Intelligent Monitoring System for Elder People
Chang WANG¹, Fu-ming SUN¹ and Yang LI²,*

¹School of Electronic and Information Engineering, University of Liaoning University of Technology, Jinzhou 121001, China
²Dalian Cloud Force Technologies CO. LTD, Dalian 116000, China
*Corresponding author

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Abstract. In order to better care for elder people, an intelligent monitoring system which consists of data acquisition equipment, network transmission module and monitoring software on mobile phone is developed. It can collect the activity states and surrounding environment of the elder people through data acquisition equipment which incorporates multiple sensors. In the system, CRC cksum technique is adopted to ensure the correctness of the collected data and personalized abnormal decision algorithm is used to deal with the problem of high false alarm rate in practical application. The tests indicated that the system can realize the intelligent remote real-time monitoring, judgment, alarm, prediction and other functions, meet the needs of modern intelligent monitoring, and reduce the false alarm rate by about 95%.

Introduction
In recent years, according to a new questionnaire survey from three endowment institutions in Nanjing, the fall incidence rate of elder people was running at 39.2%. The key factors behind the accident include sleep status, chronic medical history, external environment and drug history of the elder people [1]. It is no doubt that a remote monitoring system will help to better care for elder people through collecting their daily activity states and surrounding environment in real time.

Related Works
At present, there are a few guardianship systems for elder people. Zhejiang University of Technology released a remote monitoring system[2], which set up the prediction model by collecting data. But, it cannot send alarming information in real time. Yang Haijian et al. [3] designed a monitoring intelligent system for elder people based on Internet technology. It has timely alarm function, but it may have false alarm. Chongqing University of posts and telecommunications designed a remote monitoring system for elder people in case of falls in intelligent home [4]. It has reduced the false alarm rate after the cancellation of the alarm button, but there is still a possibility of false positives, and the monitoring coefficient is single, only monitoring the fall action, unable to monitor other symptoms of the elderly. Shi Dong [5] and others by support vector machine (SVM) algorithm to upload of data processing, but it is only through fall SVM threshold value judgment, the characteristics of single algorithm and parameters, you can't measure other abnormal behavior other than the fall.

This design based on the above problems, implements an elderly more algorithm based on WIFI intelligent monitoring system, it collects the daily activities of the elderly through the multi sensor sensing device, in addition to the timely alarm function, using the anomaly judgment algorithm and other mixed algorithm to update the regular calculation of the daily life of the elderly data. And it through the WIFI uploaded to the big data platform, users can view the current status of the elderly at any time, and the law of life.
System Design

Intelligent Monitoring Equipment

The hardware circuit mainly comprises a main processor circuit, sensor circuit unit with multiple sensors (including temperature, humidity, ambient light, magnetic field, acceleration, vibration and other high precision sensor), WIFI transmission circuit, DC/DC converter circuit, data storage circuit, clock circuit, switch circuit module etc. The hardware structure of the system is shown in Figure 1.

Monitoring Center Service Platform

The monitoring center service platform is the data application layer, using HTTP hypertext transfer protocol, mainly by the data platform, PC monitoring, mobile monitoring terminal. The data platform is mainly responsible for receiving, analyzing, integrating, alarming and saving the uploaded data. The system uses the algorithm of personalized anomaly judgment, even if the elderly do not have an accident, but also through the analysis of the law of daily activities of the elderly, to predict the occurrence of accidents. For example, according to the situation of the elderly over the night, the number and length of time on the toilet, whether or not to take medicine on time and other data analysis of sleep status of the elderly, chronic disease, external environment and medication history and so on.

System Implementation and Key Technologies

According to the Shi Dong and others are using the support vector machine (SVM) algorithm, it was proposed by Vapid et al. in 1990. It adopts the signal vector module SUM characteristics of the acceleration and angular velocity of the space change set as a vector[6], but it only through the threshold to judge the fall, single parameter, measuring range has limitations, and do not have the function to prevent false alarm. This design adopts the personalized abnormal decision algorithm, that is, multiple combination of innovation of data analysis and processing algorithms. According to different applications and scenarios choose optimal algorithm. For example, there is an example to illustrate the application of the algorithm. As shown in Figure 2 is the change curve of acceleration in the movement process. Assume that the device is fixed to the body at this times, it is used for the detection of falls in the elderly.

