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Smart home for urban Chinese elderly people in home living

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Abstract

The purpose of this thesis is to design a new smart home for urban Chinese elderly people in home living environment. This new smart home design has to be integrated all the ICT solutions which based on a literature review was proposed and also with a functional back-end system for data collection, analysis and storage.

The literature review phase of this study was to find out the existing problematic issues and solutions for urban Chinese elderly people in home living, upon comparison of two current Chinese smart home producers, it becomes clear that the current Chinese smart home may not completely meet the needs for home living urban Chinese elderly people. The design phase firstly introduces the ideas on conceptual model of new smart home design and then emphasises on involving all the ICT products, services and backend system into a real home living environment of urban Chinese elderly people. The evaluation of this research according to a scenario of how a general urban Chinese elderly people spends a day in this new smart home living environment and evaluate whether this smart home solve all the urban Chinese elderly home living issues and finally answer the research question.

This research aims to show the future direction of new Chinese smart home design and may inspire the current Chinese smart home producers and help them improve their current smart home products.

Keywords

urban Chinese elderly, health care, smart home, smart home system

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1. Introduction

Aging population has two meanings, one refers to the proportion of growing number of elderly people is rising in general population, the other one is the state of socio-demographic structure becomes the aging society. In international aging population common criteria standard, the proportion of elderly population age over than 60 accounts for 10% of the total population in a country or region which means this country or region has entered the aging society. (Etzioni, et al., 2013.)

With the rapid increase in life expectancy of Chinese population and the decades of decline in Chinese birth rate, China in nowadays has become one of the largest elderly population in the world. The Figure 1 shows the aging population in China.

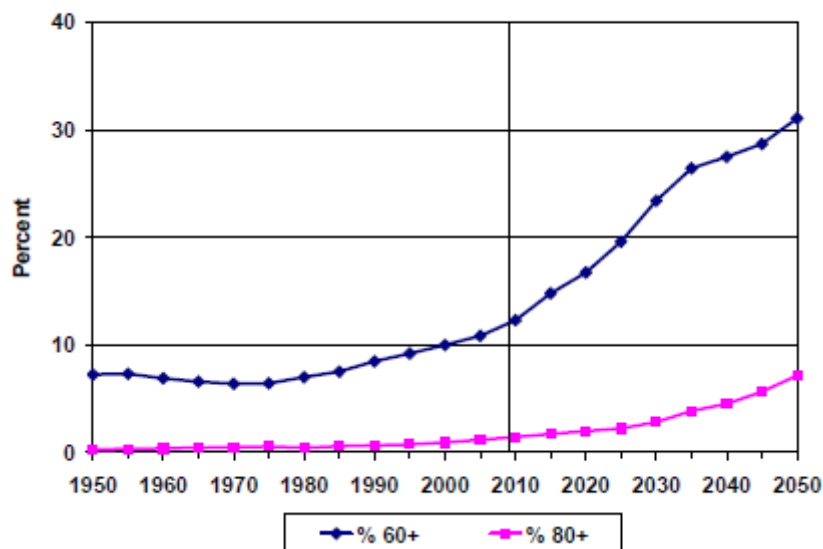


Figure 1. Overview of China population aging (Whiz, 2012).

As can be seen by Figure 1, China has entered to aging society since 2000. In 2012, the Chinese elderly population aged 60 has increased to approximate 160 million which accounts for 13% of the total Chinese population, and the average annual increase rate of Chinese aging population is 3.2%. According to United Nations statistics, the Chinese elderly population aged 80 will reach to 100 million in 2050 which is accounting for one fifth total elderly population in the world. Although the aging population in China is increasing promptly and the problems of Chinese population have become more serious, it cannot provide any effective solutions by the whole Chinese sociality due to Chinese economic strength and its actual complex condition. Therefore, the pressure of Chinese elderly people living is much greater than in other countries. (Whiz, 2012.)

The existing problematic issues of current Chinese pension can be broadly divided into three areas. The first one is the inadequate social insurance system, most of Chinese elderly cannot receive generous living allowance from the Chinese health care system after retirement, which leads to Chinese elderly people is not rich in living. The second area is lack of sufficient elderly facilities, such as the inefficient beds supplies in Chinese nursing home leads to many Chinese elderly people have to live at their own home. The last area is underdeveloped elderly care industries. Since the issues of Chinese pension were seriously emergency in recent years, there are not many companies can provide efficient services and solutions for Chinese elderly people. Due to these shortcomings of China pension environment, the vast majority of Chinese elderly people have to choose live at their own home and almost of them are lack of security and care. (Jin, 2004.) The purpose of this thesis was to propose a proper solution for urban Chinese elderly in their home living to enable them in living longer at their homes and support their lives at home by help of technology. The smart home solution is an ordinary home integrates with comfort, healthcare, safety, security by help of ICT products and technologies (Alam, et al., 2012).

It is important to find out the problems and the reasons may cause these problems before propose a proper solution. The literature review in Chapter 2 firstly analyzed the two main problematic issues and launched the detail discussion of each issue in safety and health care during the Chinese elderly home living environment, and then the author promoted a smart home concept which can be integrated the essential ICT solutions in Chapter 2. The Chapter 3 introduced the research problem and method of this thesis. The research method was based on five basic process steps on design science research which include awareness of problem, suggestion, development, evaluation and conclusion. The research question of this thesis is “how to design a smart home which is enabled to integrate the essential ICT solutions for urban Chinese elderly people?”. The Chapter 4 was emphasis on a new smart living environment demo design which include two parts, the one is conceptual model design and the other one is actual smart home demo design. Due to the outcome of this thesis was a totally new design of Chinese smart home, the author has to write a scenario of how a general urban Chinese elderly people spent a day in smart home living environment to evaluate whether the smart home design solve all the urban Chinese elderly home living issues. The discussion part in Chapter 5 firstly compared the differences between new smart home design and current Chinese smart home design, and then discussed the results after comparison. Meanwhile, this chapter also referred to the limitation and complications of this thesis. The last chapter concluded thesis and also promoted some ideas for the future design of urban Chinese elderly smart home.

2. Literature Review

The purpose of the literature review was to seek for more ICT solutions for urban Chinese elderly so that they can live at their own home with safer environment, healthier body condition and better quality life. Meanwhile, the results of all literature studies also provide a theoretical basis for smart home demo design in Chapter 4.

The subchapter of “problematic issues of home living urban Chinese elderly” aims to list the main issues of urban home living elderly daily life in safety, health and happiness and analyse the root causes of these issues. According to the results of issues analysis to find more suitable ICT solutions for Chinese elderly home living people by means of literature research.

2.1 Problematic issues of urban Chinese elderly in home living

There are many problematic issues in urban Chinese elderly home living environment nowadays, and it is not doubt that safety issues must be put in the first to solve it. Under the premise to ensure the personal safety for the elderly, then it could consider the solutions for other problems such as physical health, intelligence health, mentality happiness and living with better quality.

2.1.1 Safety issues

The main safety issues of urban Chinese elderly in their daily life at home includes falls which is most common risk, unexpected emergency issues such as fire emergency, flood emergency, gas emergency and the emergency situations with sudden illness, the most dangers risk for elderly people is when elderly person get lost in outdoors (Hu, et al., 2007). The below three subchapters claim the risks of each issue and also analysis the reasons cause these issues.

Falls

Falls are the most common risk in elderly people live at home. The previous western studies have shown that up to one third of community-dwelling older adults will fall every year (Al-Faisal, 2006). Tero, Kiel and Mor reported out the variation between 224 to 809 per 1000 person falls in UK, Finland, New Zealand, United States and Sweden each year after their prospective study in “a risk factor for falls in community-dwelling elderly” (Teno, Kiel, & Mor, 1990). The highly urbanize Chinese city Hong Kong livers showed a prevalence rate of falls is 18% in 2004 (Chu, Chiu, & Chi, 2006). Even though there has been no previous study and incidence of falls data in Chinese elderly home fall,

the falls are still the most risk for elderly people either when they live at community or at their own home (Chu, Chi, & Chiu, 2005).

Due to most of falls do not results in death or serious injury, many of elderly people treat with disapproval of their falls. But there are about 5% of falls cause fractures and more than 10% falls result in brain damage by soft tissue injury or dislocated, so as to reduce the activity of elderly. (Alexander, Rivara, & Wolf, 1992.) The Chinese disease surveillance system published their finding of mortality rate in population falls from 2000 to 2005, in the population group over than age of 60, there are 2.303 percent mortality rate for male and 2.604 percentage mortality rate for female by falls. Meanwhile, the hospitalized numbers of elderly people because of falls are 5 times more than other injuries and the hospitalized time takes 2 times longer than the ordinary patient treatment in recovery period. (Hao, Liu, & Deng, 2007.) These show the falls in elderly have a serious impact on their health and daily living life. And with comparing the elderly people who do not fall, falls in elderly people group also has a great negative impact on their social activities, spiritual and psychological states. Fall or almost fall may cause fear and impose restrictions on their activities to decline their daily activities, and even lose their confidence to do any regular activities. (Yu & Tan, 2007 June.) Thus, falls have become an important factor that affects the physical health, mental health and safety in elderly population (Hu, et al., 2007).

The urban Chinese elderly people who live at home may face more possibilities to fall. Due to large amount of Chinese population, the urban residents have limited living space. A small living space increases the probability of fall when elderly people live at home. Hong Kong is a typical urbanized city in China, there are 48% of population lives at low-cost high-rise housing consists of small floor areas which provided by Hong Kong government. (Chi & Chou, 2001.) The reasons of falls also related with various time of day. For example, elderly people are prone to fall in the morning when they get up from bed. Because of people's blood pressure will rise and may cause cardiovascular diseases at this time. The other reason is the activity of muscles and joints may not fully recover and in good condition after 8 hours lay on bed. So it is easy to fall down when elderly people get up in the morning. In addition to the morning, the high incidence of falls for elderly people is at late night when they take urination at night. Moreover, the self-diseases of elderly people are the other one of reasons cause falls at home. For instance, the self-diseases include arthritis, vision problems, dizziness, anemia. (Kong, et al., 2002.)

Unexpected emergency

In China, the mortality rate of fire in elderly people group is twice higher than average mortality rate of fire. And the elderly group over than 85 years has about four times than average mortality rate of fire in China. The fire prevention for the urban Chinese elderly people is becoming very important. (Yu, 1998.)

The reasons cause fire can be divided into three parts roughly: physical illness, inappropriate habits and lack of basic fire prevention knowledge. Many elderly people

live at home due to their mobility, unresponsive issues and even with other diseases as paralysis and dementia may cause a fire when they are cooking. And once the fire break out, it is difficult to escape the scene quickly for elderly person. The inappropriate habit of Chinese urban elderly is the other reason to cause fire. For example, Chinese people have the habit of smoking at home, the old living style of using stove for heating in the winter time and the elderly also accustomed to burn the mosquito coils for repelling mosquitoes at home in summer time. Some of devout elderly Buddhists burn incense and pray at home. These inappropriate habits are easy to cause fire. (Chen & Jian, 2007.) Once the fire is coming, the lack of awareness and knowledge of fire prevention may make elderly person become a fire victim (Yu, 1998).

In addition to the fire threats the health and life for Chinese urban elderly people, as the flood risk at home also threatens the life for elderly home liverers. In nowadays, most of urban elderly Chinese people's living places are relatively old and with a number of incipient risks as old pipes and roof leak. These factors could cause home flooding. Another common cause of flood in elderly home is the elderly may forget to turn off the water faucet after a bath or using the water. (Mao, et al., 2009.) Once the flood is coming, the slippery ground may cause fall and the electrical short-circuit may result in a great threat for elderly people (Huang, 2005).

Since most of Chinese urban elderly get used to cook and boil tea by using gas stove, which may cause carbon monoxide poisoning if in using gas stove improperly or forget to turn it off after use it (Woo, et al., 1998).

