東海大學資訊管理研究所

碩士學位論文

應用 **RFID** 定位技術與行動裝置平台

之健康照護系統

An Application of RFID Positioning and Mobile Platform for

Healthcare System

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考試委員審定書

資訊管理學系研究所＿＿＿戴光彥＿＿＿＿君所提之論文

＿＿應用 RFID 定位技術與行動裝置平台之健康照護系統＿

經本考試委員會審查，符合碩士資格標準。

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誌 謝

時光飛逝，轉眼間碩士班的求學生涯也將告一段落，對我來說我的碩士班就像是人生的一個髮夾彎，在碩士班期間我找回了自信，回想剛進入碩士班時的迷惘到現在的確立方向，我很慶幸當初選擇了繼續求學，在碩士班期間我有了更多方面的嘗試也學習了更多的專業知識，更決定要繼續攻讀博士班，對我來說碩士畢業只是一個開始，我也已經準備好要接受人生下一階段的挑戰。

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校所名稱：東海大學資訊管理學系研究所

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論文摘要：

　　現代經濟科技的快速發展改善了人們的生活，但於此同時人們也面臨高齡化社會的照護問題，這篇論文提出一個結合 RFID(Radio Frequency Identification)定位技術與行動裝置平台的健康照護系統以達到改善健康照護的目標，系統利用智慧型手機與手環的便利性，讓使用這可以更便利的紀錄日常的與運動狀態，系統中包含身理狀況模組、即時定位模組、多數據評估模組及飲食控管模組，將會統整智慧型裝置蒐集的資訊並根據使用者的生理狀況給予專業的健康照護建議。

　　RFID 是目前實際應用最成熟的定位技術之一，其具有高速動態且大量讀取的特性可以記錄大量的運動資訊，讓使用者可以透過網際網路即時記錄並查看健康照護建議，系統可透過定位技術大量的記錄使用者過去的運動習慣，使用戶可以了解自己的運動情形是否有需要改善的地方，在即時定位模組中，可以透過 RFID 的定位技術偵測老年人是否有跌倒等突發狀況，並即時通知照護人員，預防意外的發生；多數據評估模組可以讓使用者了解他們飲食與運動習慣是否有需要改善的地方，並更進一步獲得相關的飲食運動改善資訊。

關鍵詞：RFID 定位、行動裝置平台、改善健康照護、即時定位、多數據評估

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Abstract：

　　The transformation of economy and technology improve people's life. People live much more longer. But at the same time, people have to face the problem of aging population. This research is about a healthcare system that combine RFID (Radio Frequency Identification) positioning and mobile platform to achieve the goal of healthcare improvement. With the convenience of mobile phones and smart bracelet, users could easily record the exercise process dietary contents, nutrient, and dietary contents and user physiological information will be provided suggestions of nutrient allowance, according to the past dietary habits and exercise records. The system contains body situation module, real-time location monitoring, multi data evaluation module and diet module, could actively offer suggestions according to the users' basic information, including age, gender, favorite types of food, and amount of exercise alert when necessary.

　　The RFID technology has become one of the most developed technologies of localization. With the characteristics of high-speed dynamic reading, simultaneous reading of multiple RFID Tag, large capacity of data can be imported into the Reader. User can access to the Internet with smart phones without being restricted to time and places. Meanwhile, the system could record the amount of exercise and rapidly inquire the past exercise records for the reference of self-inspection. In the real-time location monitoring module, the system will locate where the elderly is, and if unexpected situation happens, the system will alert the caregivers. Through the multi data evaluation module, users could understand whether their diet and exercise conform to the healthy demands from daily health records and further learn to select suitable food and improve their exercise habits.

Key words: RFID Positioning, Mobile Platform, Healthcare Improvement, Real-Time Location Monitoring, Multi Data Evaluation

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Chapter I Introduction

In the introduction chapter, research background, motivation, objective and brief review of methods were introduced for this paper.

Section I   Research Background

The transformation of economy and technology improves people's quality of life, also makes people live longer. But at the same time, people have to face to the problem of aging population. Since 1993, Taiwan has transferred the population structure to the aging society. From 2020 to 2050, the proportion of high aged people will ascend, also leads to the low birth rate, family structure's transformation and the increasing of chronic diseases.

According to the definition of American Telemedicine Association, telehealth is people utilize the electronic communications to deliver message from one side to another which can improve patient's healthcare. Telehealth can assist the medical institutions to provide a more efficient, low-cost, customized, and immediate care service. In addition to reduce the cost of medication and the increasing time on caring, we can utilize long-term and persistent service to effectively promote the general level of people's health.

Due to the physiological function of the elderly degeneration, they are short of activity. This paper aims to combine RFID to conduct the function of position and preventive medication. In the past, it caused difficulty for elderly to record their diet habit and exercise records. With this system, elderly can order their own meals by personal diet records through the Internet and review their exercise habits in personal sport records.

Section II   Research Motivation

With the promotion of medical technology, human being's life extends. According to the definition of United Nations, the standard for ageing society is that the elderly should account for 7% of the total population. Until the end of November of 2009, the elderly accounted for 10.64% of Taiwan's population which meant that we had become ageing society. The rate of raising elderly was 5% during 1951 to 1971, but it's now about 13.6%. It means the average about every 7.7 workers needs to raise one elder. Even more, research shows the rate of raising elderly would increase up to 71.49% in 2051 [1]。

The current shift in family structure from large families to small families, low birthrates, urbanization and double-paying families in all regions has resulted an increase in the number of along living elderlies. Also, weakened family's care function. The Ministry of Interior stated that due to the aging society in Taiwan, the old age ratio is 14.4% and expected that it will gradually increase in the future. In addition, most of the children needs to work outside and can't live together with their elderly parents.

In the face of unexpected circumstances, it is usually impossible to obtain assistance at the first time. Numbers of nursing activities where underway for the elderlies, such as regular daily body temperature, blood pressure, and three-meal diet conditioning. Keeping balanced nutrition and exercise can prevent from getting fat and chronic diseases. Glanz said that nutrition, diet and health were the interaction of being healthy [2]. American College of Sports Medicine (ACSM) [3] indicated being fat and having chronic diseases as international health problems and also emphasized the advantage of doing exercise regularly. This paper plans to design a semi-automatic health information monitoring system. The original manual work items were automatically implemented by the computer system to reduce the burden of care and improve care quality.

With the development of information and communication technology, it is no longer

an empty talk to allow intelligent devices to provide services for the elderlies [4]. Domestic and foreign scholars have started to invest resources in the development of smart devices in order to respond to the problem of inadequate human resources for medical services. Lu F. Z. sad that elderly people who have the ability to consume and demand high-quality services will grow more and more in the future. This will gradually become market-oriented and bring about diversification of the equipment supplied [5]. Consider about the aging needs and ensuring the safety of elderly people, emergency buttons or life care sensors are installed in important places in the elderly's living space to ensure rapid rescue after an emergency or accident. Information will be transmitted to the nursing station to achieve living needs of the elderlies [6].

Section III   Research Objective

As the birth rate decreased, proportion of elderly population increases and society enters an aging society. This research establishes an RFID-based health information monitoring system. to help elderlies with care needs and assist medical personnel. The RFID-based health information monitoring system can assist medical personnel in physiological monitoring. Through the RFID-embedded electronic wristband, body temperature information can instantly transmit to the system. Using the mode of remote control, we regularly observe psychological needs of elderlies and relieve pressure for medical personnel. Make medical quality and environment more comfortable and perfect.

