Portable device for detecting fall

CONTROL SYSTEMS AND INSTRUMENTATION ENGINEERING PROGRAM

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Introduction

Fall detection is crucial as it can have severe consequences, including fatalities, especially for the elderly whose bodies may be frail, making them prone to accidents. Falls are the most common cause of accidents, prompting the need to address this issue by enhancing and refining research efforts. The project aims to develop portable fall detection devices to improve accuracy and precision in detecting falls. Additionally, it aims to enhance notification and display capabilities through web applications. These portable devices enable immediate awareness of falls. The objective of this research project is to create portable fall detection devices designed to incorporate alert systems through sound and messaging via LINE applications, as well as develop a web application interface for displaying fall data. This can be achieved by applying threshold-based algorithm principles in device development.

Methods

The project aims to develop a portable fall detection device using the Threshold-based algorithm in Figure 1. It starts with reviewing relevant research on fall detection to determine the Threshold value. The device utilizes Gyroscope and Accelerometer sensors, focusing on achieving a Sensitivity of 99% or higher in fall detection. Features derived from sensor data, like AM, ACM, and AVCM, are used to calculate the Threshold. Testing involves using the SisFall dataset to find the Threshold, aiming for high Sensitivity

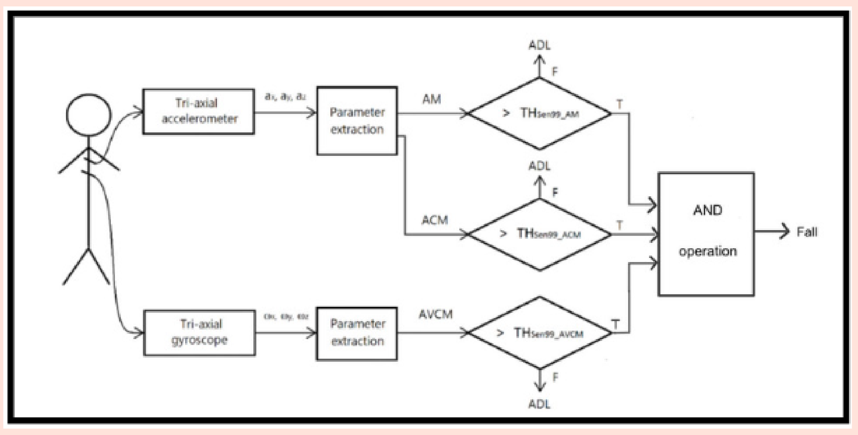

Figure 1: Algorithm for detection fall

Testing involves using the SisFall dataset to find the Threshold, aiming for high Sensitivity. Data from the device are stored in a Google Sheet database and analyzed for display on a web application. Notifications are sent via LINE messages and sound alerts through a Buzzer in case of a fall.