The elderly people live at home in addition to hedge against fires, floods and gas leaks, it also should prepare for other unexpected emergency situations with sudden illness. For example, due to fatigue, weather change and excitement could increase their cardiac load and result in sudden dizziness, the strenuous exercise will suddenly produce joint pain also. (Davis, et al., 1995.) Moreover, when the elderly people who have heart diseases, asthma, arthritis and other diseases who live alone at home may face with great unexpected emergency situation that occur with life-threatening any time (He, et al., 2005).

Lost in outside

In recent years, the term of "empty nesters" is becoming more and more popular. "Empty nesters" is a metaphor of young birds goes away and leaves the empty nest for their parents. According to statistics in 2004, the "empty nesters" accounted for half of age over than 60 years old in Chinese elderly people. A huge numbers of "empty nesters" exists in varying degrees of psychological anxiety, loneliness and depression and they are eager to go outside and meet with people. However, the major danger of elderly face is to get lost outdoor. (Zhang & Cao, 2009.)

The elderly lost in outdoor has become an increasingly serious social problems in China. In order to find the lost elderly, other family members tend to spend lots of energy and time on it and they also worried about this wandered situation occurs again after the elderly people find. Meanwhile, it brings a heavier workload on the police officers. According to the psychiatrist analysis, the previous lost experience will bring a great

psychological trauma for elderly people also, which allows the elderly themselves feel fear every time they go out of home. According to 2010 survey Chinese Union Welfare of Elderly, the amount of missing elderly population accounts for 40% of all missing population. The lost elderly usually face with higher dangers in outdoors. For example, they may not only face with water and food shortage, but also could be walking in inclement weather with the dangers of traffic and accident falls. With the longer time of elderly people lose outside, their morphology probably will change, that increase the difficulties to help elderly get their home. (Ke & Pan, 2013.)

There are many reasons of elderly get lost in outdoors. One of the major reasons is related with their diseases such as dementia, mental illness, memory loss and poor recognition ability because of their old age. In addition to diseases of themselves, the elderly lose are also affected by external environment. With the accelerated space of construction in Chinese cities, the surrounding of elderly living environment and lifestyle are changing every year. (An, 2013.) For example, the park in front of elderly living home may become an office building one or two years later. The rapid urbanization of China cause great difficulties and affect the daily life of elderly people (Chen, 2007).

To keep safety is the major and most important thing for urban Chinese elderly daily living life at home (An, 2013). After ensure that elderly people can protect their own safety, the next step is to seek several ways of approaching to keep elderly people living longer and better at their home.

2.1.2 Health issues

The basic and common approach to keep elderly people living longer is to maintain a good health for elderly adults (Lubitz, Kramarow, & Lentzner, 2003). However, the most of elderly adults usually have ambiguous definition of “a good health” and many of them consider “a good health” means without even tiny illness can be regarded as a health people. This consideration is not entirely wrong, but there are many aspects can be judged an old man whether meets the “a good health” standards. (Meng, et al., 2013.)

As early as 1982, the Chinese Medical Association on Gerontology Branch raised 5 standards in “a good health” for Chinese elderly people and mainly pointed that the major organs are health of elderly adults and with absences of disease themselves as regards to compliance with health standards. In 2013, the Chinese Medical Association on Gerontology Branch has been revised the previous five standards which based on the new progresses in concept of health from international environment and also combined with the specific circumstances in Chinese elderly living environment. The newest five standards are formulated a “The Chinese Health Elderly Standards in 2013 Edition” which redefined what is “a good health” for the Chinese elderly. To better clear and understand these five standards can help Chinese elderly people how to maintain their own good health at home and live longer. (Meng, et al., 2013.) The below five related health issues of Chinese elderly live at home will be discussed around these five standards.

Disease issues in elderly health

The disease issues in elderly health are generally divided into two types: one type is a serious illness that may cause death in any uncertain time, and the other type is ailment that won't cause life-threatening (Meng, et al., 2013).

The first standard in "The Chinese Health Elderly Standards in 2013 Edition" mentioned extent of the diseases is the main criteria for judging whether the elderly people in good health condition. If an elderly adult does not have any serious illness and his or her ailment is in a stable condition, it could meet "a good health" newest standard. (Meng, et al., 2013.)

Without serious illness refers to the vital organs such as hear, brain and kidney of elderly people are degrading somewhat due to their increasing age, but it does not lead to dysfunction. The elderly who has history of cancer, cardiovascular and cerebrovascular diseases such as myocardial infarction and stroke also can be counted within serious illness. The ailment in stable condition refers to the minor disease can be controlled after elderly people take medication or change his or her living life. (Meng, et al., 2013.) For example, although many Chinese elderly people sick with high blood pressure and diabetes, these diseases can be controlled within a safe range by taking the medication and self-conditioning (Schrier, et al., 2002).

Intelligence issues in elderly health

Having "a good health" is not enough for a Chinese elderly live at home, the elderly people should also have a normal intelligence ability and be able to handle a huge number of trivia in their life, for instance, cooking, laundry, cleaning, entertainment and so on (Meng, et al., 2013).

The intelligence is a comprehensive concept which composed of attention, observation, imagination, memory, thinking, practical and social adaptability force. With the growth in elderly age, the intelligence of elderly people is also accompanied the recession. (Meng, et al., 2013.)

A part of elderly intelligence recession is caused by age-related memory loss and the other part is due to some mental illness. In "The Chinese Health Elderly Standards in 2013 Edition", the second standard strongly suggests the Chinese elderly could simply assess their intelligence by "The Easy Chinese Elderly Intelligence Scale", then scientifically determine whether their intelligence reach the normal level based on the assessment results. For the group of Chinese home living elderly people's assessment results below than normal level, they should be more careful and seek for solutions. (Meng, et al., 2013.)

Mentality issues in elderly health

Traditionally, it would have been enough for an elderly adult who with a health body and normal intelligence to handle his or her daily living life at home. The third standard in

“The Chinese Health Elderly Standards in 2013 Edition” indicates the mentality issues are becoming a serious problem to affect the health of the Chinese home-living elderly. (Meng, et al., 2013.)

The reasons may cause mentality issues in Chinese home-living elderly group as follow:

1. the elderly prefer to stay at home and away from the outside social life after the retirement. With the shrinking life circle of retirees, the opportunity to communicate with the outside world is gradually reduced from Chinese elderly group, which lead them gradually out of touch with the rapid development of society. This marginalization of social and family situation may easily cause the elderly mental depression.
2. Some childless elderly couples and the elderly families without long-term care by their children will have a strong sense of loneliness.
3. Some frail elderly or someone with mobility reason also reduce the frequency of contact with friends and relatives that could result in intense loneliness for the elderly adults. For the Chinese elderly who have long-term residence at their home alone and are lack of communication with other people will have sad, depression and mental malaises. The immunity of the elderly body will also decrease and result in more diseases while elderly adults with long-term mentality issues.
4. When some of elderly has certain brain diseases or their brain tissue associated with aging, their mood are changing frequently and tend to lose self-control and performance in anger sometimes. The elderly in this state become more difficult to communicate with others.
5. The unexpected changes also the reason serious mentality issues caused in elderly adults group. For instance, lose spouse suddenly, accident falls, not enough money to spend and so on. There are 48% elderly group has depression with economic conditions in urban Chinese elderly people. These unexpected changes will cause long-term mental tension of elderly group. (Zhang & Liu, 2007.) Thus it can be seen the Chinese home living people are susceptible to mental illness. With comparing the health diseases, most of people tend to ignore the dangers of mental illness. (Meng, et al., 2013.)

Actually, the mental illness seriously affects the health of the Chinese home-living elderly adults. There are many manifestations of Chinese elderly who suffers from mental illness, of which the most important are the negative emotion, retardation of thinking, loss of willpower and suicidal ideation and behaviour in some serious cases. The mental illnesses also make the elderly people choose some unhealthy living ways that can help get rid of illness and loneliness, such as smoking and drinking. And this unhealthy lifestyle can also lead to cardiovascular disease, diabetes and other chronic diseases. (Zhang & Liu, 2007.)

In “The Chinese Health Elderly Standards in 2013 Edition”, the third standard wish the Chinese home-living elderly people could fully realize their own mental status and pay more attentions on the potential development of social participation. The Chinese elderly could simply assess their mental status by “The Easy Chinese Elderly Geriatric Depression Scale”, and then scientifically determine whether their mental health reach the normal level based on the assessment results. (Meng, et al., 2013.)

Living habit issues in elderly health

The “living habit” was new standard in “The Chinese Health Elderly Standards in 2013 Edition”. This standard pointed out good living habits is the basis to maintain health of the elderly people. The reason why the “living habit” was listed as one of the new Chinese health standards in 2013 was the urban Chinese elderly lifestyle has been tremendous changed in last a couple of years under the fast development of Chinese urban economics, and these changes become the serious problems are afflicting the health of Chinese urban elderly group. (Meng, et al., 2013.)

With the income and living standard of Chinese urban elderly improving, their eating habits tend to more meat and junk food compared with their previous eating habits on simple meal that result in an increasing number of Chinese urban elderly people who become obese. There are nearly 40% are overweight or in obese status during the urban Chinese elderly group by investigated from Chinese Elderly Health Association in 2013. However, only 41.27% of all urban Chinese elderly adults regularly participate in physical exercise every day. (Meng, et al., 2013.) The unhealthy eating habits lead to high blood pressure, diabetes and other chronic diseases (Bin, et al., 2004).

There are many urban retired Chinese elderly people with nothing to do every day and have to pass the time on watching TV or playing mah-jong. This bad sedentary habit seriously affect their digestive function and likely to cause indigestion, constipation, haemorrhoids and other diseases. Some of urban Chinese elderly used to choose play cards and mah-jong outdoor, it also easily leads to poor blood circulation to lower limbs and may aggravate knee degeneration when the outdoor temperature is low. (Schooling, et al., 2006.)

In addition, smoking and drinking habits also have become a serious factor that affects the health of elderly. The Chinese Elderly Health Association pointed out there is nearly 30% of male urban Chinese elderly have habit on smoking in 2013. (Meng, et al., 2013.) The elderly smokers significantly increase the incidence rates of heart disease, hypertension, cerebrovascular disease and peripheral vascular diseases. If an elderly person suffering from both smoking and high blood pressure, the stroke risk will rise nearly 20 times than others. In addition, the smokers are susceptible to arteriosclerosis obliterans and occlusive thrombus arthritis. (Xu, et al., 2013.) The drinking culture in China for thousands of years and many Chinese elderly people has the habit of drinking. A small amount of alcohol can promote the blood circulation of human body which can help people stay healthy. (Newman & Ludman, 1984.) The elderly people who have cardiovascular, liver, stomach, duodenum and other organs diseases should try to reduce the amount of alcohol, especially it must prohibit the alcohol for the elderly who is taking the medication, or otherwise the alcohol will reduce the effectiveness of medicines. (Schooling, et al., 2006.)

Self-care issues in elderly health

In “The Chinese Health Elderly Standards in 2013 Edition”, the self-care ability belongs to the fifth standard to judge whether an urban Chinese person in a good health condition (Meng, et al., 2013).

Self-care ability usually refers to activities of daily living (activity of daily living ADL) and functional activities of daily living instrumental activities of daily living IADL). ADL is the basic self-care ability of elderly people to engage themselves into their daily life activities, such as wear and wash clothing, cook and eat food, use transportation and keep personal hygiene. ADL is the basic need for a human being. IADL means of the level whether an elderly can live independently and living with quality life. For example, walk independently, do some sports, use transport by themselves. (Kempen, et al., 1996.)