Section IV   Brief Review of Methods

RFID is a sensing technologies of large number data collected and processed automatically. It can be applied to newly developed domains. Through the "tag" embedded in item, information can be import into the system. Tag is a microchip with a

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built-in radio technology. The chip can store a series of data. It can be extremely small and can be attached to various types of entities to be screened. Quickly and mass-profiling their content data in a contactless manner. Significantly increase the efficiency of article management and save labor costs. It has higher efficiency and flexibility than current bar code system. In addition to the management of commodity logistics, RFID applications in other areas are also very extensive. For example, in the management of pharmaceuticals, uses RFID to conduct drug safety management to streamline the drug screening process and identify counterfeit drugs. In hospital management, RFID is used to find and identify patients and improve the quality of the doctor's advice. During the period of SARS, ITRI installed RFID sensors at Hsinchu Dong-yuan Hospital. They let all people in the hospital wear RFID chip identification cards. Once they found out that they were ill, they could trace the pathogenesis and their route of action. There Were typical applications such as animal wafers, agricultural products production, steam traps and anti-theft devices, access control, baggage, mail, parcels, tickets, parking lot controls, etc. can also use RFID to keep track of their trends. With the decreasing price of labels and the rapid development of network technology, RFID applications have gradually entered every corner of our daily life.

1. Characteristics of RFID Tag [7]

(1) Various Style

The basic structure of the RFID tag is a combination of a microchip and a radio antenna. There are three types of tags: passive, active and semi-passive depending on the power supply characteristics. There were no specific types of appearance, such as card type, plastic button, watchband type, rings, test tubes, paper labels, e-Seal, Smart Label, etc.

(2) No Visual Contact

For RFID tags stored in a package or a container, information about the contents of the package or the contents of the container can be obtained through the pick-up device within the sensing range.

(3) Long Reading Range

RFID tag capture range is very important for different applications, based on different frequency bands and system designs. The range of the RFID tags can be from centimeter to meter.

(4) Strong Ability to Identify Items

In today's increasingly important drug safety, not only must have the ability to track and trace drugs, but also have to understand drug production performance, RFID will provide this function.

(5) Environment Durability

RFID tags can be packaged in a sturdy plastic outer layer that can be traced long when they survived severe manufacturing and shipping operations. Tags can still be drawn in grease, dirt and paint environments. Radio waves can penetrate many non-metallic materials.

(6) Data Repeatedly Written and Synchronized

For RFID tags, data can be written or modified multiple times. Most of the RFID systems can be within the antenna's effective range, and identify retrieve multiple RFID tag data at the same time.

2. Diet Aspects

Being fat is one of modern illnesses. According to the healthy index, the value of BMI higher than 24 can be called over weight, and it higher than 27 is fat. Due to the

change of lifestyle in modern societies, stress of life, being easy to obtain food and lack of related knowledge of the nutrient may cause body function degeneration and endocrine imbalance. The followings are some reasons result in fat.

(1) Lack of exercise

World Health Organization (Global recommendations on physical activity for health) [8] suggest people exercising 15 minutes a day to live longer and adults doing medium intensity exercise 150 minutes per week. Lack of exercise will weaken down the functions of insulin and compose fat.

(2) Lack of nutrient knowledge

Research on eating outside in 2008 indicated that only 5% interviewers could answer the whole knowledge about six types of food, protein and calories, and up to 40% interviewers ate more than five kinds of meat, whose amount was higher than the recommend of Health Promotion Administration, Ministry of Health and Welfare. The result showed that people still lacked the knowledge of nutrient; and according to the research, only 70% interviewers would read the ingredients before purchasing the product and more than 0% interviewers regarded the ingredient tag being able to help them eat healthier [9].

3. Real-Time Physiological Data

This research instantly senses physiological information through active RFID readers and RFID tags. For example: body temperature, heartbeat and position, improving the quality of care. The active RFID tag is placed on the wrist of the elderlies. This study intends to replace traditional manual operations with RFID location monitoring and management systems to integrate operational processes and physiological data. It also proposes an efficient way to improve the management of elderly care and reduce

incidence of accidents. Data accessed by the database can also serve as a basis for risk assessment and care safety.

Chapter II Literature Review

Some of the related literatures were introduced in chapter II. Including RFID positioning System for medical health care, use mobile services to track immediate physiological information and application of mobile devices combined with medical care field.

Section I   RFID Positioning System for Medical Health Care

Since 1993 Taiwan has entered the aging society, elderly over the age of sixty-five proportion rising, by the end of 2009 has reached 10.6%, is not predicted prior to 2020 reached 14%, is rapidly towards the aging society. With the impact of the wave of less birthrate, the aging population in the future. Aging and living independently has become a trend, and the population will be greatly improved. This situation makes a large number of remote medical needs. The use of remote health monitoring and management platform for elderly sudden accident, unwell, through wireless technology or network information technology self-measurement temperature and blood pressure. And data real-time transmission to the remote server, so that medical staff can understand the physiological information of patients at any time. It can be used for immediate monitoring, early warning and monitoring target [10]. Starting point of medical service to the hospital no longer oriented to the elderly or chronic disease as the core. To provide customized services for consumer demand. The development of integrated joint care system through policy study of cooperation from clinics, hospital to medical center area, achieve discontinuous care and integration of medical system related services sectors to participate. Provide perfect service and daily life care.

The aging population structure has greatly increased the demand for medical

services and long-term care. The development of "Tele-Home care (THC)" has become the main direction. THC has the advantage of quality can help the family caregiver ability and improve their lives. These are not subject to caregivers receive daily medical assistance. The physiological parameters of wired and wireless transmission communication and wearable miniaturized sensor to provide two-way interactive mode and professional medical personnel benefit, reduce traffic time, increase the caregiver active mobility and independent management for their disease. [11].

According to Doughty、Cameron and Garner（1996）[12]，the goal of the current system is to improve the health and quality of life of the elderly. In addition to infrared sensors and image transmission, the elderly can participate in a wider community through the use of information and communication technology, and promote the family as the focus of community health care. The RFID technology to monitor the management, not only effectively track the source of infection, distribution control of medical resources; the other is disposed in nursing homes and kindergartens, prevention of elderly and children lost or injury.

The application in the field of medicine, veterinary medicine has been widely used in the application of RFID technology, which is mainly used for the host that the identity of the animal culture. Foreign studies have pointed out that RFID can be used in medical materials of recognition and tracking, discontinuous care, patient identification and positioning, induction and distance detection, infection control, hospital medical record and electronic integration [13]. Medical equipment is available in drug alignment, audit, inventory control, prevention of counterfeit drugs, automatic medical equipment supply chain management etc. RFID in the library management automation into the housing, to help shorten the order, delivery time, flow to the precision is master materials, effectively reduce operating costs and improve the quality of health care services. The introduction

and the emergency room, operating room, emergency medical care to improve the quality[14].

