

Development of a Health Care Information System for the Elderly at Home

Dong Wang^{1,2,a}, Wan Cheng Ge¹ and Yun Guang Wang²

¹ School of Electrical and Information Engineering, Tongji University, Shanghai, China

² Shanghai University Of Medicine & Health Sciences, Shanghai, China

Abstract. The growing population aging is a serious social problem in the world today. Accidental death at home is increasing because abnormal conditions can not be discovered in time, especially to the elderly who live alone. Besides, according to statistics, over 80 percent of the elderly need the service of home care in China. A health care information system for the elderly at home is developed to monitor the real-time state of the elderly remotely in this thesis. The system can show the current positions of the elderly in the house and judge whether they are in dangerous locations or have dangerous activities. In the case of emergency, the elderly can press the emergency button. The system also provides some help for the elderly's daily life. The system offers the advantage for living at home more safely and more comfortably, and has better application prospect.

1 Introduction

With the arrival of the aging society, more and more attention is drawn to the aging problems. In China, population of labour force is thinning down, while the number of aging people is growing steadily now. Caring for the elderly becomes difficult. The children or relatives of the elderly usually can not provide enough care. Therefore, the elderly who need social services are increasing continuously. It leads to increasing the medical and welfare costs, and prevents social independence of the elderly people. Moreover, according to statistics, over 85 percent of the elderly people wish to live in their own houses. Only 6% to 8% of the elderly people accept to be taken care of in the nursing home. Because the elderly feel comfortable and warm in familiar surroundings, when he sees many acquaintances[1-3].

As the measure, a new health care information system for the elderly at home has been developed to help the elderly people to maintain their independence and enhance their quality of life. The System is composed of a server with a database and a monitoring software, smartphones with RFID cards, RFID readers and GSM base stations, and etc. This system can monitor to judge whether the elderly are in dangerous locations or has dangerous activities. The system also can offer some help services for the elderly.

2 System Configuration

2.1 System configuration

Fig. 1 shows a basic system configuration. The old person always carries a smartphone binding a RFID card

with him. The RFID readers are installed in the places of the house where need detection. In the monitoring center of the community, there are working staffs keeping a 24-hour surveillance.

When the old person is moving in the house, the RFID readers will scan the card and make sure the location of the old person. Then the workstation sends the position message to the monitoring center of the community. The message will be processed by the monitoring software in the center. For example, the system will produce an alarm when the old person has been in the balcony for too long.

If the old person has a dangerous action, such as falling to the ground, the sensor in the smartphone can detect it and the smartphone sends an alarm to the monitoring center of the community. The message will be received and processed.

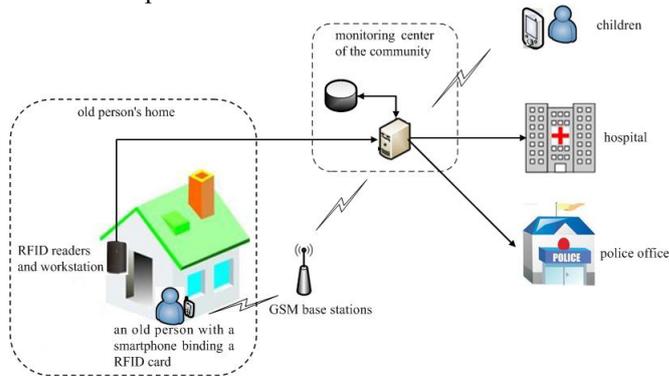


Fig.1 system configuration

2.2 System function

Based the system configuration, a new system is developed. Some hardware has been bought, such as

^a Corresponding author: wd_lulu@163.com

RFID readers, smartphones and etc. Some software has been used, such as C#, Java and database management system. The system is consist of two sections: the monitoring software and the smartphone system[4].