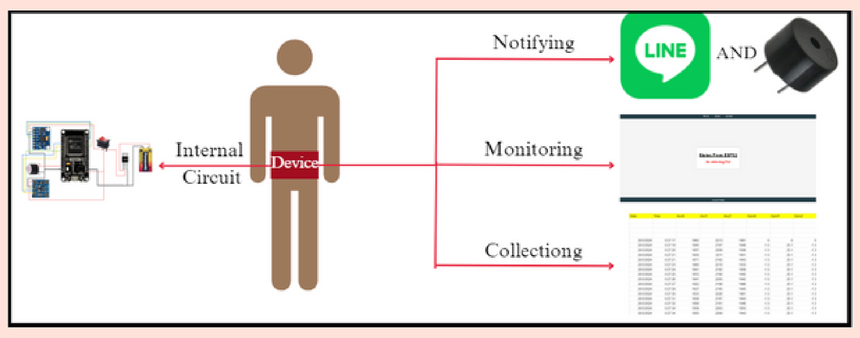

Figure 2: The overall operation of device

Data Analysis

For analyzing data to find the sensitivity and specificity values of Wang [1] and SisFall [2] 's research datasets. The SisFall [2] dataset will be used as the main dataset to find the Threshold value because this data set has a large enough number. The method used to find the Threshold value starts by selecting 60% of the data sets from the total number of data sets for training. The values in each data set will be calculated according to formulas for finding various parameter values. After that, the highest value of each data set is compared to find the smallest maximum value with the lowest value of each parameter. Because it is the value that makes the sensitivity of the training set data 100%. The value obtained is the Threshold value. used for testing with the remaining 40% of the dataset and Wang's research dataset. The sensitivity value is found by testing the Threshold value with a data set of falls the target has been set at 99%. The Specificity value is found by testing the Threshold value with the ADLs data set the target has been set at 95%.

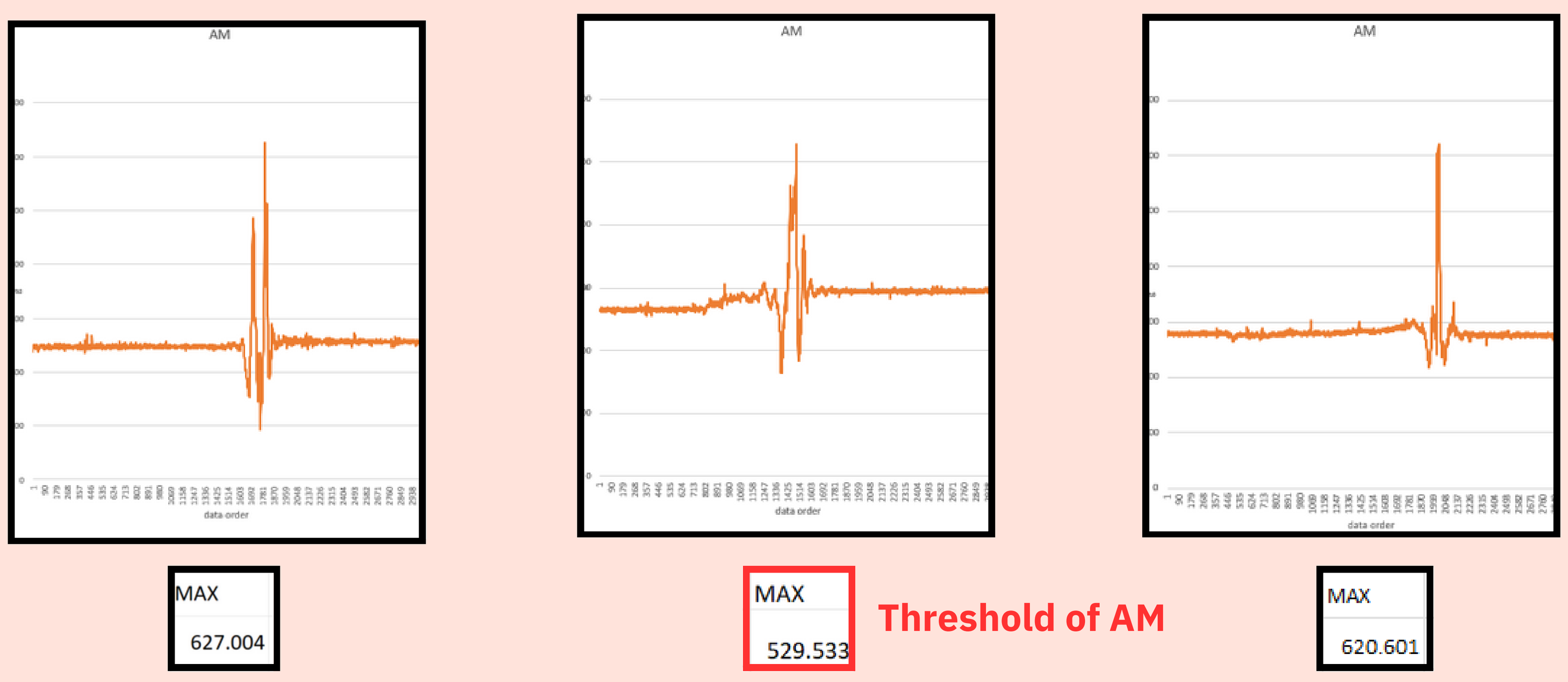

Figure 3: Compare the high values of AM feature and select the smallest value to use as the threshold value