Through a combination of sensors and wireless network systems, using sensors to detect, reduce the medical personnel directly into the housing, dignity and privacy protection by a caregiver, on the other hand also reduces the cost of human care [15]. Shen L. T. sad the use of RFID technology in the research is the label in the elderly, and the elderly who read the identification tag signal to judge the region, with the identification device installed in the rehabilitation equipment, it can record the old day record of activity, to strengthen the management of health care for the elderly face [16]. In many species and general sensors, the development of distributed sensor agent community to collect and analyze by caregivers and the state of the environment, build the life care behavior model, to provide services for home demand [17]. Development of a wireless positioning system with wireless communication and physiological signal sensors, hoping to carry the sensor's position to know immediately when in danger, reduce the search time, to increase the timeliness of emergency [18]. In the distributed data server and all kinds of sensors in wireless sensor signal transmission, the construction activities of daily living home environment monitoring system, by way of long-term health monitoring, automation, development of a set of analysis methods on the life activity data and historical data model is consistent with the observed changes, hope to achieve the purpose of the activities of daily living trend [19]. A home care system with low power consumption is proposed [20]. This system is expected to help the health care personnel to facilitate the measurement of the patient and not to be limited by distance, and to measure by wireless transmission. There are also many applications of wireless sensor technology in home care research [21-22].

Section II   Use Mobile Services to Track Immediate Physiological Information

Li Z. E said, with the use of mobile communication networks, users' physiological signals can be monitored immediately. The mobile monitoring system transmits physiological signal data such as blood oxygen concentration, pulse value, ECG data, and measured blood pressure to the system storage. During monitoring process, the physiological signals were also uploaded to the health care cloud platform. The physiological information became the user's health information history, and also available for doctors to check the user's health status [23]. With the temperature detection system and position detection system, can let the medical staff continue temperature wireless monitoring remote patient, and through multi factor data analysis, determine the personnel of disease and possibility of artificial intelligence reasoning database, also helps to promote evidence-based medicine. It can be extended to the community long-term care domain, through the network monitoring center of the elderly long-term care of the elderly with dementia, temperature management. When the participants in the upload physiological parameters, mobile phone APP application will determine the physiological parameters of the users is normal; if abnormal, will send a message to medical staff and their families, health care workers can query the back-end database to the subjects of personal data, further to call health; so, it can not only reduce the manual recording errors, can also improve the defects of traditional paper records waste and is not easy to preserve and make permanent preservation. The further use of charts to combine database related data, set up data tables to facilitate that subjects, nursing personnel or medical personnel know the subjects of health or changes, if there are significant changes occur through sending message asking participants or medical personnel can be as early as possible emergency measures [24].

Section III　Application of Mobile Devices Combined with Medical Care Field

It was mostly cumbersome and inconvenient to carry medical instrument in the past, which even needed to be used in the particular location. Thanking for the development of technology, the functions of large machines can be replaced by mobile or wearing devices to reach the goal of conveniently portable and to use it without restrictions to space. Hsu indicated that exercising was a quite common prescription in clinical medical treatment. Using intelligent mobile phones for matching the acceleration detecting device in this research allows detecting the information which examines a plurality of positions of human bodies, passes the information collected to the intelligent mobile phone for analyzing and distinguishing movements through blue bud technology, and records the time that movements pass to really grasp the patient's sport situation [25]. In the research of Jones, regular exercise could remarkably improve the conditions of patients with chronic diseases [26]. Studies on CAST/Center for Aging Services Technology referred that the elderly often lacked activities due to physical mechanism degeneration and the reduction of food variety, making the problems in daily diet quality and balance [27]. They also used RFID technology for recording the daily diet habits and building up the long-term and continual diet records for doctor survey and loaded a RFID CF Card Reader on PDA to return data (Tag ID) back to the server by Wi-Fi. By this mechanism, the long-term diet situation and the change of diet habits could be known, and the disease could also be found out earlier.

In addition, some studies used the action apparatus and information system for people to keep fit. For example, the research of My Meal Mate [28] from Britain referred that diet record and diet suggestion, the UbiFit Garden [29] for mobile devices uses blue tooth equipment to record daily activities, the virtual garden record the growth of flowers.

Besides, the research of Smart Diet offered the following functions of diet records, diet evaluation and exercise planning.

In website's information system, in the research of Dhillon's work for the old man offers the health to note down, let the healthy status of the old man can be cared about [30]. In the research of Fujimura, noting down the user's state of walking, the friends could see mutual records and encourage each other [31].

RFID can enhance the application of patient healthcare is divided into the following five items: blood management, drug management, operation management, infection management and medical equipment management.

1. Blood management in pumping blood：

The RFID tag can be attached to the blood test tube and when the patient to draw blood, giving the patients' blood RFID label written out discernible information, when the nursing staff of blood, RFID card reader is arranged beside a study to confirm the blood for the correct blood disease, can achieve it field blood recognition.

2. Drug management in hospital medication：

If the drug in the factory in the kit and the agents have been attached to RFID tags or the hospital itself on the drug bag attached to the label, through the establishment of automatic drug testing system. When the patient to medication, the drug store in this medicine bag Or pharmaceuticals to write the relevant drug information, to the inpatient ward or clinic can automatically carry out patient identification and drug comparison work.

3. High - risk pharmaceutical injection

At present, technology developed RFID with clamp into the injection tube, can provide many points of injection volume, as long as more than immediately issued a warning and not to re injection. Through the double protection: before the injection of the

first layer, to confirm whether the injection to the correct patient; injection quantity in the second limit, will effectively avoid serious and cannot be redeemed for medical negligence.

4. Operation management：

   In the course of any surgical or invasive treatment, the patient is often injected with anesthetic then into the operating room, the patient often has no perception, so it is often caused by the wrong patient, wrong site situation. If the first patient in part of patients to wear a Tag Bracelet, write their patients' basic data and information. When the patient enters the operation room, the patient is automatically induced to correct the operation and the patient enters the right operation room. After showing the patient surgery related information, actively to medical staff and patients, both can confirm whether the surgical procedure, surgical operation and the correct position. The automatic control system to operate, can effectively reduce the wrong patient, opened the wrong part of the medical negligence, and avoid serious medical negligence cannot be redeemed.

5. Special infection management

   In the special emergency conditions (such as SARS) under, in order to avoid cross infection in the hospital, to conduct separate from to conduct long-term observation, all suspected or confirmed suffering from an infectious disease and exposure to patient related medical care personnel, both should be forced to wear RFID tag bracelet. Through the "RFID disease tracking control system" record the area of activity, the path and the point in time to grasp the history of the contact，and to isolate the patient to leave the isolation area immediately when the warning, so that infection prevention and control personnel immediately with the specification limit. When our medical records confirmed suffering from occurs, system can immediately on patient contact history in this track, can effectively shorten the follow-up time, and improve the tracking range of precision is

high. RFID tags may also be the source of infection, so disinfection should also be paid attention. Use disposable tags to avoid contact with different people.

6. Medical care equipment management infusion pumps pipe safety part of life and medical instruments：

Through the RFID design of induction device, pressure detection or infusion method to confirm the presence of external knowledge infusion, transfusion medical equipment increase protective measures to normal patient infusion injection. The life of medical instrument can be inserted into RFID part number of the instrument, using annual limit or use times to the management of the instrument is to maintenance time or in this update. In addition, special functions for this instrument, the design of RFID equipment to detect whether there is abnormality happens (if the pressure is normal, not normal electricity etc.), if is automatically notify the relevant maintenance personnel management system abnormality status, avoid abnormality of medical instrument damage to patients.

