeux & Stern, 2012).

Early clinical manifestations of dementia patient(Hughes, Berg, Danziger, Coben, & Martin, 1982):

1. Memory impairment, and even influence the patient's daily work. People with dementia often forget not only things, but can't recall.
2. The language barrier, repeatedly asking and repeating the same question, and difficult to communicate. People with dementia often forget a word and cannot find the right words to substitute, seriously, they cannot call out the names of the objects.
3. Temporal and spatial positioning disorientation. Patient even in familiar places will get lost, do not know the way home, don't know where to go, even don't know how he/she come here.
4. Mental retardation, slow thinking, less calculating power. People with dementia may forget all of numbers, even the simple calculation is difficult to them.
5. Weird personality and emotions difficult to control.
6. Psychiatric symptoms. Dementia behavior changes are very significant, sometimes suddenly cried for no reason, or suddenly very angry for someone or something. Also very sensitive, and hot tempered, temporary hallucinations can occur in patients with severe delusions.
7. Unable to take care of themselves with life and work. Dementia patients showed an extremely passive and negative, idleness, aimlessly dangling at home.

1.3. Older persons physiological and psychological changes

Physiology: physiological factors affecting interaction of general older persons primarily are visual and auditory. Visual aspects, older persons may have varying degrees of visual impairment (more common is farsightedness). Hearing aspects, susceptibility and sensitivity of the voices of older persons continued to decline, manifestations are hearing loss and deafness. In addition, due to the diminution of response ability, when in the face of complex situations and emergencies, older people may easily have confused, hesitant.

Psychological: people entering old age, except appears on the decline of physical function, a mental change cannot be ignored. "Caution": focusing on the accuracy of completed tasks, sound and action. "Opinionated": rarely questioning their own thoughts and opinions, not easily bend other people's opinions. "Nostalgia": like things that they familiar. "Psychological dependence": do not want to become a burden to their children, but would like to have a reliable person as their protector.

In addition to the general characteristics of the elderly, dementia patients also have some special characteristics. Dementia can affect different people in different ways, but the most common symptom pattern begins with gradually worsening difficulty in remembering new information. This is because disruption of brain cell function usually begins in regions involved in forming new memories. As damage spreads, individuals experience other difficulties. The following are characteristics of dementia(Alzheimer’s Association, 2011):

- Memory loss that disrupts daily life.

- Challenges in planning or solving problems.
- Difficulty completing familiar tasks at home, at work, or at leisure.
- Confusion with time or place.
- Trouble understanding visual images and spatial relationships.
- New problems with words in speaking or writing.
- Misplacing things and losing the ability to retrace steps.
- Decreased or poor judgment.
- Withdrawal from work or social activities.
- Changes in mood and personality

2. Literature Review

2.1. Study on the existing navigation system

Most navigation products currently on the market are using GPS to navigate through map was presented in the form of courses, some will work with speech to prompt, its carrier are vehicle navigation devices, portable navigation devices, mobile phones and smart wearable devices, such as smart watches, smart glasses and so on.

Issues of interaction for older person：

1. Existing map from starting place to destination routes will have a variety of options, which offer more flexible options for young people, but this will give older people some trouble, for elderly, they believe less choice is better.
2. Screen of most electronic products are effected by environment, when outdoor at daytime, under the sunlight, the screen is unclear, at

night, the screen may have fluorescence phenomenon. Most of older people have poor eyesight, navigation devices generally are used outdoors, due to the inconvenience, these devices fail to provide help to older people.

3. Although it is possible to navigate on a mobile phone, but it needs to be more than one action, and the switch has more than one page, these operations are more complicated for the elderly, and navigation map on the mobile phone also provides additional information such as restaurants and hotels around users, which can provide more information for young people, but increased the difficulty of use among the elderly, prone to more errors.
4. Smart wear devices such as smart watches, its screen is too small, finger dexterity of elderly greatly reduced than young people, it is not easy to operate, and older people who have low vision, could not see the contents on the screen, so this kind of device will increase the difficulty of use for elderly.
5. Smart glasses may bring noise to sight of the elderly, so it more unsuitable for older people to use.

Overall study found that present these navigation devices are not suitable for the elderly, and design of navigation devices for the elderly especially for dementia patient is still blank, the need of designing a navigation device for older people become more and more prominent.

2.2. Acceptance of new technology for elderly

Personal and other factors affecting acceptance of smartphone

technology by older Chinese adults (Ma, Chan, & Chen, 2016), tried to make an overview of the usage of mobile phone among Chinese old adults and figure out what kind of factors can affect their acceptance of new mobile phone technology. Their research is going to test a newly proposed theoretical model for predicting the acceptance of mobile phone (smartphone) among old adults. During their testing, target participants who were willing to get involved in the study signed a consent form. They created a face to face interview with a structured questionnaire for elderly participants invited from an old center on capital city of China. The measurement scale and items had been adopted for previous researches, and had been proved useful and validated.

Remote patient monitoring acceptance trends among older adults residing in a frontier state(Giger et al., 2015), aimed to make a summary of acceptance of remote patient monitoring system among the users living in frontier area. In this paper, authors tended to establish a structured model to predict adoption of this kind of technique. In their work, technology acceptance model (TAM), was used as a fundamental theoretical model. In order to test the feasibility of their methodological approach, they choose growth curve methods and bootstrap resampling procedures, a modern robust statistical method, preliminary outcome estimates from available data.

The acceptance of personal health devices among patients with chronic conditions(Sun & Rau, 2015), also conducted a questionnaire survey and got 346 valid questionnaires for data analysis from chronic patients. Cronbach’s alpha is used to measure the set of questionnaires are reliable. To uncover the underlying relationship between question items, they used exploratory factor analysis (EFA) based on a common factor. Cronbach’s alpha assessed the reliability of variables derived from summated scales. A total of 346 valid questionnaires were collected for data analysis. Since the value of

Cronbach's alpha of the 346 valid questionnaires was 0.740, the result indicated that the questions had good internal consistency and the questionnaire was reliable for finding out the internal factors with exploratory factor analysis.

2.3. Improve the elderly's motivation to use applications via smartphone

Retired old adults are living independent lives generally and lack social activity during their daily lives. Many elder people live alone far away from their children, so it is difficult for them to receive timely care under some emergency circumstances. Under current inhabitancy pattern some of these people have to face a severe problem that their accommodations are far from the urban area, which cannot provide rapid response (face to face) like emergency rescue, psychological consultation and home care.

But with the help of information and communication technology, solving some of these problems could be possible. Some types of product even can provide elder people with a full health report and help them to live a healthier life. Like the study on the content of this article, this navigation system can be used in elderly patients with dementia who want to walk in their own city, eliminating the need for family companionship and alleviate their psychological burden, while outgoing, may help the patients slow down the progression of development, or even extend their life.

On the research problem, which is using the Internet and intelligent technology makes elderly's (especially elderly with dementia) live more independent. Along this line of thought, it can easily find that the foremost task is the elderly acceptance of these new technologies and willingness.

Through the collation and analysis of the 3 articles mentioned

above(Giger et al., 2015) (Ma et al., 2016) (Sun & Rau, 2015), I got some conclusions about barriers and incentives in elderly acceptance of new technologies as Table 1 as below.

Classification	General variables	Specific explanation
Financial Incentives	Price of new technologies	Expensive/Free or Not;
	Usage cost	Invest a lot of time and energy to learn new technologies;
	Charging cost	Charging time and electricity price;
	Performance of new technologies	Easy to use, Compliance requirements;
Non-Financial Inventives (Social-technique)	Policy	Be supported by the Government;
	Social norms compliance	Acceptance for new technology;
	Technology	The technology is mature/accurate or Not; Security risks;

Table 2.2.1Independent variables and specific classification

2.4. Research Status of accessibility information in various countries

Some countries from the beginning of the last century began to focus on accessibility, started from the physical accessibility to information accessibility proposed at the Eight Countries Summit meeting in 2000, has continued to develop the accessibility undertaking. All of these efforts has accumulated a lot of experience for the realization of accessibility society. In order to better promote information accessibility, firstly, people should start with the policies and regulations of the country, only the State attaches great importance to information accessibility, the public will be more receptive to information accessibility. Some European and American countries started early on the formulation of laws and regulations, and has achieved many results.

United States, Canada, the United Kingdom, Germany, Italy, Australia and other developed countries have issued information accessibility laws, India and other developing nations have begun integrating information accessibility into the legal system. In the 1998, United States revised of the United States with disability Rehabilitation Act, which set a precedent of global accessibility legislation. As a federal law, this Act provides for all the development by the Federal Government, maintenance and use of electronic and information technology must be able to make unimpeded use by the disabled. Currently, many of the institutions in United States are in compliance with the law to transform an existing website, and develop accessibility websites. Canada Government to amend a number of laws to protect the rights of people with health conditions or impairments, including the Canada Charter of rights and freedoms and the Canada Human Rights

Act, and added virtual worlds accessible content, explicitly includes online services, to ensure full protection of the rights of the disabled. United Kingdom disability discrimination Act was amended, and in May 2001, the special educational needs and disability Act was approved, explicitly provides for electronic resources (including Web sites) should be accessible for the disabled, gradually building a United Kingdom information accessible framework of laws and regulations.

Germany launched BITV (Barrierefreie Informationstechnik Verordnung) in 2002, provided for that all federal institutions have the duty to accessibility design of their website. In June 2006, the EU announced the "e-Europe Action Plan 2002" file; specifically requested public website of the European Union should implement accessibility. Canada Government had formulated The Government of Canada’s Common Look and Feel (CLF) Standards for the Internet governed the branding, usability & accessibility standards for its websites and web applications from 2000 – 2010, covering accessibility, navigation and format, official languages. These measures fully embody the Canada Government's focus on special populations and vulnerable groups.

2.5. Criterions and standards in Information Accessibility Area

Currently, the most representative organizations in information accessibility standards areas are W3C, ISO, IEC and so on. ISO and IEC established an International Committee for Standardization in the field of information technology, ISO / IEC JTC1, which focuses on integrity, global considerations. JTC 1 is the standards development environment where experts come together to develop worldwide Information and Communication Technology (ICT) standards for business and consumer applications. Additionally, JTC 1 provides the standards approval environment for

integrating diverse and complex ICT technologies. These standards rely upon the core infrastructure technologies developed by JTC 1 centres of expertise complemented by specifications developed in other organizations. W3C set up a sub-organization, WAI (web accessibility initiative), which focuses web accessibility research, dedicated to promoting website accessibility.

2.5.1. ISO/IEC Criteria

ISO / IEC JTC1 in order to achieve comprehensive coverage of demand for information accessibility, it released ISO/IEC TR 29138-1:2009 Information technology -- Accessibility considerations for people with disabilities in June 2009. The standard for detailed analysis of user requirements, designed explicitly for the people with disability in the access to and use of information demands, these requirements include:

1 To have cognitive ability of obtaining all ICT products showing information, including static and dynamic information, such as text information, ActiveX information, etc.;

2 To understand how, for example, how to use the product, understanding product output and display of content;

3 To have ability to operate the product, such as traverse and execute product functions;

4 To use assistive technology to use products, such as people with different types of disabilities can use different tools to use the product.

2.5.2. W3C Criteria

Web Accessibility Initiative (WAI), an organization under the leadership of World Wide Web Consortium (W3C), analyzed all types of people with health

conditions or impairments in accessing Web content features, launched web content accessibility guidelines WCAG 1.0 and the WCAG 2.0, which is a set of technical specifications, making it the most common web accessibility standards. Individuals and organizations using series specifications vary greatly, including web designers and developers, policy makers, teachers, students and other staffs. In order to meet the different needs of these persons, the guideline was structured hierarchically, including overall principles, general guidelines, testable success criteria, rich and constructive skills.

1 Principle: as the basis for website accessibility, including four general principles,

2 Perceivable - Information and user interface components must be presentable to users in ways they can perceive;

3 Operable - User interface components and navigation must be operable;

4 Understandable - Make text content readable and understandable;

5 Robust - Content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies.

6 Guideline: under the principles are guidelines, each principle contains a number of guidelines, the guidelines are not tested, but provide the framework and overall objectives to help developers understand the success criteria and better implement the techniques.

Success Criterion: for each criterion, providing testable success criteria, to allow to be used where requirements and conformance testing are needed. In order to meet the needs of different groups and different situations, success criteria are divided into three levels: A, AA, AAA, the AAA-level, A-

level is the minimum requirement and AAA-level is the highest requirement.

Sufficient and advisory Technique: each of WCAG2.0 guidelines and success criteria guidelines defines a wide range of skills. These skills can help developers in terms of accessibility issues.

