Analysis of Movement Detection Applications in Pregnant Woman Using Body Mechanic and Sensors on Android Devices

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Abstract. The purpose of this study is to see how accurate the results obtained from the reading of motion sensors in pregnant women in accordance with the criteria for mechanical motion of the body using sensors on an android device. Because with the rapid development of technology today, it must be assumed that if technology can help facilitate our lives. The method of this study was using Body Mechanics a term used to describe the use of a safe, efficient, and coordinated body to move objects and carry out activities of daily living. Body mechanics is an effort to coordinate the musculoskeletal and nervous systems to maintain a good balance. The results of the analysis in this study indicate that the daily movements of pregnant women who meet the body's mechanical movement criteria can be measured using values that can be taken from sensors on an android device. It's just that the results of these values are still considered inaccurate. This is caused by a device connection that is considered bad.

1. Introduction
Based on 41 maternal and child health data, which were sampled from Winong Puskemas Cirebon Regency throughout 2017 and early 2018 there were 65.8% or about 27 pregnant women experienced many complaints such as dizziness, nausea and weakness occurring during the first trimester of pregnancy due to lack of rest and about 17% or about 8 pregnant women experience complaints the same as the first trimester and coupled with no appetite and difficulty sleeping at night while for the third trimester there are 14.6% or about 6 pregnant women who have partially experienced no complaints like the previous trimester but the pain around the abdomen around the abdomen, cramps in the thighs[1].

Whereas through offline there were 32 respondents including 19 pregnant women respondents who were in the second pregnancy and 13 respondents in the third trimester. There were 79% or 25 respondents claiming to have complaints of low back pain, dizziness during activities because they did not understand activities that were in accordance with the rules of the body mechanic. Therefore, it is necessary to pay attention and supervision of pregnant women in carrying out their activities during conditions during pregnancy. Sitting and standing positions that are wrong can result in lower back pain in third trimester pregnant women [2]. There were 79% or 25 respondents claiming to have complaints of low back pain, dizziness when doing activities because they did not understand activities that were in accordance with the body mechanic rules. Therefore there is a need for attention and supervision of pregnant women in carrying out their activities during conditions in the period of pregnancy [3].

By utilizing the readings of sensor data on Android devices, it is expected that pregnant women can use the Android device to get a warning if there are daily activities that do not fit the criteria of body
mechanic. With the existence of android sensor technology, we can use sensors which include the accelerometer sensor, gyroscope sensor and compass sensor (magnet) to record the activities of pregnant women in daily activities [6]. And from the results of the record we can find out whether the activity is in accordance with body rules mechanic or not, via a smartphone that has been connected to one another.

The purpose of this study, the authors will see accurate results obtained from the reading of motion sensors in pregnant women in accordance with the criteria of mechanical motion using sensors on an android device and the method that uses Body Mechanics is a term used to study the use of a body that is safe, efficient, and coordinated to transfer objects and carry out activities of daily life.

2. Methods

a term of Body mechanics was used to describe the use of a safe, efficient, and coordinated body to move objects and carry out daily living activities. Body mechanics is a coordinating effort of the musculoskeletal and nervous system to maintain balance properly. Proper body mechanics is one safe way to deal with complaints of back pain in pregnant women. Body mechanics is a coordinating effort of musculoskeletal and nervous system to maintain the right balance. Body mechanics is a way to use the body efficiently, which is not much energy, coordinated, and safe in moving and maintaining balance during activity [4].

Correct body mechanics do not have side effects on the mother or fetus, are easy, and do not require expensive costs. This technique aims to reduce complaints from back pain and minimize the possibility of worse pain in the next trimester even until the postpartum period. The other benefits are to make the body fresh, improve muscle tone, control body weight, reduce stress, increase relaxation, and stimulate the enlargement of blood to the muscles and other organs so that it can increase body flexibility. With the existence of body mechanics in this study so that it becomes a reference material for researchers to find out the patterns of activities that are good and bad for pregnant women during their activities, there is also a connection with this research which is to help reduce the risk of complaints such as back pain, tingling, etc.

3. Results And Discussion

3.1 Accelerometer

Accelerometer is a device that serves to measure acceleration. Acceleration measured by an accelerometer does not necessarily have a rate of change in velocity. Conversely, the accelerometer gets the acceleration that is meant by the heavy phenomenon experienced by the mass test on the reference frame of the accelerometer device. For example, the accelerometer on the earth's surface will measure acceleration \( g = 9.81 \text{ m/s}^2 \) straight up because of its weight. In contrast, the free fall accelerometer to earth measures zero for acceleration as shown in Figure 1.

On smartphones, the accelerometer is a sensor that reads the device so that it can change the screen display from landscape to portrait position or vice versa by simply tilting the body of the phone automatically. On an Android-based smartphone there is a sensor manager that functions to activate the accelerometer sensor in finding the \( x, y, z \) coordinate values with the slope of the cellphone.

![Figure 1. Accelerometer axis](image-url)
3.2 Gyroscope

The Gyroscope is a device used to measure the orientation of an object. The Gyroscope is a heavy wheel that rotates on its fingers. A mechanical gyroscope consists of a wheel placed on a frame. This wheel is on an iron rod called the spin axis. When the gyroscope is moved, it moves around the axis. The shaft is connected by circles called dreadlocks. The dreadlocks are also connected to other dreadlocks at the base of the plate. So when the disk rotates, the gyroscope unit will maintain its position like the first time the gyroscope is rotated as shown in Figure 2.

In this study using a sensor gyroscope which is used to obtain data signals x, y, z from the movement of pregnant women while carrying out their activities, which are in accordance with the principle of body mechanics or not in accordance with the body mechanic.

