The Portable Tools of the Elderly Alzheimer Patients

Yulastri, Era Madona, Anggara Nasution and M. Irmansyah
Jurusan Teknik Elektro Politeknik Negeri Padang Jl. Limau Manih Padang, 25164, Indonesia

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Abstract: In this study we propose a portable tool to monitor and monitor patients at risk of Alzheimer's. The aim of this research is to design and make a useful tool to determine the position and condition of Alzheimer's sufferers. The research stages consisted of designing hardware, software and testing the whole tool. To find out the patient's condition, an accelerometer sensor was used which would read the values of the x, y, and z axes to determine whether the condition was okay or falling. This tool is also equipped with a panic button if the patient does not know his position and forgets to go home, an SMS notification will be sent. The results of the test, the device can send an SMS notification of the patient's position when the supervisor sends a sms, "GPS ON and the navigation module can determine the exact location by moving the reading position of the GPS module to the test point with an average of 1.99 meters. Overall the tool can function properly.

1 INTRODUCTION

Alzheimer's disease is a progressive degenerative disease of the brain that commonly affects older people. This disease is characterized by confusion, disorientation, memory failure, speech problems, and dementia. The risk of developing Alzheimer's increases with age (Neugroschl, J., & Wang, S. 2011), (McKhann et al.,2011). There are approximately 47 million people who suffer from Alzheimer's disease in the world (Ricci, 2019) and as many as 27 million of them are in Asia (Aggarwal, N. T et al., 2012). Indonesia based on the results of the 2014 National Economic Survey, the number of elderly people in Indonesia reached 20.24 million people or about 8.03% of the entire population of Indonesia. This data shows an increase when compared to the results of the 2010 Population Census, namely 18.1 million people or 7.6% of the total population. Alzheimer's disease is most commonly seen in older people > 65 years of age, but it can also affect people around 40 years of age (Holtzman, 2020). Alzhaimer's disease can make the elderly get lost when walking out and forget to walk home (Caspi E, 2014). Lack of information and time to report to the police as well as inadequate CCTV face identification tools because their use is only applied to certain areas is a problem in monitoring Alzheimer's patients. Based on data from the Radio Suara Surabaya Research Team, from January 2017 to July 2019, Radio Suara Surabaya has received 618 listener reports about missing people due to dementia or senility (Yulastri, 2021).

Due to this, an action is needed in the form of surveillance for someone who experiences symptoms of Alzheimer's (Galvin J. E, 2017).

The development of information technology has given birth to technological innovations in the health sector, including research (Khodkari et al., 2019). Mobile application-based surveillance of patients with disease-at-risk has been developed for diabetes (Aulia et al., 2018), cardiac (Islam et al., 2018) and stroke (Amritphale et al., 2017) patients. In addition, microcontroller-based patient monitoring with notification has also been carried out for vertigo patients (Yulastri et al., 2020), premature infants (M. Irmansyah et al., 2019) and the risk of prolonged sitting (E.Madona et al., 2018). In this study we made a small, low-cost, portable device to monitor and monitor patients with Alzheimer's symptoms. Several related studies have been carried out before a study conducted by (Siregar et al., 2018) used Arduino, gyroscope and accelerometer sensors to measure the falling motion of the elderly, the results showed the system could detect and distinguish between conscious and accidental falls. Using the MPU6050 sensor with a 3-axis accelerometer and a 3-axis gyroscope (Jefiza et al., 2017) conducted a study to detect elderly activities with the backpropagation method used for motion recognition. The results showed an accuracy rate of

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0.1818 with an ROC of 98.12%. A similar study was also conducted by (Aphairaj et al., 2019) using the line application as LINEBOT if the elderly were detected falling. The results showed the system could send alarms with high effectiveness.

The development of the previous research are (1) Notifications are cheaper because they use SMS compared to the internet network, (2) Monitoring can be done in two directions where the family can find out the patient's position by sending an SMS to the device used by the patient.

