Fall Detection in the Elderly With Android Mobile IoT Devices Using Nodemcu And Accelerometer Sensors

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***Abstract*— One of the causes of falls in the elderly can have serious consequences, such as injuries and can even increase the risk of death. Assistance can be provided more quickly if a fall condition can be detected immediately. For that reason, the author will make a tool to detect falls in the elderly that are formed on the belt. using a belt as a medium because the belt is a human need that cannot be separated from fashion. The tool consists of SIM808 GPS, Node MCU, Accelerometer Sensor, Buzzer and an android-based cellular. The control center is the Node MCU which is equipped with a 6-axis IMU to detect the movement of the user. And it is also equipped with a SIM808 GPS Module to transmit location and condition data from its users. The GPS data is sent to Android, the Android is used to receive the location of the fall on the user. The tool can detect several falling conditions that can be sent to android. The delivery process uses the internet. The algorithm to detect falling motion uses a threshold-based fall-detection algorithm. Design and Modeling starts from the Hardware Design, where the design has a Node MCU as a control center that has input and output. Node MCU inputs are Accelerometer sensors, SIM808 GPS Shield. Where the accelerometer is used for fall detection, then SIM808 GPS Shield is for location determination and internet signals. The accelerometer sensor will produce input in the form of angle and speed which will later be processed so as to get one output for the user's condition. The output on the Node MCU is the buzzer and sending data to the Web Server. The workings of the system start at the Node MCU which reads the accelerometer sensor. When the accelerometer has passed the Threshold limit, the Node MCU will detect that there is a fall condition for the user. Node MCU will automatically activate the buzzer and send data to the thing speak web server. Connecting between hardware and android mobile where the hardware will be connected to the internet for the process of sending data. The data transmission is sent through the Web Server.**

***Keywords*— SIM808 GPS, Node MCU, Accelerometer Sensor, Buzzer, threshold-based fall-detection and android cellular**

I. Introduction

Indonesia is one of the countries that has experienced a fairly high increase in the number of elderly people, where in 2018 the elderly population in Indonesia is predicted to be higher than the world's average elderly population. Something that must be considered is that there are 9.66% of the elderly living alone without any family at home, this has a high risk, especially for the biological aspect, because the biological aspect affects the decrease in physical endurance and is susceptible to disease. So it is not known if something unwanted happens to the elderly, from these conditions a system is needed that can detect a person's movement, especially for unusual movements such as falling.

Falls which means that falls affect millions of people in the world. Most of the elderly's activities are carried out at home, so certain places need to be watched out for. One of the most potential places for falls to occur is the bathroom (Kido et al., 2009). Some of the consequences of falling, such as pain, weakness, disability, can even increase the risk of death (Shumway-Cook et al., 2009).

Supervision is very necessary for the elderly who have a high fall potential. Supervision can be carried out by family members or close people. The person in charge of supervising is of course required to always be near the elderly so that it is easier to find out and provide help if the elderly experience a fall. However, as a family member, it is not possible to always be near the elderly to carry out direct supervision. Therefore, supervision can be carried out indirectly by utilizing current technology. One of them is to use a device that can detect falls.

For this reason, the author will create a tool to detect falls in the elderly. The control center is the NodeMCU which is equipped with a 6-axis IMU to detect the movement of the user. And it is also equipped with a SIM808 GPS Module to transmit location and condition data from its users. The GPS data is sent to Android, the Android is used to receive the location of the fall on the user. The tool can detect several falling conditions that can be sent to android. The delivery process uses the internet.

II. Literature Review

According to (Febriani, 2017) in his project entitled Threshold Analysis Using the Hidden Markov Model Method, that falling is something that everyone has experienced, as happens to children, adults, and elderly people who have experienced it. The occurrence of falling on a person often occurs because there are many things that become multi-factors, both intrinsic factors, factors that come from oneself, such as loss of balance, illness suffered. Extrinsic factors are factors that come from the surrounding environment such as slippery floors, damage to tools used and so on. When a person falls with a physical condition that does not improve or weakens, it is very fatal and becomes a serious health threat. When falling there are injuries suffered ranging from minor injuries, and serious injuries to cause death. Serious injuries suffered when falling and causing death due to getting help too late. Some people who have a high risk of falling must always be under the supervision of the closest person or nurse who can provide assistance at any time when a fall occurs. Falls are a serious medical and social problem among the elderly. This led to the development of automated fall detection systems. To detect falls, a fall detection algorithm that combines the simple threshold method and the Hidden Markov Model (HMM) using 3-axis acceleration is used. To implement the proposed fall detection algorithm create a wearable fall detection device. It has been designed and manufactured. Several fall-feature parameters of 3-axis acceleration are introduced and applied to the simple threshold method. The likelihood of a fall was selected through a simple threshold and applied to the two types of HMM to differentiate between falls, and activities of daily living (ADL). The results using the simple threshold, HMM, and a combination of the simple method and the HMM were compared and analyzed. Combination of simple threshold method and HMM to reduce complexity. The hardware and algorithms used show higher accuracy than the simple Threshold method (Lim, 2014). A technological development in terms of methods made using the Hidden Markov method will be analyzed on the Threshold as a reference for the middle value of the falling condition, this analysis produces a definite value for the Threshold that can be used for all ages, so that the Threshold results are more accurate and can immediately improve previous research so that if a fall occurs immediately detect movement and get early help.