The function of the monitoring software is shown as follows:

- ① Input the users' information such as basic information of the elderly, family information, medical records, emergency communication, and etc.
- ② Input the Communities' information.
- ③ Reminding settings for the elderly, such as medicine reminding settings and treatment reminding settings.
- ④ Real-time monitoring to show the elderly's current positions and alarm.
- ⑤ Query statistics

The function of the smartphone system includes: input the users' base information, detect the falling, detect the press of the emergency button, remind the elderly to take medicines or go to hospital, and etc.

3 Realization of RFID Indoor Positioning

3.1. Centroid localization algorithm based on RSSI

When the old person with the RFID tag in a dangerous area, the position message will be read by RFID readers and transmitted to the monitoring center. The message will be processed by the monitoring software in the center to judge whether to raise an alarm or not. This system adopts a method of RSSI to locate the old person.

RSSI(Received Signal Strength Indicator) ,is a value to indicate the electromagnetic wave energy in some medium. Because the signal strength will be reduced as it travels, the distance between signal point and receiving point can be determined by the received signal strength. According to the corresponding data, the current position of the test target will be calculated. From experience, we can have

$$PL(d) = PL(d_0) - 10\gamma \log_{10}\left(\frac{d}{d_0}\right) + X_\sigma \quad (1)$$

The equation 1 is known as signal transmission model. PL(d) is the received RSSI value, d away from the signal point. PL(d0) is the received RSSI value, d0 away from the signal point. X_σ is a Gaussian random variable, whose mean value is zero and variance is $\sigma^2(dB)$. according to the equation 1:

$$d = d_0 10^{\left(\frac{PL(d_0) - PL(d) + X_\sigma}{10\gamma}\right)} \quad (2)$$

Suppose that there are three RFID readers named A, B and C, whose coordinates are (xa, ya), (xb, yb) and (xc, yc). The current coordinate of the old person is (x, y). According to the equation 1, the distances between the current position of the old person and the RFID readers A, B and C are calculated, which are da, db and dc. The equation in terms of x and y can be obtained as follows.

$$\begin{aligned} \sqrt{(x-x_a)^2 + (y-y_a)^2} &= d_a \\ \sqrt{(x-x_b)^2 + (y-y_b)^2} &= d_b \\ \sqrt{(x-x_c)^2 + (y-y_c)^2} &= d_c \end{aligned} \quad (3)$$

The current coordinate of the old person is obtained by solving these equations as shown above. But in actual condition it is difficult to calculate the current position of the test target precisely, for random component exists when the RSSI value is in a decay process. A centroid method is adopted to improve the positioning accuracy. Some triangles for ranging will be generated when the RFID readers read the data of the current position for many times, so the current coordinate can be obtained by many times. The centroid of these coordinates will be marked as the current coordinate of the old person. For the centroid of a triangle, it should be calculated as follows:

$$\left(\frac{x_1 + x_2 + x_3}{3}, \frac{y_1 + y_2 + y_3}{3} \right) \quad (4)$$

3.2. Realization of Positioning

- ① Detect signals by the RFID readers

Long-distance RFID readers are used in this system. The reading distance should be changed by adjusting the power of the RFID reader. These readers which connect with the workstation are placed in the elderly person's rooms. By polling method, the workstation detects which readers can read the card at a certain power and records the current power message which is relating to the distance. After completing the all readers' polling, the workstation begins to calculate to locate the old man's position. Polling interval is no more than 50 ms.

- ② Calculate the current position of the old person
- The process of locating the person is shown in Fig.

2.

