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Design of Monitoring System Step Walking With MPU6050 Sensor Based Android

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Abstract

Walking is said to increase endurance, burn calories and improve cardiovascular health. To monitor the steps when walking, we need a tool that is a gyroscope sensor MPU6050. Making this tool uses a gyroscope sensor for monitoring footsteps because Gyroscope is used to measure or determine the orientation of an object based on the provisions of angular momentum. This tool has been tested by foot with a number of different steps. The device test carried out by one person testers.

Data obtained from these tests resulting from the detection lower limit value and upper limit value of X axis angle data is used in data processing is the value of the X-axis is converted into a sine wave form chart. To detect footsteps, each wave has the upper value limit is 20^{o} and the bottom value is -20^{o}. Once the step is detected, these measures will be multiplied by the width of the foot when walking, then obtained distance.

Keywords: *Gyroscope*, *Threshold*, *Distance*

1. Introduction

Technology makes humans are lazy to exercise even though exercise is one physical activity that can increase the health and prevent various diseases. Many diseases that arise from wrong lifestyle such as lack of movement and exercise. According to dr. Michael Triangto, SpKO, Sports Medicine Specialist Doctor (2014) explains that the World Health Organization (WHO) says about two million people worldwide die from diseases caused by lazy lifestyle and lack of exercise. Meanwhile, research conducted by the University of Hong Kong said the long-term effects of exercise is not as dangerous as smoking. Research carried out in 2004 it was mentioned that about 20 percent of the causes of deaths of adults aged 35 years and over due to lack of exercise.

Walking is a great way to exercise. Many of us are ignoring this activity due to the use of personal transport equipment that we have. Because walking is not a strenuous activity, there is a belief that walking does not have a significant effect, either on the health of the body and in order to reduce levels of fat and calories in the body. Walk it had a profound effect on weight loss as well on the health and fitness. Usually we are not aware of how many steps we do every day, is to meet our physical needs or not. For the health benefits of walking are advised to take 10,000 steps each day. By walking 10,000 steps is said to improve health. Walking is said to increase endurance, burn calories and improve cardiovascular health. To monitor the steps when walking, we need a tool that is a gyroscope sensor MPU6050.

Gyroscope is an angular velocity sensor is used to measure the rotational speed of an object. Gyroscope is used to measure or determine the orientation of an object based on the provisions of angular momentum, in other words gyroscope determines gravitational motions made by the user. Gyroscope has a very important role in maintaining the balance of an object to determine the slope of the axes X, Y and Z. The role of gyroscope on this tool is to determine the pace along with the distance.

At the end of the assignment was made by a microcontroller to calculate the distance to the footsteps and MPU6050 sensor connected with android applications. Previous research examines the measurement of kinematic changes in the ankle using a gyroscope sensor which measures the kinematic changes in the ankle using a gyroscope sensor. Kinematic changes shown in the form of a sine wave in android application. The authors designed a microcontroller as the final project before but adds features that can count the number of footsteps and distance with a gyroscope sensor using a comparison limit value (Threshold) on the data axis X. When a sensor is connected, then the gyroscope sensor will read the data X, Y and Z then data from all three axes are taken one corner is the X-axis X data is compared by using the upper limit value and lower limit value to detect footsteps. For the calculation of distance, must be known how many footsteps that done, then multiplied by the average width of the foot when walking. After comparisons and calculations, the sensor will show data such as the number of footsteps and distance through android application. Media transmission for sending data from the sensor to the android app uses Bluetooth HC-05. The final task Monitoring System Design Step Walking With Android-Based Sensor MPU6050 is expected later to make everyone more control of their sport because the system can monitor in real time the number of footsteps and the distance that can be viewed via mobile android.

2. Research Method

2.1 Description

In this final project will be made a tool to measure distances footsteps and monitored using android application. This android app named Jalan Sehat. This tool is designed to allow a user to monitor footsteps by utilizing a gyroscope sensor. This step counters placed on the thigh.