According to (Oktaviano, 2017), the cause of falls in most people is due to an existing disease, such as hypertension, stroke, headache/dizziness, joint pain, rheumatism, epilepsy, and vertigo. So it requires a system that can monitor the occurrence of falls. The sensor used to detect motion is the accelerometer sensor. When a falling motion occurs the system will send a notification via Bluetooth and sound a buzzer. Falling motion detection is done by calculating the difference in the value of the changes in the readings of each axis on the accelerometer. Threshold is used to distinguish between ordinary movements and falling movements. If the value of the change difference exceeds the Threshold value, the system will send a notification via Bluetooth to the supervisor and sound a buzzer.

According to (Norhabibah, 2016), the Elderly or Elderly Man is a transition period of the last human life. Decrease or loss of organ function such as loss of balance, vision and hearing begin to decrease causing the elderly to often fall. The limited physical abilities experienced by the elderly make them need supervision. This supervision is very important to do so that things do not happen that are not desirable. To monitor and monitor seniors whether there is a fall incident or not, it can be done by utilizing a tool, namely an accelerometer. In this study, the magnitude of the acceleration on the x, y, and z axes of the accelerometer sensor is processed into the total acceleration value. Then the value will be compared with a lower Threshold value and a higher Threshold value. After that the total acceleration value will be compared again with the Threshold value of the total orientation value. The total acceleration value is used to differentiate between normal activity and falls. The results of this study indicate that the developed system has a sensitivity value of 89% and a specificity of 98%.

A. NodeMCU

According to (Islami, 2017), NodeMCU is an open source IoT platform. Consists of hardware in the form of System On Chip ESP8266 from ESP8266 made by Espressif System. Figure 2.1 NodeMCU ESP8266 12E The NodeMCU can be analogous to an Arduino board connected to the ESP8622. NodeMCU has packaged the ESP8266 into a board that has been integrated with various features such as a microcontroller and the capacity for access to wifi as well as a communication chip in the form of USB to serial. So that in programming only a USB data cable is needed. Because the main source of NodeMCU is ESP8266 especially ESP-12 series which includes ESP-12E. So the features owned by NodeMCU will be more or less similar to ESP12.

Some of the available features include:

- 10 GPIO Ports from D0 – D10
- PWM functionality
- I2C and SPI interface
- Antaruka 1 Wire
- ADC

Fig. 1. NodeMCU

B. SIM808 GPS/GPRS/GSM Shield module

This SIM808 module functions as a tool for wireless communication at a frequency of 900 MHz. To activate the SIM808 module, a SIM card is required for communication to take place. The SIM808 module used in this final project is the SIM 808 module. Below are the specifications for the GSM 808 GPS/GPRS/GSM Shield,

- AVR microcontroller: ATmega32u4 (Bootloader: microcontroller)
- Operating voltage: 5V
- Input Voltage: 5V(USB) / 7~23V(Vin) / 3.5~4.3V(BAT)
- Digital I/O pins: 20 (7 PWM: 3,5,6,9,10,11,13)
- Analog Input pins: 12
- Flash: 32 KB (Bootloader: 4KB)
- SRAM: 2.5 KB
- EEPROM: 1 KB
- Clock Speed：16MHz
- GSM module: SIM808 GSM/GPRS/GPS module
- Quad-band 850/900/1800/1900MHz – 2G GSM network
- GPRS multi-slot class 12/10 55
- GPRS mobile station class B
- Compliant to GSM phase 2/2+ a. Class 4 (2W @ 850/900MHz)
- Bluetooth: Compliant with 3.0 + EDR (Not open in this version)
- Time-To-First-Fix a. Cold starts: 30s (typ.) b. Hot starts: 1s (typ.)
- ACCUracy: Horizontal position

Fig. 2. SIM808 GPS/GPRS/GSM Shield Module

C. ADXL345 Module

The ADXL337 module is an accelerometer sensor that is used to detect movement where this sensor has three axes, namely the X axis, Y axis and Z axis. This sensor will be combined with NodeMCU to be able to detect falls.

Fig. 3. ADXL345 . Module

D. *Web Server*

A web server is a computer used to store web documents, this computer will serve requests for web documents from clients. Web browsers such as Explorer or Navigator communicate over a network (including the Internet network) with a Web server, using HTTP. The browser will send a request to the server to request certain documents or other services provided by the server. The server provides its documents or services if available also by using the HTTP protocol. The server is the owner of the information that provides itself to provide services or services, while the client is the requester for the service. A web server is an HTTP server. HTTP is a protocol that supports communication between a web server and a web browser. HTTP has a simple rule, namely; the client sends a request, the server returns an answer. On HTTP servers usually use port 80. Apart from web servers, there are many other server utilities, such as ftp servers, mail servers and so on. If the web server handles requests to access the web, then the ftp server handles ftp (file transfer protocol), the mail server handles email, the database server handles the database.