Figure 1. System hardware structure drawing.

Figure 2. The fell motion curve of the elderly.
The red curve is the acceleration curve of the Y axis (vertical direction), which normal static condition should be -1g. Blue and green curves are X axis (front and rear direction) and Z axis (left and right direction) of the acceleration curves, its normal state should be 0g. The purple curve is the vector of the three axis acceleration and should be -1g.

At this point with the method of peak detection, the basic principle of peak detection algorithm for:

Step 1. First get acceleration sensor described in s period, in turn, the output acceleration data. It described acceleration data with the X axis and Y axis and Z axis acceleration. Then execute Step 2;

Step 2. Judge whether the sampling frequency of the acceleration sensor is higher than the preset sampling frequency, is Step 4; otherwise is Step 3;

Step 3. Calculation:

\[ f(t) = \sqrt{(x_t - x_{t-1})^2 + (y_t - y_{t-1})^2 + (z_t - z_{t-1})^2} \quad (t>1) \]  

(1)

\[ F(s) = \frac{1}{T} \sum_{t=1}^{T} f(t) \]  

(2)

Execution Step 5;

Step 4. Calculation:

\[ f(t) = \begin{cases} 
\sqrt{(x_t - x_{t-2})^2 + (y_t - y_{t-2})^2 + (z_t - z_{t-2})^2} & \quad (t = 2n, n \geq 1) \\
\sqrt{(x_t - x_{t-1})^2 + (y_t - y_{t-1})^2 + (z_t - z_{t-1})^2} & \quad (t = 2n+1, n \geq 1) 
\end{cases} \]  

(3)

\[ F(s) = \frac{1}{T} \sum_{t=1}^{T} f(t) \]  

(4)

Then perform Step 5;

Step 5. \( F(s) \) value compared with the preset value, and according to the comparison results determine whether the user is currently in a state of fall;

As shown in Figure 2, we can accurately measure the fall of the elderly. But if the fall caused serious consequences, such as lead to coma, so the body in a longer period of time remained stationary, does not produce peak. As shown in Figure 3, is the normal movement of the elderly when the curve, there will not be a larger peak. At this time, we can not judge the current state of the elderly, once the old man fell rather than walking slowly, the consequences will be very serious.

As shown in Figure 3, we should use the dynamic threshold detection algorithm, the algorithm is described as follows:

Step 1. First reads in s period acceleration sensor output acceleration data in turn; Described acceleration data with the x axis and y axis and z axis acceleration, execute Step 2.

![Figure 3. Normal walking curve of the elderly.](image)
Step 2. After the acceleration data collected to N, to calculate N average acceleration data as a dynamic threshold, perform Step 2.

Step 3. After calculating the dynamic threshold, the acceleration data obtained each time is compared with the dynamic threshold. And according to the comparison results to determine whether the movement of users.

This design use different algorithm for detecting different environment and different users. The system can realize the algorithm of personalized anomaly judgment, according to the needs of users and the use of the scene and so on, enables personalization of services.

Test Results and Analysis

In order to verify the abnormal decision algorithm, this design will make the following two sets of additional experiments. Two groups of judgments include: coma after the fall, and slow motion state after the fall. Since this experiment have contingency and risk, so the experiment done by 10 students, and let them try to simulate the old man slow walking pace. Each group was tested 100 times, one of the experimental results are shown in Figure 4, Figure 5.

Figure 4. Got up and slow motion state after the fall.

As shown in Figure 4, the old man fell between third and eighth seconds, then got up and moved slowly. So the system should be in third seconds to eighth seconds between the use of peak detection algorithm, once the peak coming (after eighth seconds) used the threshold detection algorithm to detect the elderly get up and slow motion. At this point the system does not alarm, to avoid the occurrence of false alarms.

Figure 5. Fall into coma state after the fall

As shown in Figure 5, the old man fell between third and eighth seconds, then fell into a coma. So at the beginning of the system use the peak detection algorithm, after eighth seconds, the use of threshold detection algorithm to detect the elderly into a coma. At this point the system immediately alarm and notify the doctor and the elderly family.

Summary

Aiming at the problem of high false positive rate in the past [1-4], this paper designs a new algorithm based on personalized anomaly judgment. In the accurate prediction of the law of old
people daily life at the same time, also can effectively prevent the occurrence of dangerous false positives, and verified in experiment.

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References