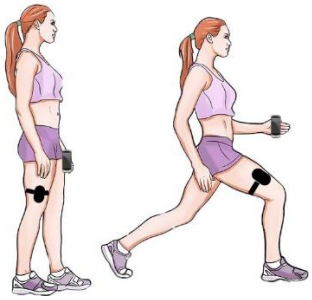

Figure 1. Tools Position

When Bluetooth is connected, the sensor will read the data results of footsteps. The data in question is in the form of angle values of the X, Y and Z. The angle value is converted into a sine wave graph so you can easily determine the threshold up and down on the corner that forms the value of the wave. In this system, take the value of one of the corner used to detect footsteps and distance calculation that is the axis X. When doing trial runs, the X-axis read data from the movement of the foot, If the gyroscope data is less than -20^{o} then there is a marker that the data has reached the lowest point, then the sensor reading the gyroscope data again. If the gyroscope data is above 20^{o} and the marker data is already read the lowest point, the step added 1. Results step is multiplied by the average width of the foot when walking. Average width feet when stepping is 0,7m. By multiplying the result of step and an average width of feet, then obtained distance. The data sent to an android smartphone via Bluetooth transmission form of the measures and the distance displayed in android application. Here is a workflow system in general how the tool works:

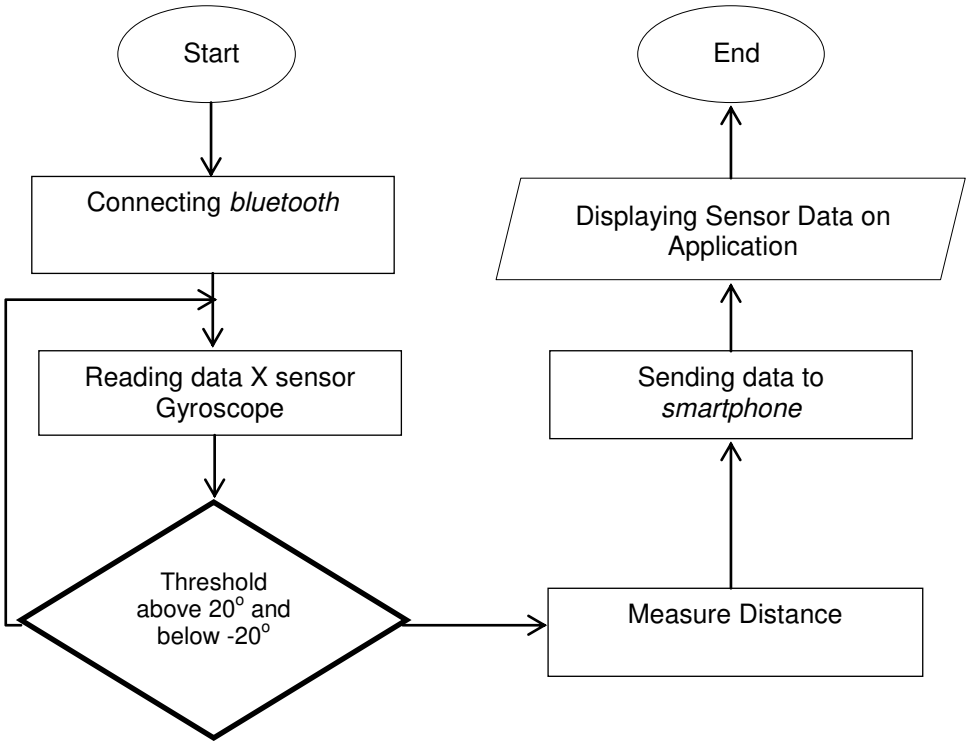

Figure 2 Work Equipment Process

2.2 Design Hardware and Software

Designing system for counting footsteps and distance controlled by Arduino Nano, MPU6050, and Bluetooth. The workmanship through two stages, the design of hardware and software design. Hardware design includes the design tool that combines a gyroscope, an Arduino Nano, Bluetooth HC-05 and a 9V battery. Gyroscope is used to obtain the output value of the data in the form of X, Y and Z then processed into data such as the number of footsteps and distance. Software design, source code for the calculation steps and distance put on Arduino Nano then do the upload so that the source code is stored on the Arduino Nano. Arduino Nano act like Brain on this instrument. Data from Arduino is then sent to an android application that acts as a monitoring.