E. *IoT (Internet of Things)*

IoT (Internet of Things) can be defined as the ability of various devices that can be connected to each other and exchange data through the internet network. IoT is a technology that allows for control, communication, collaboration with various hardware, data through the internet network. So it can be said that the Internet of Things (IoT) is when we connect things (things) that are not operated by humans, to the internet (Hardyanto, 2017).

But IoT is not only related to controlling devices remotely, but also how to share data, virtualize everything real in the form of the internet, and so on. The internet becomes a liaison between machines automatically. In addition, there is also a user who serves as a regulator and supervisor of the work of the tool directly. The benefit of using IoT technology is that the work done by humans becomes faster, younger and more efficient.

F. *Android Mobile*

The development of this Edunvi game application is based on the Android operating system. There are various definitions of Android by several experts, one of which Safaat (2012) states that Android is a Linux-based mobile device operating system. Meanwhile, according to J.F. DiMarzio (2008), Android is a Java-based operating system that operates on the Linux 2.6 kernel. Android is not a programming language but Android is an environment to run applications. Android provides an open / open source platform for developers, making this operating system very popular in the market. Most of the smartphone vendors produced are based on Android.

G. *12V . battery*

A battery is a device used to store electrical power. This tool is very functional because it can be used when you are on vacation or like the author, this tool is used to power the NodeMCU later.

III. METHODOLOGY

A. *Hardware Design*

This hardware design is based on the wiring for each device.

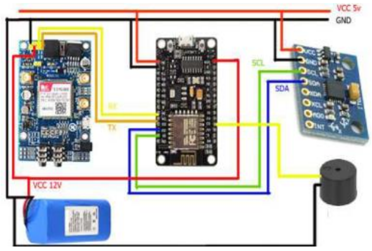

Fig. 4. Hardware design

In the hardware design there are SIM808, NodeMCU, and Accelerometer Sensors. The SIM808 is connected to the NodeMCU via Serial communication, namely RX and TX. The accelerometer sensor is connected using SDA and SCL where the pins are located on pins D1 and D2 of the NodeMCU. And each ground on the device is connected to one so that the devices can communicate with each other.

- In the design of NodeMCU and Accelerometer using SDA and SCL pins for data transmission. The wiring is green which is the SCL pin and blue is the SDA pin. For Vcc and Ground are connected to each other to get power. The design of a program that can produce results in the form of an accelerometer and a gyroscope. This system uses an accelerometer.
- In the design of NodeMCU and SIM808 generated by sending data Rx and Tx. NodeMCU uses the Serial software library. Make a program to Get GPS or retrieve GPS data accurately. The program takes the longitude and latitude values to be sent to the web server.
- In the design of the NodeMCU and Buzzer using pins D8 and Ground. Pin D8 is connected to vcc on the buzzer while ground is connected to ground on the buzzer. Make a program to activate the buzzer using pin 15 by forming an output as an output. To activate it by using digitalwrite 15 high.

B. *Communication System Diagram*

In this Connection Diagram is an explanation of the hardware connection on Android via the internet.

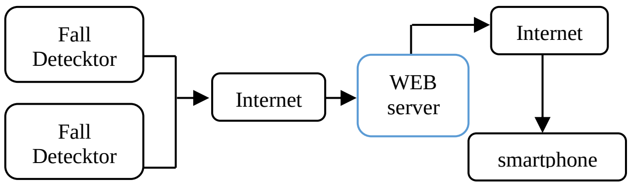

Fig. 5. Communication System Diagram

Connection between hardware and cellular (android) where the hardware will be connected to the internet for the process of sending data. The data transmission is sent through the Web Server. Data retrieval on mobile (android) will also go through the internet for data retrieval on the web server.

C. On-Device Software Diagram

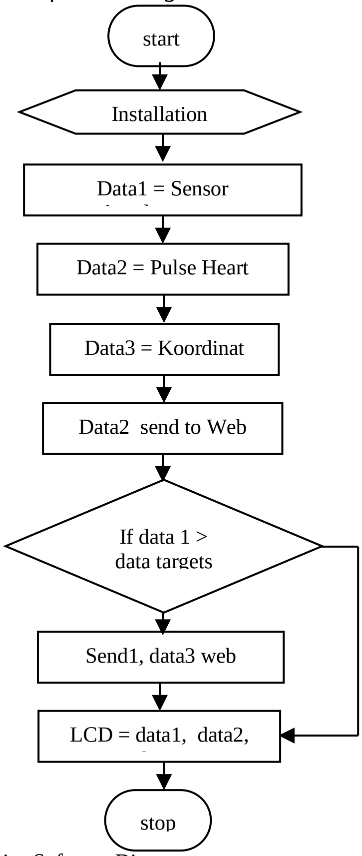

Fig. 6. On-Device Software Diagram

Software diagram on the device where the diagram is used for program flow in the Node MCU later. Data transmission on GPS and Accelerometer Sensors is sent to the webserver if the data is more than the target or a fall is detected. The process will repeat itself because it enters the looping program on the Arduino IDE.