Chapter III Research Methodology

Chapter III is about the research methodology of this paper. Including system architecture, system features, RFID location positioning method and system security.

Section I　System Architecture

It would be easy for users typing in personal data when using the app for the first time, in order to provide personal data for front-end and back-end. After the preparation works, system will come up with the first health evaluation information and analyze whether the users are healthy or not. Based on the evaluation, the system will give appropriate diet plans and exercise distances for being sent to the diet and sport modules in the front-end app. Both modules are evaluated in a cycle of one day, the diet module calculates the total calories that have been taken and the sport module records the total distance of exercise which is then converted into calories that have be burned. Through the evaluation of these two modules, the system will determine whether the diet and exercise are balanced. If it's balanced, the data will be stored in the server database; Otherwise, if it's not, the system will give some advices and analyze them again. However, if diet and exercise are still not balanced, the data will be recorded and sent back to the server.

Managers and medical workers have the access authority to visit history records in the system. When the diet and exercise conditions are not in normal value for a long time, user would be contacted and offered some guideline. Figure3-1 shows the design of interactive health diet and healthcare system, which can be separated by four parts, namely smart phone app, smart bracelet website and server. Using app for recording and analyzing all diet and exercise processes also gives some suggestions and then sends the data back to the server, so that the app and server can share the data through the internet. After the user installs the app and keys in personal data, the system will analyze the user's

health conditions. Location information collected by RFID tags is transmitted to the RFID reader. After the reader senses the tags, it sends information back to the sever. At this time, the management server encrypts the data and sends it to the database via Internet. When all of these steps are done, the app will give some recommendation about eating and exercise. Besides, the records are able to be reviewed at any time. The server is to collect and manage the data in PC so that managers and medical workers can apply the data to medical services through this system.
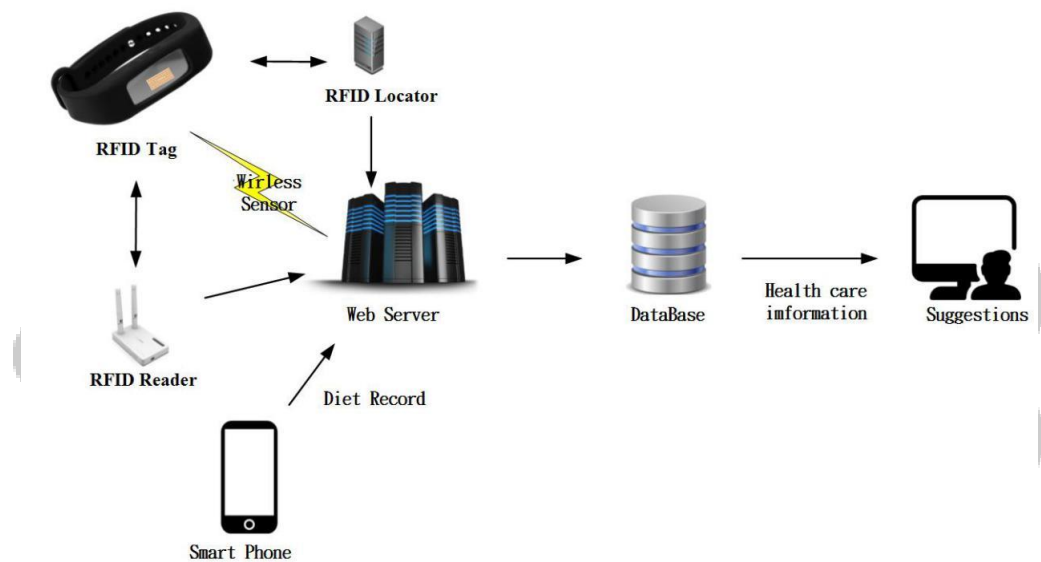

Figure 3-1 The Design of Interactive Health Diet and Healthcare System

Section II   System Features

In the front-end development, the smart phone app is developed based on the Android mobile operation system to record a user's basic diet and exercise data, analyze the diet and exercise records, convert them into health suggestions, and then send the results back to the server. The back-end development is constructed by Apache server to receive and manage data. If needed, managers and medical personnel can have those records for medical purposes. In this case, it is more convenient for medical workers

finding out users' unbalance diet or lack of exercise and then noticing the users to make improvement immediately. This part of the function provides an introduction to major dangerous diseases, risk factors, and precautions. Users can also check if they are in high-risk group and understand what to look out for when they understand the condition. Disease information query function examines the top ten diseases of the Chinese people, including kidney disease, gout, heart disease, hypertension, diabetes, stroke, dementia and other elderly diseases, giving users good health education information.

Section III RFID Location Positioning Method

Through the RFID captured data into Data Center Processing, with a special algorithm to generate points, line and plane location information. And the location information in asynchronous way, using message middleware to asynchronous publish to Message Server. According to the characteristics and demands of people and things, to provide and convert the identification and Supervision service to the application program. Using RFID as the positioning method, Active RFID and RFID Reader are placed in a nursing home environment locator. In order to correctly record the location of nursing homes, place the main location in the middle of the corner and the important channel. The radio waves are sent by RFID reader, and the tag active signals are transmitted in the range, and the sensors read the signals to obtain physiological data.

In the localization applications of wireless networks, the research on localization technology using RFID is divided into four main categories:Time of Arrival(ToA), Time Difference of Arrival(TDoA), Received Signal Strength Indication(RSSI) and Angle of Arrival(AoA) [32].

1. Time of Arrival, ToA

Time of Arrival, ToA requires a definite time between the antenna and the active tag, in order to estimate the distance. The geometric principle of the TOA__1(To be numbered) shows, the use of 3 antenna positioning active tags, the distance is ri, (r=1,2,3), defined as ri＝(ti-t0)c, the constant t0 for the launch of reader to tag time. ti arrived in time for the tag active antenna signal. C is the speed of light, the distance of the active tag is estimated using the distance radius of the three antennas. Can be used in variety of distance location, transfer time signals is important for this method, if the interference signal of the internal environment too much, lead to accurate measurement of the signal propagation time, will cause the error of positioning, but this positioning method is suitable for remote or close positioning system. In addition, in the process of measuring signal transmission, to the transmitting end and the receiving end synchronous, if one party sends too fast or too slow, it will produce error measurement signal caused by the positioning error. The principle of its calculation is shown in Fig 3-2.
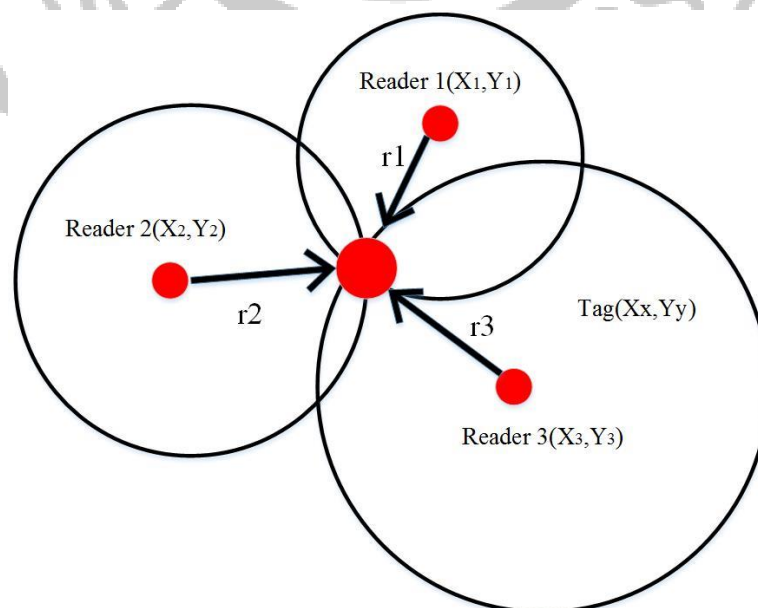