WCAG2.0 guidelines put forward 4 principles, 12 guidelines, 61 testable success criterions and a wealth of constructive skills. When the webpage does not meet Web accessibility standards, we can contrast the WCAG2.0 guidelines, find the problems, then according to WCAG2.0 techniques to identify specific situations in order to modify the page to meet web accessibility standards. For example, there is non-text content in a webpage, the non-text content cannot be well processed by assistive tools, thus, the people with health conditions and impairment cannot use website smoothly, then this webpage does not meet web accessibility standards. At this point, we can according to the WCAG2.0 guidelines and find specific success criteria 1.1.1 non-text content, and can also find recommended skills provided by success criteria 1.1.1, then depending on the various situations, choose the recommended skills that we need, such as skill G94, it describes a simple procedure to resolve the problem, we can follow these steps to modify the webpage to meet web accessibility standards.

1 WAI provides WCAG2.0 guidelines, besides, it also provides related document:

2 How to Meet WCAG 2.0 - A customizable quick reference to Web Content Accessibility Guidelines 2.0 requirements (success criteria) and techniques is essentially the WCAG 2.0 checklist.

3 Understanding WCAG 2.0 – it has additional guidance on learning and implementing WCAG 2.0 for people who want to understand the guidelines and success criteria more thoroughly.

4 Techniques for WCAG 2.0 – it gives you specific details on how to develop accessible Web content, such as HTML code examples. The techniques are "informative", that is, you do not have to use them. The basis for determining conformance to WCAG 2.0 is the success criteria from the WCAG 2.0 standard, not the techniques.

To sum up, in terms of website accessibility standards, WCAG2.0 guidelines released by W3C and its sub organization WAI, is more comprehensive and more authoritative international standard. WCAG2.0 guidelines offer a guide to accessibility standards framework, not only structured the framework hierarchically, making the principles, guidelines, testable success criterions more clearly and in detail; and also provides a wealth of constructive skills and the preliminary reference procedure to solve the problems do not meet accessibility standards. WCAG2.0 guidelines is critical to the development of website accessibility; it brings a better user experience of webpage for the majority of persons with disabilities as well as ordinary users.

2.5.3. Corporations' efforts refer to information accessibility

Many international corporations are very concerned about the development of accessibility and making many practical to achieve. IBM has been committed to providing services for the disabled, since 2000, IBM established six information accessibility Centre in the United States, Japan, Europe and China, and developed a range of software and hardware products to promoting the development of accessibility. Microsoft not only develop some information accessibility products, but also added accessibility technologies to the original product, reserved application API interface, to extend existing products to support information accessibility technologies,

such as in the browser adds the ability to set accessibility options.

Since the release of information accessibility concept in “Tokyo Declaration” in 2000, research on information accessibility has been full attention. From the very beginning of the definition of information accessibility and research on accessibility for people with disabilities, to the current field of enacting information accessibility laws, regulations and standards, experienced a process of gradual accumulation. The purpose of information accessible is that to make everyone can fairly, easily, unimpeded access to and use information in any case. It primarily covering electronic information technology and web accessibility.

2.6. ICT system for elderly

The Internet can be used in the system of health care services for the elderly, starting from conception of a Georgia State University Professor Upkar Varshney, he used the technology adopted by intelligent pattern to solve the problems of the elderly care for vulnerable groups such as medical services, and opening up the Internet, intelligent terminal and information technology in medical applications of technology (Varshney, 2007).

In the area of intelligent monitoring, General Electric Company conducted a study called emergency system for caring for the elderly, the main principle is arranged in a series of sensors around the elderly, these sensors can collect information from elderly, through the Intelligent analysis of sensor data, when the old man is dangerous, timely alarm tips and advise the guardians, protect the safety of the elderly.

Intel also make some studies about intelligent monitoring for the elderly. Intel Seattle Research Institute conducted a research project called "care assistant”, mainly to help caregivers to monitor the status of the elderly,

through a variety of micro-sensor equipment installed in the elderly's daily items, and remind caregivers whether the elderly take medicine timely and other activities.

Video surveillance network at the University of Dundee, by install some cameras in the indoor areas that elderly often stay, such as home, Ward, through image recognition and video recognition technology to identify the status of older persons, if the system find that the old man fainted and so on, it will contact medical personnel timely. Limitations of such system is also very large, mainly geographical limitations and personnel problems, only in a few specific locations to monitor the behaviour of the elderly, and can only occur in elderly people fainting to contact medical personnel.

For the old-age home, IBM made a series of smart retirement solutions, through the terminal access vital signs monitoring products for the elderly, collecting important data of the elderly, and upload these data to the elderly aged information service platform by wireless communication technology, and then specialist of health could provide services for the elderly. This system made retirement at home more professional, efficient and humanistic.

It is easy can be seen from the study present situation above, many scholars have made an in-depth study in health care, intelligent monitoring, life care, old-age home for older persons, many internationally renowned companies provide a range of products and solutions for the elderly also. These products and solutions have some problems as follow:

1 Intelligent monitoring devices for elderly is expensive, high maintenance costs, not suitable for wide dissemination;

2 The feature of elderly service product is single and it cause low utilization rate;

3 Some service applications have regional restrictions, lack of

flexibility;

4 No special product for dementia patients, unable to meet the needs of special groups of ICT systems;

To solve these problems, based on the available elderly care system, developing an ICT system to meet needs of patients with senile dementia to walk around in their own city by themselves is necessary.

2.7. Research question

“Accessibility is about designing so that more people can use your web site effectively in more situations.” (Henry, 2007) Similarly, developing an accessibility mobile application for diversity users in different usage scenario is necessary, especially for special group who have special needs. Thus, this master project will focus on the research question:

How to develop a mobile application for dementia patients to help them walking in their own city?

According to this research question, I need to address the following issues:

1 Combining the needs of dementia patients, analysis of difficulties when they are walking on the street;

2 Design the proper UI interfaces and interactive systems for dementia patients;

3 Achieve the simplest and most useful features for dementia patients.

2.8. System-related technical background

2.8.1. Android Platform

Android system is developed by Google and the Open Handset Alliance

and are mobile device platform based on Linux kernel, mainly used in mobile terminals such as mobile phones and tablet computers. Due to the Android system is an open source operation system, the Android system obtained rapid development and wide application, became one of the largest number of users' mobile phone operating system. According to 2014 mobile phone operating system analysis report (Strategy Analytics) shows that Android mobile operating system has a global market share of 84.6%, number of devices is for 1.07 billion.

2.8.2. Android framework

Architecture overview of the Android platform is divided into four parts, the bottom is the Linux operating system kernel, mainly to provide and implement security mechanisms, process management, driver functions, second layer includes Android runtime and program libraries, the third layer is the application framework, relating to view system and resource manager, the fourth layer is the application layer, including address book, browser and so on.

2.8.3. Android Features

Android has a lot of features, and provides many conveniences for the development of this project.

1. Support for multiple sensor types

Android phones not only has the ability to compute, storage and communications, and because Android can support for various types of sensors, it makes mobile terminal with increasingly powerful IntelliSense capabilities. Android system supports motor sensors such as accelerometer, gravity sensor, gyroscope, rotating vector sensor etc., are used to measure

the sensor along three axes of acceleration and angular acceleration, environmental sensors such as thermometers and barometers, photometer, are used to measure environmental parameters, such as air temperature, pressure, light, humidity, etc., position sensors such as direction sensor and magnetic meter, are used to measure the physical location of the device. Using the Android platform, we can easily access to the sensor equipment, collecting sensor data.

2. Supports a variety of network connections

   Mobile Terminal bottom communication functions, have been packaged in the Android, Android library functions can be called very convenient to achieve terminal communication. Meanwhile, Android developers can use HTTP or Socket communication modes to establish communication connection with the server. In addition to long distance communication connection, Android can also provide some close communication features, such as Bluetooth connectivity, NFC (Near Field Communication) connectivity technology etc.

3. Supports terminal location and map information

   Refer to the terminal location, Android system can support two modes, one is GPS positioning, the other is based on the network location. GPS positioning is based on the phone's GPS chip, receiving satellite signals to lactate outdoor position. Network location, is through searching and collecting some location information, such as BS (base station) information, Wi-Fi information, and send this information to locate the server, then the locate server returns the location information. In terms of map, Baidu, AutoNavi and other corporate have opened their map API for developers, in addition, embedding Google Maps service within the Android system enable developers to display map information.

4. Future Android system intelligent development technologies

Currently, the Android system is further developing, along with scientific and technological progress and social development, Google corporation provide powerful support for Android system, such as intelligent voice recognition function, this function through mobile terminal devices to obtain voice data, and then conveying the date to the server to conduct intelligent match, recognizing the speech content, and converting voice messages into text messages. Technology like this will be more and more, will make Android more intelligent.

2.8.4. Outdoor location technology analysis based on mobile terminal

Location information is an essential part of this project, the location accuracy and reliability can also be a vital part of this project. The mainly location mode based on mobile terminal are: GPS positioning, WIFI positioning, BS positioning and AGPS positioning. The positioning principle, strengths and weaknesses of four positioning methods are not the same. The following comparative analysis the four-positioning technology in detail.

1. GPS positioning

GPS (Global Positioning System) started from the United States military project in 1958, is providing radio navigation satellite positioning system to the whole global incessantly. The positioning system includes a ground control segment (master control stations, antennas, the ground stations and communication system), the space segment (distributed in 6 orbital plane of 24 satellites), user device (GPS position Terminal), etc.(Kaplan & Hegarty, 2005)

GPS positioning has the advantage of cover range wide, and positioning precision high(Kaplan & Hegarty, 2005), but also exists with series of

limitations, like capture GPS signal for a long time in the first time, about several minutes to more than 10 minutes; GPS satellite signal could easy be blocked by buildings and other objects, in city, in the buildings, positioning terminal received not GPS signal or only received a weak GPS of signal happens often, these limitations makes GPS system in the exists with positioning blind spot(Kleusberg & Langley, 1990).

2. BS positioning

Base station positioning technology is mainly taking the existing communications network positioning characteristics to locate a mobile(Zhao, 2002). Due to the different characteristic values, BS positioning can be divided into: signal point location such as the AOA (Angle of Arrival); ranging location technology based on signal propagation time, such as TOA (Time of Arrival), TDOA (Time Difference of Arrival); according to BS signal strength to estimate the distance of localization technology etc.(Cong & Zhuang, 2002). Due to multipath effects and BS Clock synchronization issues, no matter what kind of BS positioning all have accuracy problems(Simon et al., 2004).

Base station positioning is a low accuracy method, errors between dozens to hundreds of meters, but communication base station covers a wide range, and indoor positioning can be achieved. GPS positioning use GPS satellites, could raise outdoor positioning accuracy up to ten metres, but cannot be used in indoor. So combined two methods, AGPS positioning system comes.

3. AGPS positioning

AGPS (Assisted Global Positioning System), is a positioning technology that combine of the mobile phone base station positioning and GPS positioning. By this way, it can well avoid slowly first time GPS positioning, unable located indoor. GPS positioning slowly for the first time, because positioning terminals in order to get the GPS frequency band have to search for the whole

frequency band, this search method leads to unnecessary waste of time. But in AGPS, GPS satellites frequency band, location information can be obtained through the local base station, thus saving a lot of time. Regarding to GPS cannot provide location service indoor, AGPS adopted base station positioning to assist GPS positioning(Djuknic & Richton, 2001).

AGPS positioning processes are as follows:(Djuknic & Richton, 2001)

a) First, the mobile get to the current communication base station information from communication base station;

b) Upload base station information to AGPS location server via mobile communication network, query the GPS satellite information;

c) AGPS location server according to the base station information find the GPS satellite information (including the GPS satellite frequency bands, elevation and other information), and returns the information to the mobile terminal.

d) Phone's GPS module can quickly search the current GPS satellite based on satellite information from the server, and collected GPS position information (pseudo range data), upload to the server again.

e) Server combines pseudo range data and assisted positioning information, get the longitude and latitude of a mobile terminal, and return location information to the mobile phone, this is the last procedure of AGPS process.

4. WIFI positioning

WIFI positioning applies only to indoor location, less to do with this project, so without much analysis here.

2.8.5. Introduce of development kit

Mobile Terminal and Services Terminal is implemented in the Eclipse integrated development environment, Eclipse is an open, extensible platform based on JAVA, Eclipse is a framework platform, anyone can build environment from plug-in components. Terminal Android development is to install the Android SDK (Software Development Kit) in Eclipse to implement. Communication between the Terminal and the server is based on Socket mechanism(Meier, 2012).

Server-side will be developed by using Visual Studio, adopted Windows MFC framework. MFC (Microsoft Foundation Classes), which is a class library used to develop graphical interfaces provided by the Microsoft. C++ class encapsulates Windows API, and facilitates the development of Windows programs(Blaszczak, 1997).

Positioning function can be used to provide location services for the users of the system, and combining of positioning and maps to realize the function of navigation.

This project will use both Baidu Android SDK and Google Android SDK. Because next step may conduct user testing in both China and Norway, using maps of the two companies can ensure that users in two country have the same and good user experience. And the two companies' positioning SDK are basically the same, so it is very easy to program development.