In December of 2000, the Chinese Aging Research Centre survey of 20,000 elderly people who over than 60 years old in 20 provinces of China. After the self-care ability (ADL and IADL) test, it showed there were 5.2% urban Chinese elderly and 8.9% who live in rural areas cannot take care of themselves. And these proportions are greatly increased in the past ten years. Resulting in the increasing number of urban Chinese elderly cannot take care of themselves because the Chinese family structure has been changed. (Meng, et al., 2013.) In the traditional Chinese family during the past time, the children have obligations to take care their parents. Due to the imbalance development of Chinese different cities, there are more and more young people choose to live in a few big tier one cities. However, their parents have to stay at their own home and lack of help from their children. Accompanied by the popularity of Chinese”one child” policy, the number of young people are reducing and the elderly people are increasing. There will be more and more elderly people cannot be took care by their children in the nearly future. These “empty nesters” who are not properly cared would face more risk of disease so as to lose their ability to take care themselves. (Logan, Bian & Bian, 1998.)

2.1.3 Other issues

Therefore, the problematic issues of urban Chinese elderly in home living can be mainly divided into two main areas which discussed above. Of course, the urban home living elderly people usually have to face more complex issues in their real life, such as a great many urban home living Chinese elderly face the problem of insufficient income, venerable aged people have more safety and health issues than the younger elderly, the welfare and health care treatments that local government provide to their elderly group has huge differences in different regions. (Zhang & Goze, 2006.) Given the complexity of pension situation in China, this thesis only generally pointed out two main problematic issues in urban Chinese home living life and sought for some fine and effective solutions for those problems by means of science and technology.

2.2 Solutions

This chapter discusses main concepts reach to ICT solutions for urban home living Chinese elderly people in two subchapters among safety and health.

2.2.1 Safety ICT solutions

The fall ICT solutions are firstly given in this subchapter, and unexpected emergency ICT solutions and lost in outside ICT solutions are then discussed in detail.

Falls ICT solutions

Due to the large population and limited living space in China, a great many Chinese urban elderly have to live in their crowded home. The limited living space is one of the reasons to cause elderly fall. There is no a fine scientific and technological solution existed so far in the whole world to make a limited space bigger. It could make a larger living space or enable to provide more conveniences when elderly people take activities at their own home by means of redesign the whole house and replace all the futures. (Chou & Chi, 2000.) In this thesis, it will only discuss the ICT solutions for Chinese elderly falls at home.

The raised blood pressure will cause cardiovascular diseases that may easily to fall down when elderly people get up in the morning. Therefore, the elderly need to know whether their blood pressure value stays safe. A blood pressure monitor or heartbeat monitor is necessary to use on tracking and monitoring the blood pressure value in elderly people's daily life. All changed blood pressure value can be showed directly to the user and let them know if their health condition at risk in every second. Due to most of urban Chinese elderly are not accustomed to use technical products such as blood pressure monitor or heartbeat monitor, the smarter solution is to trigger the alarm automatically by the product when the blood pressure changed dramatically. (Agarwal, et al., 2011.)

The high incidence of falls happen on elderly people is when they take urination at night, the muddle-headedness and dark environment easily lead to elderly fall. That is why a smart lighting system is needed when the elderly get up at night. The light will turn on automatically when elderly get up and turn off automatically as well when they go back to bed. For more convenient on elderly using, one-key touch to turn the light on and off design is a fine solution to control the whole system. And an automated alarm is needed as well in case the elderly fall down. (El-Bendary, et al., 2013.) Alwan (2006) mentioned a smart and passive floor may suite these needs and keep home living urban Chinese elderly safe. This floor is based on fall detector and also has function to send alarm automatically to the hospital and emergency center

In other reasons may cause falls at home like instance, arthritis, vision problems, dizziness, anemia can be solved by medications and other medical devices (Chu, Chi & Chiu, 2005).

Unexpected emergency ICT solutions

The elderly group over than 85 years has about four times than average mortality rate of fire in China. The fire prevention is very important for urban home living Chinese elderly (Wang & Fan, 1997). In addition to teach the necessary fire safety knowledge to elderly person, a smart and fine ICT solution is also necessary. The smoking detector is widely used in the room and kitchen in nowadays, but the problem is it may cause a few false alarms when elderly smokes indoor or pan-fry some food. The temperature sensor used for monitoring the heater temperature and it is also can be accompanying used with smoke detector to reduce false alarms. Once the emergency fire happens and the elderly cannot turn off the heater or fire source immediately after alarms, the system will shut down the heater automatically and send alarms to fire agency at the time. (Kwon, Shim & Lim, 2012.)

Due to almost of urban Chinese elderly are using gas stove for home cooking and boiling water, a gas detector is needed for sending alarms and shut down the gas stove automatically when the gas leaks. The gas detector is mainly used to monitor carbon monoxide in the air and alarm when carbon monoxide poisoning. (Kwon, Shim & Lim, 2012.)

It is the same principles to prevent floods as gas leaks, a water leak detector is needed. A water leak detector can provide early warning to minimize home damage and protect home living elderly. And it will also send sound alarm when the water leaks. (Kwon, Shim & Lim, 2012.)

For elderly sudden illness at home living, the ICT solutions will be discussed in health ICT solution at the following subchapter.

Lost in outside ICT solutions

The related elderly diseases such as dementia, mental illness, memory loss and poor recognition ability is the main reason caused the elderly lost outside. The other reason is the changes in external environment may confuse the urban Chinese elderly. The GPS location tracking in outdoor is the best ICT solution for elderly lost in outside until now. The GPS monitor collects the current position where the elderly person stays and uploads the position data into the system back-end by means of 3G or WIFI. (Calvo-Palomino, et al., 2009.) After these data processed in system back-end, the foreground of elderly move in outside can be easily displayed in computer monitor and followed by the staff who works in the health centre. Once the elderly people lost in outdoors, the health centre staff will call his children or friends in the first time and tell them the address where the elderly current stay. This is only for those elderly who do not know they have already lost. (Hinch, 2013.)

And for those elderly people who know they have lost, they can press “one-key” dial to contact health centre staff or use their mobile phone to tell their family members or friends (Hinch, 2013).

2.2.2 Health ICT solutions

In this subchapter, the following topics are considered: disease ICT solutions, intelligence ICT solutions, mentality ICT solutions, living habit ICT solutions and self-care ICT solutions.

Disease ICT solutions

All the home use ICT equipment and system cannot have the function of treatment as hospital ICT equipment. A fine disease ICT solution for home living elderly should have the characteristics of disease prediction and prevention (Chu, Chi & Chiu, 2005).

The home living elderly people could know whether his physical condition deteriorated and also know which disease they might get in the nearly future by means of using ICT devices. These ICT devices aim to collect data from the home living elderly every hour per day. These collected data include heart rate, blood pressure, sleeping condition, activity and so on. All the data are sent to the backend system via network, and finally the system is to determine the user's health condition after data calculation and compare with previous user data during the backend computers process. For example, a sensitive pedometer is very effective approach to collect the daily activity value from the elderly people. After compare the user recently activity value with his average activity value of last month, the back-end system send a notification to the user and his doctor when the comparing result exits a significant change. (Ruiz, Ramos, & Ramón, 2013.) The reason may cause this significant change is arthritis. The elderly user can find it out by checking the medical equipment in hospital (Huo, et al., 2009).

Similarly, the blood pressure monitor, sleeping monitor and other ICT devices can measure an elderly's comprehensive health values in his daily life, and upload to the back end system for storage, analysis and comparison. It is an effective approach to predict diseases and remind the elderly to check in hospital promptly. (Ruiz, Ramos, & Ramón, 2013.)

Intelligence ICT solutions

A part of elderly intelligence recession is caused by age-related memory loss and the other part is due to some mental illness (Mace & Rabins, 2011).

According to the Petersen group's experiments in 2005, the elderly memory loss patient can alleviate symptoms of amnesia through the medication treatment and improve the sleeping quality. The medication treatment for elderly memory loss patient can be followed the doctor's instructions. And sleeping quality improvement can be relied on the ICT solutions. (Ronald, et al., 2005.) The bed sensor is for analysis the user's sleeping and wellbeing conditions include sleeping hours, sleeping quality and send alarm to the health centre in emergency. The doctor can give the elderly better advices under the sleeping data from the bed sensor. When the emergency situation appears, such as the elderly has a

long sleep and does not get up from the bed, the bed sensor also sends an alarm to the health centre. (Kortelainen, van Gils & Parkka, 2012.)

In addition to medications therapy and sleeping quality improvement, some video games can also help improve the elderly people's intelligence (Chang & Liao, 2012). For example, the urban Chinese elderly prefer to play mah-jong and Chinese chess, the problem is usually mah-jong needs to gather at least four players to play, and the mah-jong computer game allows single player to play online with other internet players. The video game is the other ICT solution for urban Chinese elderly group who has intelligence recession issues. (Chang, et al., 2011.)

Mentality ICT solutions

The main reasons cause mentality issues in Chinese home-living elderly group include stay at home and away from the outside social life after the retirement, the loneliness in childless elderly couples and prolonged physical illness. The physical illness can be treated by medication and medical devices, but the treatment for loneliness and depression need to meet the emotion needs and know how to release. (Luo & Waite, 2014.)

With rapid development of science and technology in nowadays, using video online chat with friends and family is becoming common and easy for urban home living Chinese elderly. However, with the increasing requirements from general internet users, the online chat software becomes more complex to use. Since most of urban Chinese elderly people are not highly educated as well as lack of skills in using technical devices, it takes long time for them to understand the usage of nowadays' online chatting software. The customized online chat software is needed for elderly group. (Pan & Jordan-Marsh, 2010.) All the contact person profile pictures of elderly people's family and friends are displayed in a computer monitor, the elderly people only need "one-click" the profile picture to connect with the person they want to talk with. The customized chatting software has the principle of "less is more" and makes every urban Chinese elderly easier to communicate with others. (Alaoui & Lewkowicz, 2013.)

Apart from the customized online chatting software to make elderly communication easier, the entertainment is also a very effective approach to release the negative emotions from the elderly people. The most common entertainment activities of urban Chinese elderly at home are listening to the radio and watching TV. In order to better meet the needs from the young Chinese group, the content of television programs are getting younger. A customized TV contains multiple elderly TV programs, and the entire television program broadcasting time is also customized according the home-living elderly people's daily habits. (Trinh, Chung & Kim, 2012.) For instance, some elderly people have old habit to watch news in dinner time, and some elderly have habits to listen some soft music before sleep. A customized TV could combine with the customized online chatting software to prompt Omni bearing services in communication and entertainment in order to bring more happiness into the urban Chinese elderly people's daily life. (Alaoui & Lewkowicz, 2013.)

Living habit ICT solutions

There is no fine solution exists in the world to change a person's bad habits by means of medication or technology. A person only relies on himself to change his own bad habits. The living habit ICT solutions provide more effective and scientific approach to help the use get rid of his bad habits gradually. This ICT solution is similar as a personal assistant who can specify a set of rational plan for the user through the user's own health condition. (Huffman, 2013.)

With the income and living standard improving, the urban Chinese elderly people tend to eat more meat and junk food than vegetables. The phenomenon of elderly obese is getting worse in Chinese cities. The solution for this phenomenon is to collect the data of elderly people's height, weight and age first, and then derive the value of elderly obesity through the scientific formula calculation. When the obesity value is too high, the backend system will send all the data of elderly to the doctor and specify a new diet and exercise plan for the elderly under the doctor's advice. (Huo, et al., 2009.) In a real life, it is not every elderly will follow the plan and complete each task every day. The ICT devices where elderly use daily keep transferring the data in activity, blood pressure and weight value to the backend system. Then a doctor will send a new notification to the user and remind him to follow the execution of the plan. The whole process is like a private health assistant who would like to help the elderly specified plan, monitor the plan execution and give feedback to the user timely. (Schäferal, et al., 2010.)

Similarly, this private health assistant will help the elderly overcome his sedentary habit. Due to many retried urban Chinese elderly people spend much time on sitting sofa and watching TV or playing mah-jong. The private health assistant will remind the elderly to stand up walk around for a while time to time in the daytime. The pedometer will monitor whether the elderly people stand up and walk by the instruction. Meanwhile, the walk distance and duration data of the elderly will also upload to the back end system, so that the doctor can monitor the active state of elderly for each period per day. (Aoyagi & Shephard, 2011.)