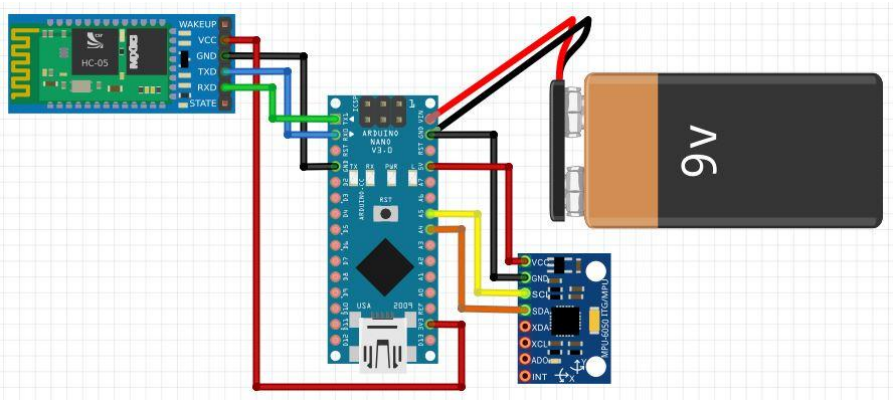

Figure 3. Design Hardware

Figure 4. Design Software

2.3 Design Testing

In design testing, the testing doing by one person to activity leisurely walk. This is the design of the test:

Table 1. Design Testing

Activity	Footsteps	Distance
Leisurely Walk	4 Step	2,4 Meter
	8 Step	4,8 Meter
	10 Step	6 Meter
	15 Step	9 Meter
	20 Step	14 Meter

3. Results and Analysis

From the activity of walking done by testers as much as 4, 8, 10,15 and 20 steps. At the time of running sensor reading corner footsteps. Data obtained from the angle of the monitor serial Arduino then convert the data into a corner in order to determine the movement graph wave of footsteps generate how many waves. Wave results determined threshold above and below the threshold for detection of footsteps that will be displayed on the android application. Having in mind the results of the detection threshold comparison step shown in android