Android Positioning SDK is Google/Baidu provides mobile developers the location services interface. Developers can apply for KEY value, and can easily add precision of maps positioning features in Android program. It also provides different positioning strategy, including high-precision mode, low power mode and use device mode.

When users have positioning needs, system will call location SDK interface function, send locate requests, location SDK modules will collect positioning information based on GPS, and send positioning information to the server, after the server's computing, return the positioning result to positioning SDK, finally realizes the function of location in the terminal system.

Using Baidu/Google map SDK positioning function has the following advantages(Kashevnik & Shchekotov, 2012):

1. High positioning accuracy. Adopting mix positioning, according to the current status of the device automatically collect locate signal source, outdoor GPS position about 10 meters, indoor location is about 30-50 meters.
2. Position covering a wide range. Position covering a wide range. Locate server recorded information about the base station coverage area is more than 95%.
3. High positioning speed. Positioning time is less than 1s.
4. In the position process, use less data traffic consumption. Due to positioning and communication process only involves positioning basis and positioning result, positioning operations conducted in positioning server, so the positioning request traffic is very little.

In addition to positioning SDK, this project also requires map SDK, in this project, I also use two (Baidu/Google) maps SDK. Baidu/ Google Map Android SDK are suitable for Android system mobile device application development, by calling the Baidu/ Google map SDK interfaces can use maps and map data, build map applications in demand. Map SDK provides map display and map functions, including 2D, 3D map, satellite map, by accessing Baidu/Google map servers can also achieve real-time traffic map. In addition,

Baidu/Google map interface is also provided for some basic map operations, such as through clicks, double click, long press of gestures operations to achieve map scaling, rotating, and altering the angle function(Rogers, Lombardo, Mednieks, & Meike, 2009).

Baidu/Google maps also provides public transport information, bus transfer plans, drive route planning and walk path retrieval functions. In addition, using the positioning to get the latitude and longitude, Baidu/Google also provides a function of convert between geographical coordinates and addresses. Includes forward geocoding (achieved the address or place name convert to the corresponding location on the Earth's surface) and reverse geocoding (achieved addresses on the surface on the Earth convert to standard address or place name) (Rogers et al., 2009).

3. Methodology and Theoretical Basis

3.1 User Centred Design

This chapter explains the User Centred Design theory, summarizes the design process and key tools of User Centred Design, and uses User Centred Design method to design the key points of the product, providing theoretical support and method guidance for the follow-up thesis and design.

3.1.1 The Basic Connotation of User Centred Design

In the international standard ISO13407(“ISO 13407,” n.d.), the User Centred Design method is defined as, User Centred Design is to achieve

smooth product usability and design process planning and management. The User Centred Design method argues that the design process should focus on the user, make users naturally accepting the product with existing mental and behavioural habits, rather than forcing the user to re-construct a mental model. In the initial stages of the product life cycle, the product strategy should be to meet the needs of users as the basic motivation and goal; in the subsequent product design and development process, the user's research and understanding should be used as a basis for decision. At the same time, the product at various stages of the evaluation information should also be derived from the user's feedback. Therefore, the concept of user is the core of the entire design and evaluation.

Application of User Centred Design method for enterprises and users have significant advantages: in the design phase, broaden the horizons of the designers, made the product close to user's expectations, reduce the wrong design, while quicken the design speed; in the implementation process of design , in order to combine the views of various departments to form a unified development strategy, thus avoiding the mutual conflict; when the design is completed, to ensure that products are easily accepted by users, while reducing user learning difficulties, reduce training and after-sales service costs; the most important thing is to improve the user's satisfaction.

3.1.2User Centred Design process and main tools

After summarizing, the User Centred Design method is divided into four steps: user research, task analysis, design realization, evaluation and improvement. The key tools used in the main activities and phases are shown in the following table.

The research tools used in this paper are: focus group, questionnaire survey, user interviews, field observation, desk research, low-fidelity prototype design, high-fidelity prototype design and usability testing.

Questionnaire survey is to provide relevant questions for the respondents to answer based on research topics, usually divided into closed-ended questions and open-ended questions. Questionnaires can be distributed through the Internet and on-site, but the answers are not the exact answers, as the respondents are influenced by the environment and other factors when answering the questionnaires. Therefore, the choice of subjects, the problem set, the location of the distribution, test time decide the effectiveness of the questionnaires.

User interviews are a great way to explore the potential needs of users and can be thought of as a heuristic approach to interviewing. Not only according to the contents of users' answer to ask a chain of questions, but also can summed up the content that users cannot accurately express and discuss with them. Before the interview, the questioner should list the outline of the questions, after the interview, the questioner should sort and summarize the results.

The field observation method is a method that the observer use his own sensory organ systematically or scientifically to observe the social phenomena in a natural state with a purpose and plan. In many studies, designers and researchers often find that some of the habits or phenomena that users describe during an interview are different from the actual use of the product. This is sometimes not the user's deliberate concealment. Therefore, after the interview, in order to further accurately obtain the users' experience information in the actual use of product, the research team members will select representative users to participate the observation experiment.

Desk research(M.R. Hill, 1979) is a market research term that

investigates information that already exists and has been collected for a specific purpose, that is, the collection, screening, of secondary information and judgment whether it has been resolved in whole or in part. Desk research is relative to the field research, usually the first step in market research, to collect the existing market data for further investigation.

Low-fidelity prototypes(Sefelin, Tscheligi, & Giller, 2003) is mainly paper prototypes, generally static, do not have interactive features. High-fidelity prototypes are prototypes that are closer to the final product and are used to design and test many factors such as interaction, environment, visual design, engineering, and software.

Usability testing(Dumas & Redish, 1999) is the most important tool in the User Centred Design method, and it is also a distinctive feature of User Centred Design, which is different from the traditional product design method. Invite real users to test the design that includes a series of tasks, observations, or interviews to document the behaviour of the user in the process, such as confronting doubts, Errors, steps to success, and other feedback to reveal problems they encounter in the actual use of the product, and to understand their perceptions of the design. Commonly used methods are laboratory testing, field testing, remote testing. A typical usability test procedure is to plan testing, recruit users, execute tests, analyse test results, and report test results(Kaikkonen, Kekäläinen, Cankar, Kallio, & Kankainen, 2005).

3.1.3The key point of product design using User Centred Design

User identifying

The User Centred Design method emphasizes user-centricity, where users refer to potential consumers of new products. Therefore, in the first phase of the User Centred Design method, accurate user positioning must be performed. First, the user model is established to identify a virtual person with a virtual identity and personality traits, and with the objectives and tasks of using the new products. Secondly, describe a brief story of the scene, including the user with what purposes, and difficulties to use the system. It is possible to identify the target users at the very beginning of the user study, or narrow the scope of users by using a wide range of user surveys (including questionnaires, focus groups, and situational interviews) for accurate user targeting.

Identify user needs

In the user research phase, through the user survey tool will produce a list of user needs, which cover a wide range of user needs. User needs can be divided into three levels, physical / functional level, physiological / psychological level, subjective emotional level. In the phase of identification of user needs, through classification of these need, differentiate the importance of different needs, according to the actual situation, identify the user's real needs, important needs, and usability needs.

Communication and coordination

By using User Centred Design method to product design, the design process usually lasts a long time, so the design team's communication and collaboration is important. At the same time, the communication between the design team and the users is also critical. The user's understanding and cooperation are the guarantee of the design process be smoothly executed.

Iteration

In User Centred Design method, iteration is also a very important part. Through usability testing, user experience and feedback, improve the existing design, which involves user survey and design implementation, continuous iterative and improvement, the maximum to meet the needs of users. At the same time, user study, task analysis, design implementation, evaluation and improvement are not step by step, but according to the actual situation to modify the program constantly.

Usability testing

Usability testing exists at all stages of User Centred Design, focusing on observing the operational behaviour of the user when he or she operates the product. Usability testing can avoid spend a lot of effort and financial resources to change the product defects, due to the difference between the user needs and product. Usability testing can help designer identify problems as soon as possible, the maximum of meeting user needs.

3.2 User study

3.2.1Persona

Persona is a fictitious user that represents a group of users(Battini, Faccio, Persona, & Sgarbossa, 2011). When building Persona, the number of the role should not too much, not more than 5 is appropriate. Persona with refined features of the user group will help designers find their core needs, make users fresh up. A persona can be more representative than any real individual. A persona should include information on gender, age, profession, geographical, habits and so on. A product will typically design 3-6 personas to represent all target user groups. User model is more concerned about how users use the product, how to interact with the product, which is a relatively continuous process. Persona is designed to better understand user needs and the differences between different user groups.

3.2. User needs study

In general, the user needs can be divided into product level and experience level. For users, the design and design goals can be divided into three layers, Visceral layer, Behavioural layer, Reflective layer respectively(Lindgaard, Fernandes, Dudek, & Brown, 2006). The Visceral layer concerns the sensory stimulation that people feel, is the most direct experience form. Behavioural layer requires the user to carry out information processing independently, through a certain learning process to master the skills and complete the task, which can access to enjoyment and the sense of accomplishment. Reflective layer is the highest level, it is based on the first two layers. It refers to the user’s feelings, consciousness, personal experience, memories, cultural background and other factors.

In this paper, user needs are divided into two parts: usability needs and user experience needs. The reason for this is closer to the user, and treat users' need as the main needs. We first need to understand the user, usually o find the final product users by observation, questionnaire and interview, and then creating a persona. The purpose of user study is to understand the needs of users, to determine the task based on user needs.

3.2.2Create product function list

Function list is based on the function of the product, to create the interface design plan. Designers should list the priority function according to the product market positioning, target user groups, project progress, should also list the technical support conditions based on technical conditions. In this paper, in order to meet the needs of target users, the function of application should be designed concise and practical and the function that target users most looking forward to should be highlighted.

3.3 Smart phone Application interface design process

3.3.1Interface architecture design

Architecture design is the product structure design, it is the basic framework of product. To facilitate the user access to content accurately, quickly and efficiently, classification and navigation of consent should be designed. Good product architecture is clear, no unnecessary level, have a good coordination in the breadth and depth of the hierarchy, all the major functional modules can be accessed through the main interface, have good compatibility with the expansion of future product functions. The product architecture is generally divided into hierarchical architecture, matrix

architecture, organic architecture, and sequential architecture. Combined with the above analysis and summary, and my own experience in the project, this paper summed up three principles of smart phone interface design: 1, clear architecture, no redundant architecture; 2, the hierarchy of breadth and depth should be good coordination; 3, to maintain all the functional modules can access from the main interface.

As the mobile Internet applications are restricted by the mobile device screen, the user scenario and other restrictions, the hierarchical architecture is the most widely used. Mobile Internet application information architecture can be divided into four basic types: shallow and wide, shallow and narrow, deep and wide and deep and narrow. Shallow and wide means that the arrangement of information has a certain law, and downward flattened divergence around a centre point; shallow and narrow, lightweight arrangement of information, can help users to quickly access information; deep and wide, do not limit the width and depth of information, each node has a myriad of possibilities. Users need to go through a certain number of steps and processes to be successful when acquisition of information; Deep and narrow, limit the width of the information, and information content will continue to expand. The user needs to further down operation, to achieve the final information to obtain the standard. In these four basic types, the human brain is most likely to accept a shallow or narrow information architecture. In other words, shallow and narrow is the most common mode of thinking of the information architecture, such as the design of mobile phone address book, the user can quickly find the contacts based on alphabetical order. In addition, in other entertainment-oriented applications such as games, the architecture of information is often designed in a deep and wide form. Users need to think and explore to find the final answer. Based on the above analysis, we can easily find, for the elderly, especially for dementia user groups, the shallow

and narrow information architecture type is most likely to be accepted and used, so in the process of design mobile phone application for the elderly population, designer should try to function concise, this will not only make it easier for the elderly to use the design of the product, but also make them to accept such products from the heart. Therefore, the design in this paper is used in shallow and narrow information architecture.

3.3.2Process design of the Interface

Flow chart is a graphical language means to draw the procedure of user use of this product and the steps of user achieve specific functions. A flow chart will help designers eliminates a lot of text description of the product requirement documents and interactive design documents, also help technical staff to understand the design intent at a glance, easy to organize the logical order of the software. The importance of the flow chart is to analyse whether the logic of interaction is reasonable from the perspective of the user’s use logic. Flow chart is intended to help designers to understand the functional structure of the product and the user’s using target by operating each step. Interactive design focuses on the interaction behaviour between users and product and users how to better accept the output of the product information.

Specific to the smart phone interface design, here summed up five principles: 1, the product must have a clear interactive process, each process corresponds the user's operating habits; 2, the user can cancel the currently executing operation, the feedback of the operation must be clear; 3, the user at each layer are clearly aware of his/her location of the product, where he/she could go, where is the previous and next step, how to return to the main interface; 4, errors tolerance, the wrong operation can be restored; 5, have a good guide for new users and complex processes.

