

Design of Anti-fall Alarm for the Elderly Based on Three-axis Acceleration Sensor

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Abstract: The safety of the elderly is a big problem in the aging society. The design of the elderly anti-fall alarm can effectively improve the safety of the elderly. For how to judge whether the elderly is falling or not, this design uses the method of nonlinear dynamics to analyze the acceleration data of the action. Nonlinear dynamics studies the qualitative and quantitative variation of various motion states of nonlinear dynamic systems, especially the complexity of the long-term evolution behavior of the system. Due to the influence of various nonlinear factors, the signal generated by the fall process is generally non-stationary, non-linear and non-Gaussian random signal. Aiming at the research purpose of this topic, this paper adopts the analysis method of symbol entropy to realize the accurate judgment of the threshold.

Keywords: Nonlinear Dynamics; Symbol Entropy; Threshold

In recent years, the proportion of the elderly population in China has been increasing year by year. With the flow of the working population, the phenomenon of empty nesters has become more and more. the problem of supporting and caring for the elderly has gradually become the focus of society. Among the problems of caring for the elderly, falls are the most common problem for the elderly. Falls are extremely harmful to the elderly. If the elderly are not timely rescue that will be even life-threatening.

At present, there are three basic methods for fall monitoring: (1) Based on the analysis of video images, the real-time motion of the object is monitored by the camera. the disadvantage is that the user's privacy cannot be guaranteed; (2) Based on the analysis of the acoustic signal, the fall event is judged by the analysis of the frequency of the vibration

caused by the impact, but its installation is more complicated and the capital investment is relatively large; (3) Based on wearable devices.

1. Design Purpose

At present, most of the products with human motion recognition technology on the market are based on visual recognition technology. Visual recognition is mainly used for static recognition, such as face recognition. However, the visual recognition technology cannot be accurately identified when the light is not good, and it is easy to leak user privacy. There are few products based on acceleration sensors for human motion recognition. At present, most of the human motion recognition technologies based on acceleration sensors have the problems of large computation and poor portability. Considering the user's privacy and minimizing interference with the user's lifestyle, wearable devices are the most suitable. Among them, the sensors used for fall detection mainly include acceleration sensors and tilt meters, but the main problem is that the judgment is not ideal when the side falls or finally does not lie flat on the ground. In view of the above problems, the hardware design of a detection device based on acceleration sensor is designed. the impact and the tilt angle of the human body can be detected only by the acceleration value. the symbol entropy method is used to judge the fall threshold to realize the judgment of the fall event, and the experimental results and conclusions are given.

2. Design Scheme

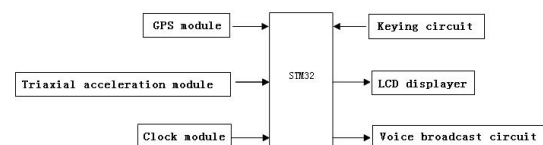


Figure 1. System Principal Block Diagram
According to the research content of the system, the scheme of the system is designed.

the STM32 single-chip microcomputer is selected as the main control system. the system will realize the function of anti-lost and fall detection for the elderly, as shown in **Fig. 1**.

The GPS positioning module is used to obtain the location information. GPS is a high-precision satellite navigation system, which can provide real-time location information and send the location information to the server. the server then sends the location information to the designated recipient through the communication network. the three-axis acceleration sensor can detect the resultant acceleration when the fall occurs, so as to determine whether the fall occurs. the clock chip is also added in the design. the system can display the current time value in real time, and can use the key setting circuit for calibration. the clock parameters and positioning

information can be displayed on the LCD screen. the main purpose of the voice broadcast circuit is that when the guardian finds the location of the elderly according to the location, the mobile phone can be used to remotely control the voice broadcast circuit to make a sound, so as to facilitate the elderly to have family members to find, which can play a role in appeasing and prompting.

3. Fall Recognition Scheme Design

The fall process and posture analysis have been described above. This design will judge whether the elderly fall through multiple parameter values, which are the inclination values of the body, and judge the angular velocity and acceleration values, and analyze the common state parameters, as shown in

Table 1.

Table 1. Attitude and State Table

State Parameter	Walk	run	Up and down the stairs	fall	decubitus
Angular velocity change	Smaller	General	Smaller	Larger	Smaller
Acceleration change	Smaller	General	Smaller	Larger	Smaller
Variation of inclination angle value change	Smaller	Smaller	Smaller	Larger	Smaller

According to the analysis, when there is no strenuous exercise, the resultant acceleration will not be greater than 1.2G, and the inclination angle will not exceed 30 degrees. the movement posture of the elderly is relatively simple. Usually, the judgment method of acceleration and angle should be used to exclude strenuous exercise, such as long jump, frog jump and distance sprint. Non-standard, as shown in **Fig. 2**.