Results

Test results of the Threshold values with fall datasets from two sources, SisFall [2] and Wang's research [1], are as follows:

	Sensitivity	Specificity
AM	99.70%	-
ACM	99.41%	-
AVCM	99.26%	-
AM+AVCM	98.96%	-
ACM+AVCM	98.81%	-
AM+ACM+AVCM	98.66%	-

Table 1: Test Results with Datasets from SisFall [2]

	Sensitivity	Specificity
AM	100%	41.66%
ACM	100%	57.50%
AVCM	100%	83.33%
AM+AVCM	100%	84.16%
ACM+AVCM	100%	84.16%
AM+ACM+AVCM	100%	84.16%

Table 2: Test Results with Datasets from Wang [1]

The test results with the SisFall dataset show Sensitivity values exceeding 99% when using a single feature like AM, AVM, or AVCM, while using multiple features together yields a Sensitivity greater than 98.5%, as shown in Table 1. Conversely, the test results with Wang's research dataset demonstrate a Sensitivity of 100% for all features selected in this project. This indicates the effectiveness of fall detection using the Threshold values calculated in this project.

Regarding data transmission, the developed system can store all feature and fall status s in Google Sheets for analysis and display of fall status through a web application. Additionally, it can send notification messages through the LINE application to caregivers when a fall occurs. Examples of successful data transmission and storage are depicted in Figures 3-5.

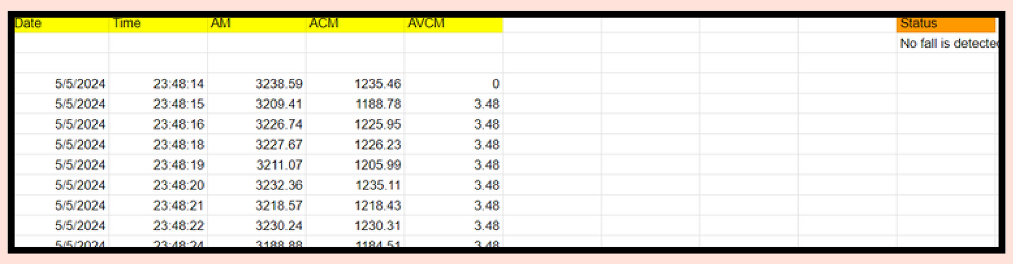

Figure 4: Data collection and fall status

Figure 5: Line notification

Figure 6: Monitoring website

Conclusion

The results in this project demonstrate that using more than one feature together is highly effective, achieving a sensitivity of over 98.5% on a public dataset (SisFall) and a perfect 100% sensitivity and 84.16% specificity on another dataset (Wang's research dataset). This suggests that the chosen thresholds for fall detection are reliable. The system can not only detect falls but also transmit data effectively, storing information in Google Sheets and sending notifications to caregivers through a LINE app.

Figure 7 : Actual wearing

References

[1] Fu-Tai Wang, Hsiao-Lung Chan, Ming-Hung Hsu, Cheng-Kuan Lin , Pei-Kuang Chao, Ya-Ju Chang, 2018, "Threshold-based fall detection using the hybrid of tri-axial accelerometer and gyroscope", Institute of Physics and Engineering in Medicine, 2018, 4-24, [25/09/2023].

[2] Angela Sucerquia, Jose David Lopez, Jesus Francisco Vargas-Bonilla, 2017, "SisFall: A Fall and Movement Dataset", Sensors, 17(1), 198. https://doi.org/10.3390/s17010198.

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