3.3.3Interface Wireframe Design

Wireframe is a very important part in software or website design process. A wireframe is a method of integrating all three elements of the structure layer: integrating interface design by arranging and selecting interface elements; integrating the navigation design by identifying and defining the core navigation system; integrating information design by placing and prioritizing information components. By putting these three together in a document, the wireframe can identify an architecture based on the basic conceptual structure, pointing out the direction in which the visual design should move forward.

According to analysed some mobile phone application wireframe diagrams, summed up the wireframe design generally follow several principles: 1, highlight the key of the expression, to maintain concise; 2, follow the interface structure specification; 3, consider the user experience; 4, pay attention to functional expression rather than the expression of the appearance; 5, consider the scope of smart phone handheld operation.

3.3.4Visual design of the interface

Visual design of a product is direct contact with the user part, it is to convey the most obvious part of the information to the user, whether the product visual design is reasonable and attractive, directly determines the user's loyalty. Therefore, the visual part is very important. Reasonable visual design should follow: the accurate expression of brand image; guide the user's visual path through the colour, lines, spacing and other visual elements of the design reasonably; the designer communicates to the user the interaction flow in the interactive design and maintains consistency. Specific smart phone interface design need to follow several principles:

1, according to different systems, different screen size and resolution to design;

2, to keep the page with a layering;

3, visual appearance should have impact;

4, the use of metaphorical design and the icon mapping should be unique;

5, create a unified brand image;

6, using the grid to enhance the user experience and reduce development costs;

7, important content to stay in the first screen;

8, the same icon in different operating conditions (normal, selected, press) should have a clear visual distinction.

3.3.5Interface usability testing

Availability assessment can be divided into three categories: Usability Test, Usability Inquiry, and Usability Inspection(Karat, 1997). There are many methods refer to usability testing, such as focus groups, Cognitive Walkthrough and heuristic evaluation etc.(Nielsen, 1994a). Young have separated more than 60 usability test methods based on the literature review. The most common approach to improving product usability is to use a fast-iterative design. Through continuous evaluation of product prototype collect users' feedback data, according to feedback data to continuously optimize the product user experience, improve the level of product usability. The evaluation process is based on usability testing methods to establish the evaluation criteria.

3.4 Key technologies of Android positioning

The Location based service application is mainly used the positioning interface provided by the Android. The simplest way of mobile phone positioning is to use the smart phone GPS module. GPS accuracy is the highest, but, there are also obvious shortcomings: 1, power consumption; 2, by default, most users do not open the GPS module; 3, to obtain the first positioning data from the GPS module positioning, may need long time; 4, cannot be used indoor most of the time. Of these, 2 and 3 are relatively fatal. It should be noted that, GPS is the use of satellite communications channel, connectivity can also be used without network. Another common positioning method is base station positioning, this method is to collect the Cell_ID and some other information (mobile network number, mobile country number, location area code, etc.), and then access some location services through the network, get and return the corresponding latitude and longitude coordinates. Compare with GPS, the accuracy of base station positioning is lower, but the advantage is it can be used indoors, only if the network is unobstructed. There is also a positioning method named WIFI positioning. Similar with base station positioning, this approach is to obtain some information from the current connected WIFI, and then access the network location services to obtain latitude and longitude coordinates. Because both WIFI positioning and base station positioning need to use the network, so in Android also collectively called them as Network method. Finally, need to explain is AGPS. The essence of AGPS is still GPS, but it will use the base station information to assist the GPS, and then to modify the GPS results, so this method faster than traditional method, the accuracy of AGPS slightly higher than GPS.

In the Android positioning service, there are two very important classes: LocationManager and LocationProvider. LocationManager which defines the methods of system location access; LocationProvider defines the location

service provides methods. According to the device, you can use different location technology to achieve location services, get GPS positioning and network positioning based on the static constants GPS_PROVIDER and NETWORK_PROVIDER in LocationManager on Android platform. LocationManager.GPS_PROVIDER: get Locate information through GPS, the accuracy is high, but positioning is time-consuming and power consumption. Meanwhile, the location information may not be obtained because of weather or surface obstacle. And if the mobile terminal does not have GPS module installed, it cannot obtain GPS information through the method; LocationManager. NETWORK_PROVIDER: get Locate information through the mobile cellular network, although the accuracy is low, but the positioning speed is fast and less power consumption, and the mobile terminal does not need to install the GPS module. Considering the program universality, the we need to design program automatically selects the implementation method of LocationProvider according to different signal environment, so it uses another class, Criteria, it is packaged the condition to obtain LocationProvider, according to the current equipment automatically select LocationProvider.

From GPS module start to obtain data, the time will be long, may be 2-3 minutes, the program may be blocked by requested function for a few minutes, if the program exceeds the response threshold (usually this value is 5 seconds), will prompt the user terminate the program. Based on this consideration, you must use the asynchronous mode to get location information on Android platform. Here need to use another important class, LocationListener, it contains several member functions, all of them are callback function. The most important one is onLocationChanged (), this function is called after the Android obtained a new Location information, you can achieve desired function in this function. Do not wait for the callback function onLocationChanged () to be called, and we need to set a timeout

mechanism. If timeout, onLocationChanged () still did not return value, Android also provides a function getLastKnownLocation (). This function will return to the location information that the Android platform obtained for the last time. Therefore, even if onLocationChanged () is not called, we can still get a location information.

Here leads to a question: Is the return value worthy of trust?

If you have used location based service or some map program, you will find a phenomenon: at some point you open the map, the results are targeted to the place where you last used the map program. This is because the program is using getLastKnownLocation () to obtain the location. The solution to this problem is that we need to define a standard to determine whether Location should be trusted or not. Android's Location class containing latitude, longitude also contains a lot of other information, such as when the location information was obtained, through which way to obtain, etc. We can determine whether the Location is obsolete or credible based on this information.

Finally, discuss the overall program solution. Android's official documentation gives the recommended solution: first register their own LocationListener, it is listening both GPS_PROVIDER and NETWORK_PROVIDER; then call getLastKnownLocation () to get a Location value, which can be used as an alternative value; and then receive the location information returned from onLocationChanged () for an acceptable period and compare it to the previous value. In the end, there will be left the best results after screening, we need to determine whether the results are acceptable. If acceptable, return to the user, if not, tell the user system cannot position at this point. The whole process needs to define two important functions: one is to compare two Location information, to return to the better one; another function is used to determine whether the Location information

can be accepted.

4. User needs study

4.2. Application introduction

The name of the application in this article is: Smart Location. The purpose of this application is to help people with senile dementia to identify their location, to remind them where they are, to help them think about where they are going and what they are going to do. In addition, due to the frequent loss of senile dementia patients, this application can set and store the user's home location and information, as well as detailed navigation routes to help users suddenly forget their home address and home routes back home smoothly. In addition, due to the specificity of patients with senile dementia, when they forget the home address and information, at the same time, they may also forget carrying a mobile phone with them, so the application will provide regular reminders function, prompting the user there is a mobile phone with them, this can ensure users to remember they have brought their own mobile phone with them, on the other hand also increased their sense of security on their heart.

4.3. Explore the user’s real needs

User needs study method

The target users of this study are mainly people with senile dementia, and only for senile dementia patients at the initial stage of a disease. Due to people with senile dementia may be triggered at any time, when they may suddenly forget a lot of information, such as their family members’ names,

their own name, their own age, etc., for this situation, one-to-one interview is more suitable for them. The interview site chosen in the user's home, the benefits of doing this is to allow them to be interviewed in a familiar environment, and there is at least one relative and friend accompanied them, so that respondents can relax themselves, it will also help to increase the trust of the interviewer and improve the authenticity of the interview.

Before the interview, a Participant consent form is required. This means that the interviewer voluntarily participated in the interview and can withdraw from the interview at any time. In addition, the interviewer is required to keep the personal information of the respondents strictly confidential. The specific details of the Participant consent form are given in the Appendix.

Purpose of User Interview

One-to-one interview allows designers and users to interact directly with each other, and through a series of questions, the designer will clearly understand the needs and ideas from the user. Through this interview, the designer can obtain the user’s background, the experience of the use of ICT products, combined with the application function to explore the actual use scenario, and user's specific needs in the real scenario, such as combined with the user before the lost themselves experience, the interviewees can tell the designer about his/her circumstances, his/her needs, the problems he/she is facing, etc. Through the interview to obtain user information, to create a typical user roles and scenario scripts. Thus, finding the user's needs, to provide a theoretical basis for product design.

Interview Guide

The main purpose of user interviews and observation is to discover the

deep information, understand the user's true goal and motive, through observing the user's usage and feedback in the real environment to extract the relevant behaviour patterns, as the basis of the establishment of the user role. Interviews involve the user's goals, behaviour, attitude and ability, need to obtain information from the user, including:

1, the personal situation of the respondents, including living habits, physical condition, such as age, gender, educational level or profession title, retirement, average monthly income, source of income, whether to go out frequently, whether have other chronic diseases, whether live with their children, etc.

2, Survey respondents' perceptions of “Smart Location” and their needs. Such as: what kind of positioning application they need, whether to use a similar application before, whether use smart phones, and some other requirements and expectations for “Smart Location”. Specific interview guide of this paper, please see the appendix.

Analysis of Interview Result

User	Gender	Age	Course of disease	Status
U1	Male	65	1 year	Retired
U2	Female	62	2 years	Retired
U3	Female	63	3 months	Retired
U4	Female	67	7 months	Retired
U5	Male	69	1.5 years	Retired
U6	Male	72	9 months	Retired

Table 4.1 User’s personal information

User	Education level	Occupation before	Monthly Pension

		Retirement	(CNY)
U1	Junior Diploma	Train driver	4000
U2	Bachelor Degree	Teacher	5500
U3	Bachelor Degree	Clerk	4500
U4	Master Degree	Headmistress	7000
U5	Bachelor Degree	Artist	6700
U6	Bachelor Degree	Teacher	6200

Table 4.2User’ s education and occupation information

Based on interviews with three patients with dementia (U1, U2, U3), the following results were obtained:

1. Three respondents were between 62 and 72 years of age;

2. The time of illness of three respondents were: one year (U1), two years (U2) and six months (U3);

3. All three respondents have retired and are living with their children;

4. The education levels of the three respondents were: primary (U1), university (U2) and junior secondary (U3);

5. The monthly salary of the three respondents before retirement is: 3000 CNY (U1), 6000 CNY (U2), 10000 CNY (U3);

6. Three respondents rarely go out, their scope of activities is mainly at home, if they go out to have exercise, they must be accompanied by his family;

7. Of the three respondents, two have been lost themselves before. They lost themselves in their unconscious time, and finally U1 was brought home by the policeman, U2 was found by their families, they were not aware of their lost themselves at first, but when they found themselves lost, they have forgotten the home address and orientation, and do not know ask who to give

them a hand;

8. Three people think that senile dementia impact on them is loss of their memory suddenly, so that they forget some very important information, they are insecure, in their daily life, they need someone to take care of.

9. U2 and U3 have experience with the use of smart phones, U2 only use the phone for 1 year, U3 use mobile phones more than 2 years;

10. U1 do not know what is the mobile phone application, after the interviewer explained, U1 still cannot understand what is mobile phone application, U2 and U3 are very familiar with mobile phone applications, they are most often used WeChat applications, which is the most popular social phone applications in China, they use WeChat to contact their loved ones and friends;

11. In daily life, U2 and U3 all indicate that they may use the mobile phone at any time, especially when they receive messages, they will hear the phone's voice and vibration prompts, at any time to view and send messages;

12. U1 and U2 have presbyopia, U2 need to wear glasses when the use of mobile phones;

13. None of the three have used maps and location-based mobile phone application;

14. All three said they would like to have a mobile phone applications specific designed for them, but U1 expressed great concern, he felt he might not understand how to use this phone application;

15. Three people hope “Smart Location”can be easy to use, not too many functions, but must be practical. U2 proposed, her cell phone capacity is very small, so she do not want “Smart Location” take up too much phone space.

According to the user's response, we can find their age are at high incidence of senile dementia. According to their situation and the doctor's judgment, all of them are in the first stage of senile dementia. Because of education and income differences, their experience of using the smart phone is different, the understanding of the application of mobile phones are also different. They have not had the experience of using location-based software, according to their description, in their past experience, when they lost, the phone does not have any help to them. Based on their responses and analyses, “Smart Location” initially needs to have the following functions:

1. Tell them where they are at any time;

2. According to their needs to prompt them what to do and where to go;

3. User interface should be user friendly, the font should be large enough, the visual and interaction design should be simple;

4. “Smart Location” should have sufficient error tolerance;

5. Design of user interface should be flat, the application of all the content to be simple to understand, to ensure that they can easily learn the application.