- Program Initialization

The process for including libraries to support the program. The libraries are libraries on serial software, libraries on GPS and libraries on wire. Make program initialization where the library is followed by the word include while the variable is followed by the words int and const char. The program enters the SSID and password of the wifi so that NodeMCU can connect to the internet.

- Program Setup

the program runs a number of times only then is continued by entering the loop part of the loop. The program can be seen in the screenshot below. Creating a program in this setup section, there is a wifi connection process and a calibration process on the accelerometer sensor. The process of connecting to wifi can be done when the wifi that has the SSID and password that has been determined is active so it can run. If the process is running, it is continued by giving the number 0 on the web server so that the condition does not fall will be sent to the web server.

- Program Loops

Loop program which is used for the iteration process that determines the condition of falling and not falling. Creating a program loop is an iterative process which is used to determine falling and non-falling conditions. This condition has accelerometer data retrieval and delivery on a web server. Delivery of the web server is done by activating the buzzer first. Web server delivery is longitude, latitude and condition

D. Software Diagram On Android

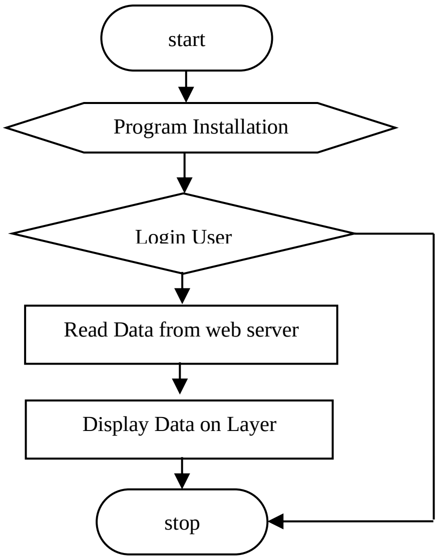

Fig. 7. Software Diagram On Android

Starting from start to start a program, then enter the program initialization. Then enter the user login menu, if the user is logged in, the program will automatically retrieve data on the web server and display it on the Android screen.

- Android Program Initialization

In the android program using the app inventor, the program is a variable identification program. The initialization of the program is the process of creating supporting variables in the program. The process of creating a global type variable which means that the variable can be used anywhere and anytime.

- User Login

At the user login there is an option to enter a user and password in the application. The program used can be seen in the image below. In the program there is a branch with the condition that if the user is the user and the password is admin then it can enter the next process.

- Read Data Web Server

On Read data from web server is retrieving data from web server where the file is of type json. The json file is processed in such a way that it gets the result of type string. On the web server data retrieval is stored per variable to filter the data. The data is used replace command to change the word limit in json. The process calls the json converter system to retrieve the json data on the web server.

- Tool Design Fall Detection

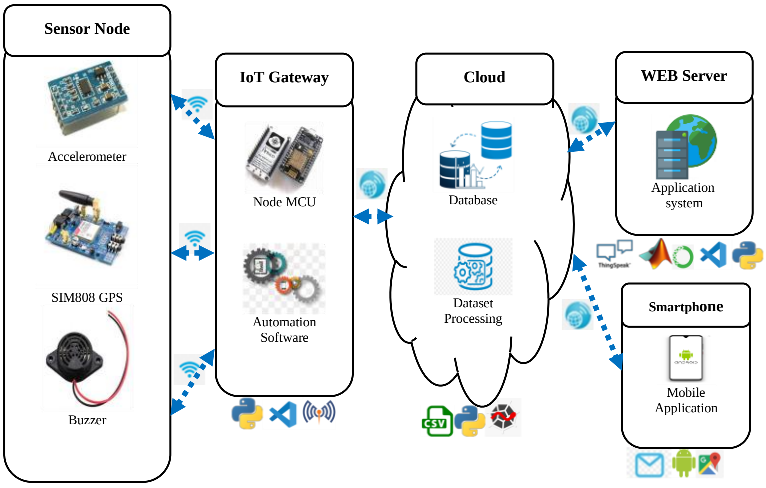

Fig. 8. Tool design fall detection

In Fig. 8. there is a fall detector which contains a NodeMCU device, an Accelerometer sensor, a buzzer, and a SIM808. All these devices are connected together with a PCB.