The approach to making this tool uses a wearable sensor based (M. Mubashir et al., 2013). Wearable sensor based, used for device cost efficiency, installation and arrangement of the design is also not complicated. Therefore, the device is relatively easy to operate (A. Hakim et al., 2017). With this tool the supervisor can find out the position of the patient by sending an SMS to the device attached to the patient with a certain format. This tool is also equipped with a panic button if the patient does not know its position and forgets to go home. In addition, this tool also uses an accelerometer sensor which is a protection for Alzheimer's patients when the majority of patients are elderly when they go out and fall, the sensor will detect the tilt of the patient, the majority of whom are elderly people, fall left, right, backward and forward and send notifications. SMS to supervisor for the coordinate of the patient's position. The aim of this research is to design and make a useful tool to determine the position and condition of Alzheimer's sufferers. It is hoped that this tool can be used as a monitoring and tracking tool, especially for Alzheimer's patients to stay healthy and protected in their activities.

2 METHOD

The method used in this research is making prototype tools starting from literature study, system design, hardware design, software design, hardware testing, software and analysis of test results. This tool for monitoring the position of Alzheimer's patients is used for elderly patients who are placed on their waist, when Alzheimer's patients leave the house for a long time and forget to go home, the supervisor wants to know their location, so orders are carried out by the user or supervisor with a specific command format sent to SIM800L. Then the message on the SIM800L will be processed by Arduino nano. The working principle of the tool can be seen in Figure 1. Location data sent by GPS U-Blox Neo coordinates the location of the patient's whereabouts. This data

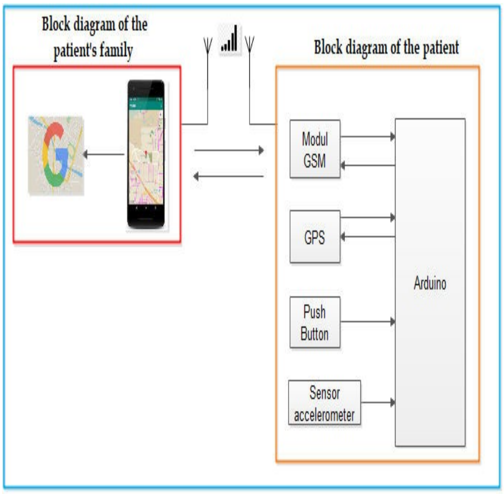


Figure 1: System Block Diagram.

will be processed by Arduino nano which will later be sent to SIM800L. SIM800L will forward the contents of the message in the form of the location coordinates of the whereabouts to the supervisor's cellphone. This coordinate point is opened in the Google Maps application where from the message there is a web url address. In the Google Maps application, the patient's location can be seen in the form of a digital map. The push button functions as a panic button if the patient does not know his position and forgets to go home, Arduino will process it, and GPS U-Blox Neo will send location coordinate data to SIM800L and then forwarded by SIM800L to the patient supervisor's cellphone. The accelerometer / tilt sensor functions to detect the slope of the patient, the majority of whom are elderly people who fall, whether they fall left, right, backward and forward. Arduino will process it then it will be forwarded to GPS U-Blox Neo and will send location coordinate data to SIM800L and then forwarded by SIM800L to the patient monitoring cellphone.

2.1 Hardware Design

This circuit consists of an Arduino nano functioning as a microcontroller, a GSM SIM800L module, a GPS module, a push button, a tilt angle detector using the MPU6050 accelerometer. The battery is connected to the 5V and GND pins, as seen in Figure 2. The MPU6050 sensor has 2 (two) pins that will be connected to the Arduino pin, namely pin A5 (SCL), pin A4 (SDA) on the microcontroller detecting the tilt of the patient's position which is placed on protoype bag when experiencing a change in position which is divided into several conditions. To determine the patient's condition on the accelerometer sensor can be seen in table 1. The battery as a mobile voltage source for this system is connected to the + 5V and GND microcontroller and + 4V to the SIM800L GSM module. To get a voltage of + 4VDC, a DC-DC converter is needed. The RXD pin on the SIM is connected to pin 7 on the Arduino and the TXD pin is connected to pin 7 of the Arduino. The series of GPS modules is connected to the 3.3V pin on the Arudino as a voltage input. The GPS is connected to the GND pin on the Arduino for grounding. The GPS module has 2 (two) pins that will be connected to the Arduino pin, namely pin 0 (TXD) panic button is connected to the 5V pin on Arduino as a voltage input. Meanwhile, the output is connected to pin 2 such as in figure 3(a). The device is made to be placed on the patient's belt. The design of the tool box can be seen in Figure 3(b).