5. Prototype Design, Development and Evaluation

The first stage of the design, we call it prototype design. At this stage, designer mainly the design of product features, application flow, information architecture, interactive details, page elements etc. These prototypes provide an opportunity for feedback: whether to meet the needs of the user and their operability(Ellen Agger, 2001). Prototype is a valuable design tool (Nielsen, 1994b). In the initial design phase, prototype is able to explore and test the user. In the actual design layout and more detailed interaction problems, prototype can be evaluated and tested. The final high-fidelity-prototype can be used to display the final demo of the application.

This part is one of the most important contents of this paper. Mainly related to prototyping, development and initial user testing. This part also relates to the comparison with some applications that already exist. This part has X iteration. The prototype in this paper is called *“Smart Location”*.

According to the actual user's needs, “Smart Location” comes into the prototype design stage. At this stage, this paper uses iteration method to design and evaluate the mobile phone application. The iteration method can find the shortcomings of the design and the gap between the designed products and the users' needs. These defects and problems can be modified and solved in time to achieve the satisfactory of users.

5.1. Iteration 1

In this iteration, designing an easy understanding and useful guide pages are considered a good stat for an application. The guide page is a process that leads users to a faster and more enjoyable to achieve their goals, and

can timely provide help before the user encounters an obstacle during the use of the software product. In interactive software products, the guide page design is to give users some of the necessary help when the user first uses the product to enable users to quickly understand the function of this product and the specific mode of operation. In order to complete the different guidance content and guidance target, the guide page design of software product will be based on the needs of diversification. The guide page is the product introduction and guidance when users using the software product for the first time. As the traditional manual is relatively boring, users are not willing to read such an introduction if they think it is not necessary. But in computer software products, through a more vivid performance method to achieve guide page design (same as the introduction for a product), so that this kind of description information is more acceptable to the user, and allows users in the shortest time to understand the main function and operation of the software. A good UI design requires many conditions, but the user-centred design principles will be the most basic(Fei Wan, 2012), which is also very applicable in the guide page design(Li Zhang, 2015).

The guide page has the function of guiding the user to understand the function, characteristic and operation method. Depending on the place of the software application guide page, it is generally divided into pre-guide page and inter-guide page(Li Zhang, 2015). This section will focus on pre-guide page. Pre-guide page is showed when the user complete to install the software application, and the first time to open the software application. The guide page is usually composed of 2 to 6 pages of continuous or related discontinuous pages, some application guide page up to 10 pages. Pre-guide page is the content that before the user to use the software application. At that time, the user has not much understanding of the product features, layout, specific operation methods and other content. So, the role of pre-

guide is mainly to introduce the product's general content, core functions, more competitive functions than similar software application products, as well as important operational steps. This can be convenient for users to determine whether this product is the product he/she want, whether to meet the needs of users and operating habits of users. Most of guide pages provide a “skip” button, which is a better choice for both old users and users who are familiar with software applications.

The design of the guide page should follow the following guidelines(Li Zhang, 2015):

Rationalization principle

The content of the guide page should follow rationalization principle. That is, only to guide the necessary content, the meaningless content, will increase the redundancy of information, interference with the presentation of important information. According to the different purposes and starting points, guide page can be divided into product description class, the user direction class, promotion class and problem solving class. At the beginning of the design, guide page should be full analysed, resulting in a rationalized design.

Arrangement optimize principle

After determining the contents of the guide page, it should be optimized the arrangement. The most commonly used design methods of guide page are text and interface combination, text and illustrations combination, dynamic effects and music combination, video effects and so on. Commonly used arrangement methods are showed one by one, the story in series, festival content.

Eyeball effect principle

Effectively attract the user's eye to make the guide page to play a multiplier effect. This principle request designer to focus on the key content, in order to achieve the purpose of highlighting the information.

Concise and practical principles

All content on the guide page should be universal designed. To ensure that everyone can understand the contents on the guide page, and through the contents of the guide page to know how to use this software application. The guide page should not be pursued the exquisite images and effects, because this may let some people feel troubled, and lose the practicality.

“Smart Location” guide pages are illustrated as blew:

Figure 5.1Guide page of Smart Location

Mild dementia participant U3 from user needs study was invited into this initial user testing of iteration 1. Firstly, I introduced the concept of guide page principles and give her a detailed explanation of every principle. Because she is well educated, so she understood all the content what I explained to her.

She like this kind of guide pages very much. “These pages are really useful for me”, U3 said. She believes that these guide pages in full compliance with the above four principles, “Reasonable structure, orderly information, important content highlights, practical information are the most prominent features of these guide pages”, U3 said. When she saw the first guide page, she can naturally understand that by sliding around on the screen, she can choose a different page. For her, this teaching method is very interesting, through 2 minutes of learning and operation, U3 has fully understood the contents of the guide page and mastered the left and right sliding method.

When U3 saw the "skip" button in the upper right corner of the guide page, she had some doubts, and she pointed out "why should you set this button?" When I explained to her the reason, she immediately refuted me that "for people diagnosed with dementia like me, this button is unnecessary, because she often forget what to eat yesterday, what she did in the morning", so she suggested that remove this button from these guide pages, so that each time the user opens the application, they can see these guide pages which can deepen their impressions, especially when they forget how to operate, such a guide page can prompt them to operate these application, and these guide pages can be used to enhance their impression and understanding of the application operation and function.

Baidu map is China's most popular positioning and navigation applications which provides service to almost 500 million users. In order to compare the Baidu map and the "Smart Location" application, the Baidu map's guide pages (Figure 5.2) are also shown to the participant U3, U3 believed that the Baidu map guide pages are concise, but did not provide effective content, she even did not know how to operate, do not understand the contents in the picture. "I am so disappointed, I do not know what Baidu map provides these guide maps plans to do, these guide pages do not have

any help to me." Obviously, Baidu map highlights their slogans and new features on their guide pages, but the content for the elderly and people diagnosed with dementia is no help.

Figure 5.2Baidu map guide page

In summary, the guide page in the interactive design should be based on project needs, designing guide page should consider the different needs from different users. The guide page is not only important for new users, but also allow old users to quickly grasp the new upgrade function, can play a very good auxiliary role to enhance the user experience. For people diagnosed with dementia, designers should take full consideration of their cognitive decline, make the guide page content simply and easy to understand.

5.2. Iteration 2

According to the interview results and analysis, combined with the function of “Smart Location”, the main interface design of “Smart Location” is as follows:

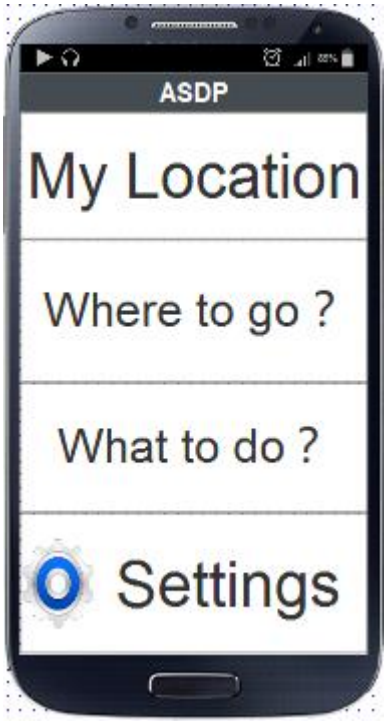

Figure 5.3"Smart Location" initial main interface

In the main interface, the main function of the application has its own button, the user select 'My Location' button, he/she can know the his/her real-time location; select 'Where to go' button to see their advance input information; select 'What to do' button, user can see their own task list set in advance; in the 'Settings' menu, the user can select the timing reminder time, reminders style (voice or vibration or both), etc.

U1, U2 and U3 all think that the interface design is clear and intuitive, they are easy to find the corresponding button for each function. The button is large enough and will not press the wrong button normally. And the main interface has not any content that they hard to understand. U1 has no experience to use smartphone before, but he also understands how to operate, how to achieve the corresponding function. But U2 and U3 pointed out that find the way to go home is the most important function of this phone application, but they do not see this feature in the main interface, so they feel that if add this feature in the main interface may be more convenient for them.

Combined with the U2 and U3 recommendations, the main interface is redesigned as follows:

Figure 5.4Redesign of “Smart Location” main interface

For the redesigned “Smart Location” main interface, U2 and U3 are basically satisfied, they found the button that can help them to get home, and the button located the most prominent position in the interface. They use the function at any time they lost themselves and find the right way home. But U2 raised another question, her cell phone screen is 4 inches, the main interface plus a button, that makes each button become smaller than before, and there is no obvious boundary between these buttons, she felt a little troubled, she said, "I'm not sure I can pick the right button every time."

According to U2’s recommendation, the main interface is redesigned as follows:

Figure 5.5Redesign of “Smart Location” main interface

The problem troubled U2 may be a problem for most users, so this article changes the text colour and background colour of the second and fourth buttons, so that each button looks more independent and the boundaries between the buttons become clearer. This may effectively reduce of the selection error.

In the 'What to do' menu, where the user can enter what they want to do, the size of the text box is fixed, the size of the text will be based on the number of words, more text input, every word becomes smaller. In order to keep consistent with the home page, this menu also has five text boxes, the user can enter five different sets of texts.

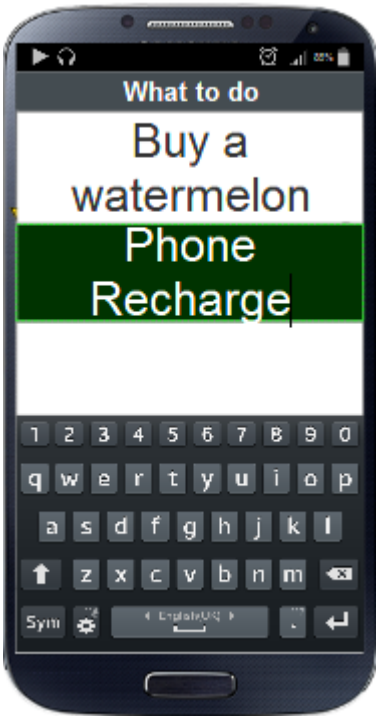

Figure 5.6'What to do' page

U1 think that he cannot use the input method to enter text, so he cannot use this feature, unless with other people's help; U2 raised the same problem, she thought the small screen input method is very difficult to use, this design will make her give up using of this feature. U3 said that this page is not necessary to be divided into five text boxes, these text boxes should be combined into one text box, which can display larger text, the user can use punctuation to separate tasks.

Figure 5.7Redesign of 'What to do' page

According to U1 and U2 requirements, "Smart Location" added voice input, solved the problems that they meet. Based on U3's views, five text boxes were merged into one text box, this will help users use this feature more efficient.

5.3. Iteration 3

The most common layouts that an application can use are Table Layout and Linear Layout(da Silva, Paiva, & da Cruz, 2016).

Table layout of Android is used to show fixed number of tables in horizontal orientation. It include "android.support.design.widget" library of android. Tables organise content at high level by creating different view sections . Tables are created using ViewPager class in Android's "android.support.V4.view" library. The ViewPager provides animations to

switch left and right between tables and they can efficiently organize tabs for the application. ViewPager requires custom implementation of PagerAdapter that generates pages to display.

Android Linear Layout is a view group that aligns all children in a single direction, vertically or horizontally. You can specify the layout direction with the ‘android:orientation’ attribute.

For people diagnosed with dementia, which layout is more meet their expectations and habits? This paper will conduct an initial user testing among people diagnosed with dementia.

Test participants.

User experience experts Thomas Tullis and Bill Albert argue that in the early stages of design, fewer participants are needed to determine the major usability issues, and as the design progresses, the designers need more attendees to find the remaining problems (Albert & Tullis, 2013). As this test is the early stage of the Android application interface layout design, U1, U2, U3, U4, U5 were asked to participant this testing.

Test preparation.

Prepare two identical models of Android mobile phones (Figure 5.6 Figure 5.7), run these two layouts of prototype on two mobile phones. Design two different task cards, requiring participants to complete these two different tasks. Task 1, open the Tab2 page. Task 2, first open the Tab1 page, and then open the Tab3 page.

Testing process.

During the test, a one-to-one test was performed by one host during the test, and two designers were observed and recorded between the observations. The test is as follows: First, the host will introduce the test background and precautions to the participants; then, the host presents the first task card to the participant. The participant completes the task, makes a choice of the two layouts and tells the view of the two layouts; Then, the host presents the second task card. The participant completes the task and allows the participant to make a choice of the two interface layouts and say their views and the reasons. Finally, when all participants have made a review, the host informs the participants that the test is finished and expresses thanks.

Test results and analysis.

User testing data statistics in Table 5.1.

Participant	Task1	Task2
U1	Table	Table
U2	Linear	Table
U3	Linear	Table
U4	Table	Table
U5	Table	Table

Table 5.1Statistics of user testing data between Table Layout and Linear Layout

From the table 5.1, we can see that in the first task, U1, U4, U5 chose the Table Layout, they thought, compared to click on the screen, left and right sliding on the screen is more comfortable and easy, and can slide anywhere of the screen, in other words, they can complete the task by one hand.