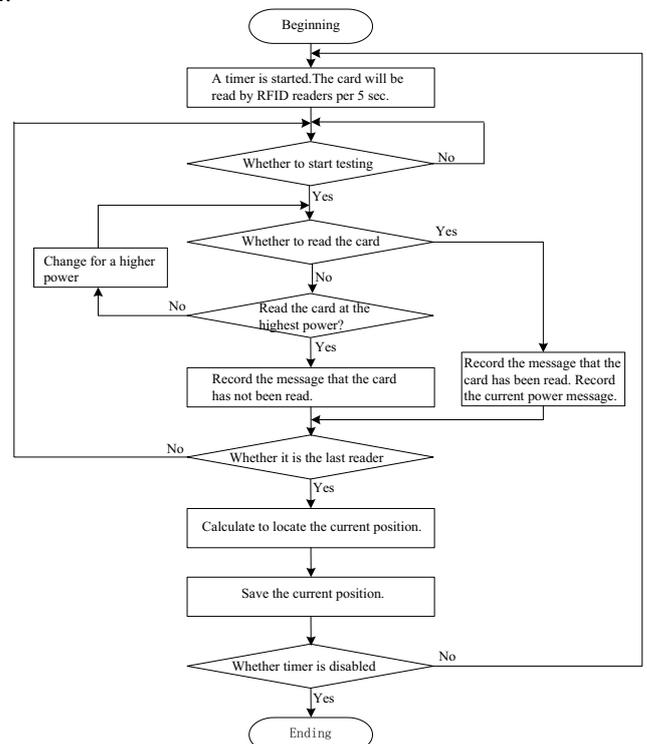


Fig.2 realization of positioning

4 Monitor a fall and process the emergency button

The smartphone in the system acts as the carrier of a RFID card, as well as the tool of detecting an old man's current motion to judge whether to alarm or not. The changes in his motion can be measured by the acceleration sensor in the smartphone.

4.1 Process the fall

The action of the old man can arguably be seen as a state of rest or an uniform motion. When the old man is falling down, he is usually in accelerated motion. And the acceleration is increased along the direction of the acceleration of gravity. The main algorithms are described below.

① Keep waiting, with monitoring the changes of the tri-axial accelerometer's square. If the square exceeds the threshold value, then proceed to next step.

② Give a loud sound for alarming, and wait for an external input.

③ If there is no external input, it should be considered that a fall occurs. And a real alarm will be sent to the monitoring center. Otherwise, if there is an external input, the loud sound will be stopped. And go back to the first step to keep waiting.

4.2 Process the emergency button

It can be considered that the old man is pressing the emergency button by himself when the system detects a long press on one or more keys of the smartphone. It should be detected that the keys must be released after being pressed for a while.

4.3 The main process of the Smartphone system

The main process of the Smartphone system can be divided into several sections as shown below.

① Complete system initialization to get the configuration information. One of the main functions is to get the contact numbers stored in the Smartphone. Another is to search the linking information of the acceleration sensor in the Smartphone. In the first five seconds of system initialization, the system configuration interface can be entered if the command button is pressed.

② Start a thread and open the sensor, so the pressed key and the value of the sensor can be detected.

③ Get the tri-axial accelerometer's current values for the acceleration sensor and evaluate their square. If the square exceeds the threshold value, a loud alarm sound will be given. It is possible that a fall may have occurred, so if the cancel button is pressed in the next ten minutes, this loud noise will be stopped. Otherwise a warning message will be sent to the monitoring center by the Smartphone.

④ When the system detects a long press, a warning will be sent to the monitoring center by the Smartphone.

5 System application

At the monitoring center, the current position of the old person is showed as fig. 3, Fig.4. If necessary, the working staff in the center will phone to the old person, or go to his home to offer help, or phone to the hospital or police office.