Table 1: Accelerometer Sensor Value for fall detection.

Fall Direction	Patient's Condition			Information
	x	y	z	
Normal	0°	26 ° - 90 °	21 ° - 90 °	The patient is fine
Fall to the left	-65 ° - -90 °	-25 ° - 0 °	90 °	The SMS is sent in the form of a patient's location link : www.google.com/map/place
Fall to the right	65 ° - 90 °	25 ° - 0 °	90 °	The SMS is sent in the form of a patient's location link : www.google.com/map/place
Fall forward	70 ° - 90 °	90 °	20 ° - 0 °	The SMS is sent in the form of a patient's location link : www.google.com/map/place
Fall back	-70° - -90 °	90 °	-20 ° - 0 °	The SMS is sent in the form of a patient's location link : www.google.com/map/place

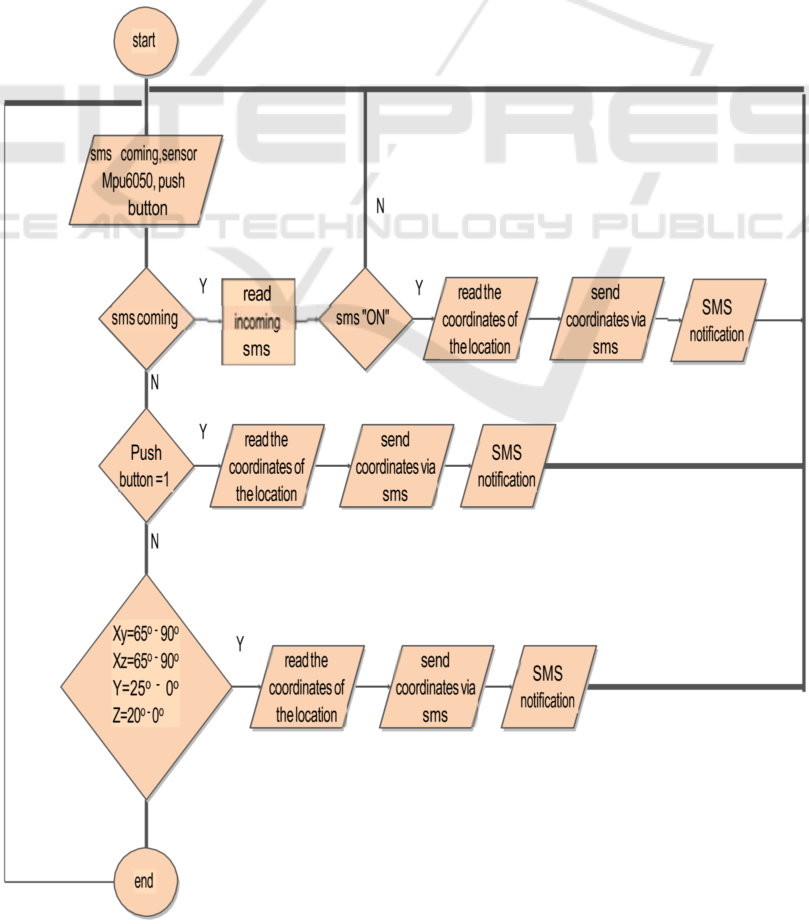
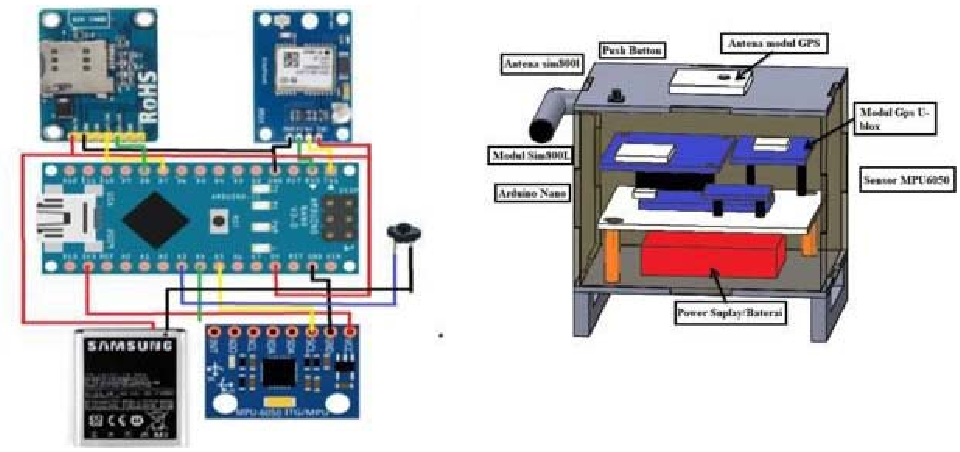


Figure 2: Flowchart of Alzheimer's patient monitoring tool.