Obviously, U2 and U3 did not agree with their point of view, because they chose the Linear Layout, they suggested that click on the screen is more convenient, slide around the screen need their fingers touch with the screen for a short time, if they sudden interruption of touch, they cannot successfully complete the task. But to the second task, all participants have chosen Table Layout, because they said, Table Layout default page is Tab1, without any operation, and Linear Layout need to click the screen once, to the second step, Table Layout only requested them slide the screen twice, but Linear Layout requested them to return to the main page first, and then click the Tab3 button, the activity range of their fingers on the screen is large, and all the testers cannot operate the task with one hand, while using the Table Layout they can easily achieve this task.

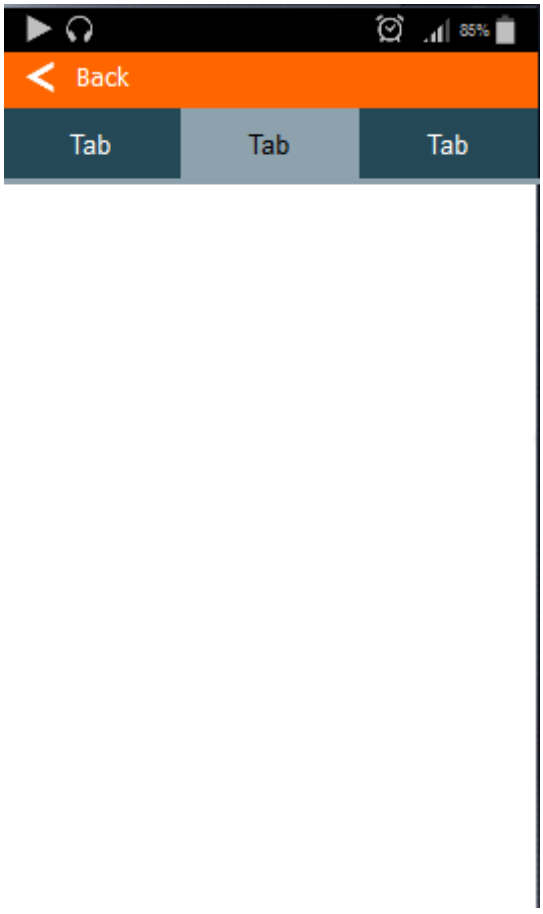

Figure 5.8 Table layout

Figure 5.9Linear layout

Obviously, for these participants, Table Layout have a great advantage, so this paper uses the Table Layout as "Smart Location" application interface layout.

One of the most important structural elements in an Android application is the action bar, which is usually located at the top of the screen when the application is running. In the Android design specifications(Google.Inc, 2017), the action bar can be divided into four different functional areas: application icons, view widget, operation buttons and more operations.

View widgets are used to facilitate the user to browse or switch the display content in the application, the label is one of the widget style. If the application needs to display the content in different views, the tags can navigate between them. The operation button is used to show the most

important operational behaviour in the application. To put the operation buttons in multiple operation bars, there are three options: the main operation bar, the top bar, the bottom bar. The operation bar layout in Android design specifications(Google.Inc, 2017) . In order to allow users to quickly switch the screen and view, the top bar can be placed in labels. If the main operation bar does not have enough space to display the operation icon, the bottom bar can be used.

Through this usability test of Android mobile phone application interface layout, we can get some meaningful design reference. When design a mobile phone interface layout, we should consider not only to follow the target users' habits, but also to make users easily to find the most important operation button, which can improve the efficiency of users to complete the task, to give them a good operating experience.

5.4. Iteration 4

The location and navigation functions are the core features of the "Smart Location" application. Through the user needs analysis can be found, people diagnosed with dementia have a very strong fear of getting lost, their families even because this does not let them to do some outdoor activities, which greatly affected their normal lives. Walking outdoor occurs because many people diagnosed with dementia suffers have hypertension and feel a compelling urge to walk. Approximately 40% of them get lost when they are walking outside(Stratton, 2007).

However, the map applications of the mobile phone on the market today greatly facilitate people to travel, but there are some drawbacks. Firstly, the application operation is complex, in order to highlight the powerful features of the map application, it has been added a lot of functions, but these features are usually not used, thus increasing the burden on users. Secondly, mislead

the user, in order to allow users to use their products, application interfaces are unusually designed gorgeous, but it is difficult for users to quickly find the right button or interface. Thirdly, excessive advertising, some map applications often appear advertising, so that users feel bad experience when using the application(Zheng, 2012).

As a result, usability evaluation has an indispensable role in map and navigation applications. Usability evaluation is the process of systematically collecting and evaluating the usability data of the interactive interface. Hartson pointed out that usability evaluation of both the product interface and prototype is important (Hartson, 1998). The purpose of the navigation application usability evaluation includes: improving the existing navigation interface and improving its usability; evaluating the usability of existing navigation interface and achieving usability targets effectively before designing new navigation interface. The navigation interface design process is an iterative process, including design, usability evaluation, improve the design. In the design process, the usability evaluation object is the prototype, that is able to reflect some of the characteristics of interactive interface design, and can achieve some or all of the functional design entities (Zhang & MacKenzie, 2007). Newman believes that the usability evaluation of the prototype is an effective way to improve the interface design(Newman, Lamming, & Lamming, 1995). As the usability affect the navigation quality profoundly, in the navigation interface design process, gradually improve the usability is a core purpose.

In order to improve the usability of this application, in the navigation aspect, "Smart Location" has a relatively large innovation. "Smart Location" is mainly to help people diagnosed with dementia to find the way home, so "Smart Location" is a home-based navigation applications. The maps and location interface is cancelled, "Smart Location" transfer the location and

navigation information into simple text and voice, and provide the information to the user, eliminating the operation of viewing the map and finding the navigation route. In other words, if the home address information was inputted in advance, "Smart Location" can automatically broadcast navigation voice and prompt text to help users find their own home without any operations. Thus, "Smart Location" is not a navigation application, but an application that helps users find their way home. The address information of the home can be set by the user or their family members before the user leaves home. If the address information is not changed, the user only needs to set the address information once, and each time the "Smart Location" application will automatically plan the user's home route according to the user’s current location.

"Smart Location" changed a map view into a "list view". It was inspired by the world-famous hotel reservation platform "Booking" application. When users book your hotel with "Booking", after entering the date and city, users will have two options, one is the list view and the other is the map view. Through the list view, users can see the hotel name, price, stars, ratings and other information to help them to make decisions. After switching to the map view, users can clearly see the location of hotels, and which hotels are nearby. "Booking" clearly to presented all the hotel information to users through these two views, it greatly enhances the efficiency of users to make decisions. However, the "Smart Location" main task is to help people diagnosed with dementia in the sudden forget the direction of their home address, in the circumstances, complex map navigation operation for them is an impossible task. Thus, "Smart Location” has made a change. In traditional navigation application software, such as Google Maps is an application combined with the map and navigation, but "Smart Location" cancelled the map view which easily confuse the user, only use the list view to display the

navigation information to the user. And "Smart Location" also add the voice broadcast function, so that users can only listen to the sound or use their eyes to find their way home.

The navigation interface of the "Smart Location" is as follows (Figure 5.8).

Figure 5.10The Navigation Page

There is a navigation voice button on the page. This button is turned on by default. If the user does not need voice service or they think the voice service will disturb other people, click the button once to close the voice service, if users want to open the voice service again, they can also click this button.

U6 from user needs study was invited to test prototype in this iteration. When he saw the navigation interface, he felt very satisfied, first of all, he thinks the font size is appropriate, the interval layout is reasonable, each line provides him clear navigation information, especially after he heard the voice navigation prompt, he said “It is very convenient, so I do not need to wear glasses at any time. Turning the phone voice to the maximum, I can hear and understand the contents of voice navigation". When he is moving around, the voice navigation works at any time, even if he did not follow the voice prompts to walk or goes a wrong way, "Smart Location" will base on his location to re-plan the route, "This is perfect, even if I cannot follow the route, but the police or other pedestrians can send me home follow the voice or text navigation" U6 said excitedly.

U6 also pointed out that the design of this application did not take into account the noisy outdoor, if he put the phone into his pants pocket, he could not hear the voice navigation, the problem is that if he suddenly forgets his home address, he may also forget that he brought his mobile phone, "Smart Location" should take this into account, and add a mobile vibration reminder. "When I forget everything, I can feel the vibration of my mobile phone, I may memorize that I wander with my mobile phone, and then I can take the phone out from my pocket to see the navigation text on phone screen or listen to voice navigation information" UX said.

The user's subjective psychological factors affect people's perception ability, thinking ability and responsiveness ability, which also affect the user to use the navigation interface (Butow, 2007). According to the issue suggested by UX, other four users were asked this vibration reminder function, and three of them thought it was necessary to add the vibration function, while the other did not give any comment. Because there is no user involved in the test disagree with this, "Smart Location" added the vibration reminder function. In

order to make this function meet the needs and habits of users, this paper designed a test to verify how long between two vibrations is the most reasonable.

"Smart Location" provides five optional times which are 30 seconds, 1 minute, 2 minutes, 5 minutes, and 10 minutes. U1, U2, U3, U4 and U5 from user needs study were asked in this testing. In the end, we got the feedback that one of them chose 1 minute, one chose 5 minutes and the other three participants chose 2 minutes. So, “2 minutes” got the most votes. Based on the above test, "Smart Location" added the vibration function, and every two minutes to give a vibration prompt to users. On the navigation page, "Smart Location" also added a vibration switch button (Figure 5.9).

Figure 5.11Navigation Page with vibration button

5.5. Iteration 5

Four teachers(Yamagata, Coppola, Kowtko, & Joyce, 2013) from Pace University stated “Caregiver anecdotes attest that music and photographs play an important role for family members diagnosed with dementia, even those with severe dementia. Modern technology can be utilized with people diagnosed with dementia in portraying favourite music and family photographs via apps developed in close partnership with geriatric facilities. Anecdotal research has shown that non-verbal late-stage dementia patients have become stimulated when iPods played their beloved tunes. There is an unmet need in geriatric facilities for stimulating dementia patients, as well providing hard-core data for proving increased cognitive abilities with technology. The stimulation of cognition and memory are crucial to the health of older adults, especially since there is a significant increase of older adults suffering from dementia”. Their words gave me a lot of inspiration, "Smart Location" is a mobile application mainly developed for people diagnosed with dementia, it should provide users with some features to stimulate their cognition and memory, which is very helpful for their conditions. As the condition becomes more and more serious, the patient is increasingly dependent on the caregiver, if there is an application can accompany them to spend some happy time, and they can operate the application by their own, this not only improve their quality of life, but also reduces the burden and pressure on caregivers.

From the analysis of user needs, people diagnosed dementia spent most of the time with their caregivers spent. But caregivers not only need to take care of these patients, but also busy with some other things. Thus, some of patients always feel very lonely. They often do not know what to do, the

quality of their life is very low, which is very unfavourable for their disease recovery.

Under such a circumstance, "Smart Location" was added the album function (Figure 5.10), album integration in the application, and the album can store some old photos of users, as well as the user family members' photos. Users can read these pictures in their spare time, this action may help them restore their cognitive ability and memory. In addition, because "Smart Location" added such a feature, users use this application more times, they will become more and more familiar with this application. In this way, when they suddenly forget their home address, they may be able to use this application.

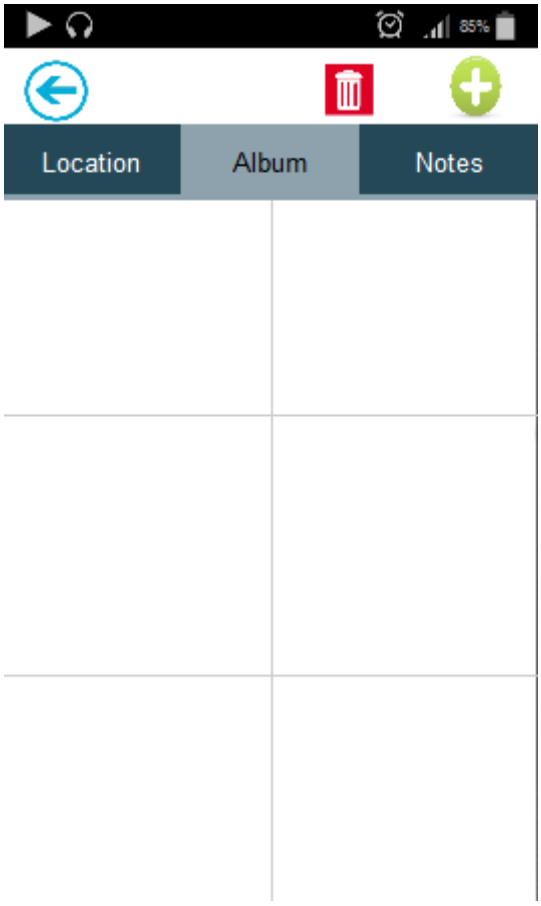

Figure 5.12Album page

"Smart Location" album provide users three main functions, import

photos, views photos and delete photos.