a. 4 Step

Figure 5. Display android 4 Steps

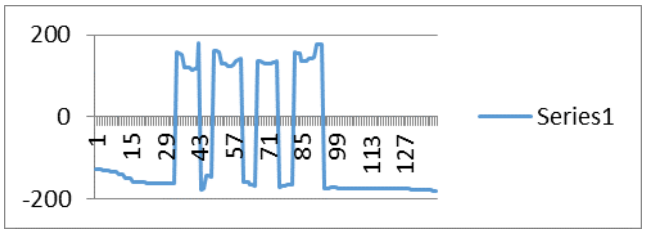

Figure 6. Wave Movement Sensor Data Results 4 Steps

b. 8 Step

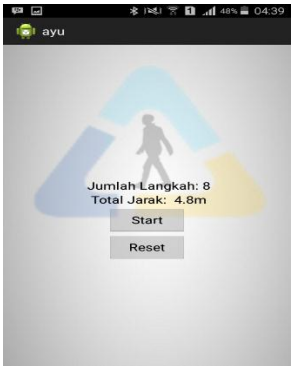

Figure 7. Display android 8 Steps

Figure 8. Wave Movement Sensor Data Results 8 Steps

c. 10 Step

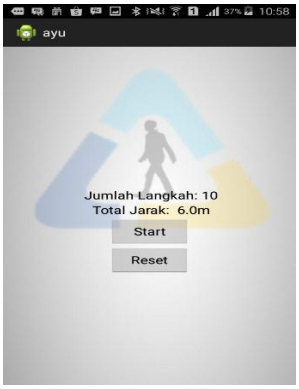

Figure 9. Display android 10 Steps

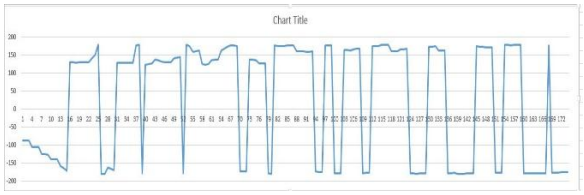

Figure 10. Wave Movement Sensor Data Results 10 Steps

d. 15 Step

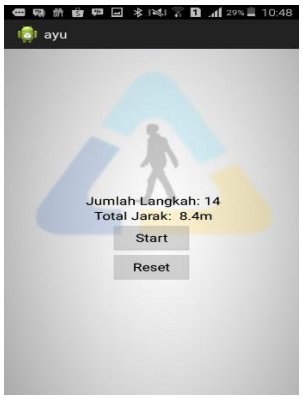

Figure 11. Display android 15 Steps

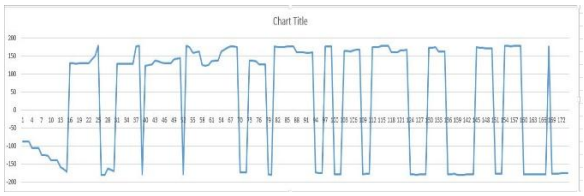

Figure 12. Wave Movement Sensor Data Results 15 Steps

e. 20 Step

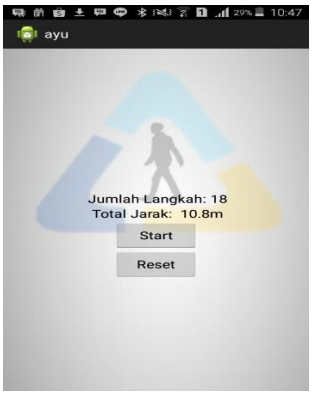

Figure 13. Display android 20 Steps

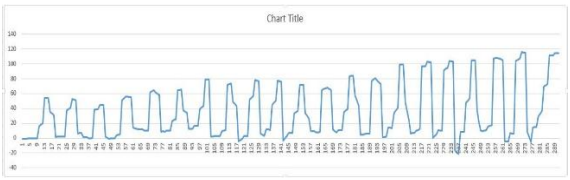

Figure 14. Wave Movement Sensor Data Results 20 Steps

3.1. Tolerance Estimate Result

The results of calculation footsteps can be changed easily. Therefore, the results of the calculation steps shown on the android app in particular to projects in this thesis are often obtained measurement results are unstable and measurement error occurred (error). It can be caused by several factors:

1. Position of the tool is not appropriate
2. The response time is slow and has a noise measurement
3. Distance bluetooth too much can destabilize angle detection.
4. Power Instability makes intermittent connections

3.2. Scenario Measurement

Testing is doing by counting the number of footsteps during a leisurely stroll. Tests performed on one person. Based on the results of calculations output footsteps calculated manually compared with the results of calculations using the application

footsteps healthy path in units of steps while the distance in meters. Difference calculation of both devices then calculated the percentage of erro

Table 2. Difference Calculation Step Walking

Calculation from tools	Manual calculation	difference
4	4	0
8	8	0
10	10	0
14	15	1
18	20	2

From the test results can be seen in case of error on the test data. It can be inferred fault error occurs because the connection is not stable and the position of the tool is not appropriate. the results of wave movement is also different footstep there is high there is nevertheless a low amplitude waves cause gait every step must be different (can be seen on the points test results). The slope of the foot is very influential in the corner that read sensor. The more steps taken, the more noise that occurs in the sensor. The following is a calculation error obtained

Table 3. Average Percentage Error

Calculation steps when walking		
Calculation from tools	Manual calculation	Error %
4	4	0
8	8	0
10	10	0
14	15	7,14
18	20	11,11
Average percentage error		**3,65%**

4. Conclusion

Based on the observation, analysis, and implementation of the final project on monitoring of footsteps, the author makes some conclusions:

1. Process footstep detection and distance calculation using the gyroscope sensor that is done by a wave detection angle values result from the walk were taken from the upper limit value (Threshold Above) and a lower limit value (Below Threshold) on the X axis gyroscope sensor. Upper limit value is 20o -20o and lower limit value. This value is obtained from the value angle X gyroscope converted to Microsoft Excel in the form of a wave then the wave measured point average of the highest and lowest point when

walking, the authors use the value of the upper limit and lower limit value 20o -20o. If the value of a point above and below the waves in accordance with a predetermined threshold, then detected was a footstep. Results step is multiplied by the average width of the foot when walking. Average width feet when stepping is 0,7m. By multiplying the result of step and an average width of feet, then obtained when walking distance.

2. Application monitoring footsteps and distance with a gyroscope sensor is designed to use Android Studio to display the results of footsteps and distance. This application has a controlling Start, Stop and Reset. Start Button is used to start the count steps and distance, Stop Button is used to stop and distance calculation footsteps for a while while the Reset Button is used to calculate the initial step of the feet and the distance as before.
3. The results of monitoring of footsteps is very dependent on the position of the tool and the position of our body movement as it can cause errors error. The position of the tool that does not fit and style when walking step affect the width, height and low waves.
4. The results of monitoring footsteps dependent on the power used. If the power is not big enough then the Bluetooth connection is disconnected so as to disrupt the process and distance calculation footsteps
5. From the results of tests performed to detect footsteps as much as 57 times, the value of error of 3.65% means that the system is able to detect the activity of footsteps quite well.

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