

ICVEE THE DEVELOPMENT OF WIRELESS

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The Development of Wireless Body Area Network for Motion Sensing Application

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Abstract. The information era has driven the society into the digitally-controlled lifestyle. Wireless body area networks (WBAN) as the specific scope of wireless sensor networks (WSN) is consistently growing into bigger applications. Currently, people are able to monitor their medical parameters by simply using small electronics devices attached to their body and connected to the authorities. On top of that, this time, smart phones are typically equipped with sensors such as accelerometer, gyroscope, barometric pressure, heart rate monitor, etc. It means that the sensing yet the signal processing can be performed by a single device. Moreover, Android opens lot wider opportunities for new applications as the most popular open-sourced smart phone platform. This paper is intended to show the development of motion sensing application which focused on analysing data from accelerometer and gyroscope. Beside reads the sensors, this application also has the ability to convert the sensors' numerical value into graphs.

1. Introduction

The need of quantity and quality of health service these days grows bigger and bigger. It is caused by the increasing amount of elderly who followed by chronic health problems. Moreover, people now become more aware of health, so they require more service to prevent, monitor, and even cure the diseases. The urban society then demand a simpler way to fulfil those needs, and that is how wireless body area networks (WBANs) take part.

As a branch of wireless sensor networks (WSN) technology, WBANs is specifically designed to be place in, at, or around human body. It consists of sensors which able to read any vital signs, transmit the data to a microcontroller sink, then the wireless module forwards the data to another device connected to the network [1]. This network enables remote health care monitoring, the patient, hospital, and physicians are able to read those vital signs anytime without distance limitation. The IEEE 802.15 has standardised this technology with low-power, low-cost, and low bit rate performance [2].

The current WBAN technology, very close to daily life, is built in a smart phone. Many hand-held devices have sensors, even without the user's knowing. Accelerometer and gyroscope is one of the most included sensors. For example, when a smart phone can read your speed while driving using map application, and when it can adjust the screen when we rotate the device. That is accelerometer and gyroscope respectively. The most interesting part is, smart phone is a *one-go* device for WBAN because it has sensors, microcontroller, and wireless module at the same time.

At the same time, the development smart phones technology and its platform also support the mobility of WBAN technology [3]. Smart phones can act as gateway or sink for the nodes (sensors), and connected to the server or further networks. Moreover, Android development as an open source



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platform makes it possible to make a smart phone acts as the data processor and also the end system at once.

Accelerometer itself can be used for multiple applications related to positioning. The most popular research in WBAN is about heart disease. Patient with high heart attack risk are usually monitored with ECG sensor also can be combined with accelerometer to examine the influence of movement on the heart rate during daily activities [4]. Therefore, accelerometer can also be used in a more complex sensor networks to give more information for health monitoring [5] [6].

The past works of WBAN applications in Android smart phones is classified into two groups: medical and non-medical purpose [7]. Android platform is chosen by many researchers for its popularity and open-source characteristic, so the developers can freely expand the applications for many purposes.

A motion recognition-based pedestrian navigation discussed at [8] used a smart phone which equipped with accelerometer, magnetometer, gyroscope, and barometric pressure sensors. While the common pedestrian navigation used sensors, which mounted on the shoes or helmet, this application simply used a smart phone with all the required sensors the pedestrian using the smart phone can access the indoor navigation service simply by downloading the application. Furthermore, other positioning methods using the radio frequency (RF) chip, such as GPS or Wi-Fi, could be integrated with the PDR system to complement and improve the positioning accuracy.

This paper aims to show recent work in developing a motion sensing application in an Android smart phone. The application collects data from the three axes of accelerometer and gyroscope value. The numerical data then converted into graphs in order to monitor the pattern of the movements.

2. Wireless Body Area Networks

Wireless sensor networks which has been taking attention these past years has a specific field which only focus on human body. This technology changes the old health care paradigm into a more continuous and reliable gathering and objective analysis of patient's physiological aspects [9].

With the nodes or sensors which are placed on the body or everyday clothing, the ultra-low power connectivity connects physiological parameters data to the computer network. The data can be accessed by the user, hospital, doctor or physician, and any other authorized users. Actually, WBANs is not only can be applied for medical purpose but also for entertainment, sports, military, and other applications [10]. The figure below is an illustration of a wireless body area network.