U4, U5, U6 from user needs study were invited to test the prototype in this iteration. First of all, the designer introduced the album features, test procedures and precautions. This test requires each participant to test the album features of the three applications, namely "Smart Location", "Google Photo", "Flickr". "Google Photo" and "Flickr" are very successful mobile photo album applications, the download times of each application are more than 10 million in the Google application market. Three participants should complete the following tasks or answer the questions:

Which button do you see at first glance?

Please import / upload a specified photo.

Click to view a photo.

Please delete a specified photo.

Do you have any comments on the interface and the operation flow for the application?

After finishing this initial user testing, and comparatively analysing the test results, we found the following common problems:

Important button should be placed in the eye-catching location. According to the user's browsing habits, the top left corner of the interface page is the most prominent. The upper left corner of the page is the best location for the main function of the application. “Import photos” is a very important feature for the album, without this first step, no matter how good the user experience of the album is meaningless. Thus, the position of "import" button is very worthy of attention. When users browsing an application interface, their visual focus is placed in the upper left corner, the right-hand button is easily overlooked by the users. "Smart Location" made the mistake in the initial design. In the user testing of this iteration, four of the five

participants saw the button at first glance was not "import", but "delete". However, after the user testing, "Smart Location" put the "import" button on the most prominent position (Figure 5.11).

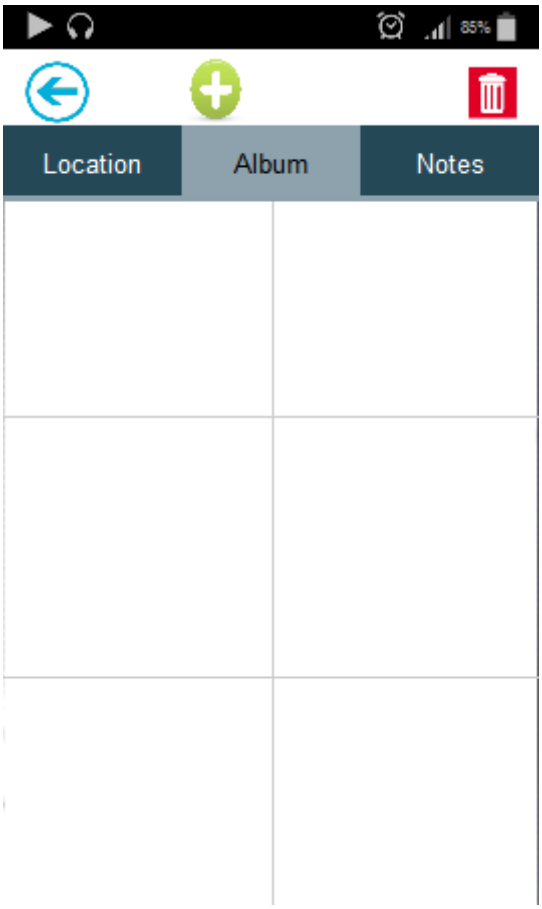

Figure 5.13Redesign of Album

In addition, the function of importing photos should be designed to meet the user's mental model, the user has a mental model used to describe the performing the task of software / website. This model based on their experience, the experience comes from using other software and websites. If designer ignore the user's mental model, do not meet the basic users' expectations, the software and websites will become difficult to use or annoying. This is because the program forces an unfamiliar conceptual model to its users, rather than on users' existing knowledge and experience. We need to pay attention to the behaviour is: the user has built up some inherent

concepts of the album. To observe the process of the participants to complete the task, we found that almost all users believe that album is a folder to store photos. And the majority of users think photos must be stored in the folder, cannot exist independently in the album. Users' mental model is to create a folder in the album first, and then import photos into the folder, rather than directly import photos to album. "Smart Location" does not provide the "create album folder" button, only to provide "import" button. Some participants will hesitate for a few seconds and tentatively click on the "import" button.

About importing and deleting photos, application should provide timely feedback. Norman(Norman, 2002) gave "feedback" a deeply exposition when he stated the Execution/Evaluation Action Cycle in the book of *Design Psychology*. Users will compare the differences between what happened and what they expected to happen. Timely feedback helps users to evaluate whether the previously action will help them to achieve the target, and it also helps the user re-adjust the operation or proceed to the next step. In addition, we should try to promptly and clearly let the user understand what the program is currently doing. For example, in certain operations, users can always get the success prompt of their operation. When importing and removing photos, the application should give users timely feedback, so that users could know the operation has been successful, the user will feel sense of security from this. Flickr and Google photo are doing well in this respect, and have a successful prompt after the operation. Google photo give a text prompt after transfer photos, the user can clearly know the operation has been successful. Flickr provides users with a progress bar in the process of uploading photos, which is a very good example of feedback, receive a favourable response from all users. And Google photo will automatically jump to new page after uploading photos, this "silent" feedback is also a good tip.

Before designing the album, "Smart Location" draws on the advantages

of Flickr and Google photo, taking "timely feedback" into account, users will receive feedback both import photos, delete photos. This design get a high rating in the user testing of this iteration.

The application should provide the undo operation. When uploading a photo, only Google Photo provides "Cancel" button on the upload interface, but after clicking, just a pop-up dialog box tells the user to switch to another page to cancel upload. And then the user cannot cancel the upload either by clicking "Cancel" or "Continue" on the dialog box. In fact, Google Photo and Flickr did not provide the function of cancel upload. Once the user wants to terminate the upload, they have to exit the application. Similarly, Google Photo and Flickr do not provide a revocation function after deleting photos. If the user is operating incorrectly, there is no way to recover. But Gmail support this service. If the revocation of operation like Gmail can also be achieved in album products, will undoubtedly bring a lot of convenience to the user.

In the initial design process, "Smart Location" did not take this into account, in the user testing of this iteration, when participants import an incorrect photo, or accidentally delete all the photos, the participants will feel very nervous and depressed, a participant even gave up the testing because of operational errors. But when add "Undo" button in the application (Figure 5.12), all users feel very satisfied. U4 said "I am a patient with dementia, I have cognitive impairment, and I often forget some things, but this button makes me not afraid of operational errors, I can try again". U6 also said that this button gave him confidence, he does not worry about deleting all photos in album any more.

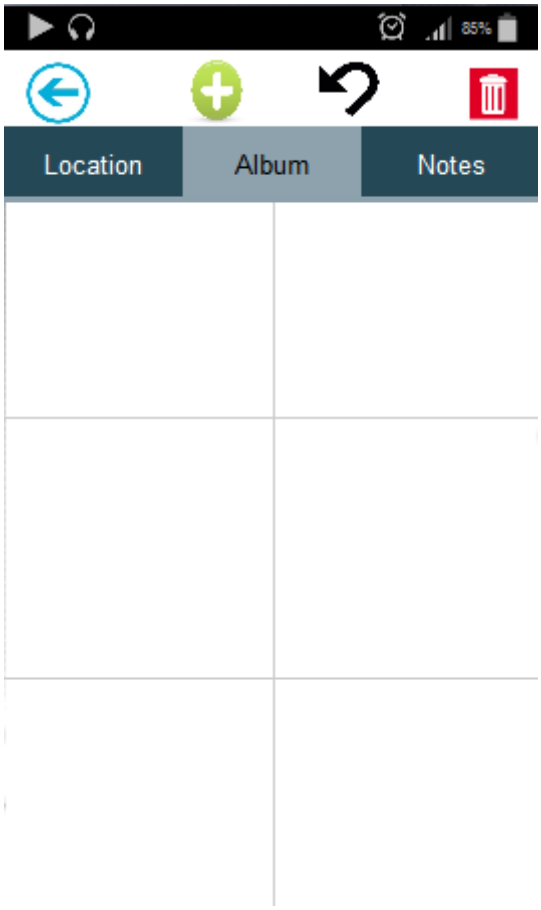

Figure 5.14Redesign of Album page and add Undo button

6. Results (Final user testing)

After the user needs study, prototype design, development and original user testing, "Smart Location" has initially met the user's needs. This section is mainly stating the final user testing and testing results analysis.

User testing with people diagnosed with dementia

The final user testing was conducted with six participants from user needs study. The testing uses a prototype that has been iterated over several iterations.

During the testing process, one of the usability staff was responsible for the testing process and the communication with the user, and the other one

was responsible for observing the test process and data records. The test time for each participant was approximately 45-60 minutes. Then, participants executed some pre-set test tasks, and each test task was conducted under the background of scenario description. The participants carried out these tasks without any interference. In this process, the observer staff needs to record two kinds of the data: observe the participants' behaviour, record usability issues that may lead to poor user experience. Staff need to obtain the participants' performance data (effectiveness and efficiency) in the course of completing the task by observing the participant. At the end of each task, we communicated with participants through the background query, and talked about some issues when they were using the application to explore the real reasons. After all the test tasks are completed, staff made a brief summary to exchange the user's deep impression, expectations and needs. The summary interview after the testing is to understand the participants' really thoughts. After some operation experience with the application, the participants have a practical understanding of the application. Asking the participants some open questions, it has a great reference for the improvement of user testing(Spool, 1999).

In the user testing process, we collected qualitative and quantitative data. Qualitative data include two aspects: one is the users' performance data at their first time; the other is the users' evaluation of the application, question data and users' feedback data. And the quantitative data are: the users' time-consuming and other performance data.

6.1. Preparation of the test

6.1.1 The participant of user testing

From the past usability test statistics, usability experts Nielsen and Landauer argues that, 6 individuals participate the test will find 89% of the usability problem (Nielsen & Landauer, 1993) According to the results, this test selected 6 participants, all of them from the user needs study, will find about 89% of the usability problem. These participants have never used "Smart Location" before, so they are absolutely novice users. The purpose of this test is to evaluate the initial experience of users to use the "Smart Location" application, and to find out the usability problem.

In order to avoid the impact of the emotions, we must prepare tasks, questionnaires, mobile applications, test equipments before the test.

6.1.2 Test documentation

Before the test, we prepared the following documents:

The personal information questionnaire of participants;

Participant consent form;

Test documents: including test tasks, post-test interview questions.

6.1.3 Test Equipment

The main test equipment: An Android mobile phone (this test uses the Samsung Galaxy Note 3).

6.1.4 Test staffs

There are two staff for this test. Before the start of the test, test staff A is

responsible for the test flow control and the interaction with the test object. Test staff B is mainly responsible for mobile phone environment configuration. In the course of the test, test staff A is responsible for recording the task completion, the number of errors; test staff B is responsible for recording the task completion time, recording the start and stop time of each task.

6.2 Task design and Users' Performance

In the testing phase, the user needs to perform the entire task process, including browsing the guide pages, familiar with the layout, switching view pages, inputting their home address, browsing text navigation information, listening to voice navigation, importing photos, deleting photos, undoing operations. We mainly look at the user's ability to find each function and understanding.

Task 1:

Open the application, browse the guide pages, and understand the contents of the guide pages.

Purpose:

Test the user's understanding of the content on guide pages;

Test whether users have understanding obstacles when they view guide pages;

Test whether guide pages can help users to master the operation and function of the application or not.

User Performance:

All user feel that the guide pages are very useful for them. U2 said, "I did not pay attention to the guide page of an application before, seeing the

teaching interface is very happy, I do not need rely on other’s help to operate the page now." She was very excited when she learns slide the screen, this is the ambition that "Smart Location" want to achieve, in the information world, everyone is equal. U6 is also a teacher like U2, he likes this guide page, he believed that in the application for the elderly, it is necessary to add a guide page function, as guide page could direct people how to use the application. “Teaching people to use your application is the beginning to enhance the user experience, and is also a crucial part of application design. U5 is an artist, he commented that the design of the guide page is very intuitive, with a reasonable colour schemes, “The guide page of this application is not only practical, but also artistic, it can attract the user's eye, so that users will love this application from the guide page.” U1 like to repeatedly slide the guide pages for several times, he mentioned that repeatedly slide the guide pages allowed him to browse the page content more than one times, it can also deepen his memory.

Task 2:

Browse the page layout, slide the page layout into the different function pages.

Purpose:

Test whether the user master the application page operation;

Test whether the user can switch from one function page to another.

User Performance:

As the effect of guide page, all users have a very deep understanding of the layout. They know that the left and right sliding can switch pages, they can also slide around to find the features they need. "No barrier." U1 said proudly. U3 thought that switching the page by one hand exactly meet her expectations, she can use one hand to switch the interface flexibly. She spent

most of her time watching TV at home, she can hold the TV remote control in one hand, the other hand to operate the application. U5 commented that this layout is very space-saving, it leaves the space to the content part, so that the application can make the font larger. This more convenient for our elderly. "I think this layout is very smooth to operate, especially when you want to switch page, gently a stroke on it, I feel smart phone bring me more fun." U3 said. Through the users' feedback, we can find the user is very satisfied with this layout.