The ICT solution of private health assistant cannot change the user's bad habit, but it could give the user detailed plan according to the user's own health and with the advices from the doctor. Meanwhile, this private health assistant monitors the complete schedule in the plan and given feedback timely. After comparing with the real people assistant, this ICT solution uses more scientific, detailed and responsible approach to solve the bad living habits from the home living elderly people. (Aoyagi & Shephard, 2011.)

Self-care ICT solutions

Solving a bad living habit may need a "private health assistant", sometimes the elderly do need the services of the real people when they live alone and encounter some difficulties in their life (Sun & Wang, 2012).

There were 5.2% urban Chinese elderly cannot take care of themselves. Meanwhile most of urban elderly people are lack of help and need to be taken care in case of their children

are not living around. For the elderly group who are lack of self-care ability, they need a quick and easy solution when they need help and services. (Sun & Wang, 2012.)

Currently it is very popular to call the housekeeping company and ask for services in China. The staff in housekeeping usually has a long conversation with the elderly people then provide corresponding assistance and services. Due to a great amount of urban elderly in need of help and the housekeeping companies are limited, many elderly people cannot connect to help desk of housekeeping company at the peak of the day such as morning and noon. It is known that the housekeeping companies could not meet all the elderly people's needs. The ICT solution may allow the housekeeping companies to provide more services for the elderly people. (Wang & Zhu, 2010.) According to the reason in most of elderly people have a regular living habits in their daily life such as go shopping in the morning, and then do the laundry and clean the house, cook and eat at noon. The ICT device is set a few fast dial keys for elderly people, and the backend system will receive different information when the elderly dial different keys. For instance, to dial number "1" or profile picture "clean" means come and help me clean the house, dial number "2" or profile picture "cook" means help me cook the food at home. All the numbers are set according to personal preference of elderly people. And it must to tell the staff about food menu first if the elderly need them to buy some food. In addition there is a special dial button on the device for elderly to call emergency help. (Roka, 2011.) For example, the elderly needs a car to the hospital because the sudden onset of arthritis (Luo, et al., 2013).

The ICT solutions of fast dial build a bridge between the elderly who need help and the housekeeping companies which provide help and other services. It aims to help urban home living Chinese elderly people get more services and be taken care timely. (Roka, 2011.)

2.3 Smart home concept research

To find out many of ICT solutions for current problematic issues of urban Chinese elderly home living is almost useless, the more important thing is to involve these ICT solutions into the real living environment of urban Chinese elderly people and make themselves safer, healthier and happier. The concept to integrate ICT elements into an ordinary family is smart home. (Portet, et al., 2013.)

Bierhoff mentioned in his book of Smart home environment as one way to improve the quality of life is by making the home environment a more comfortable place to live in by turning it into a smart home environment (Bierhoff, et al., 2007). The smart home is an ordinary home integrates with comfort, healthcare, safety, security and energy conservation. In smart home, it is common to use remote backend system for monitoring user's health data, home devices control and even support remotely from hospital or housekeeping companies. (Alam, et al., 2012.)

The early definition of smart home was given by Lutolf (1992,p.32) as the smart home concept is the integration of different services within a home by using a common communication system. It assures an economic, secure, and comfortable operation of the home and includes a high degree of intelligent functionality and flexibility. In nowadays, with the emergence of a large number of intelligent devices, especially the automation smart devices have completely subverted the traditional impression of people think about smart home. For instance, the home living mobility elderly control the light, curtains or air conditioner by simple touch the device interface. In traditional smart home, the mobility elderly people have to call for housekeeping service and invite staff to do it. Meanwhile, the children of the mobility elderly who stay out of home could also easily detect home living environment by mobile phone or computer. Once any emergency happens, the children will get the alarm notification immediately. Remote monitor and control is the other major difference between modern smart home and the traditional one. (Alam, et al., 2012.)

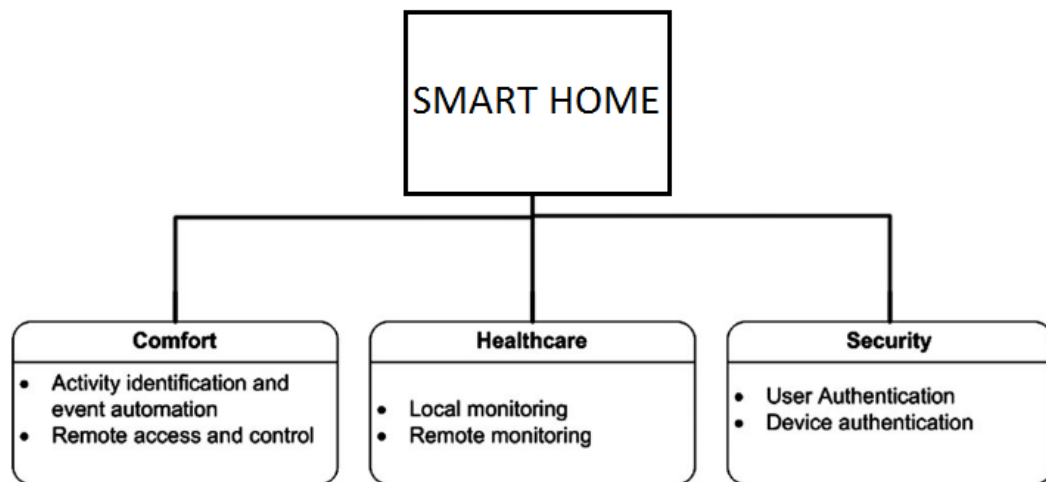


Figure 2. Categorization of smart home projects according to the intended services (Alam, et al., 2012).

The Figure 2 shows the categorization of intended features and services in a modern smart home which divided into three parts as comfort, health care and security. From all the feathers and services in Figure 2, in addition to the feathers of automation and remote monitor/control in smart home which mentioned above, it is also feasible for user to check his own physical and activity data through phone or computer. The security is the third major feather in smart home. After user and devices authentication, the security services are not only ensure the accuracy of user's data, but also protect the information of the user. (Alam, et al., 2012.)

The user groups of smart home living are extensive, which include young people group and also can be the elderly people group and children. Since most of young people can take care of themselves properly and the children are generally taken care by their parents

in China, the Chinese elderly group has more needs from smart home to make them live with a safer, healthier and better quality life. (Raad & Yang, 2009.)

With the popularity of smart home concept, there already a few local Chinese companies put their foot on smart home design for the urban Chinese elderly people. One of the most famous smart home named “U-HOME” by Haier aims to provide the solutions on locating, tracking, identifying, monitoring and management by means of RFID, wireless and sensor technologies. (Zhong, Su & Feng, 2013.) The “Changhong” is the other one of the most famous company which specialized on smart TV, monitor, alarm, security and access control. Both of these two companies are leading the smart home market in China. Although the Chinese smart home products have already appeared in the Chinese local market, there are still many shortcomings and a room for improvement of Chinese smart home products. (Sichuan new, 2014.)

The Appendix A shows whether the features and services from these two companies meet the ICT solutions of urban Chinese home living that mentioned in Chapter 2. The “X” means meet the solution and blank space means does not meet.

From Appendix A, it can be seen these two current Chinese smart homes may not fully meet all the needs of urban Chinese elderly people. The “U-HOME” smart home integrated more ICT products and also provide more effective ICT solutions for Chinese elderly people than “Changhong” smart home product. But both of these two smart home have a common problem that is lack of backend system development, this is also one of the main reasons these two smart home may not fully meet all needs and requirements of urban Chinese home living elderly people. Alam et al.(2012) ponit out the future trend of smart home would be interagated into more high-tech means and empahsised on user data management and analysis.

3. Research Problem and Method

Hevner and Chatterjee (2010, p.23) define design science research (DSR) as a research paradigm in which a designer answers questions relevant to human problems via the creation of innovative artifacts, thereby contributing new knowledge to the body of scientific evidence. The principle of DSR method is to create an innovative way to solve the practical issues in people's daily life. For instance, the existing Chinese smart home with its products and services may not completely solve the basic issues in urban home living Chinese elderly group, therefore the current Chinese smart home is needed to involve with some new ideas and improve its design for better meets the needs of the urban home living Chinese people. The author of this thesis aimed to propose some ideas into the new Chinese smart home demo design which was basis on the literature review and the existing situation of Chinese smart home products. That is the reason DSR is the most appropriate method may be chosen for this thesis.

There are many of excellent instructions for guiding the research process in design science, the Figure 3 is one of these instructions and it presents the general methodology of DSR. Vaishnavi and Kuechler (2004, p.18) propose the advantages and reasons to select Figure 3 as DSR process methodology due to it emphaseizes the knowledge generation inherent in the method and it originated in an analysis of the process inherent in any design effort.

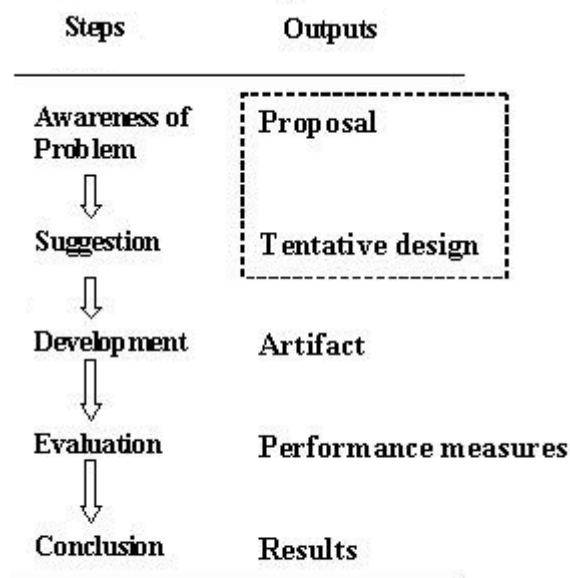


Figure 3. The general methodology of design research (Vaishnavi & Kuechler,2004).

The Figure 3 shows five basic process steps on design science research which include awareness of problem, suggestion, development, evaluation and conclusion.

The research problem of this thesis was the many of problematic issues existed in current home living environment of urban Chinese elderly people. With the large increased numbers of elderly population in China nowadays and the other reason such as inefficient bed supply and lack of elderly-care facilities, more and more urban Chinese elderly choose to live at their own home. The literature review part of this thesis promoted two main problematic issues in safety and health and launched the detailed discussion of each issue. After find out ICT solutions in each issue, the author promoted a smart home concept and analysed two typical existing smart homes in China. The current Chinese smart home may not completely meet the needs for home living urban Chinese elderly people after the author compared the features, services and backend system between these two Chinese smart home and the ICT solutions. The objective of this thesis was to create a new smart home design which can provide related ICT solutions for urban Chinese home living people based on a literature review was proposed. The research question of this thesis was “how to design a smart home which is enabled to integrate the essential ICT solutions for urban Chinese elderly people?”

The suggestions were given on the research question based the previous literature review as well, a new smart home design for urban Chinese elderly people has to be integrated all the ICT solutions and also with a functional back-end system for data collection, analysis and storage. The ICT solutions include the related ICT products and the services from third party providers such as health centre, hospital, fire station, entertainment companies and so on.

The development of new smart home was divided into two parts, the first part is smart home conceptual model design and the second part is actual smart home design in a real urban Chinese living environment. In conceptual model design of smart home, the smart home is divided into three components and how these three components work with each other. Due to the importance of backend system, the following chapter is emphasis on functional model design in smart home backend system. The second part is emphasis on involving all the ICT products, services and backend system into a real home living environment of urban Chinese elderly people. In the end of the development, the thesis presented an overview of smart home in real life processing which is combined with previous conceptual model of smart home design and the real home living environment of smart home design. The purpose of the whole smart home demo development is to provide solution for the research question. It aims to integrate with all essential ICT solutions and solve all the problematic issues of urban Chinese elderly home living people by means of new smart home design.