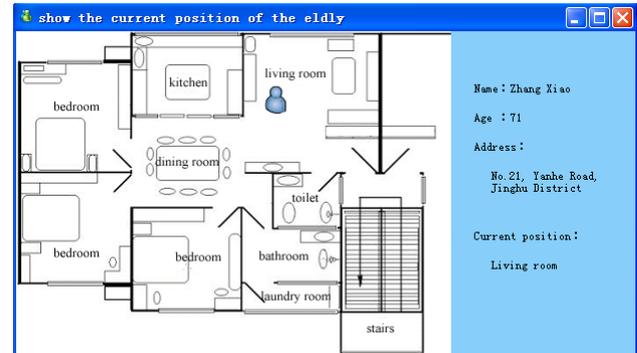


Fig.3 showing the current position of the elderly

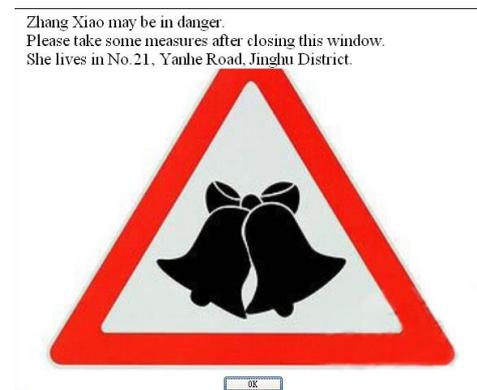


Fig.4 the alarming window

In case of asking for help owing to emergency, the old man can press the emergency button in the panel of Smartphone for three seconds and the system will enter the emergency state at once.

An RFID card uniquely identifies an elderly person in the healthcare information system. With the RFID card, data of the elderly person which are stored on the server can be accessed, such as their name, age, health information, house information, etc. There should be a defined procedure on the RFID card for the issue, cancellation, and alteration of authorisation to enter and amend data, including the changing of personal passwords. Especially, medical records of the old person should only be read by someone who has right to do that, such as his children and doctors. Hence, it protects the elderly person's privacy efficiently. With an RFID card, medical information of the elderly person in the system plays an important role in community health record. Benefits include carrying out the work of community healthcare, which can provide more protection for the quality of elderly life.

Many old people are so forgetful that the system offers a timely reminder service according to the requests of them or their children. For example, time to take medicine or hospital appointments can be set in the

system in accordance with specific conditions. When it is the correct date and time, the system will provide a reminder for them. The system also provides old people with some healthy recipes via the Smartphone or remind him not to eat certain kinds of food.

6 Discussion

The analysis of the elderly satisfaction about the various services provided by the system is shown in Fig.5. Most of them are satisfied with five services as follows, such as monitoring service in a dangerous area, monitoring service when a problem occurs, active alarm service when an emergency happens, timely reminder service (reminders to take medicines or reminders about appointments, etc), and notification service for leaving the house. As for the service providing the elderly with healthy recipes or basic nursing knowledge and skills, and the service for storing of medical records, they are not very satisfied. It shows that the basic functions of the system are, in the main, satisfactory. Compared with some other systems in which people are monitored by cameras, there is better acceptance and less fear for the elderly, because this system only sacrifices part, not all, of their privacy. They also feel that it is necessary and effective to send an active alarm by pressing the emergency button themselves in emergency circumstances.

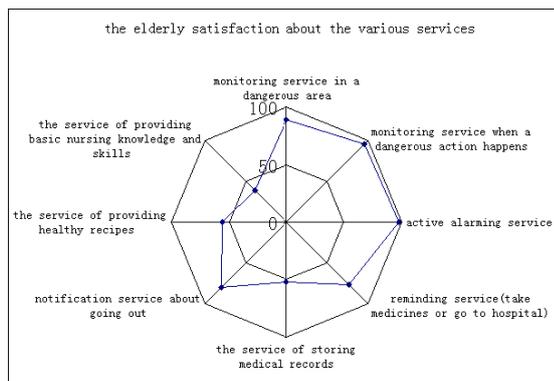


Fig.5 the elderly satisfaction about the various services

CONCLUSION

In summary, this thesis presents a scheme of a health care information system for the elderly at home based on radio-frequency identification technology and sensor technology. For the elderly, the system greatly reduces their risk of being severely injured if they are in an accident. At the same time the elderly's privacy has not been invaded [5-7]. The system has been developed to solve the social problem that there is nobody to look after the elderly in some families. The improved healthcare information system for the elderly may achieve reasonably good social and economic benefits.

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