Task 3:

Input user's home address

Purpose:

Test whether the user can successfully find the input home address button;

Test what kind of problems the user will encounter when they enter the home address;

Test whether the user will click the "OK" button after inputting their home address.

User Performance:

The button of enter the home address was put in a very significant position, five users have successfully opened the interface, only one user was not sure for this button. If the home address was the not changed, this interface only need to use once, so this feature will not be used frequently. Because U1 was not able use the phone input method to input Chinese characters, so he cannot use the traditional input method software to complete this task, but this experiment phone was installed a "iFlytek Input" application, which integrates a powerful Chinese voice recognition function, so "IFlytek Input" smoothly help U1 completed this task. The other five users

successfully completed the inputting part, but U5 did not click on the "OK" button after inputting, and directly click on the “return” button, which led to his task failed. If users do not click "OK" button, the application will not save the inputted text information automatically. In general, the input address function does not give user too much troubles.

Task 4:

Browse navigation text messages.

Purpose:

Test whether the user can read the contents of the navigation text;

Test whether the user can understand the text of the navigation tips;

Test whether the user can find his home based on the navigation text;

User Performance:

In the test of this part, all users perform serious and positive attitude, because they know that this feature is the most important function of "Smart Location". All users can read the text prompts, they can find the correct route according to the text prompts. U1 said, "For me, the navigation information must be refined and short, it can let me understand this information in a short time. I think this application is doing very well at this point, I could understand the text prompts in a very short time."

U6 mentioned that compared to other complex map pages, this short text navigation page made him to be a "navigation expert". "I do not have to worry about getting lost at any time because the text can help me to find my home, this is so simple. "

U3 thought that the text prompts just like the TV subtitles, “it will change follow the user's movement, this is really great, even if I go a wrong way, it will re-planning routes, so that I can find home in any place.” This feature got

positive feedback from users, it also shows that this function is meet the needs of people diagnosed with dementia.

Task 5:

Listen to the voice navigation prompt.

Purpose:

Test whether the user can listen to the contents of voice navigation;

Test whether the user can understand the content of voice navigation;

Test whether the user can keep up with the language of the language speed;

Test whether the user can find his home through voice navigation;

Test whether the user sees the voice navigation switch button.

User Performance:

In the user needs study stage, some users expressed that they want a voice navigation function without much operation. U4 likes to go to the park at sunny days, but she cannot see the texts on the phone screen when she is under the sun. "The voice navigation function is what I expect for a long time," she said. Three users believed that the voice speed is appropriate, the other three users thought that the speed is a little bit fast, if the surrounding environment is noisy, they may not hear the voice content. In addition, they hope the voice navigation can be repeated three times for every prompt, this can ensure that they can hear the voice content clearly, understand the voice prompts well. U2 mentioned that the voice navigation can completely liberate her hands, she just put the phone into the coat pocket, and she can hear the voice content clearly. Because she needs to use crutches, so the put the mobile phone in her hands to check the text prompt is very inconvenient. Thus, voice navigation is a good solution to this problem.

Task 6:

Import photos, Deleting photos, Undoing operations.

Purpose:

Test whether the user will use the “Import” button to import a photo;

Test whether the user will use the “Delete” button to delete a photo;

Test whether the user will use the “Undo” button to undo the operation;

Test whether the user will use the album to view photos.

User Performance:

Users did not encounter any obstacles when they use the memory album, and all users are like this feature. U4 is very fond of watching her children's photos, she used to look at her home albums, but now her children almost did not print photos, so to see the children's recent photos are very inconvenient. "Smart Location" provide such a memory album function is very handy to her. "Her kids can put recent photos and some old photos into this album," U4 said.

"The phone album often appear some other photos, very messy, and this application will only have photos that I imported, I will put photos with story into this application, in my spare time, I can slowly read these photos." U5 said happily. As the user said, "Smart Location" album is different with the phone album, users can put their favourite pictures into the "Smart Location" application, the user can always look at and talk about these photos to stimulate their memory.

Quantitative statistics are shown in the following table:

Time second	U1	U2	U3	U4	U5	U6

d (s)						
1. Read guide page	42s	30s	28s	29s	36s	37s
2. Swift view page	3s	1s	2s	1s	1s	2s
3. Input home address	78s	43s	62s	44s	37s	60s
4. Read text navigation message	20s	13s	16s	13s	19s	18s
5. Listen to voice navigation message clearly	12s	4s	8s	4s	8s	4s
6. Import a photo	10s	6s	6s	8s	7s	6s
7. Delete a photo	3s	2s	2s	2s	3s	3s
8. Undo an operation	2s	1s	1s	1s	1s	1s

Table 6.1Time required to complete user testing tasks using Smart Location

From the test results, six testers did not encounter many problems in the

use of "Smart Location". Some of them do not participate in the iteration, in which case they can successfully complete the task is very gratifying. When the user was asked about the overall impression of "Smart Location", "simple" "practical" were the most mentioned words. Some users have not used the experience of smart phones, but through this test they like to use the "Smart Location" and smart phone. They thought "In fact, the operation of smart phone is not so difficult." In addition, users feel that there is no redundant feature in "Smart Location" application, which makes them more like this application. "Every feature in your application is what I need, I will use your application", U6 said.

In the end, all of them were asked to rate “Smart Location” based on their satisfaction level after using it, in a scale of 1-5. Their ratings are presented in the table below.

User	Rating
U1	4.2
U2	4.3
U3	4.7
U4	4.9
U5	4.9
U6	4.6
Average	4.6

Table 6.2Rating from users based on satisfaction level after using Smart Location

"Smart Location" received an average rating of 4.6 out of 5, which is a very good score. Feedback from the user perspective, it is can help people diagnosed with dementia, basically meet the user's expectations. But there is always room for improvement.

7. Discussion

The main discussion in this chapter is whether the tested application meets the initial needs of the user. This chapter is mainly through the user's actual use scenario to analyse whether the "Smart Location" solved the user's actual needs.

U1 lives in Beijing's courtyard, leisure time he often plays chess game with his friends. He lives with his son, but during the day time, his son has to go out to work, neighbours and friends often come to take care of him. Before he was sick, he went to school every day to pick up his grandson home, but since he was sick, his son was afraid of his loss, they do not let him out by himself. But "Smart Location" gave him confidence, he no longer worries about he will lost himself. In the user testing process, he believes that if he goes out with this phone, he will not get lost, because the phone will prompt him to go home. In addition, U1 did not have the experience of using the smart phone, so he worried that he cannot use these applications smoothly, but after the user testing, "these worries are redundant, the operation is very simple," U1 said.

Before U2 retirement, she was a teacher. Before the illness, she used to do volunteers with friends to help some people with mobility inconvenience. But after the illness, her life has changed totally, she was quiet, do not like to go out, rarely contact with other people. When she saw the memory album function, she suddenly felt the sunshine comes to her heart, because through this feature, she can import some photos when she was a volunteer, which can make her feel she returned to the previous life. In addition, the navigation function in this application become simple, as long as user open the application, without any operation, "Smart Location" will plan a home route for the user automatically.

Before U3 retired, she was a clerk, after retirement she mainly at home to take care of her granddaughter. But after the illness, she can no longer take care of children. It makes her very lonely, the family worried that she will get lost, often persuaded her not to go out. But when she used the "Smart Location", she found that she could walk around at any time. She is equipped with a pair of headphones for the phone, she can always listen to the voice navigation message broadcast from her headset, if she suddenly forgets the home address, navigation voice in her headset can still take her home.

We have analysed the function, concept and interaction behaviour of the "Smart Location" respectively. At the same time, we have evaluated the using situation of "Smart Location" by the user testing. Through the accumulation of these studies, we have tried to summarize a user experience conceptual framework regarding design an application for people diagnosed with dementia.

We will discuss the application with a good user experience needs to be met three levels: “Useful”, “Easy to use”, “Users want to use”.

"Smart Location" is "useful", referring to it should meet the needs of users, to achieve the user's goal - to provide users with navigation and album services.

"Smart Location" is "easy to use", mainly refers to the user interaction with the application should meet the cognitive and operation levels.

First, the user can easily understand the functions and concepts of the application. The application of the functions and concepts should be intuitive, met the user's mental model; another level is that users’ interaction process should be smooth, users can successfully complete the task, and even cannot feel the existence of the product when they of using the product, the best interaction is not feel the existence of interaction.

"Smart Location" is " Users want to use", refers to the product give the user's good feelings when using this application, it gives user satisfaction in the visual (auditory), the use experience and the user's psychological.

Therefore, a mobile application for a people diagnosed with dementia should have the following characteristics: the necessary features, smooth interaction process and emotional level of satisfaction.

8. Conclusion and Future work

In this thesis, the research in design and developing a usable and accessible application for people diagnosed with dementia has been presented. In terms of the methodology used, the user-centred design, usability testing research methods, and mental models are appropriate for this process. We collect user needs through focus group interviews and user testing. During the user testing, the user's participation in each iteration provides real feedback to improve the prototype, providing a more usable and accessible navigation application for people diagnosed with dementia. Participants have also shown a positive attitude towards using of "Smart Location" in the future. Because they find it more accessible. From the whole process of user-cantered design, we found that users are gradually showing a positive attitude for learning mobile applications knowledge. They provided positive feedback and provide requirements for "Smart Location", which they thought was designed for them. Thus, they show more willingness to learn and use the application. It must be recognized that this is a good learning process for them. In terms of achieving the aims of the study, "Smart Location" has addressed identified usability and accessibility issues faced by people diagnosed with dementia during the study period. All six students agree with the above point of view. Some people commented that if they could learn and use it, their friends would do the same thing. After the final user testing, when asked whether they will use "Smart Location" in the future, U6 said: "Of course, I will use it, it transfer complicated things to simple things, very suitable for me." In short, "Smart Location" has achieved its main goal, which is designing a more useful and accessible application for people diagnosed with dementia. This study addresses cognitive functioning and quality of life for people diagnosed with dementia via technology. This

research will discuss developed mobile application in the scope of helping improve the quality of life of people diagnosed with dementia.

In the course of the research on dementia users, we have explored and tried the most typical method in the field of usability engineering -user testing, in order to better collect the qualitative and quantitative data in the process of using the product. During the study, we also found a lot of new phenomena and problems. As the market does not exist a mobile phone products for people diagnosed with dementia, so we cannot conduct the comparative study. Only the user's feedback can be used to determine the availability of mobile applications. In addition, our better user experience for dementia user mobile phone application product concept model is only based on the analysis and evaluation of "Smart Location", due to various restrictions on the conditions, we have no real effect and effectiveness of the model for a full validation, so the model can only be called a tentative job. Although it is only a try, but because the theoretical model for dementia users was carried out very little, so we hope that our work should to play a guiding role in the future.

There is no doubt that "Smart Location" has greater potential and space in the future, with the future iterations, some functions beneficial to people diagnosed with dementia will be added to this application. What is more anticipated is that with the popularity of wearable devices, such applications in the future can be developed on wearable devices. This will provide a better user experience for people diagnosed with dementia.

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Appendix

A. Participant consent form

Introduction and purpose:

This study aims to get views and feedback of users regarding to using the multifunctional mobile application for senile dementia patients.

Procedure:

If you agree to take part in this study, you will be asked a few questions related to yourself and some feedbacks of using mobile instant messaging applications. Then you will be asked to perform some tasks with regards to the application. The total time required is approximately 45 minutes.

Voluntary Nature of the testing/Confidentiality:

Your participation in this study is entirely voluntary and you may request to stop if you feel any discomfort during the session. Your name will be kept confidential and your information or study result will be represented using pseudonyms to protect confidentiality.

Participant certification:

I have read the above information and I consent to participate this study.

Name of participant: _____

Signature: _____

Date: _____

B. Interview guide

1. How old are you?

2. How long have you suffered from dementia senile?

3. Are you retired?

4. What is your level of education?

5. Before you retire, what is your monthly salary and position?

6. Please describe your usual schedule.

7. Do you often go out? Do you need someone to accompany you when you go out?

8. Have you ever lost yourself? Please describe the specific circumstances when you lost, the reasons for the loss, how to return home, and difficulties you were facing.

9. What is the greatest impact of senile dementia on you at present?

10. Have you used a smartphone? How long has it been used?

11. Do you know what is Application? What is your most frequently used Application?

12. When do you use your phone? How long will it take to learn how to use an Application?

13. Do you have presbyopia? What difficulties did you experience when using your phone screen?

14. Have you used mobile maps and other location-based software?

15. Would you use an application specifically developed for the senile dementia group to help them go home?

16. What are your needs and expectations for such an application?