E. *Threshold-based fall detection*

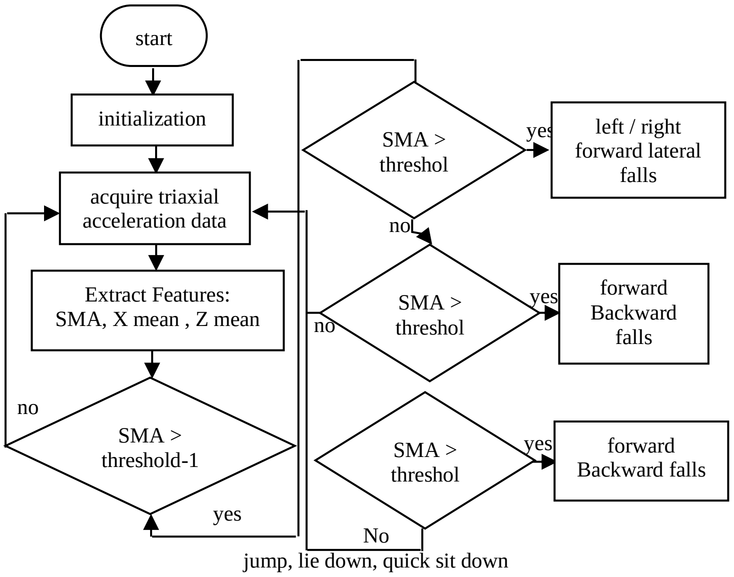

Fig. 9. threshold-based fall detection

Acceleration values could be adopted to detect lateral falls towards the right and left directions. At the same time, the mean of z-axis acceleration values would be employed to forward and backward fall detections. For the lateral fall detection, the mean of x-axis acceleration values is formulated as.

$$x_{\text{mean}}[n] = \frac{1}{N}\left(\sum_{i=n-N+1}^{n} |x[i]|\right)$$

The threshold value would be obtained by intensive displays the mean of x-axis acceleration values for human activities, including the lateral fall, walk, run, tread, going upstairs, and going downstairs. For the purpose of inspection, it is noted that six lateral falls occur one after the other. Therefore, the Threshold-2 is selected as 10.05 m/s2 through experimental observations. Similarly, in spite of the fact that this parameter is not theoretically verified, the feasibility would be proved later through realistic experiments.

IV. Results

A. *fall-detection*

In the fall detection test, this is a test on the accelerometer using a Threshold of value 3. Threshold is the point used to determine the condition of falling on the user. The threshold is determined by testing the data when a fall occurs. Testing the fall detection data includes falling forwards, backwards, to the right and to the left. The fall detection test with the accelerometer sensor before being combined with the acceleration formula can be seen in Fig. 10 – 17.

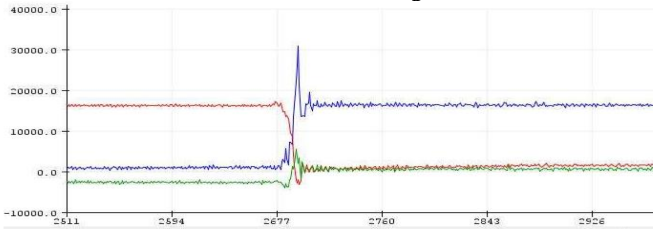

Fig. 10. Falling position to the left

In Fig. 10. there is a falling position to the left using the x, y and z axes. Where the initial standing position then fell to the left and the signal experienced a spike.

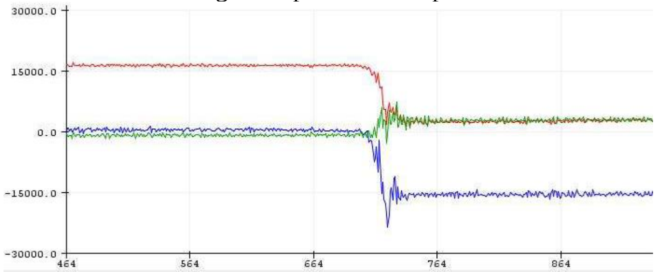

Fig. 11. Falling position to the right

In Fig. 11. there is a falling position to the right using the x, y and z axes. Where the initial standing position then fell to the right and the signal experienced a spike.

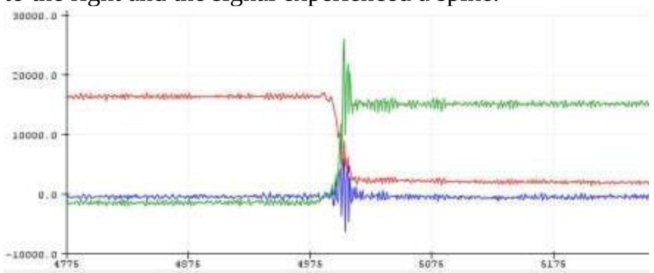

Fig. 12. Position Falling forward

In Fig.12. there is a forward position using the x, y and z axes. Where the initial standing position then fell forward and the signal experienced a spike

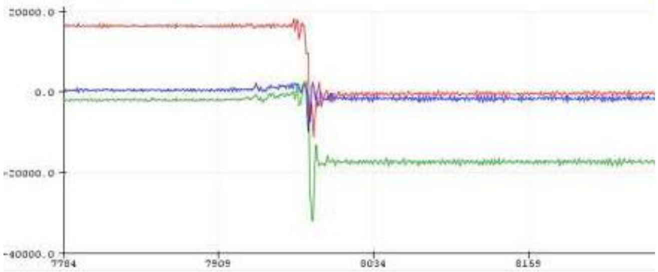

Fig. 13. Falling back *position*

In Fig.13. there is a backward position using the x, y and z axes. Where the initial standing position then fell backwards and the signal experienced a spike. In the formula for fall detection, the author uses the acceleration formula where the formula is:

acceleration = $\sqrt{x2 + y2 + z2}$.