(a) **(b)**

Figure 3: Designing Tool Prototype.

2.2 Software Design

The flowchart for monitoring Alzheimer's patients with SMS notifications can be seen in Figure 2. The process starts with the initialization of I/O. Furthermore, there are three stages of checking, first the incoming SMS is in the SMS format "ON", the second is the panic button with a value of "1" and the Accelerometer sensor reading. The device will read the patient's location and send an SMS notification of the patient's location to the supervisor's cellphone.

3 RESULTS AND DISCUSSION

Furthermore, testing the tool aims to determine the advantages and disadvantages of the system that has been made. The test is carried out in two stages. First, testing system performance, secondly testing tool notifications. This bag prototype-shaped device is then attached to the patient, as seen in Figure 4.

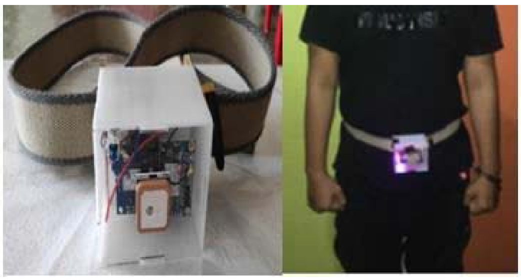


Figure 4: Installation of monitoring devices for Alzheimer's patients on the body.

3.1 System Performance Testing

This test is done to determine the performance of the tool, starting with testing the tilt sensor on the accelerometer. The data taken is based on the slope of the angle 0^o, 20^o, 25^o 70^o, and 90^o to the left, right, front and back then the sensor data is displayed on the serial monitor, so that the results are in accordance with table 1.

Figure 5: Testing of Alzheimer's patient surveillance tools.

Based on table 1, when the patient's condition is normal, the accelerometer sensor is tilted x = 0^o, y = 26^o - 90^o, z = 21^o - 90^o. When the patient falls to the left, the patient is in a tilt position x = -65^o - -90^o, y = -25 ^{o} - 0^o, z = 90^o. Furthermore, when the patient falls to the right, the patient is in a tilt position x = 65^o - 90^o, y = 25^o - 0^o, z = 90^o. When the patient falls forward, the patient is in a tilt position x = 70^o - 90^o, y = 90^o, z= 20^o - 0^o. Meanwhile, when the patient falls backwards x = -70^o - -90^o, y = 90^o, z = -20^o - 0^o. Changes in the angle value will affect the sensor value of the MPU6050 sensor. The greater the

Table 2: Detection test falls on the system.

Category	Number of experiment	Notification Fall		Accuracy %	Detection %	
		Yes	No			
Face down	15	14	1	90	Yes	No
Recumbent	15	14	1	90	90	10
Total	30	28	2			

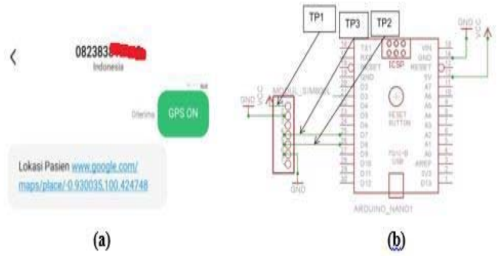


Figure 6: (a) The supervisor sends the message “GPS ON”, (b) SIM800L Measurement Point.

change in angle, the greater the sensor value of the MPU6050 sensor. So when the sensor value of the MPU6050 sensor shows the data value that has been set when it falls left, right, forward and backward, SIM800L will send an SMS to the number 08526359xxxx. The SMS that contains the link for the longitude and latitude coordinates only when the GPS module gets a signal. If when the MPU6050 sensor shows the Alzheimer's patient data has fallen and the GPS module does not get a signal, then the SMS sent will only contain “Patient location” which does not have a link for the longitude and latitude coordinates. Furthermore, testing the detection of tools for falls and prone incidents is carried out. The test results can be seen in table 2. Based on the experiments in table 2, some falling activities such as falling on your back and falling on your stomach can be detected by the system as falling activities with an accuracy rate of 90%.