Due to this is new smart home design for urban Chinese elderly people, it is difficult to use a real user usage data to prove whether this smart home design can really work and be able to solve all the problematic issues. The evaluation of this research according to a scenario of how a general urban Chinese elderly people spends a day in smart home living

environment, and evaluate whether the smart home design solve all the urban Chinese elderly home living issues and finally answer the research question.

4. Smart living Environment Demo Design

The smart living environment demo design is divided into two parts, one part is conceptual model design which is emphasised on smart home conceptual model design. The other part is actual smart home demo design in a real urban Chinese elderly home living environment.

4.1 Conceptual model design

The conceptual mode design is firstly introduced the three components as ICT products, system and services in smart home conceptual home design, then analysed the entire working process and data transition from internal to external in smart home conceptual design.

4.1.1 Smart home conceptual model design

The smart home simply consists of three components as ICT products, system and the services. The reason of this simply design was to let the smart home be more widely promoted and applied. In addition to the simple design, the smart home should has all essential features and services in order to allow the elderly people spend healthier, safer and better quality life.

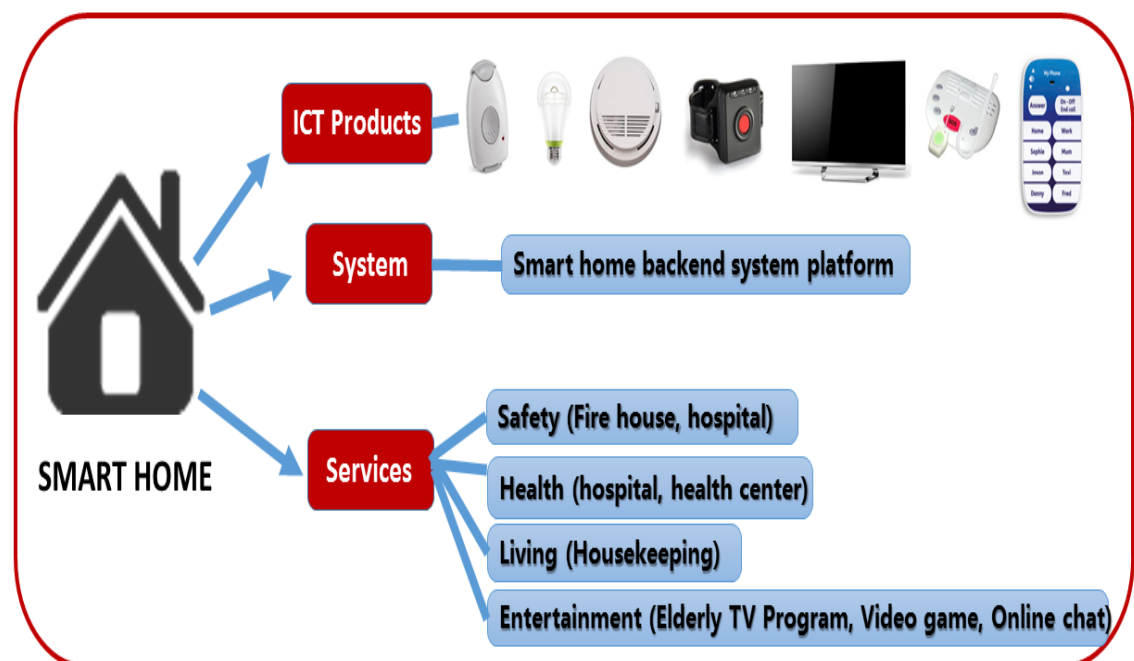


Figure 4. Three components in conceptual smart home design.

In Figure 4, the ICT products means the user can choose the ICT products according to their own health condition, living environment and income. Some elderly people urgently need an electronic blood pressure meter due to their heart disease, and some urban elderly people prefer to watch youthful TV programs than elderly TV shows, they may not choose smart TV and some customized elderly TV programs. Some of urban Chinese elderly choose limited ICT products due to lack of income. In fact, not all the ICT products could perfectly combine with the smart home backend system. The elderly people should be aware whether the open port and transmission protocols of the product are available, so as to ensure all the data that product detected could be transmitted to the smart home backend system.

The system is the core of the whole smart home design, it plays the role as a “middle man” to collect and analysis users’ data, then provide the results to the third party vendors as hospital and fire house. All the services are provided by third party vendors are basis on the results. For instance, since the system found out the user’s recent activity data value has significantly decreased when compared with the average data value in last month, the doctor in hospital sent a notification to the users and ask whether the users in illness.

In addition to the hospital is one of the third-party service providers, some emergency relief agencies such as fire house and some entertainment companies like video game producers, elderly TV program producers and social media companies are also belong to third-party providers. As can be seen in Figure 4, the service providers are divided into four categories as safety, health, living and entertainment. The living category is for the vendors who facilitate the life for the elderly such as clean the house, buy food, do the laundry and so on. The housekeeping is a typical vendor service in living category. The health centre is belong to health category and mainly provides the health services such as regular health check and review, health advisory, health environment supervision and so on.

While the smart home is simply divided into three opponents, the internal working process in each opponent and the interaction during these three opponents is becoming complicated. The Figure 5 specifically shows the entire working process from internal to external in smart home.

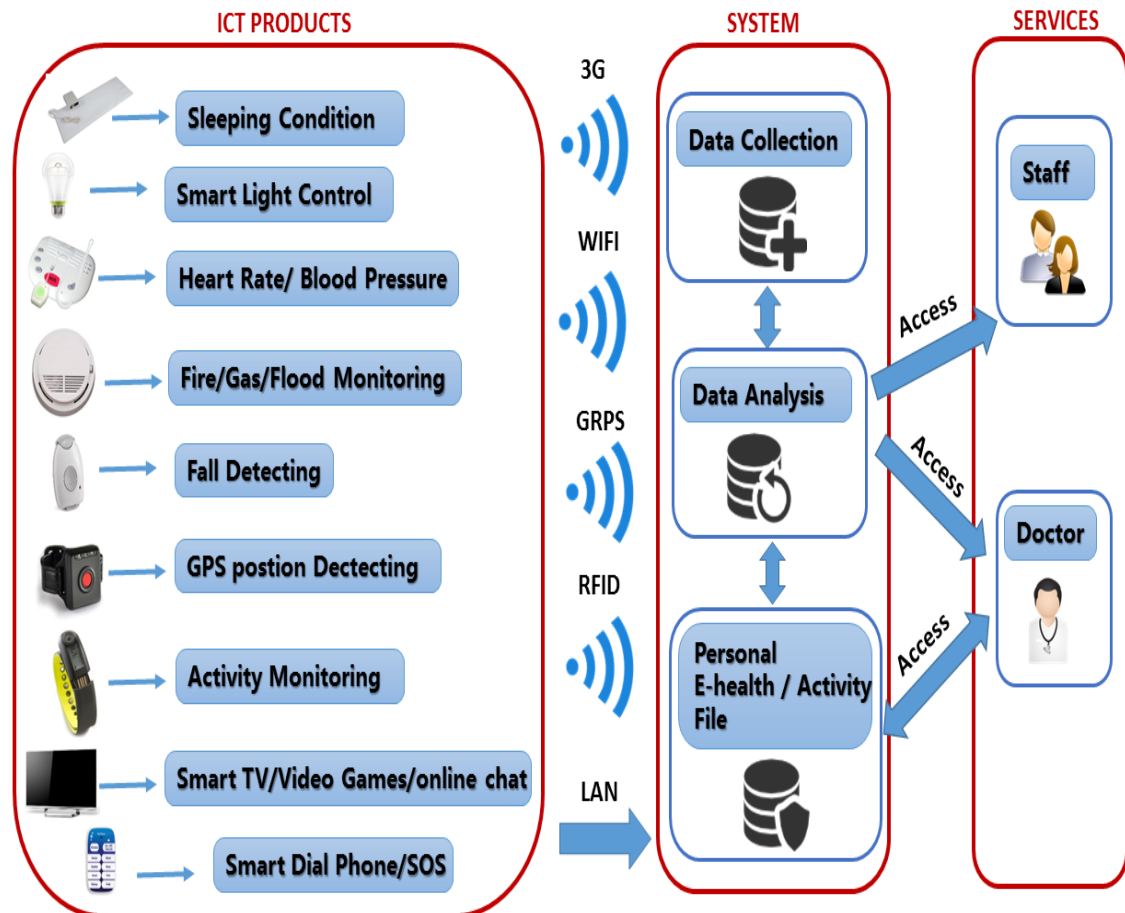


Figure 5. The conceptual work flow in smart home components.

The entire smart home design from internal to external is integrated with all the ICT solutions whether in ICT products or backend system which discussed in Chapter 2. The purpose of the smart home design was to better solve all the essential issues of urban home living Chinese elderly people.

The internal work flow in components of ICT products consist with nine ICT devices as sleeping sensor, smart light, electronic blood pressure meter, kitchen detecting unit, fall sensor, GPS watch, activity monitoring wrist, smart TV and elderly smart phone. As can be seen from Figure 5, each ICT device has one or more features. The sleeping sensor device aims to monitor the sleeping condition of the elderly people, one-third of a person's life time is spent in bed, and the sleeping quality of a person determines his health condition. The smart lighting control device aims to help elderly take urination at night so as to minimize the chance of elderly fall. The electronic blood pressure meter for measuring the blood pressure values of the elderly. All the kitchen emergency sensors such as smoking sensor, gas leak sensor and water leak sensor are combined with one kitchen detecting unit aims to monitor the fire, gas and water leak condition. The kitchen detecting unit will send the alarm automatically in any emergency situation. The fall sensor is for detecting falls emergency and also sending alarm automatically when user is in danger. During the outdoor activity, the position of urban Chinese elderly people is detected by GPS watch and all the activities data are also monitored and collected by

activity monitoring wrist. Meanwhile, the activity monitoring wrist can also monitor the user activity data inside home. The customized elderly TV programs, elderly video games and easy use online chat software are provided by vendors from third party. Meanwhile, the services from third party vendors also provide emergency services and home keeping services. Due to different features in various ICT products, the user data that every product collected are also different. However, all data transmitted to the backend system under the permission of APIs port and transmission protocols by means of 3G, WIFI, GPRS, RFID and LAN with cable connection.

All the data will be transmitted to the second component of the smart home which is smart home backend system. There are three steps during data processing in backend system. Firstly, all the data are gathered in system database. And then all the data are divided into three categories as health data, activity data and service usage data. Every type of data will be compared and analyzed with pervious data. For example, the blood pressure of elderly people has increase 5% after compared with his previous average blood pressure value last month, after the doctor asked this elderly person and found out he has been eaten many of junk food and lack of needed exercise in past week. The same comparison of activity data of elderly people can also be known whether his physical health condition has been changed. Comparing and analysing the service data can help the service providers better know the entertainment performances of urban Chinese home living elderly and in order to improve the quality of services. All the results of data analysis and comparison will be stored in the system database which is the third step in backend system data processing. The file is full with data time, data analysis and the result in data comparison could naturally become a daily E-health record of user.

The last component service is simply divided into common staff from services providers and the professional doctor from the hospital. For user personal privacy considering, all the common staff only have right to browse a certain results in data analysis. For example, the TV programs vendors only have right to know the situation in TV program usage data of elderly people. The professional doctor in the hospital has all rights to browse all the data of user which help the doctor better know the physical health condition, activity situation and living environment of the elderly people in order to be more effective in future diagnosis and recommendations.

The greatest advantage of this conceptual design is to integrate all ICT solutions and also collect all the elderly data for analysis, comparison and storage in order to establish a personal E-health file for elderly people's daily life. The great versatility in data processing backend system is the biggest different between new smart home design and existing smart home design. And more specific functional module and data transmission process module in backend system design will be discussed in following Chapter.

4.1.2 Backend system model design

The backend system is the core of the entire smart home design and also the biggest difference with other Chinese existing smart home. The backend system acts the role of the human brain to gather all data of health, activity and living services for the elderly people, after analysing and comparing the data with previous data, the system send all the abnormal feedback to the elderly people's doctor. Meanwhile, all the data and comparing results are stored in the system database. It has the same meaning as the human brain to collect data, analysis data, store data and give some feedbacks. The Figure 6 shows the specific functional modules inside the backend system in smart home design.

