

Fall detection and notification system to fast emergency management for the elderly

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Abstract. An elderly person needs special attention from his family environment; however, in general elderly people still want to live independently and not depend on their family. On the other hand, elderly people have a high risk of falling accidents because they experience a decline in health, especially physical health, which can result in serious injury or death if treatment cannot be done immediately. To overcome this, a tool is needed that can detect falls in the elderly so that it is hoped that the elderly can be treated immediately. The elderly fall detection tool is designed using accelerometer, gyroscope and GPS sensors. The function of the tool is to detect an elderly person's fall and then respond by sending information to family members from the mobile phone number that has been stored in the tool's programming. The tool has dimensions of 3.4 x 7 x 3 cm which can be put into an elderly person's pocket. Testing of the tool was carried out by the subject performing a falling movement 10 times. The tool succeeded in detecting and sending fall information to Telegram 9 times so that the success rate of the fall detection tool was 90%.

1 Introduction

As time goes by from year to year, aging is inevitable and physical in nature with reduced appearance [1]. Falling is one of the effects of aging [2]. According to WHO data, 28-35% of elderly people over 65 years have experience falls each year and the pattern will increase with age [3,4]. The incidence of falls requiring treatment in hospital increased by about 3% and those who received injuries from the fall increased by 25% [5]. The risk of falls in the elderly can occur due to trips, slips, vehicle accidents or other factors. The consequences of the fall can cause serious injuries, fractures, motor disorders, fear of falling, morbidity or mortality [6]. On the other hand, elderly people still want to live independently.

Previous research related to the treatment of fall conditions for the elderly is alarm system with emergency notification when fall down condition from wheelchair user [7]. In this study specifically for elderly or someone who is independent in daily life but must use a wheelchair in carrying out their activities. When the wheelchair user falls out, the alarm will activate and the device will send the news of the fall to the mobile number stored in the tool's

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programming. In reality, not all elderly directly need wheelchairs. Wheelchairs are needed by elderly only when the physical condition of the elderly is no longer able to walk.

To bridge the elderly who are still active in their activities, with no need for a wheelchair and the family still can monitor especially the event of a fall out a tool was designed to detect conditions when the elderly fall out happen. The device will send a short message to the mobile number of one of the family members that has been saved in the program. The dimensions of the tool are small so that it can be put in the pocket of the elderly. By sending fall out news, it is hoped that the handling of elderly can be done quickly.

2 Method

To realize the fall detection tool and notification system, it will be described in this section the block diagram, flow chart and dimensions of the tool designed.

2.1 Block diagram

The hardware and software design is carried out using research methods based on literature studies, in the form of literature data from each component, information from the internet in the form of scientific publications, journals and using theories from supporting books. The block diagram in Figure 1 describes how the system works.

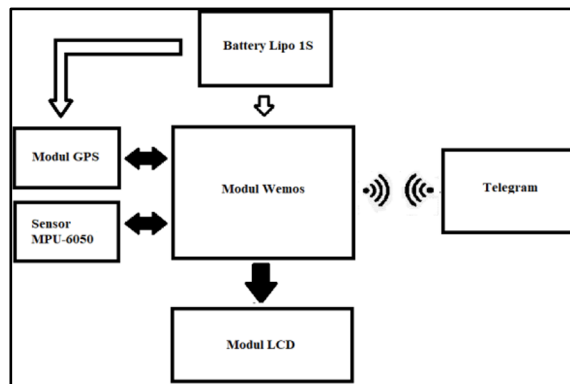


Fig. 1. Device Block Diagram

The main part of processing all data is processed on a microprocessor using WeMos D1 mini. Wemos D1 mini (ESP8266 module) is a microcontroller integrated into the Wi-Fi module and has a smaller size than the NodeMCU series [8]. This tool uses the MPU-6050 fall detection sensor as a sensor to detect if a fall occurs in the elderly. MPU-6050 has 3 axis Accelerometer and 3 axis Gyroscope [9]. The three-axis rotation angle includes Yaw, Pitch, Roll [10]. All components use a supply in the form of a rechargeable battery.

When the sensor detects a falling movement, it will send a signal to the microcontroller and will notify families who have the Telegram application on their smartphone so they can find out the location of the elderly person when the fall occurs. The following are the component functions in the block diagram of the entire tool:

- TP4056 Module as a battery charger
- Switch as a tool on/off control
- MPU-6050 sensor as a fall motion detection sensor
- Battery Lipo 1S as the power source of this tool
- GPS Module as a location tracking tool

- WiFi Wemos D1 for receives input and processes programs
 - Telegram for application to receive notifications sent by tools.
- The connection for each pin on Wemos can be seen in Table 1.