Information:

x = accelerometer sensor results on the axis x.

y = accelerometer sensor results on the axis y.

z = accelerometer sensor results on the axis z.

Figure 10. – 13. shows the system test to determine the most appropriate Threshold value to distinguish a person's falling condition. The test results on the calculation results can be seen in Figure 14. - 17.

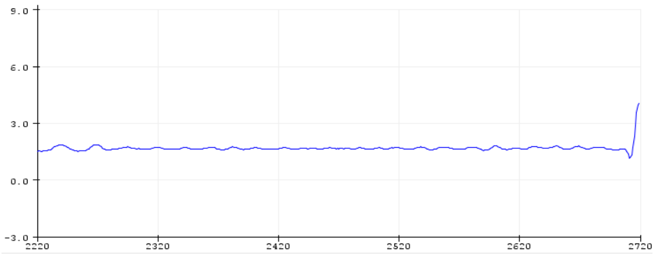

Fig. 14. Fall forward

In Figure 13. the data used for the condition of falling in a forward position. The beginning of the standing position is to step on a number less than 3 but when you fall, the value will automatically increase to more than 3.

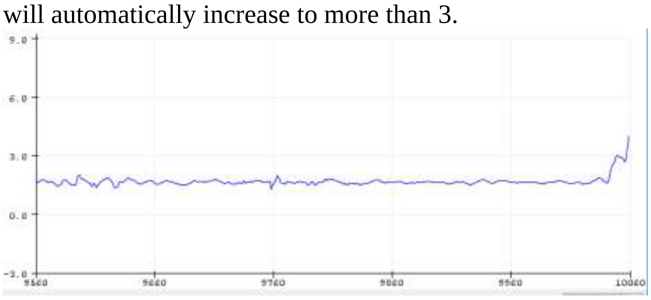

Fig. 15. Fall to the right

In Figure 14. the data used for the condition of falling in a forward position. The beginning of the standing position is to step on a number less than 3 but when you fall, the value will automatically increase to more than 3.

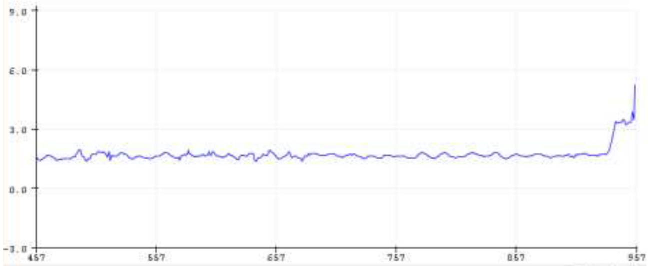

Fig. 16. Fall to the left

In Figure 15. the data used for the condition of falling in a forward position. The beginning of the standing position is to step on a number less than 3 but when you fall, the value will automatically increase to more than 3.

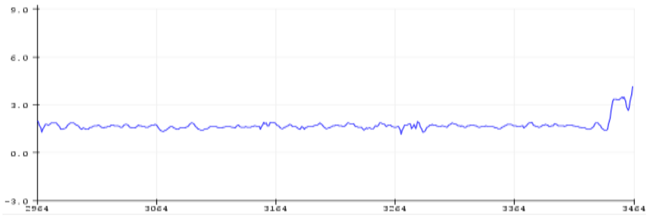

Fig. 17. Fall back

In Figure 16. the data used for the condition of falling in a forward position. The initial standing position is stepping on a number less than 3 but when it falls, the value will automatically increase to more than 3. Based on the test results, it can be concluded that the most appropriate Threshold number to determine the condition of falling is the Threshold value 3. If the threshold is too sensitive or less sensitive then it can be changed in the Node MCU program.

B. Threshold-based fall-detection

To detect whether a fall event occurred, a threshold-based algorithm was used. This threshold value is used to distinguish between falling motion or not falling. If the acceleration resultant value generated by the sensor exceeds the predetermined threshold value, a fall event occurs. Determination of this threshold value by analyzing all the acceleration resultant values from the testing phase, it is necessary to measure the accuracy, sensitivity and specificity values to see the accuracy of this fall detection. The greater the value of sensitivity and specificity, the better the accuracy. Sensitivity and specificity are calculated by Equation: ADL motion. From all the resultant data of ADL motion acceleration, the maximum value is taken to be used as a threshold value.

The fall detection under study is a fall that does not get up again. To detect a fall that cannot get back up, several stages are carried out. The first stage is to check whether the resulting acceleration resultant value exceeds the predetermined threshold value. After the first stage is fulfilled, the second stage gives a 1000ms delay. The third stage re-examines the acceleration resultant value generated from the sensor, whether for five seconds there is no significant change (a difference of 0.05g). If there is no significant change, it can be said that the person fell and did not get back up. An illustration of a falling person is shown in Figure 2.