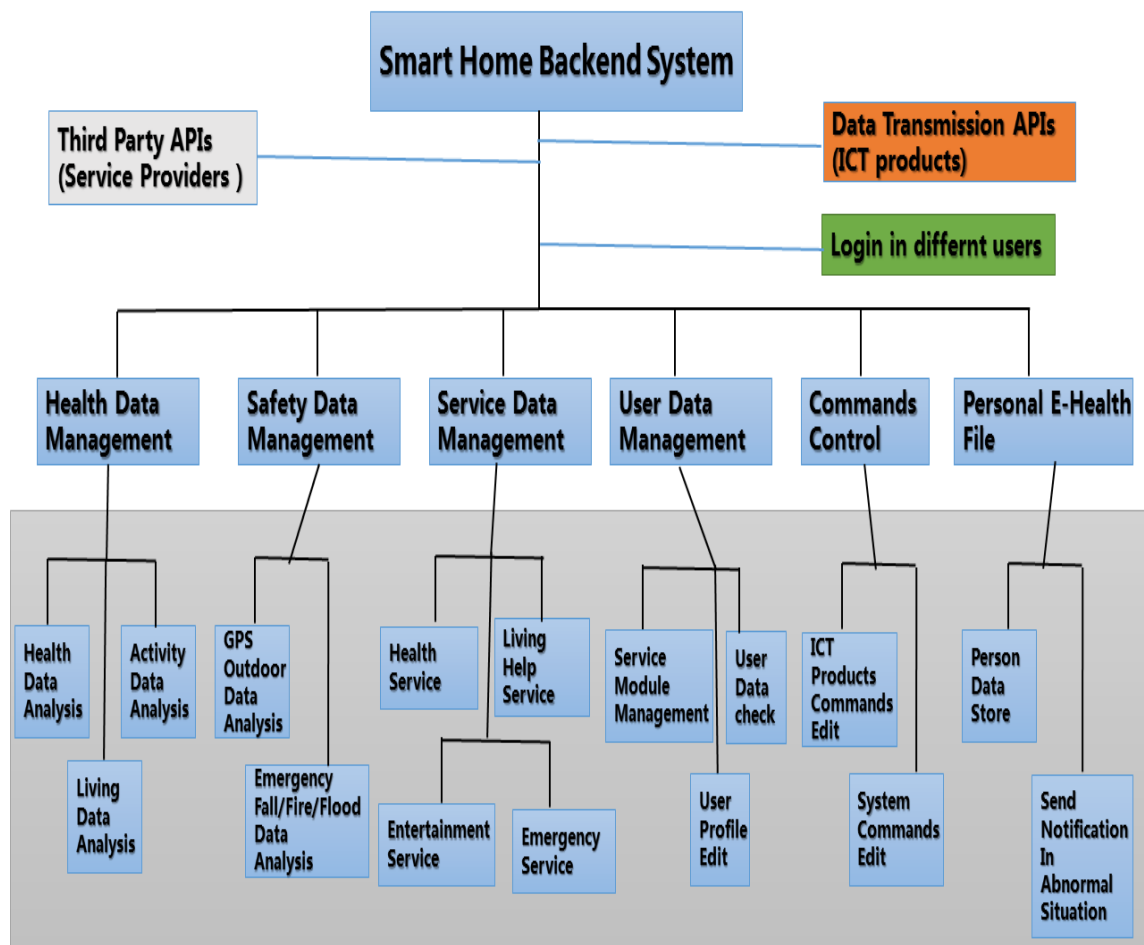


Figure 6. Fuctional module design in smart home backend system.

As can be seen from Figure 6, the backend system is divided into six main functional modules as health data management module, safety data management module, service data management module, user data management module, commands control module and personal E-health file module. The intention in module division design was to treat differently in various categories of user data and with more convenience. For instance, the health data management module is for health data analysis, activity data analysis and

living data analysis. The sleeping condition is a typical living data. The health data management module help the users collect and analysis their health data.

In safety data category, the safety data management module takes all the responsibilities on elderly people's life safety issues. Therefore, the safety data management include sub-functions as GPS outdoor analysis and all the emergency data analysis such as fall, gas leak, water leak, fire and so on. The safety module ensures the users to live in a safety environment.

The service data category is primarily used to manage the service type, service quantity and the usage condition of the services. Due to there are four types of service providers, the design of sub-function modules are also divided into four categories and each sub-function module only in charge of one type of service. The Health service is provided by hospital and health care centre. The living help service is mainly provided by housekeeping companies. Some entertainment companies provide game services, customized TV services and online chatting services in sub-functional module of entertainment services. The emergency service is provided by the corresponding mechanism. For example, fire emergency alarm will be sent to the fire station automatically. The service data management module allows user to customize their needs by their preference.

As a user of the system, the elderly people also has right to access into the system and check his health data, activity data and the service data that he has reserved. Meanwhile, the elderly people have permission to modify the services that he has reserved before. But for the other data such as health data and activity data, the elderly people have no right to modify any of it. Therefore, the service module management and user data check are two sub-functional modules which are belong to user data management module. In addition to modify the service information, the elderly person also has permission to modify his own profile information such as his contact detail. The user profile edition is the third sub-functional module in user data management. The user data management module allows user to browse his own health, living and services data and meanwhile he also has permission to edit the service data that he reserved before.

Due to the backend system is integrated with many ICT products, how to properly manage these products becomes a problem. The commands control module is design for managing the complexity in various ICT products integration. In this module, it needs two commands control functions to respectively set the commands for ICT products and system control. Therefore, two sub-functional modules as the ICT products commands edit and the system commands edit are belong to the commands control module. The elderly people or other staff in third-party vendors could customize different commands for various integrated ICT products, meanwhile the system commands also could be edited by elderly people or working staff. The commands control module is for properly managing ICT products by all the different users during the system working process.

The last module is the most important feature of the entire smart home backend system. To build up a personal E-health file is not merely to store all the health data, living data

and usage of service data of elderly people, the more important is to analysis the elderly people's health index and behavioural characteristics through the variation data value in each time. For example, the elderly people's activity value has decreased suddenly recently, the personal E-health file module send a notification and the elderly people's entire E-health file to the doctor in order to help the doctor with more accurate diagnosis and recommendations. Therefore, the personal E-health file module has two sub-functional modules as personal data store and sends notification in abnormal situation. The last personal E-health file combines the functions with information storage, information analysis and automatic reminders aim to emphasis on the health condition changes in elderly people's daily life and help the elderly people take the optimal treatment timely.

It cannot be regarded as a complete system if this system is only composed of functional modules. A complete system needs to connect with other equipments and meanwhile the data that each equipment gathers also can be transmitted to the system. Therefore, the data transmission APIs are needed for transferring the data from ICT products to the smart home backend system. For the service providers, they also need to connect their own internal system to smart home backend system. That is the reason the backend system also needs an open port for third party APIs and related transmission protocols in order to exchange the data between these two systems smoothly. In user groups, the different groups of users should have different permissions to access when they are using the system. For example, the doctors can browse the user's complete E-health file, but the third-party company staffs only have limited permission to access a part of user's file.

Whether in smart home conceptual model design, or detailed smart home functional module design, it would be meaningless if all the conceptual design cannot be put into a real home living environment of urban Chinese elderly people.

4.2 Smart home demo design

The smart home demo design aims to integrate all the previous conceptual design ideas into a real urban Chinese elderly home living environment. The smart home demo design is also divided into two parts, one is the smart home with all ICT products, and the other part is combined the previous conceptual model of smart home design with the real home living environment.

The design of smart home is not extraordinary demanding on various requirements for the urban elderly Chinese living environment, which means any home in any size and structure could be transformation into a smart home. This smart home design is applicable to any urban Chinese home.



Figure 7. Smart home demo design.

Due to the large population in China and limited urban residential area, most of urban Chinese elderly people have to live in the building and area of their living is quite small. Figure 7 shows the basic component elements in an entire typical urban Chinese elderly people's home that includes living room, kitchen, bedroom and bathroom. Due to the crowded living space, the home living elderly people is easy to fall. The fall sensor is for fall detecting and automatically sending alarm in abnormal situation. The fall sensor could be embedded in some products such as floor or necklace. In order to ensure the safety of the home living elderly people, the ICT product with fall sensor should always be carried. The activity wrist is the other ICT product that elderly people should carry about every day. The activity wrist aims to monitor the daily activity statue of the elderly people. In addition to monitor the activity of the elderly people daily, the activity wrist also reminds the elderly people to do some sports. A certain hours of activity per day could make elderly people become healthier. Both of these two devices must be carried when urban Chinese elderly people live at home. When the elderly people go out, the additional outdoor GPS detector is also needed to carry on. The outdoor GPS detector aims to track and analysis the walking route of elderly people outside. In addition to these three daily devices must be carried, the remaining ICT devices are installed in each room of smart home.

As can be seen from Figure 7, the rest of six ICT devices are installed in bedroom, bathroom, kitchen and living room in smart home design. In bedroom, the sleeping sensor is put under the mattress and used for detecting the user sleeping condition and wellbeing. Generally, one-third of person's life is spent on sleeping. A good sleeping condition is crucial for a person's health. The ICT product with sleeping sensor could analysis and detects the sleeping condition of the home living elderly people. This product is not only for monitoring the sleep time and sleeps quality of elderly people, but also send an alarm in any abnormal cases such as fall out of bed and suffocation. For some elderly people has respiratory disease, their airway obstruction may leads to suffocation when they are in deep sleep. The ICT product with sleeping sensor protects the lives and keeps safety when elderly people are sleeping at bed. The electronic blood pressure meter is placed next to the bed in bedroom. Due to the blood pressure of elderly people is usually rose and may cause cardiovascular diseases in the morning when people get up, putting electronic blood pressure meter next the bed could be more convenient to use for the elderly people. While most of urban Chinese elderly are used to take a nap after lunch, the electronic blood pressure meter also help the elderly people to measure their own blood pressure after lunch.

The smart lighting unit is set both in bedroom and bathroom. The main purpose of smart lighting unit is to prevent elderly people fall when they take urination at night. The elderly people turn on or off the lights by touching a button beside the bed when he takes urination at night. In addition to one-key turn the light on and off, the smart lighting unit also can automatically adjust the brightness of the lamp according to the illumination of the room. This feature of lighting unit is no longer to allow the elderly people fall.

The kitchen alarm device is integrated with various sensors such as smoking sensor, temperature sensor, gas leak sensor and water leak sensor. When some accidents happen in the kitchen, the kitchen alarm device will make a loud sound alarm to remind the home living elderly people to turn off the oven or other equipment. If the oven won't be turned off after alarm sounds for a certain time, the kitchen alarm system will automatically shut off all potentially dangerous equipment. This kitchen device is installed in the kitchen as be shown in Figure 7. The water leak sensor is also could set in bathroom for preventing the water leak under the requests of elderly people.

The elderly people usually spend his leisure time in the living room. The design in living room of smart home was integrated with two ICT products as smart TV and smart elderly phone. The smart TV is a tool to help elderly people communicate with his children and friends through internet. Meanwhile, the elderly people also can watch his customized TV programs through smart TV. In order to enhance the intelligence, the elderly people can participate in online games such as mah-jong online game. And the elderly people also can participate in online sports course and take some exercises at home. For example, many urban Chinese elderly people do taijiquan in outdoors every morning, since they participate the taijiquan TV program through the smart TV, they can do this exercise every morning at home. The smart TV is not only providing more approaches to communicate with the outside world, but also to provide a more happiness life for the elderly people. The smart elderly phone allows the elderly people to set his own contacts

on the phone according to his preferences and living habits. For example, some elderly people have mobility issues due to their arthritis, then they can set up the first key of smart elderly phone as housekeeping contact number. After fast dial, the house keeping company will be sent a staff to elderly people's home and help them do the laundry and clean the house. The other benefit for setting one-key dial is to help the elderly people fast and directly contact to the hospital or other relevant emergency agencies when they are facing with dangers or suddenly feeling unwell. The smart TV and smart elderly phone bring more happiness and help into elderly people's daily life.