Table 1. Wemos Pin Connections

No	Pin Wemos	GPS Module	MPU-6050	LCD Module
1	D1	-	SCL	SCL
2	D2	-	SDA	SDA
3	D3	-	-	-
4	D4	-	-	-
5	D5	TX	-	-
6	D6	RX	-	-
7	D7	-	-	-
8	D8	-	-	-
9	3V3	-	VCC	VDD

As seen in Table 1 above, pin D1 is connected to the MPU-6050 Sensor and LCD Module. Pin D2 is connected to SDA on the MPU-6050 and SDA on the LCD Module. Pin D5 is connected to TX and pin D6 is connected to RX on the GPS module

2.2 Hardware design

The system circuit scheme applied to the device can be seen in Figure 2 below.

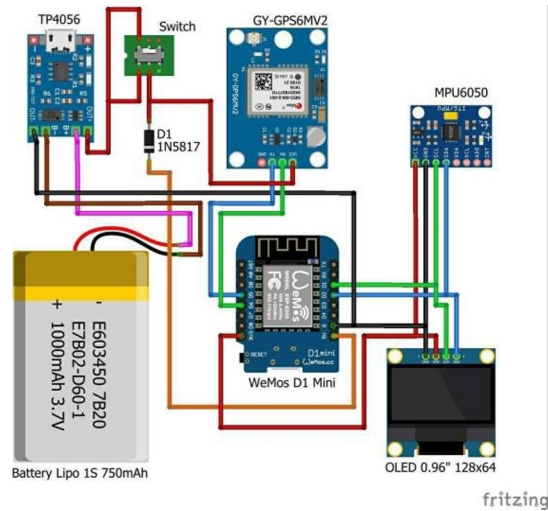


Fig. 2. Device Design

When a falling movement occurs, the MPU-6050 sensor will detect the angular velocity and angular changes that occur. If there is a change in the accelerometer touching the upper and lower limits, Wemos will wait for 3 seconds. If there is no further movement after that, WeMos will detect that the movement is a falling movement and send the information to Wemos for processing. If there is movement again within those 3 seconds, then the movement will not be confirmed as a falling movement by Wemos.

After Wemos receives information about the falling movement, Wemos will process the data, then Wemos will activate GPS and will track the location of the falling movement using

GPS. After receiving information about the location where the falling movement occurred, Wemos will send the information to the target Telegram application. This information is in the form of confirmation that there really was a fall and sending a Google Maps link showing the location where the fall occurred.

2.3 Tool dimension

This fall detector device placed into a transparent box that has dimensions 3.4 x 7 x 3 cm. At the top there is a switch to turn this device on and off. When used, this tool will be placed in the user's trouser pocket with the Y axis in an upright position. Figure 3 show the box of the fall detection device.

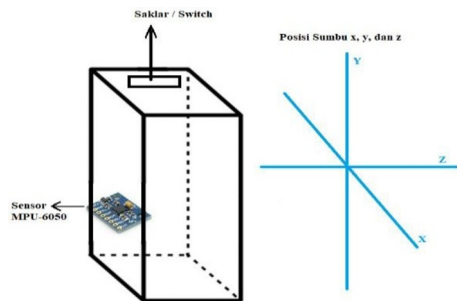


Fig. 3. Box of The Fall Detection Device

2.4 Telegram bot operation in device

The Telegram application is used to receive notification messages when a fall detector is active. Receipt of notifications by the Telegram application can be seen in Figure 4.



Note: Messages sent using Indonesian.

Fig. 4. Telegram App Notification

The notification displayed is in the form of the text “Attention! Falling Motion Detected!” and accompanied by a Google Maps link to the location where the fall occurred also there is the words "Valid, Not Valid" on the Google Maps link provided. This is caused by the GPS module not being able to work properly and it takes approximately 5-10 minutes to function and must be outside.

2.5 Flowchart design

The structure of the program flowchart for fall detection device can be seen in Figure 5.