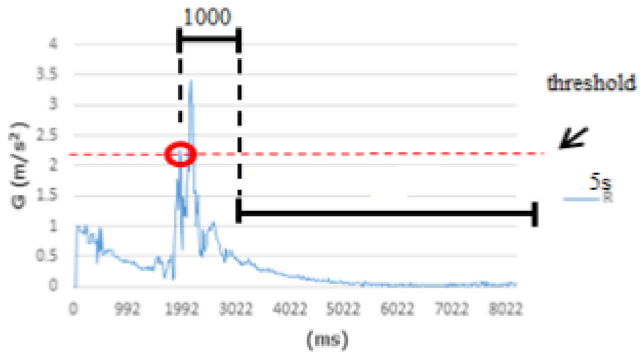

Fig. 18. Graph of Falling Motion Resultant Value

From the results of data acquisition, the resultant value of the acceleration of each motion is obtained. This resultant data will be used as a reference in finding the falling threshold value. The search for this threshold value is shown in Fig. 18

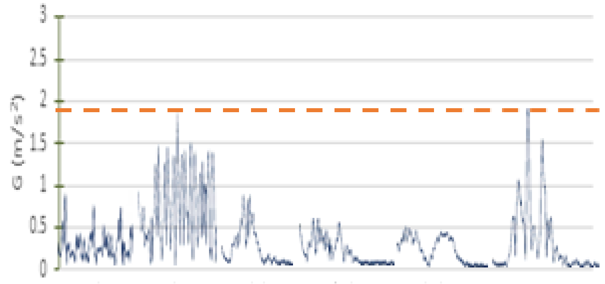

Fig. 19. Finding Threshold Value

From Fig.19, the threshold value used is 1.8g. If the threshold value is compared with the resultant acceleration of falling motion, it is as shown in Figure 4.

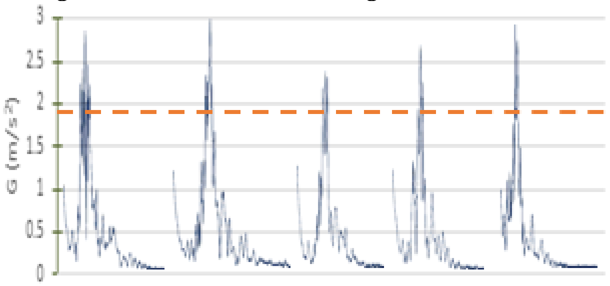

Fig. 20. Threshold Value of Falling Motion

The following are examples of the motion of falling that does not get up again, falling but getting up again and the motion of daily activities. In Figure 5, after the acceleration resultant value exceeds the threshold value, then after one second, it is checked whether the acceleration resultant value is constant for 5 seconds. This check returns true, which means it is identified as falling motion.

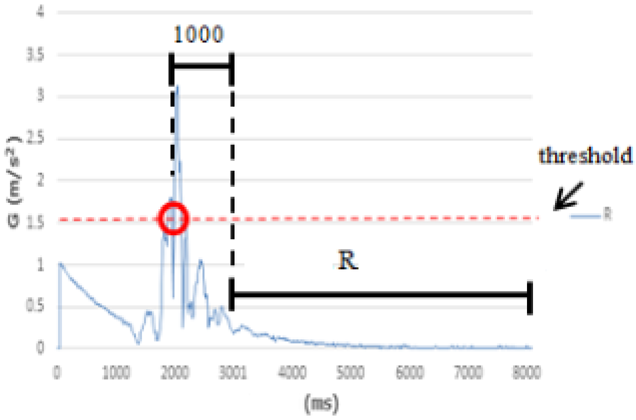

Fig. 21. Falling Graph Ends Lying Down

In Fig.21, after the acceleration resultant value exceeds the threshold value, then after one second, it is checked whether the acceleration resultant value is constant for 5 seconds. This check returns a false value because there is a significant change that is identified as not falling motion.

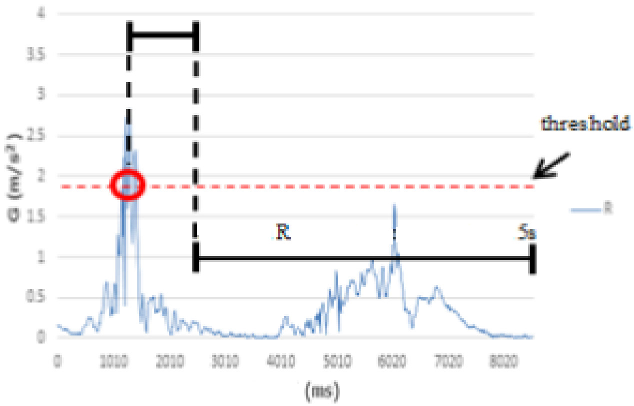

Fig. 22. Graph Falls Then Gets Back

Fig. 23, shows a graph of the walking motion. The moving motion graph is well below the threshold value so the sensor does not report a fall.