The smart home design in Figure 7 shows how a Chinese urban elderly people living environment with bedroom, bathroom, kitchen and living room to integrate all the ICT products and solutions, and also discusses in detail about how the urban Chinese elderly people live with safer, healthier and their life become more conveniences and happier by this new smart home design.

It is not enough for a smart home only simply put some ICT products in each room. A real-life smart home should be actually worked and solved all the issues of urban Chinese elderly home living people. Therefore, a real-life smart home should be also integrated with the previous conceptual model design of smart home. The Figure 8 presents a real-life smart home processing with integrated conceptual model design.

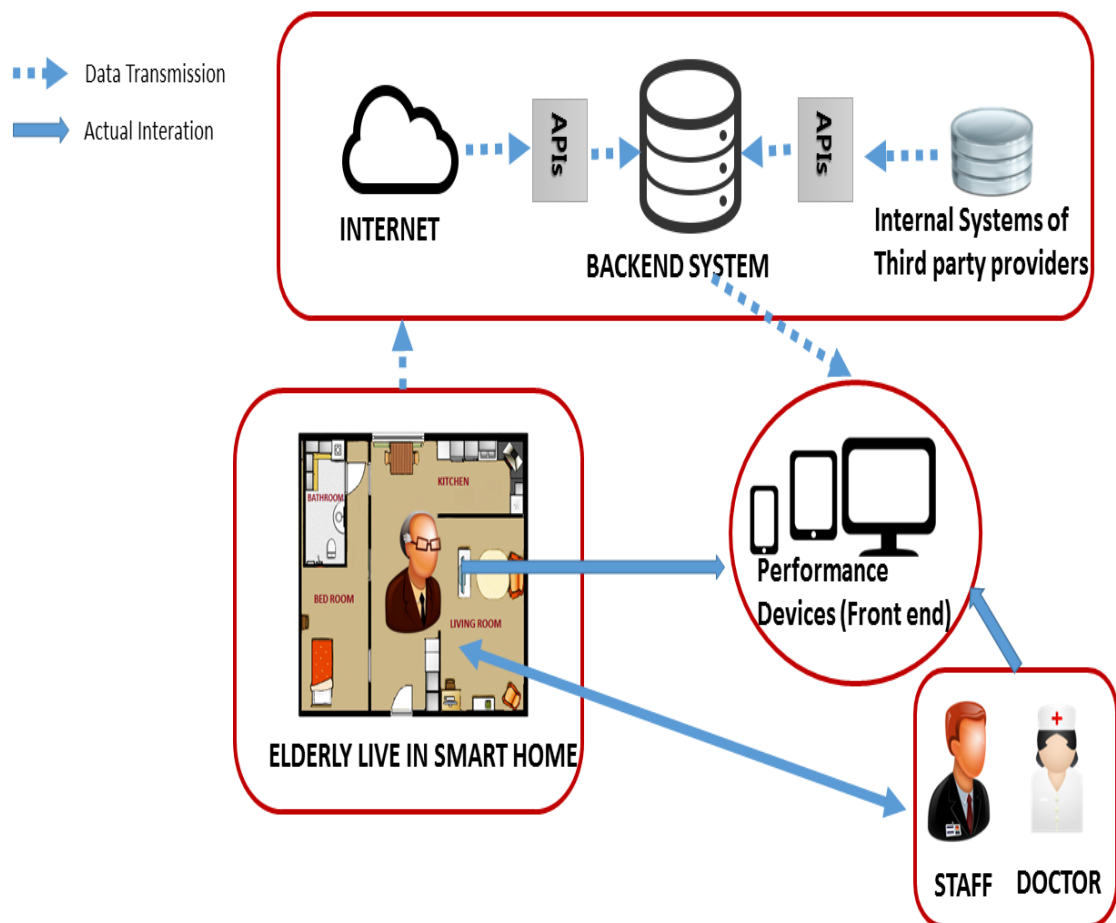


Figure 8.Overview of smart home in real life process

In a real life, due to most of urban Chinese elderly people are lack of electronic technical skills, it is almost impossible the elderly people who live at smart home could get his own health data, activity data and service data information through all the ICT devices by using backend system. Therefore, it needs the frontend to present all the data information of the elderly people by means of tables and figures. The approaches to access to the front-end can be via the web in desktop computer or downloaded app in mobile devices. Meanwhile the staff and doctor in third party also have the same approaches to access into the front-end. The doctor will directly contact with the elderly people when he finds any abnormal data of the elderly people's body. Of course, if the elderly people feel uncomfortable about his body, they can also contact to the doctor initiatively. These interaction processes are presented in lower half of Figure 8. The "actual interaction" in Figure 8 means user could see these interactions real happen.

The other type of interactions real happens too, but user cannot see the interaction process through their eyes. The upper half of Figure 8 shows the whole process in data transmission from the smart home of elderly people to the front-end by various performance devices. During the entire process, all the data are collected by the ICT products that elderly people use in smart home first, then the data are uploaded into the backend system of smart home under the permission of APIs. Meanwhile, the other internal systems of third-party vendors are also combined with the smart home backend system and have permissions to access a part of elderly people's data. Finally, all the results are displayed in the front-end interface after data analysis and storage in backend system of smart home.

Whether the conceptual design or the actual internal layout of smart home, it can be seen to build a smart home for urban Chinese elderly people is a huge-scale project. Especially the backend system of smart home is completely difficult to meet all needs of urban Chinese elderly people. This thesis was only promoted a preliminary design draft of smart home and also pointed out the direction can be solved the real problematic issues of urban Chinese elderly in home living environment.

4.3 Evaluation

Whether from the conceptual point of view that how the data transmission, analysis and process in backend, or from an actual living environment of how to put the ICT products in every room and how to use them inside the smart home, it can be concluded that this smart home design can solve the real problematic issues of urban Chinese elderly in home living environment. Since this is a totally new design of Chinese smart home and no one in this world actually used it before, it is difficult to use the real user usage data to prove whether this smart home design can really work and actually be able to solve all the problematic issues that mentioned before in Chapter 2.

The scenario of how a general urban Chinese elderly people named "Lee" to spend a day in smart home living environment aims to evaluate whether the smart home design solve all the urban Chinese elderly home living issues according to the situation of Lee spent

his day in smart home environment. The Table 1 presents the basic background information of Lee.

Table 1. Information of Lee.

Scenario Name:	A day of Lee
Character:	Lee (Male, 67 years old)
Location:	Lee's home in Shanghai
Family Information:	Lee's wife past away three years ago, his son is working and living 200 kilometres far from Lee's home.
Health Condition:	Hypertension, diabetes, arthritis
Habits:	Taijiquan, Mahjong, chat with friends

AM 6:30

Lee woke up with the soft music in the morning. Meanwhile, all his sleeping data that sleeping sensor has been monitored last night such as sleeping duration, sleeping condition have been transmitted to the smart home backend system.

After Lee pressed the button in remote controller of smart lighting unit, the soft music stopped playing and the bedroom light was turning on.

Every morning, Lee used to measure his blood pressure first before he got up from bed, and today was no exception either. Lee reached to the electronic blood pressure meter which was placed on the table besides the bed and started to measure his blood pressure. He was very happy to see all normal values were displayed on the monitor of electronic blood pressure meter. Meanwhile, his blood pressure data already has transmitted to the smart home backend system.

After his blood pressure measurement, Lee got up and walked to the kitchen and tried to make himself a cup of tea. As usual, he turned the stove on and put a pot of water on it, then went to the laundry in bathroom. Suddenly, the "bee bee" whoops came from the kitchen, and Lee just realized the boiling water was ready but the stove was still on. Lee went to the kitchen immediately and turned off the stove. "Thanks god, the smart kitchen alarm device just saves my life" Lee talked to himself. After drunk a cup of tea, Lee left home and headed to the park for his regular morning exercise - taijiquan.

AM 7:00

During the morning exercise, Lee met one of his old friends name Wang in the park. Wang told Lee that he recently knew a good doctor who may cure Lee's arthritis, but the

clinic is far away from Lee's living place. Lee decided to go there by himself after breakfast.

AM 7:30

Lee was back home and prepared breakfast for himself. Meanwhile, the activity data has been transmitted to the smart home backend system. Suddenly, the "Dee Dee" whoops came from the living room, and Lee recognized it was time to take pills. Lee went to living room, and confirms the notification from his elderly smart phone. After breakfast, Lee left home and headed to the clinic.

AM 10:00

Lee was lost on the way to clinic, he has to press the "help" button on his outdoor GPS detector. After 15 minutes, the staff from the housekeeping company appeared and drove Lee to the clinic directly. Meanwhile, his son contacted with Lee in the first time and asked for what happened.

AM 12:30

After visited doctor in the clinic, Lee went back home. In every noon, Lee was used to turn on the smart TV and watch the global news. While watched news, Lee was also chatted with his friends by means of online chat software was install on smart TV.

PM 2:30

Lee got a call from the doctor in the afternoon and been told his activity scale has declined these days. The doctor concerned his recurrent arthritis and strongly suggested him to come to the hospital and took some physical test. The smart home backend system analysed the Lee's abnormal activity values and automatically sent a notification to Lee's doctor. That was the reason the doctor contacted to Lee this afternoon.

PM 5:30

After Lee took the physical test in hospital, the prescription that doctor gave to Lee is according to the results of physical examination and also combined the information of Lee's personal E-health data.

PM 9:30

Since the onset of arthritis, Lee almost fell when he cooked dinner at kitchen. Once Lee fell at home, the fall detector will send the alarm to the emergency automatically.

AM 2:30

Before Lee took urination in the middle night, he presses the button in remote controller of smart lighting unit to turn on the bedroom and bathroom light. With this smart lighting unit, Lee was no longer to worry that he got fall in the dark environment.

This was how Lee spent his day in new smart home environment. In reference to the situation of Lee's day in new smart home, the Table 2 below shows whether the new smart home design meet the solutions of urban Chinese home living which mentioned above. The "X" means meet the solution and blank space means does not meet.

Table 2. Evaluation of smart home after Lee's day.

Problematic Issues	New smart home
Falls	X
Unexpected emergency	X
Lost in outside	X
Disease	X
Intelligence	X
Mentality	X
Living habit	X
Self-care	X

As can be seen in Table 2, the new smart home design can solve the main problematic issues for a general Chinese elderly people lives at home which was presented in Chapter 2. However, the entire world is full of complexity and uncertainly, this smart home may encounter a variety of problems in practical using by urban Chinese elderly home living people. Therefore, how the new smart home will eventually work out only can be evaluated when the real smart home is built and lived with real urban Chinese elderly people.

5. Discussion

The purpose of the study was to find out solutions for existing problematic issues of urban Chinese elderly people in home living. After found out the ICT solutions for each problematic issue, the more important thing was to involve these ICT solutions into a real living environment of urban Chinese elderly people and make themselves safer, healthier and happier. The concept of an ordinary home is integrated with ICT elements to make itself with safer, healthier and happier is named as smart home. (Alam, et al., 2012.)

Since different smart homes are in different design and with integrated with various ICT elements, the problems that smart homes solve for the users are different as well. Even though the Chinese local company already entered elderly smart home business, the smart home they build cannot fully solve all the issues of urban Chinese elderly people in home living environment after analysis in Appendix A. (Zhong, Su & Feng, 2013; Sichuan news, 2014.) The new smart home design aims to solve all the essential problematic issues of urban Chinese home living elderly people. From Table 3 to Table 10 present the comparisons of falls issues, unexpected emergency issues, lost in outside issues, disease issues, intelligence issues and mentality issues in U-HOME, Changhong and the new smart home.