Fig 3-2 Active tag positioning

2. Time Difference of Arrival, TDoA

Time Difference of Arrival, TDoA distance between the target and the reference is calculated by the time difference of the received signal. But the difference is that signal arrival time difference is estimated by relative time rather than the absolute arrival time, so the partial error of the system is eliminated. But in the measurement of signal propagation, to sending and receiving terminals simultaneously, if one party sends too fast or too slow, the time interval generated between them will cause the error distance of speculation, eventually led to the positioning of the error. This method solves the problem that the signal is not synchronized with the sensor. As long as the number of sensors is enough, it can be located on the target. Make two readers as i、j measuring the different arrival time of signal between two tags where τij. Then Rij becomes the signal propagation distance difference between reader i and reader j, and the signal attenuation formula (1) is shown as follows:

$$R_{ij} = C\tau_{ij} = C(\tau_i - \tau_j) = R_i - R_j$$

(C means the speed of light) (1)

3. Received Signal Strength Indication, RSSI

Received Signal Strength Indication, RSSI .The strength of the signal for RSSI varies with distance. According to the target's distance, and the signal attenuation formula (2) is as follows:

：

$$P_r = \frac{P_t G_r G_t \lambda^2}{(4\pi d)^2}$$ (2)

The Pr(d) of the formula is the received power, Pt is the transmission power, Gt is the transmitter antenna gain, Gr is the receiving antenna, λ is the wavelength, and d is the

distance between the transmitter and the receiver. Although the overall signal with increase distance attenuation, but in fact it is vulnerable to the signal environment, reflection, refraction, diffraction and external factors affect the receiving and sending messages, resulting in signal interpretation on the attenuation laws of positioning error or some. The distance through the signal strength meter reference point and the point to be measured, according to a plurality of distance values can be measured using a similar point ToA positioning principle, while Figure 3-3 show relationship between RSSI and distance experiment data of the scholars.
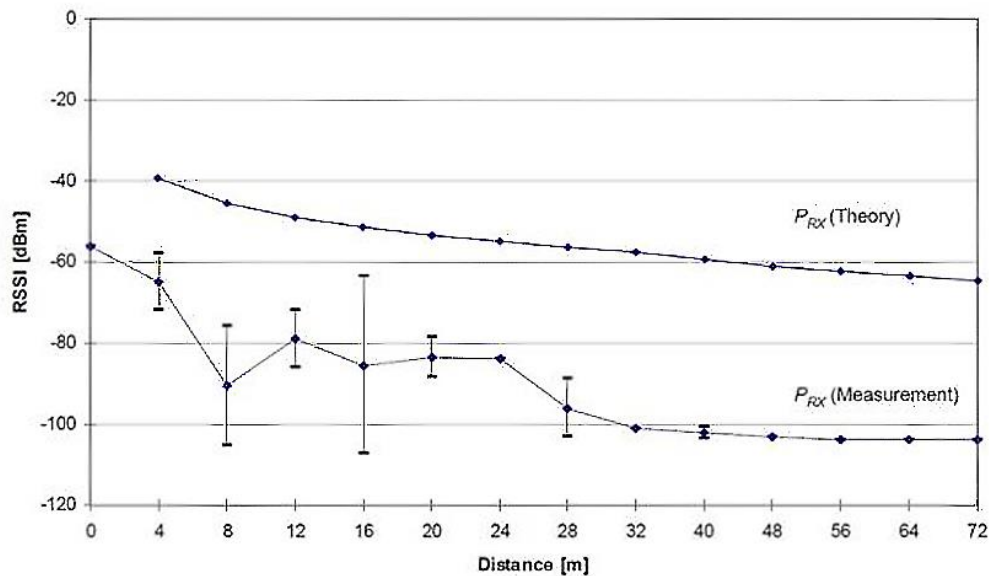

Figure 3-3 The relationship between data and Signal strength index

4. Area of Arrival, AoA

Area of Arrival, AoA uses directional antenna (directional) measurements to obtain the position of active tags (active, tag), such as using two or more antennas to measure an active tag, the intersection point of two or more straight lines is the location of the active tag. However, this method is needed in a low interference environment, because if there is too much interference in the positioning environment, it will cause signal scattering or an active tag is too far from the antenna to affect accuracy. Therefore, it is necessary to

determine the location environment without other interference noise so as to avoid data detection errors at the sensing points.

Section IV System Security

RFID technology has brought many people to the convenience, such as a Easycard can take the MRT, shopping, parking or as identity identification. The application of RFID in medical care and medication management, improve our medical and drug safety; After the library imports RFID, the administrator does not have to worry about finding a book. With the RFID production resume guarantee, no longer worry about buying illegal food products. In the RFID security campus environment, the teacher parents do not have to worry about missing children. Embedded in RFID tags of military, in the management will be more stringent. But the issue of using RFID is a matter of security. Personal privacy information will not be violated. With the above issues, can be divided into two levels, information security issues and personal privacy issues.

1. Information Security Prevention Methods

RFID is a kind of using radio recognition items information technology, its real effectiveness must join the intermediary software and back-end information application system together to activate, so as long as the application of information software and hardware, there will be information security concerns. In addition, the reader and the label through the air exchange of information in the process may also be interested in people to steal or damage caused by data outflow or destroy. Tag data protection security guide the tag data protection can be divided into four aspects: the label memory access control, data encryption, label destruct command set and modifying or removing tag content prevention.

(1) Memory access control, the current number of label hardware to take the password to read

and write tags. In general, tag memory access control can prevent the contents of the label from being inadvertently modified, and its effectiveness and the integrity of the password management mechanism.

(2) Label data encryption, due to the RFID tags, it is difficult to build encryption mechanism in the label, the contents of the RFID tag can be written before the label, by the RFID system server or RFID reader first encrypted, in order to achieve the purpose of data encryption.

(3) Self-destruction orders, an RFID tag shall have all activities to terminate the tag when it determines that the reuse value is lost. In order to prevent the tag from being improperly reused.

(4) Avoid modifying or removing tag content. It is more common to use fragile antenna devices on RFID tags. Once a tag is removed from its attached object, the circuit of the tag is destroyed and the tag loses its ability to operate. This function can also be used to check whether the object represented by the RFID tag has been subjected to accidental damage.

2. Work Control

(1) Physical Control

Set obstacles blocking radio waves in the application environment of RFID systems to limit signal acquisition. Its purpose is to prevent attackers from approaching RFID devices to make illegal modifications, destruction, and theft. Obstacle blocking capabilities can also prevent unauthorized retrieval.

(2) Operational Instructions

Operational instruction makes users familiarizes with RFID application. Strengthen information security and privacy protections.