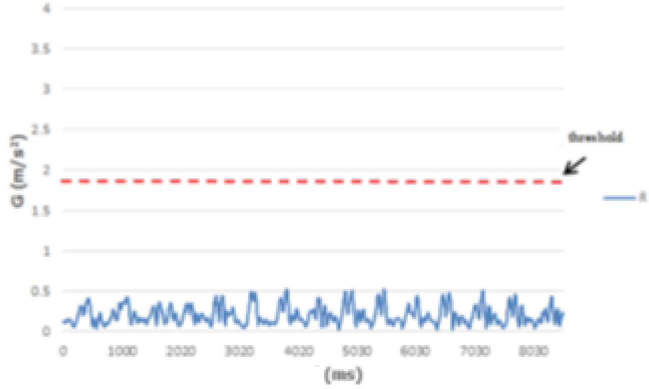

Fig. 23. Motion Graph

In the testing phase, it is necessary to measure the accuracy, sensitivity and specificity values to see the accuracy of this fall detection. The greater the value of sensitivity and specificity, the better the accuracy. Sensitivity and specificity are calculated by the equation:

$$Akurasi = \frac{TP + TN}{TP + FN + TN}$$

$$Sesnsifitas = \frac{TP}{TP + FN}$$

$$Spesifitas = \frac{TN}{TN + FP}$$

TN = True Negative (humans don't fall and sensors report no falls)

FP = False Positive (humans do not fall, sensors report falls)

FN = False Negative (humans falls and sensors report no falls)

Falling scenarios are so diverse that they must be tested with a number of falling motions and non-falling motions. The scenario and the results can be seen in Table 1.

TABLE I. FALL SCENARIO

Category	Condition	Sensor	Note:
Fall back	Ending up in a sitting position	fall	TP
	Ended up lying down	fall	TP
	Ends in a sideways position	fall	TP
	Get back up (considered not falling)	Don't fall	TN
Fall forward	With knees	fall	TP

	With forearm protection	fall	TP
	Ended up lying down	fall	TP
	With rotation, ending in a sideways position to the right	fall	TP
	With rotation, ending in a sideways position to the left	fall	TP
Fall to the right	Ended up lying down	fall	TP
Fall to the left	Get back up (considered not falling)	Don't fall	TN
Falling Perpendicular	Berakhir dengan posisi berbaring	fall	TP
ADL	Get back up (considered not falling)	Don't fall	TN
	Leans against the wall then slides vertically and ends up in a sitting position	Don't fall	FN
	Sit on a chair then stand up	Don't fall	TN
	Lie on the bed then get up	Don't fall	TN
	Walk a few meters	Don't fall	TN
	Bend over then return to an upright position	Don't fall	TN
	Run	Don't fall	TN
	up and down stairs	Don't fall	TN

V. CONCLUSION

The mapping of the problem in this study is how to make elderly fall detection using NodeMCU and accelerometer sensors, how the SIM808 GPS module sends the location of the fall to the user and how to detect falls that can be sent to a smartphone.

One of the causes of falls in the elderly can have serious consequences, such as injuries and can even increase the risk of death. Assistance can be provided more quickly if a fall condition can be detected immediately.

For that reason, the author will make a tool to detect falls in the elderly that is formed on the belt. using a belt as a medium because the belt is a human need that cannot be separated from fashion. the tool consists of SIM808 GPS, NodeMCU, Accelerometer Sensor, Buzzer and android-based cellular

The control center is the Node MCU which is equipped with a 6-axis IMU to detect the movement of the user. And it is also equipped with a SIM808 GPS Module to transmit location and condition data from its users. The GPS data is sent to Android, the Android is used to receive the location of the fall on the user. The tool can detect several falling conditions that can be sent to android. The delivery process uses the internet. The algorithm to detect falling motion uses a threshold-based fall-detection algorithm.

Design and Modeling starts from the Hardware Design, where the design has a NodeMCU as a control center that has input and output. NodeMCU inputs are Accelermeter sensors, SIM808 GPS Shield. Where the accelerometer is used for fall detection, then SIM808 GPS Shield is for location determination and internet signals. The accelerometer sensor will produce input in the form of angle and speed which will later be processed so as to get one output for the user's condition. The output on the NodeMCU is the buzzer and sending data to the Web Server.

The workings of the system starts at the NodeMCU which reads the accelerometer sensor. When the accelerometer has passed the Threshold limit, the NodeMCU will detect that there is a fall condition for the user. NodeMCU will automatically activate the buzzer and send data to the thingspeak web server.

Software design is a connection between hardware and android mobile where the hardware will be connected to the internet for the process of sending data. The data transmission is sent through the Web Server. Data retrieval on android cellular will also go through the internet for data retrieval on the webserver.

This monitoring can be monitored through various aspects including through smartphones. Nowadays, smartphones are owned by many people, including the elderly. Smartphones also now have many embedded sensors such as accelerometer, gyroscope and GPS. The combination of accelerometer and gyroscope sensors can detect falling movements by utilizing various fall motion detection algorithms, one of which is the threshold-based fall detection algorithm. The advantages of using the threshold-based fall detection algorithm are that it requires low battery power consumption and requires low computational work but has a fast response, the fall detector data transmission speed has an average of 10.9 seconds in 10 trials.

With the results of the data that has been tested, the accuracy value is 98%, the sensitivity value is 95% and the specificity value is 100%. Thus, this fall detection model can be said to have quite accurate results.

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