![Gyroscope axis](image)

**Figure 2.** Gyroscope axis

3.3 Activity Recognition

Activity recognition technology is a technology that allows the key to overcoming health problems, because the technology can monitor individual physical daily activities and long duration so that they can estimate calories consumed every day. Based on the calories consumed, the system can provide recommendations and recommendations when they fail to complete sufficient training and also build a system to encourage people to do more activities as shown in Figure 3.

![Activity Recognition on mobile](image)

**Figure 3.** Use Recognition Activity on mobile
With a cellphone that already has an accelerometer, there are two possibilities for monitoring a person's physical activity. The first is to change the cellphone as a pedometer, measure the number of steps and calorie consumption for each user. While the second is recognizing the right physical activities such as walking, running, cycling, driving and others. Apparently the pedometer solution is quite simple, this gives an indication that it is good for each calorie consumed by the user, even for cases such as walking, running, climbing stairs, etc. It fails to estimate calorie consumption correctly, as in the case of cycling (helps health but not can be measured with a pedometer).

3.4 System Architecture Analysis

System architecture analysis aims to identify the architecture to be built. Below is the system architecture that was built is shown in Figure 4 below:

![System Architecture Diagram]

Figure 4. System Architecture

The mobile platform is one of the subsystems chosen for the development of this software. Software architecture on the mobile platform illustrates how software interacts as illustrated in the image. Technology Analysis and Implementation. The implementation of technology contains information on the technology used in this study such as sensor gyroscope technology, accelerometer sensor technology, firebase technology and the method used in this research, namely the SVM (Support Vector Machine) method.

3.5 Accelerometer and Gyroscope sensor

This sensor works by producing acceleration values on the x, y and z axes in units of m / s² (meters per second squared). When doing a movement or gesture by moving the smartwatch when used on the hand, the acceleration value on each axis will change, this shown in Figure 5. This value depends on the speed and pattern of movement. The following is a picture of data generated from certain gesture movements.
Figure 5. Accelerometer and Gyroscope sensor

Gesture pattern that is carried out at the beginning of the movement is marked with a black circle at the beginning of the line and moves in the direction of the arrow until the end of the movement on the tip of the arrow. Acceleration values generated and recorded at frequencies generated and received at certain frequencies based on these movements will produce time series data, and can be expressed with

\[ X = \{x_1, x_2, x_3, \ldots, x_i, \ldots, x_n\} \]
\[ Y = \{y_1, y_2, y_3, \ldots, y_i, \ldots, y_n\} \]
\[ Z = \{z_1, z_2, z_3, \ldots, z_i, \ldots, z_n\} \]

\( X \) is the time series acceleration data that occurs on the x axis, \( Y \) time series data on the y axis and \( Z \) time series data on the z axis of the accelerometer. Data length (n) of the time series data generated depends on the recording frequency and data recording time, which in Figure 5 is from the beginning to the end of the recording of the smartwatch movement. Ignoring readings on the x-axis of the smartwatch accelerometer sensor when the value is located between 9.1 m/s² and 10.5 m/s² (± 0.7 approximately 9.8 m/s²) because this is generally in activities such as ascending and down the stairs and is the period when the user puts his foot on the ground. Figure 6 shows an overview of the raw data from the accelerometer sensor on the smartwatch with the activity of climbing the stairs:

Figure 6. Accelerometer sensor data in climbing stairs
The accelerometer on the x axis is perpendicular to the earth and the user's leg is on the ground, then the x axis of the accelerometer is around 9.8 m/s² (± 0.7 greater or less than 9.8 m/s²) in the first period to the 10th period. From the period of 11 to 50 users have raised their feet on the ground illustrated by signal variations around 4 m/s² up to 20 m/s². In this period the x axis is no longer perpendicular to the earth, while the user lifts his feet on the ground which results in a different x-axis value, so the x axis depends on the angle of the x-axis and the linear acceleration of the user's feet.

![Data sampling in walking activities.](image)

Figure 7. Data sampling in walking activities.

Ignoring readings on the x-axis of the smartwatch accelerometer sensor when the value is located between 9.1 m/s² and 10.5 m/s² (± 0.7 approximately 9.8 m/s²) because this is generally in activities such as ascending and down the stairs and is the period when the user puts his foot on the ground. After checking the accelerometer raw data on the x axis from the activities of walking, climbing stairs and descending stairs, it was found that the ratio of the number of sampling above from 10.5 m/s² in the activity goes to the sampling number below 9.1 m/s² equal to or greater than 1.4 and the average x-axis accelerometer on the smartwatch is greater than 10.3 m/s². Meanwhile in the activity of going up/down stairs, this ratio is less than 1.4 and the average x-axis accelerometer on the smartwatch is less than 10.4 m/s². Therefore, after ignoring all data placed between 9.1 m/s² and 10.5 m/s². So the system is able to differentiate between walking, up/down stairs activities[10].

4. Conclusions
The activity recognition application can help detect the risk of activities that are not in accordance with the body mechanic of 83.9%, except that the level of accuracy in sending data as much as captured by the sensor still needs to be improved. This is because the commissions that are used are limited to bluetooth. This activity recognition application can recognize information on activities at risk of 93.1% agreeing to help avoid the risk of complaints such as pain in the back, abdomen and tingling. This is due to the presence of sensors that help detect activities carried out. The activity recognition application can help remind or notify the risk of activities to pregnant women when there are 92.6% risk indicators. The lack of this is that there are still many errors when detecting movement, because the sensors used are quite sensitive.
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