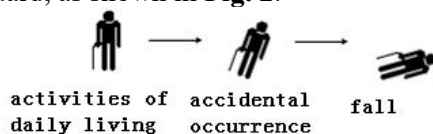


Figure 2. Fall Posture

When the fall occurs, the two most obvious indicators of the change are the angle change of the X axis and the Y axis, and the change of the combined acceleration. the fall first rolls, that is, the angle of the X or Y axis shifts. As the human body contacts with the ground, a positive acceleration will be generated. the degree of acceleration change according to the tilt angle value is different, so the combined acceleration is generally used in the calculation. To judge, when the fall occurs, it is in a gentle change, that is, the supine state, so the fall detection of the human body posture is based on the above principles.

The general state of motion of the elderly will not be very intense, so the threshold set for the elderly's anti-fall detection is generally fixed, and it does not need to be set by buttons or other means. Therefore, this design will select a set of commonly used state parameters as the criteria for fall evaluation, and combine the state changes when falling above, so the threshold of the combined acceleration is set to 1.5G and the angle value is defined as 30 degrees. When both are satisfied at the same time, the system can determine the occurrence of a fall. the design uses the JY. 61 triaxial acceleration sensor to collect the above parameters, as shown in **Figure 3**, which is the physical diagram of the module.

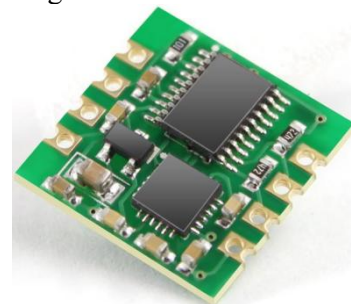


Figure 3. Triaxial Acceleration Sensor

4. Loss Detection Technology

About the loss detection of the elderly, we

must first clarify the design mechanism. the first is that the alarm can be triggered when the loss occurs, that is, the traditional wireless communication method is used to design the form of the mother-child machine. the two cannot exceed a certain distance, otherwise it is judged to be lost. This detection mechanism still binds the dynamics of the host, and cannot achieve long-distance transmission. And if the elderly need a wide range of activities, this detection mechanism cannot be used. Therefore, at present, the positioning detection method is used to obtain the positioning information of the elderly, which can prevent the loss of the elderly. For the acquisition of positioning, it is distributed according to the activity scene of the elderly. the scene of the elderly 's activity is not fixed, and if it is lost, it is difficult to control the walking route of the elderly. Therefore, GPS technology cannot obtain the positioning information of the elderly in real time. Once the elderly enter the indoor scene, GPS will lose the satellite positioning signal. Therefore, the design of the anti-lost detection system for the elderly must use the base station positioning method, using the operator 's location service to design, to achieve positioning acquisition, location service is the use of multiple base stations to obtain information, as shown in **Figure 4**.

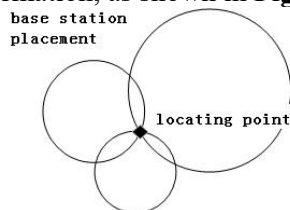


Figure 4. Base Station Positioning

According to the nearest base station range, the circle calculation is carried out, and the position of the base station is calculated separately to determine the current coordinate information. the more the number of base stations is, the higher the calculation accuracy is. In remote mountainous areas, due to the small number of base stations, the positioning effect is relatively poor.

5. Innovation Content

(1) The design uses a three-axis acceleration sensor to detect the motion parameters of the elderly. the sensor can realize three-axis acceleration detection, and can detect the standing angle value. When the angle value and acceleration parameters meet the system

alarm threshold, the system enters the alarm processing.

(2) The judgment of the fall threshold adopts the method of symbolic entropy: the symbolic sequence describes the dynamic characteristics of the system in the simplest way, and studies the running state of the complex dynamic system. According to this characteristic, the symbolic time series method is used to analyze the numerical value of the fall process. Shannon entropy, a statistic reflecting the overall characteristics of the symbol sequence, is introduced to describe the information expressed by the probability of each symbol sequence in the numerical symbol sequence of the fall process.

(3) The main purpose of designing a voice broadcast circuit is to act as a reminder after a fall, suggesting that the elderly family is successfully sent, the family is looking for, plays a certain role in comfort, and can play a role in calling for help. At the same time, if the family or medical staff comes to find according to the positioning information, if the elderly is not found within the target range, it can be found according to the sound.

6. Conclusion

Aiming at the characteristics of the elderly, this design combines micro-sensor, digital signal processing and wireless transmission technology, and uses the acceleration generated by human motion to design a fall detection device based on acceleration sensor, which can provide security and accurate monitoring for the elderly. At the same time, it protects the privacy of users. In the actual wearing experiment, the robustness of the fall algorithm is proved. the implementation of remote monitoring of the daily life status of the elderly and stroke patients who act alone can not only improve the rescue efficiency of medical staff and the quality of life of patients, but also evaluate the independent living ability and health status of the monitored objects. It can also make the elderly get timely rescue in a familiar environment to reduce the psychological pressure of the elderly and reduce the possibility of falls.

References

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