3.2 Testing Tool Notifications

This test is conducted to determine whether the device can send SMS notifications and determine the position of the patient. The first test The supervisor will send a message "GPS ON" to the patient's device to test the SIM800L to work properly so that it can communicate with the microcontroller as a link to the GSM network. When the GPS module gets a signal, a message is sent containing "Patient location www.google.com. / map / place ”and when the GPS module does not get a signal, the message sent is only the message“ Patient location ”which does not have a link for the longitude and latitude coordinates. When sending SMS from SIM800L to the supervisor, the voltage is 5.04V on the GND and RX pins, while when receiving SMS the voltage is 1.38V on the GND and TX pins. Measurement points and SMS notifications can be seen in Figure 6.

Furthermore, testing of tool notifications is carried out when the panic button is pressed. When the push button is in high condition, the SIM800L will send an sms to the supervisor, the output voltage is 4.8V, then the GPS module gets a signal, the message is sent "Location of the patient is www.google.com/map/place". When receiving a signal, the output voltage on the GPS module at the GND and TX pins is 4.8 V, while at the time of sending the signal, the voltage at the GND and RX pins is 2.5V. The measurement point and SMS notification when the panic button is pressed can be seen in Figure 7. We hope you find the information in this template useful in the preparation of your submission.

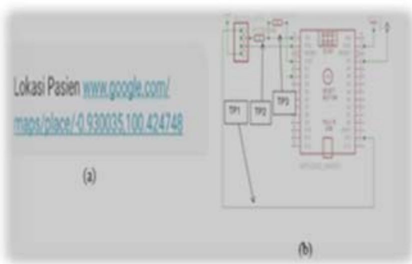


Figure 7: (a) SMS notification when panic button is pressed, (b) GPS module measurement point.

To determine how accurate is the reading of the coordinates of the location captured by the GPS satellites using the Ublox Neo-7M module by

Table 3: The difference between the shift from the GPS reading point to the test point.

No	Test Location	Google Map		Modul GPS		Error
		Latitude1	Longitude1	Latitude2	Longitude2	(meter)
1	location 1	-0,930057	100,424882	-0,930035	100,424848	2,79812
2	location 2	-0,940817	100,382332	-0,940811	100,382089	1,67962
3	location 3	-0,928732	100,350293	-0,928711	100,350288	1,49266
			Average			**1,9901**

Table 4: The results of the GPS module testing observations.

Input data	Which are expected	Observation and testing
Data from module (latitude & longitude)	The GPS module can pinpoint the patient's location	The GPS module can detect the latitude and longitude coordinates of the test well, with an average difference in the shift in the module reading points of around 1.9901 meters.

calculating the difference in the shift of the coordinate reading point (latitude and longitude) with the coordinate value obtained from the Google Maps application. The test was carried out at three different locations in the city of Padang. The coordinates of the test position can be seen in Figure 8.

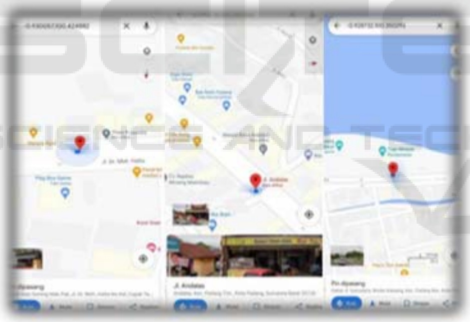


Figure 8: GPS test position.

In table 3, there are latitude1 and longitude1 values, which are taken from test points that use the Google Maps application on a smartphone. The latitude2 and longitude2 values are obtained from the data from testing the U-blox Neo-7M GPS module. Calculation of the distance between two points on a curved surface (spherical Earth theory) by utilizing latitude and longitude values can use the Haversine Formula method (F. Farid and Y. Yunus, 2017). This method is an equation for the use of navigation in order to calculate the distance between coordinates in the Desimanl Degree (DD °) geographic projection system. So that the value of the difference between the shift in points read by the GPS module will be obtained.