Table 3. Fall issues comparison in U-HOME, Changhong and new smart home (Zhong, Su & Feng, 2013; Sichuan news, 2014).

Issues	ICT Solutions	U-HOME	Changhong	New smart home
Fall	1. Blood pressure monitor or heartbeat monitor	X	X	X
	2. Smart lighting system			X
	3. Automated alarm	X	X	X
	4. Fall detector			X
	5. Backend system for data collection			X
	6. Third part support (hospital)	X	X	X

Table 4. Unexpected emergency issues comparison in U-HOME, Changhong and new smart home (Zhong, Su & Feng, 2013; Sichuan news, 2014).

Issues	ICT Solutions	U-HOME	Changhong	New smart home
Unexpected emergency	1.Smoking detector	X	X	X
	2.Temperature detector			X
	3.Gas detector	X		X
	4.Water leak detector			X
	5.Automated alarm	X	X	X
	6.Backend system			X
	7.Third part support (fire house/hospital)	X	X	X

Table 5. Lost in outside issues comparison in U-HOME, Changhong and new smart home (Zhong, Su & Feng, 2013; Sichuan news, 2014).

Issues	ICT Solutions	U-HOME	Changhong	New smart home
Lost in outside	1.Outdoor GPS monitor	X	X	X
	2.Outdoor activity data collection and analysis			X
	3.Backend system			X
	4.Third part services (health enter)	X	X	X

Table 6. Disease issues comparison in U-HOME, Changhong and new smart home (Zhong, Su & Feng, 2013; Sichuan news, 2014).

Issues	ICT Solutions	U-HOME	Changhong	New smart home
Disease	1. ICT devices			X
	2. Physical health data collection (heart rate, blood pressure, sleeping condition)			X
	3. Health data analysis and comparer			X
	4. Automated alarm	X		X
	5. Personal E-health file in backend system			X
	6. Third part services (health enter)	X		X

Table 7. Intelligence issues comparison in U-HOME, Changhong and new smart home (Zhong, Su & Feng, 2013; Sichuan news, 2014).

Issues	ICT Solutions	U-HOME	Changhong	New smart home
Intelligence	1. ICT devices (bed sensor)			X
	2. Video games			X

Table 8. Mentality issues comparison in U-HOME, Changhong and new smart home (Zhong, Su & Feng, 2013; Sichuan news, 2014).

Issues	ICT Solutions	U-HOME	Changhong	New smart home
Mentality	1. Easy use online chat software with personal settings.			X
	2.Touchable smart TV with customized TV programs	X		X

Table 9. Living habits issues comparison in U-HOME, Changhong and new smart home (Zhong, Su & Feng, 2013; Sichuan news, 2014).

Issues	ICT Solutions	U-HOME	Changhong	New smart home
Living habits	1.Activity monitoring data and management			X
	2.Health data collection and analysis			
	3.Personal living plan under the advices of doctors			X
	4.Automated alarm in emergency	X	X	X

Table 10. Self-care issues comparison in U-HOME, Changhong and new smart home (Zhong, Su & Feng, 2013; Sichuan news, 2014).

Issues	ICT Solutions	U-HOME	Changhong	New smart home
Self-cares	1.Easy dial to third part support (housekeeping company)	X	X	X
	2.Customized ICT devices of asking for help	X		X
	3.Emergency fast dial	X	X	X

As can be seen from Table 3 to Table 10, the new smart home meets all the needs for urban Chinese elderly home living people. And two existing Chinese smart homes have a common problem that is lack of backend system development, but the functional backend system is the core in new smart home design (Zhong, Su & Feng, 2013; Sichuan news, 2014). That is the main reason the new smart home design is better solution of urban Chinese elderly home living people than other two Chinese smart homes theoretically. Due to this new smart home is not actually built and taking into account the complexity and uncertainty in the real world, it is difficult to judge which smart home is better for urban Chinese elderly people to solve their real home living issues. And this is one of the limitations of this thesis.

There are many solutions to solve a problem in this world, due to the users are different and the background of users is completely different as well, it is not possible to determine which solution is the best one for this problem. For each problematic issue in urban Chinese home living elderly people, the author of this thesis is merely to find a proper solution according to his own existing knowledge and literature study. And the author of this thesis believes there is always a better solution exists and better meets the needs of urban Chinese elderly people. All the solutions in previous literature review may not be the best is the other limitation of this thesis.

Lack of valuable and detailed information of two existing Chinese smart homes is the limitation of this thesis too. Since the business idea of building up a smart house was just started in China in past few of years, there are only few smart home producers until now. Due to the current Chinese smart homes design are related to commercial secrets, all the technical information of existing Chinese smart homes design are hard to find. The related research information of Chinese smart home “U-HOME” and “Changhong” are all from the website of news, which can simply be aware of their functions and barely know the internal technical information of these two existing Chinese smart home design.

For the design of the new smart home, it is theoretically meet the needs of urban Chinese home living elderly people and help them solve all the problematic issues by means of science and technology. Since the new smart home is not actually built and there is no user to live inside, it is hard to evaluate the smart home could solve all essential issues in urban Chinese elderly home living environment as its design. Assuming the new smart home design could solve all the issues of urban Chinese people, the new problems on how to actually build this new smart home, how difficulties in technical part during the building and how much is the cost of the new smart home are the future limitation may be considered.

Alam et al.(2012) propose the future trend of smart home would be interagated into more high-tech means and empahsised on user data management and analysis. The new smart home design was to integrate with ICT products, services from third party venders and powerful functional backend system, and it could be the trend for future smart home conceptual demo design in urban home living Chinese elderly people used. This is one of the implications of this thesis. In addition to present the future direction of urban Chinese elderly people how to spend a safer, healthier and happier life in new smart home, the other implication of this thesis is to present the main problematic issues in urban Chinese elderly home living people and promote the suitable solutions by means of sciences and technologies. In the past time, the Chinese children have obligations to take care their elderly parents at home. Due to the traditional Chinese family structure has been changed and imbalance development of Chinese different cities, there are more and more young Chinese people choose to live in few tier one cities, but their parents have to stay at home and lack of help from their children. Accompanied by the popularity of Chinese”one child” policy, the number of young people are reducing and the elderly people are increasing which means there will be more and more elderly people cannot be taken care by their children in the nearly future. The problematic issues of urban Chinese elderly in home living become more and more serious, but currently there is lack of effective solutions to solve all these problematic issues. This thesis summarizes the common problematic issues and related ICT solutions in elderly Chinese people at during their daily life which may help other researchers could explore this topic widely.

The greatest implication of this thesis is to design a new smart home which could meet the essential problematic issues in urban elderly Chinese people in home living. This new design may inspire the current Chinese smart home designers and help them improve their products.

6. Conclusion and Future Work

In this study a new smart home design for urban Chinese elderly people based on a literature review was proposed. Comparing with two current Chinese smart home design of U-HOME and Changhong from Table 3 to Table 10, not only does the new smart home design meet all the needs and requirements of urban Chinese home living people, but also the new smart home design is embedded with powerful backend system that can enhance the personal E-health file establishment so as to provide a more comprehensive and detail data analysis of Chinese elderly people's daily health. The new smart home design is the proper solution to enable elderly people in living longer and happier at their homes and also support their life at home by help of technologies. Although this new smart home design may not be achieved currently as a result of expensive cost and high difficulty in technical establishment, the new smart home design may guide the design trend for future Chinese smart home and it also may inspire the current Chinese smart home designers and help them improve their current smart home products.

Since China is a developing country and it exists variety of pension issues such as inadequate social insurance system and lack of sufficient elderly facilities. These issues will result in a large number of elderly people have to choose live at their own home in the nearly future. Building a safer, healthier and happier living environment for Chinese elderly people by means of science and technology will become increasingly important. And in the future, there are more companies will be involved into the elderly care industry and design more different smart homes for urban Chinese home living elderly people. Due to different elderly people may have different physical, health, psychological needs and even various economic conditions, the future smart home design also may be integrated with different customized ICT solutions by users. But no matter what kind of customized ICT devices or new ICT solutions the urban Chinese elderly people request, the new smart home design still could satisfy their users and meet the needs of them. The back-end system of the new smart home design has a function to integrate with third party APIs of service providers and data transmission APIs of new ICT devices, meanwhile the internal functional modules of the back-end system are also flexible to increase or decrease any module. This flexible and powerful back-end system is the reason that the new smart home design enables to meet the needs of different users in the future.

Although the back-end system of new smart home design is extraordinary strong and smart, it is still has a room for future improvement. As the Chinese elderly population is increasing continually, and the number of doctors do not correspond to the dramatic growth as Chinese elderly population, which will lead a serious shortage of doctors in the future and a large number of Chinese elderly people live without proper care. Therefore, the future smart home design needs to be more smart and will be interagated into more high-tech means and empahsised on user data. For instance, the backend system of future smart home can be integrated with treatment programs in order to provide treatment

recommendations after the system automatically analyzes and compares the elderly patient's health data. The backend system will continue to record and analyze elderly patient's health data during his treatment, and also notify elderly patient when any accident occurs in his health data. If the elderly patient can be cured in the end of treatment, the smart home backend system will determine this treatment recommendation is effective and store in the system backend database. This effective treatment recommendation will also be provided to the other elderly patient who encounters the same issue next time. When the elderly patient's health condition has not been improved after treatment, the smart home backend system will determine this recommendation is invalid and automatically define as a fail case for hospital and institution research and development. Throughout the whole treatment process, the backend system actually plays the role of a doctor in electronic version. Thus, the future of smart home will emphasis on backend system development and play as a electronic doctor who can analyze diseases and provide medical advices for the Chinese elderly patient in case of insufficient number of doctors. While the failure treatment data will also send to the hospital and research institutions to analyze and research automatically in order to provide more accurately solutions for elderly patient next time.

With the rapid development of science and technology, the new smart home design will be achieved in the nearly future. However, the Chinese government should spend more efforts to improve the social security system and encourage more companies to participate in the pension industry at the moment in order to develop more elderly care products and solve more problematic issues in urban elderly Chinese home living environment. Overall, this thesis presents the future direction of urban Chinese elderly people how to spend a safer, healthier and happier life in new smart home and also points out the suitable solutions for the main problematic issues in urban Chinese elderly home living people by means of sciences and technologies which may inspire the current Chinese smart home producers and help them improve their current smart home products.

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Appendix A. The ICT solutions in U-HOME and Changhong smart home (Zhong, Su & Feng, 2013; Sichuan news, 2014).

Issues	ICT Solutions	U-HOME	Changhong
Fall	1. Blood pressure monitor or heartbeat monitor	X	X
	2. Smart lighting system		
	3. Automated alarm	X	X
	4. Fall detector		
	5. Backend system for data collection		
	6. Third part support (hospital)	X	X
Unexpected emergency	1. Smoking detector	X	X
	2. Temperature detector		
	3. Gas detector	X	
	4. Water leak detector		
	5. Automated alarm	X	X
	6. Backend system		
	7. Third part support (fire house/hospital)	X	X
Lost in outside	1. Outdoor GPS monitor	X	X
	2. Outdoor activity data collection and analysis		
	3. Backend system		
	4. Third part services (health enter)	X	X
Disease	1. ICT devices		
	2. Physical health data collection (heart rate, blood pressure, sleeping condition)		

	3.Health data analysis and comparer		
	4.Automated alarm	X	
	5.Personal E-health file in backend system		
	6. Third part services (health enter)	X	
Intelligence	1.ICT devices (bed sensor)		
	2.Video games		
Mentality	1. Easy use online chat software with personal settings.		
	2.Touchable smart TV with customized TV programs	X	
Living habits	1.Activity data monitoring and management		
	2.Health data collection and analysis		
	3.Personal living plan under the advices of doctors		
	4.Automated alarm in emergency	X	X
Self-cares	1.Easy dial to third part support (housekeeping company)	X	X
	2.Customized ICT devices of asking for help	X	
	3.Emergency fast dial	X	X