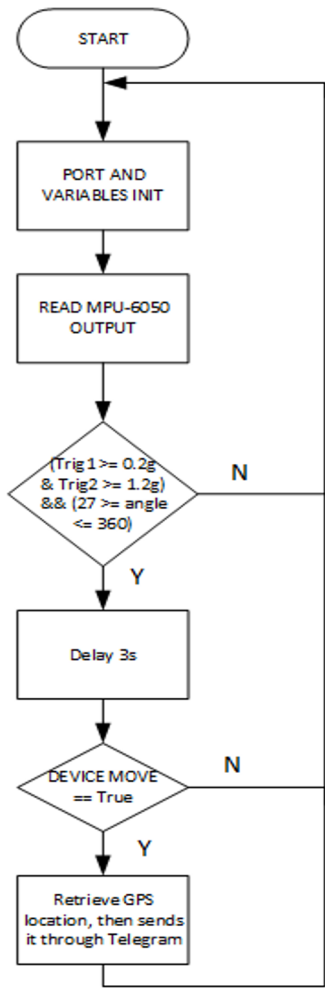


Fig. 5. Program Flowchart

As shown in Figure 5 above, when the device is powered on, the program will begin initialisation for all variables involved, including the MPU-6050, Wemos, GPS, LCD, and Telegram BOT. The MPU-6050 sensor will continuously send data regarding acceleration and angular velocity to the Wemos Module every 1.5 seconds interval. When the Wemos Module detects a change that indicates a falling motion, the first step is to verify that the change is indeed a falling motion. The Wemos Module will wait for 3 seconds. If there is any additional movement within this period, the event will not be considered a fall, but may just

be a shift, shock, or other accidental activity. If no change is detected within 3 seconds, the Wemos Module will confirm the fall event. The Wemos Module will request location data from the GPS Module. After that, the Wemos Module will use wireless connectivity to send the information to the specified Telegram application. The message sent to Telegram will contain the notification "A fall occurred!" and will be accompanied by a Google Maps link that can be accessed to find out the location of the fall event.

3 Implementation status, testing, and trial

Table of tool experiments regarding the name of the experiment subject, time, and success, can be seen in Figure 6.

Testing	Results	Tools	Code
1 Getting the acceleration value and angle alteration when the sensor falls down	MPU-6050 sensor can get the acceleration value and gradient value from the x-axis, y-axis, and z-axis	Sensor MPU-6050	Succeed
2 Send message notification to the Telegram users	The Wemos modul can send a simple message notification and Google Maps link of the fell location	Wemos D1 WiFi Modul	Succeed

Fig. 6. Device Testing Table

In the experiment, several experiments were carried out to test the value and success of the tool in carrying out its function. The experiment was conducted by placing the device on the pants pocket (see in Figure 6). Then the user performs a falling motion. This experiment was carried out as many as ten times trying to fall. Some of the tests carried out can be seen in Figure 7.

Testing	Name	Day	Date	Time	Status
1	Ivan	Wednesday	7-Jun-23	14.10 WIB	Success
2	Ivan	Wednesday	8-Jun-23	14.11 WIB	Failed
3	Ivan	Wednesday	9-Jun-23	14.13 WIB	Success
4	Ivan	Wednesday	10-Jun-23	14.14 WIB	Success
5	Ivan	Wednesday	11-Jun-23	14.15 WIB	Success
6	Ivan	Wednesday	12-Jun-23	14.15 WIB	Success

Fig. 7. Experimental Table



Fig. 8. Placement of the Tool on the Right Pants Pocket

Therefore, it can be seen that the success rate of this tool can be calculated using the following formula:

$$\%success = \frac{\text{number of successful attempts}}{\text{total of attempts}} \times 100\% \quad (1)$$

Then the formula will find a result of 90%. So, in the 10 experiments conducted, the success rate of the device in detecting falling motion was 90%.

4 Conclusion

In this tool, what is meant by falling is a sudden movement and a sudden change in acceleration and angular velocity. When the MPU-6050 sensor detects an acceleration with a lower limit of 2 m/s² and an upper limit of 12 m/s², and experiences a change in angle of 27°- 360°, the tool will conclude that it is a fall. After that the tool will send a notification to the telegram application that has been addressed and accompanied by a google maps link that can be opened to find out the location of the elderly when the fall occurred. If the device does not change until it touches the predetermined boundaries, then the device will assume that the movement that has just been detected is not a falling event. This could be because the device was only bumped, shaken, accidentally fell, and others. In testing this tool, 10 attempts were made by performing a falling motion. Of the 10 attempts, the device successfully detected the falling motion and sent a notification to the telegram in 9 attempts. Therefore, it can be concluded that the success rate of this tool to detect falls is 90%

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