Furthermore, the observation and module testing are carried out on the patient's position as shown in Table 4

The GPS module testing is conducted to find out how accurate the Neo-7M GPS module is in determining the coordinates of the location because the GPS module's reading accuracy value greatly affects the process of tracking the accident location to find the location of the victim. The GPS module in this study can read the coordinates of the location well.

4 CONCLUSION

(1). While sensor accelerometer MPU6050 in slope range –y = -25º - 0 º the conditions of patients fall to the left. In the range y = 25º – 0º patients fall to the right, the range z = 20º – 0º patients fall to in front and the range z = -20º – 0º patients fall to the back. The position of rotation point at X axis which have slope kemiringan x_y = 65º – 90º, $-x_y$ = - 65º – 90º , x_z = 70º – 90º dan $-x_z$ = -70º – -90º. (2). GPS U-BLOX NEO Module has difficulty to reach the satellite signal to determine the longitude and latitude position while inside the room and can get the longitude and latitude position easily outside the room. (3) Once the GPS U-BLOX NEO Module get the signal then the GSM SIM800L module sent a SMS "Lokasi Pasien www.google.com/map/place" to 08526359xxxx. If the patient supervisor sent the SMS "GPS ON" to 08238381xxxx and push button is pushed or high condition and the patient fall to left, right, in front or to the back with the position shift of GPS Module reading to the testing point average is 1.99 metre.

REFERENCES

Neugroschl, J., & Wang, S. (2011). Alzheimer's disease: diagnosis and treatment across the spectrum of disease severity. *The Mount Sinai journal of medicine, New York*, *78*(4), 596–612. https://doi.org/10.1002/msj.20279

McKhann, G. M., Knopman, D. S., Chertkow, H., Hyman, B. T., Jack, C. R., Jr, Kawas, C. H., Klunk, W. E., Koroshetz, W. J., Manly, J. J., Mayeux, R., Mohs, R. C., Morris, J. C., Rossor, M. N., Scheltens, P., Carrillo, M. C., Thies, B., Weintraub, S., & Phelps, C. H. (2011). The diagnosis of dementia due to Alzheimer's disease: recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimer's & dementia : the journal of the Alzheimer's Association*, *7*(3), 263–269. https://doi.org/10.1016/j.jalz.2011.03.005

G. (2019). Social Aspects of Dementia Prevention from a Worldwide to National Perspective: A Review on the International Situation and the Example of Italy. *Behavioural Neurology*, *2019*. https://doi.org/10.1155/2019/8720904

Aggarwal, N. T., Tripathi, M., Dodge, H. H., Alladi, S., & Anstey, K. J. (2012). Trends in Alzheimer's disease and dementia in the asian-pacific region. International journal of Alzheimer's disease, 2012, 171327. https://doi.org/10.1155/2012/171327

2020 Alzheimer's disease facts and figures. (2020). Alzheimer's & dementia : the journal of the Alzheimer's Association, 10.1002/alz.12068. Advance online publication. https://doi.org/10.1002/alz.12068

Caspi E. (2014). Wayfinding difficulties among elders with dementia in an assisted living residence. Dementia (London, England), 13(4), 429–450. https://doi.org/10.1177/1471301214535134 https://www.suarasurabaya.net/kelanakota/2019/Sejak-2017-SS-Mencatat-Ada-293-Kasus-Lansia-Hilang-Karena-Demensia/

Galvin J. E. (2017). Prevention of Alzheimer's Disease: Lessons Learned and Applied. Journal of the American Geriatrics Society, 65(10), 2128–2133. https://doi.org/10.1111/jgs.14997

Khodkari, H., Maghrebi, S. G., Asosheh, A., & Hosseinzadeh, M. (2019). Smart Healthcare and Quality of Service Challenges. *9th International Symposium on Telecommunication: With Emphasis on Information and Communication Technology, IST 2018*, 253–257. https://doi.org/10.1109/ISTEL.2018.8661125

Aulia, A., Tanzil, F., Wairooy, I. K., Gunawan, L. K., Cunwinata, A., & Albert. (2018). A development of android-based mobile application for getting ideal weight. *Telkomnika (Telecommunication Computing Electronics and Control)*, *16*(3), 1289–1294. https://doi.org/10.12928/TELKOMNIKA.v16i3.8342