(3) Security of Intermediary Software

The intermediary software is responsible for receiving the tag information obtained by the RFID picker, collating it, and forwarding it to the database analysis software. It can simplify the work complexity of the database administrators and analysts in the enterprise, so that they can focus on the processing of information without having to consider the complicated hardware configuration during data collection. To enhance the security of the intermediary software, an encryption mechanism can be used to enhance the security of the intermediary software. Develop software security verification of the program when developing intermediate software. In addition, regular updates and bug fixes are made to the operating systems of the intermediary software to reduce the chance of attackers' invasion.

(4) RFID Privacy Prevention

A. Using a Specially Designed Label

The special design of the label is mainly through the label circuit design, to achieve additional functions or support special instructions to protect, more frequently in the way to Kill Command, Sleeping Command and password protection.

B. Kill Command

If the label support kill Command, such as EPC Class 1 Gen 2 label, when the label received is sent out by Kill Command, they will make their own permanent failure, after making the label for any instructions before the reader, such as reading or writing, everything will not have any reaction. Therefore, the data is not supporting for the label. But due to the destruction of this action is not reversible, once has the destruction of instructions is to cancel out the label.

C. Sleeping Command

The methods and concepts of the same label destroyed, when your label refers to

support dormancy for the transfer to receive Sleeping command, the label will enter dormancy state. After, will not be obtained from the query response. In the wake of the received label must take the Wake Up command, the label will restore the normal operation. With the destruction of instructions compared to dormant instructions compared with the elastic, no need to void can achieve privacy protection label holder, making label can be recycled.

Chapter IV System Implementation

Section I   RFID Targeting Experiment

In this chapter, we will first introduce some basic assumptions, experimental environment and experimental equipment. The experimental part will be applied to the care environment in Real-Time Body Situation Module.

1. Basic Assumptions

(1) Assume That The Interference is Minimal

Since RFID is based on radio frequency technology, it will interfere with signal transmission between RFID readers and tags due to radio waves, temperature, and metal objects in the environment. Therefore, we want to experiment with minimal interference. With the 3-D Tag-Based RFID System, the analog signal strength is weakened in the environment [33]. In formula (3)。 d0 means the reference distance, n means the path loss indication, Xσ means Gaussian random variables that represent an average of 0. The standard deviation σ is the degree of environmental interference, smaller represents less interference. When σ=0 means that it is in an ideal non-interference environment, σ=10 means that it is in a highly disturbing environment.

$$PL(d)[dB] = \overline{PL}(do) + 10nLog\left(\frac{d}{dO}\right) + X_\sigma \quad (3)$$

(2) Assume That All Laboratory Equipment Capabilities Are Consistent

Although the RFID device specification standards used are the same, but due to the internal components of the device, some performance might be weak. To avoid this situation occurs in the experiment, we assume that all devices will be the same performance.

(3) Experiment Environment

The experimental environment is 9 x 3 x 3 square meters in length, height and height, 6 RFID readers in the ceiling, 40 Reference Tags, and 8 tracking tags. The spacing between each Reader and reference tags is 1 meter, as shown in Figure4-1. At the end of the exhortation phase, remove all reference tags and place the tracking tags in the environment in a random manner.
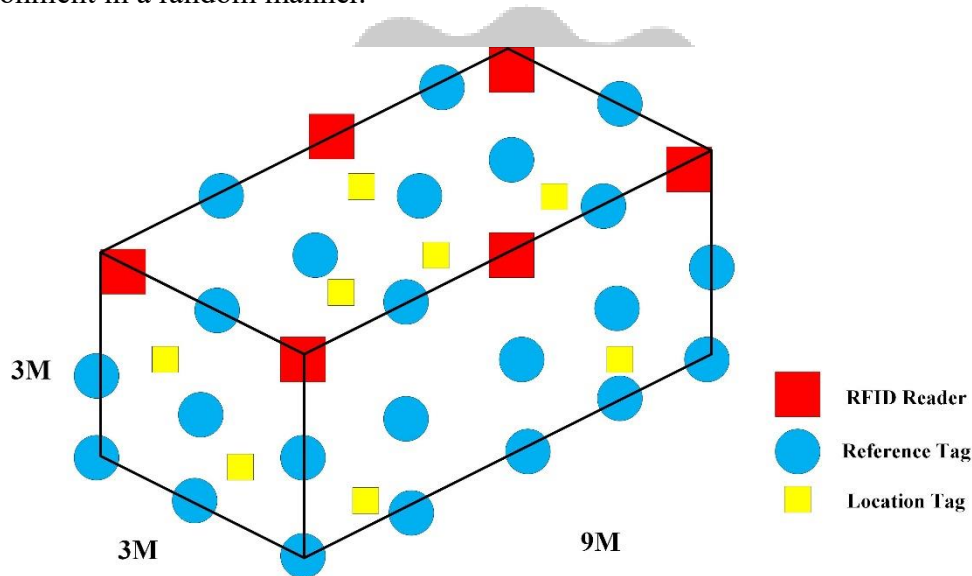

Figure 4-1 Experiment Environment

(4) Experimental Equipment

The UR1000L RFID extractor and active RFID tag produced by Microprogram Corporation are used as simulation experiments. The operating frequency is 922MHz~928MHz, and the reading distance is 100 meters. It can handle up to 150 tags.

Section II   Health Care System Architecture

This healthcare system app is designed for mobile equipment. In the database design, Android mobile device with SQLite is used, it contains the advantages of being more compatible with most of the SQL software in the market, such as MySQL and Microsoft

SQL Server, light and convenient, and available in Android app without installation. When the app has recorded user's information, the healthcare system app will send the records and data to the back-end for maintainers to inspect, synchronize and backup every 24 hours to offer managers and system maintainers checking whether it has any problems. The healthcare system uses Apache server and MySQL database as the back-end to record and backup the user's data. Besides analyses and data feedback, it also let users retrieve data when they reinstall the app again. Figure 4-2 shows the synchronization process of healthcare system's SQLite and MySQL data list. The Json on the healthcare system app is used for sending data to Apache server through HTTP Protocol, and the PHP, written by Json Parser, gets the data from SQLite and fills in the data at the right columns and rows. The user can just type in the name and birthdate to retrieve the old data.

The system developing environment could be used as the developing tool as following:

1. Environment: MacBook Pro 15" Retina, CPU 2.3GHz, RAM 16GB, SSD 256GB.

2. Server: HP ProLiant ML10 Gen9, CPU Intel Xeon E3-1225v5(3.3GHz/8M), RAM 24GB, Storage 10TB.

3. Mobile Device: ASUS ZenPad 3s 10 , CPU MTK MT8176 2.1 GHz + Quad-core, 64bit, RAM 2GB, Storage 64GB.
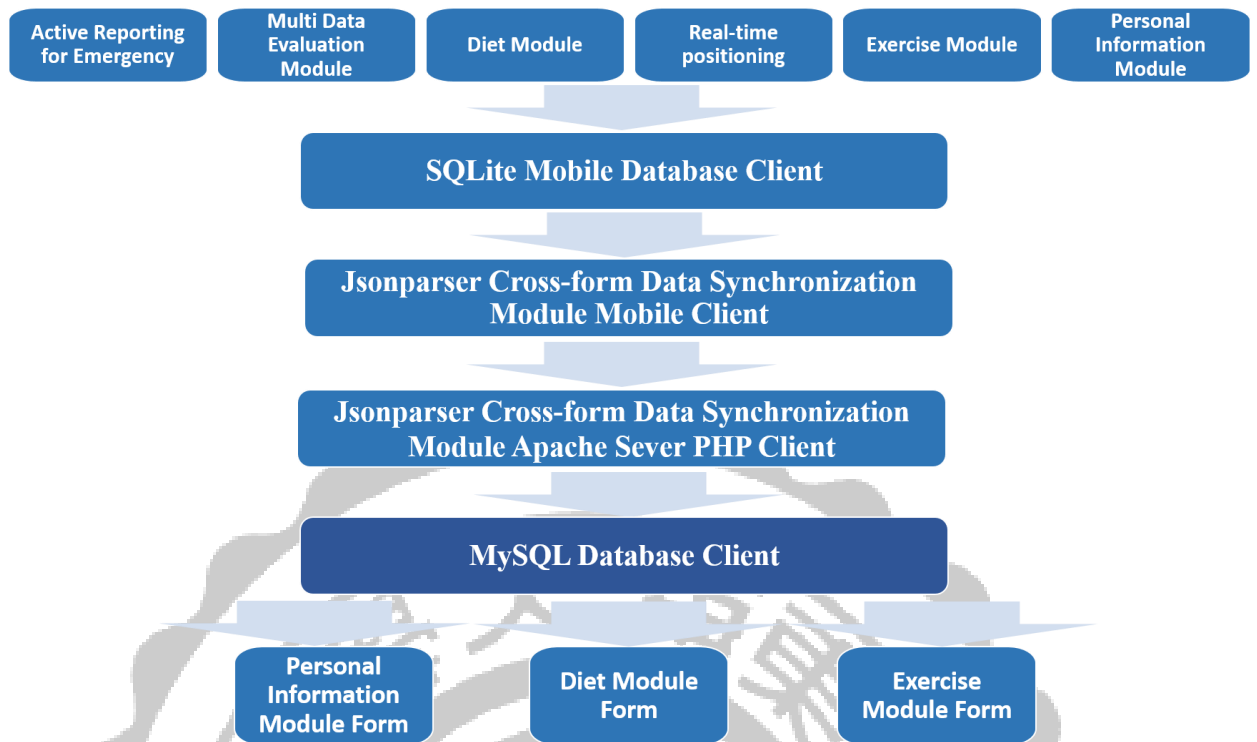
Figure 4-2. Healthcare System App Developing Structure

Section III   Implementation of the System

1. Body Situation Module

The Body Situation Module will collect data from personal and diet modules, Suggestion module will analyze a user's age, height and weight to offer the users' basic daily exercise distance and then check the calories consumption record to suggest and adjust the new distance. If the calories are under the basal metabolic rate, the system will suggest the users to cut the exercise distance to deal with unbalance. If the under the circumstance of the consuming calories is higher than the basal metabolic rate, the system will suggest extending sport distance for the user. The basic module offers a user to set up the regular distance and duration. The suggestion module and the basic module will record the exercise distance, duration & route and supply for user reference. All the data

will be transferred to mobile phone database SQLite as the storage and integrated the evaluation data together with the diet module. Comparing the diet module and the sport module, if the metabolic rate consumption is higher or less, the exercise module will be revised or updated. The user will receive the new suggestion exercise distance after relative data evaluation.

2. Real-time Location Monitoring

All the movement of the senior people will be record. As long as the managers press "check location record", they are able to control the aged people's any action in order to ensure their security such as prevent them from getting into the hazardous places or walking in the midnight. The managers and the caregivers can receive this information as a reference.

Elderly's were safe because of "Real-time location Monitoring." This monitor permits managers to make sure if elderly staying in the secure places. The system will record and identify the elderly's movements, and provide necessary medical assistance. These two methods are "elderly's location" and "location record", separately. When the manager clicks "elderly's location" which is equipped by the active RFID, the system will immediately illustrate the elderly's place. Therefore, the managers can see whether the elderly stay in the secure areas or the threatening sections. If the elderly appears in somewhere dangerous, both managers and caregivers can alert them and prevent any accident from happening. The system illustrates in the Figure 4-3.
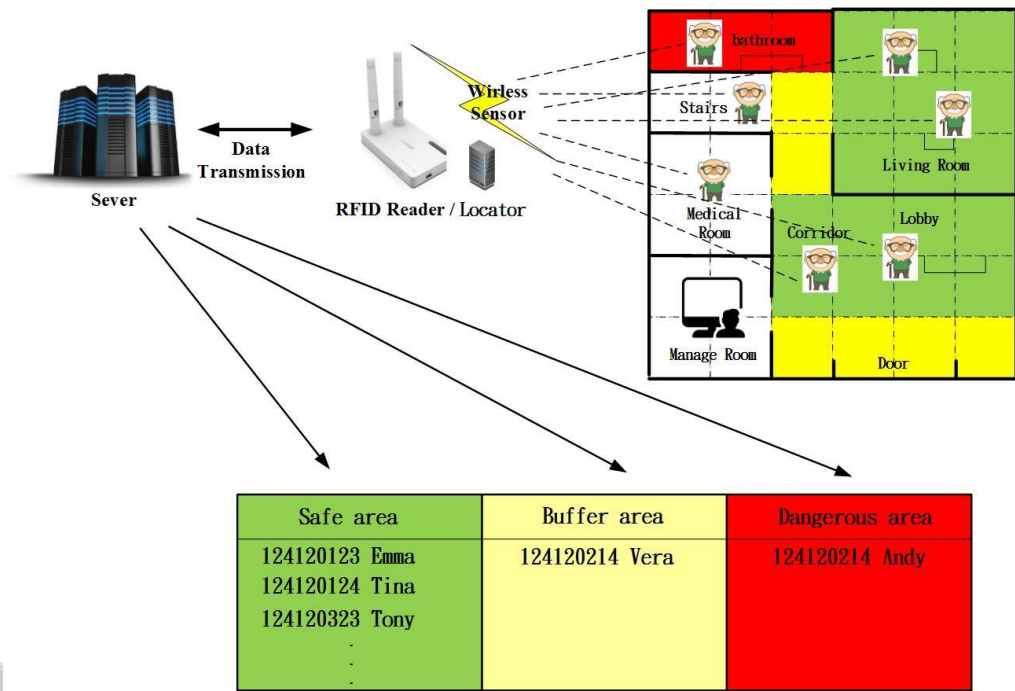
Figure 4-3 The Illustration of Checking Elderly's Location

3. Active Reporting for Emergency

The function of the "emergency return" can monitor and control the patients' physical information such as the elderly's temperature and heart rate. This can offer the caregivers some providing services of home nursing. All human need to take a rest meaning it is impossible for a person inspects the elderly within 24 hours everyday. With the system management, the caregivers' do not need to do everything. Their working load can reduce. Apart from this, if RFID tag detect the elderly's abnormal, the system will automatically warn the system administrators. Besides, if the urgency incident breaks out, the elderly can also press personal distress button by themselves to prevent risks.

4. Multi Data Evaluation Module

Multi data evaluation module monitors the data from both diet module and exercise module under the background data and analyses simultaneously, then feedback the suggestion data instantly. Based on different age, height, and weight in personal data

module, those data are evaluated and come out with suggestion data. When the evaluation launches, it collects the data from the diet module and the exercise module simultaneously and keeps modifying the suggestion data and feedback those modules to keep a user's body balance. There are four conditions in the multi data evaluation module.