Islam, M., Sadhukhan, R. K., Haque, M. M., Rahman, N., Alam, S. S., Chowdhury, M. S. R., Abdullah-Al-Kaiser, M., & Shahnaz, C. (2018). Android based heart rate monitoring and automatic notification system. *5th IEEE Region 10 Humanitarian Technology Conference 2017, R10-HTC 2017*, *2018-January*, 436–439. https://doi.org/10.1109/R10-HTC.2017.8288993

Amritphale, A., Amritphale, N., & Dubey, D. (2017). Smartphone applications providing information about stroke: Are we missing stroke risk computation preventive applications? *Journal of Stroke*, *19*(1), 117. https://doi.org/10.5853/jos.2016.01004r

Yulastri, E. Madona, M. Irmansyah, and A. Nasution. (2020) Alat Deteksi Jatuh Berbiaya Murah Dengan Tracking Position Untuk Pasien Vertigo dan Sinkop. *J. RESTI (Rekayasa Sist. dan Teknol. Informasi), vol. 4, no. 6, pp. 9–11, 2020*, doi: 10.29207/resti.v4i6.2608.

M. Irmansyah, E. Madona, and A. Nasution (2019). Design and application of portable heart rate and weight measuring tool for premature baby with microcontroller base. *Int. J. GEOMATE, vol. 17, no. 61, pp. 195–201, 2019*, doi: 10.21660/2019.61.ICEE12.

E. Madona, M. Irmansyah, and A. Nasution (2018). Sistem Informasi Untuk Posisi Dan Lama Duduk Dengan Smartphone Android Berbasis Mikrokontroler. *Elektron J. Ilm., vol. 10, no. 2, pp. 1–5, 2018*, doi: 10.30630/eji.10.2.75.

M. Mubashir, L. Shao, and L. Seed (2013). A survey on fall detection: Principles and approaches. *Neurocomputing, vol. 100, pp. 144–152, 2013*, doi: 10.1016/j.neucom.2011.09.037.

A. Hakim, M. S. Huq, S. Shanta, and B. S. K. K. Ibrahim (2017). Smartphone Based Data Mining for Fall Detection: Analysis and Design. *Procedia Comput. Sci., vol. 105, no. December 2016, pp. 46–51, 2017*, doi: 10.1016/j.procs.2017.01.188.

F. Farid and Y. Yunus (2017). Analisa Algoritma Haversine Formula Untuk Pencarian Lokasi Terdekat Rumah Sakit Dan Puskesmas Provinsi Gorontalo. *Ilk. J. Ilm., vol. 9, no. 3, pp. 353–355, 2017,* doi: 10.33096/ilkom.v9i3.178.353-355.

Siregar, B., Andayani, U., Bahri, R. P., Seniman, & Fahmi, F. (2018). Real-time monitoring system for elderly people in detecting falling movement using accelerometer and gyroscope. *Journal of Physics: Conference Series*, *978*(1). https://doi.org/10.1088/1742-6596/978/1/012110

Jefiza, A., Pramunanto, E., Boedinoegroho, H., & Purnomo, M. H. (2017). Fall detection based on accelerometer and gyroscope using back propagation. *International Conference on Electrical Engineering, Computer Science and Informatics (EECSI)*, *2017-Decem*(September), 19–21. https://doi.org/10.1109/EECSI.2017.8239149

Aphairaj, D., Kitsonti, M., & Thanapornsawan, T. (2019). Fall detection system with 3-axis accelerometer. *Journal of Physics: Conference Series*, *1380*(1). https://doi.org/10.1088/1742-6596/1380/1/012060.

Holtzman, D. M., Mandelkow, E., & Selkoe, D. J. (2012). Alzheimer disease in 2020. *Cold Spring Harbor perspectives in medicine*, *2*(11), a011585.

Ricci, W. A., Lu, Z., Ji, L., Marand, A. P., Ethridge, C. L., Murphy, N. G., ... & Zhang, X. (2019). Widespread long-range cis-regulatory elements in the maize genome. *Nature plants*, *5*(12), 1237-1249.

Yulastri, Y., Madona, E., Nasution, A., & Irmansyah, M. (2021). The Elderly Alzheimer Patient's Portable Tools for Position Detection with SMS Notifications. *Indonesian Journal of Electronics, Electromedical Engineering, and Medical Informatics*, *3*(4), 156-163.