(1)   Diet calories under suggestion calories, it suggests users to have more calories and halt the exercise until the calories get balanced.

(2)   Diet calories over suggestion calories, it updates the suggestion data and exercise module to consume more calories.

(3)   Exercise distances under suggestion distance, it keeps the diet calories and suggests users to maintain the current exercise distances.

(4)   Exercise distances higher than suggestion distances, it updates the diet suggestion to get more calories and halts the module until it gets balanced.

5. Personal Data Module

   (1) Personal information Management

    Personal information management is designed for managers to manipulate the elderly's physical information which contains the relative functions such as "search", "add", "delete"and "RFID tag condition." As well as the functions describes below.

A.   Add: As the elderly removals into the nursing home, they need to have the personal information such as "gender", "name", "birthday", "ID", "contact number", "address", "financial situation", "emergency interconnection", "illness". All the information will be stored into the system database. The system can not only identify the paten's status, but the managers can as well when the elderly equips the serial number.

B. Search: The managers can browse the registered data and the patients' any movement especially when they leave the nursing home. The original cogitation is to provide the managers to reform the manual mode for raising the efficiency. Furthermore, the medical personnel can access to the elderly's different kinds of disease. Therefore, the medical personnel can contact the elderly's emergency contact person immediately when the emergency circumstances occur.

C. Delete: They are "delete data" and "dropout". "Delete data" is designed for delete the information of the registered elderly. "Dropout" permits the managers cancelling the electronic RFID tag wristband and liberating it for the next user to prevent the resource wasting.

D. RFID Tag: The administrators or the staff can verify the registration condition of RFID tags. The managers can confirm all functions with this.

As shown in Figure 4-4, when a user turns on the app for the first time, it will check on and certificate with the back-end server to insure whether the user have ever logged in. If there is no record, it will offer a list for the user to fill up and send back to back-end server for back-up.
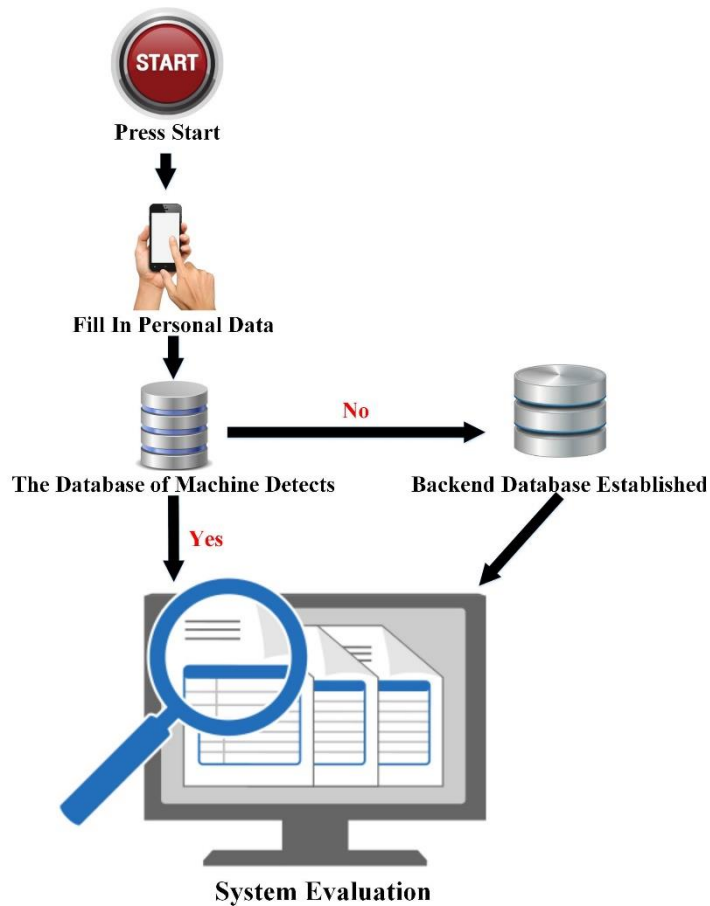
Figure 4-4 The Process of Logging in

6. Diet Module

Diet module receives the data from personal data module, and the sport module then does the background monitoring; after that, the data are sent to diet suggestions and basic records. Diet suggestion analyzes recent diet conditions and basal metabolic rate to offer the diet suggestion and exercise time. It also allows the users choosing the meal of breakfast, lunch or dinner and then gives some advice about food. The basic record is responsible for recording a user's eating time, such as breakfast, lunch, and dinner, and the name of food calories and nutrition. Recording after all these procedures, the data will be synchronized and analyzed with those in the sport module. After the multi data evaluation of diet module and sport module, if the result is lack of calories or large amount

of exercise, the diet module will receive the update from the multi data evaluation module. Diet suggestion receives the update then analyzes and evaluates it again; the last step is to give a new suggestion to users.

CHAPTER V Conclusion

There are a lot of treatises about diet domestically, but they seem still not complete enough. A good diet habit could prevent from chronic diseases and postpone bad illness conditions. However, the studied objects are mostly patients or people who are over-weighted. The targets are focused on eat-out persons, and their diet records are kept in a server for medical consult and also the users' review. These data used to only be stored in client-end or hospitals for medical treatment. There was no such self-survey system being able to keep personal diet records all the time. Besides, previous systems were always less the user's willingness in the process of ordering meals because of complicated procedures. This research completes the Personal Smart Healthcare System and allows caregivers tracking their daily diet situation and the amount of exercise to balance their diet. It not only prevents from illnesses, but also saves the insurance cost. The smart meal ordering system can simplify the user interface and process to be a study tool for clinic medicine and research. Through Personal Smart Healthcare System, the long-term recording data can be a medical research material to control diseases (over-weight, under-weight), and the use of red, yellow and green signals can help users understand food ingredients. Diet and exercise are two major factors in health to control user's weight and cardio-pulmonary functions through index management and to keep notifying their body conditions. This study tries to replace the labor force with science and technology to create a convenient and intelligent care environment. Therefore, RFID technology is applied to medical information system to improve information efficiency. Through the research of workflow analysis and system analysis, it helps system developers to import the system more effectively and makes location monitoring management system more widely used in the elderly health care level.

Due to the wireless recognition system is the use of radio waves to transmit

identification information, so it is widely to used. Safe and simultaneous reading of multiple RFID data and also can be used repeatedly, so it has considerable application potential. The application of the RFID technology in the clinical care facilities increased, and the health care industry can provide significant benefit. RFID has the advantage of automatic recognition and information capture, especially in the management of disaster and emergency conditions. The future of hospital business investment, both should be reduced and the electronic medical record, physician order system and drug information system integration barriers can management RFID technology to help hospitals and health care articles. Sensitive issues for implantable RFID chips, although only millimeters in size it will safety and harm, but still need to formulate relevant standards.

This research focuses on the development and design of the smart Healthcare System and RFID locating. It is discovered that there were some similar systems, but few about ordering and sport healthy status detection system. Wish we could combine those systems with this research. It would make elderlies healthcare become more complete. In the design process, we should try to add more experts and users' opinions to simplify the operating interface and processes. And also, the RFID location technology can be more humanize. Nonetheless, some insufficient and hidden problems can still be improved to make it better & more acceptable.

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