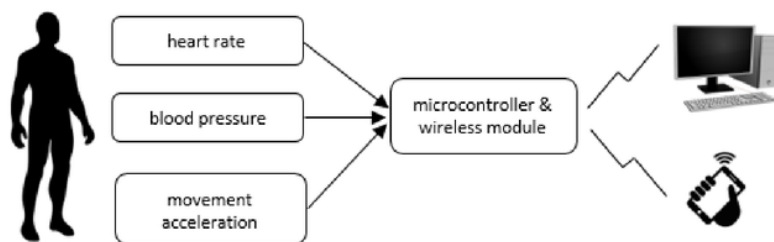


Figure 1. Simplified WBAN network architecture

According to the figure, WBAN architecture has three level of hierarchy: sensor(s), data hub, and medical network. The connectivity of the sensors to the processing module is conducted using radio frequency media. Several wireless standards such as ANT, Bluetooth, Sensium, Zarlink, and Zigbee are the alternatives as written in the IEEE 802.15.6 standard [11].

Furthermore, the data hub handles the data processing, storing, and sending to the next destination or network. The device can be a PDA or smart phone which also equipped with wireless module. The other alternative is, if all the sensors and the hub are built in a single equipment, then between the sensors to the data hub can be connected by wire, and the wireless part is only from the hub to the extended network [12].

At the medical network, the data can be used for further analysis and/or diagnosis to the monitored symptoms of the user. The authorised physicians or doctors can use that data anytime to help them giving the right medication or treatment [13] [14]. As mentioned earlier, WBAN application can be very wide. For medical purpose only, there are various sensors which can be used such as heart rate sensor, ECG, EEG, EMG, blood pressure, blood oxygen saturation, accelerometer, gyroscope, magnetometer, and many more.

Accelerometer and gyroscope are used to monitor the acceleration of the user's movement and the orientation respectively. The data can be continuously changed during the sensors are worn and the user is moving.

3. System Design

The design of the system is actually included in the smart phone. However, the common WBAN architecture is illustrated in figure 2. The development process is conducted by following the Android development process.

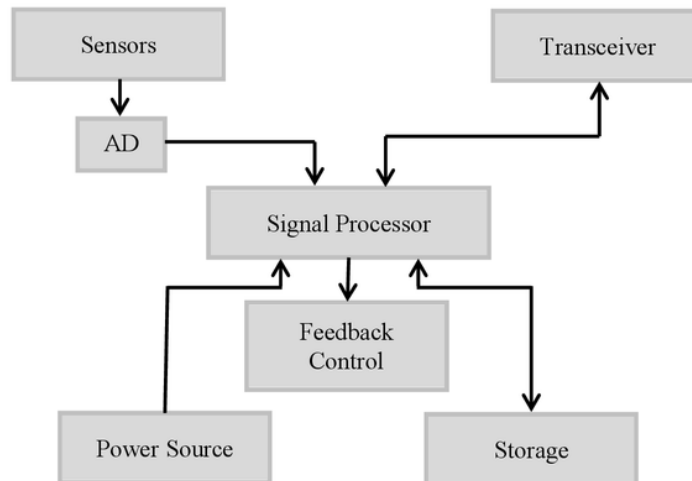


Figure 2. WBAN Architecture

The diagram of the data collection process is shown in the figure 3 where it starts with programming the application, install to the smart phone, move it so the sensors can detect the acceleration and orientation, the application then reads and represent the data into a graph that can be continuously changing as long as the smart phone is being moved.

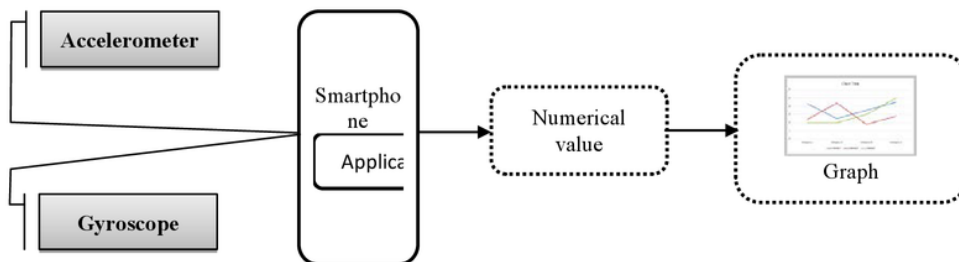


Figure 3. General system design

4. Result and Discussion

The development of the application first needs to understand how to collect data from the accelerometer and gyroscope of the smart phone. The figure 4 below shows the preview of the application.



Figure 4. Preview of the Application

The application is able to read random movement acceleration and orientation of the user when the smartphone is being held. Then the numerical data can be collected and converted into a graph as shown in the figure 5 and 6 respectively. For example, when the user shakes the smartphone, the movement graph can be shown on the application.

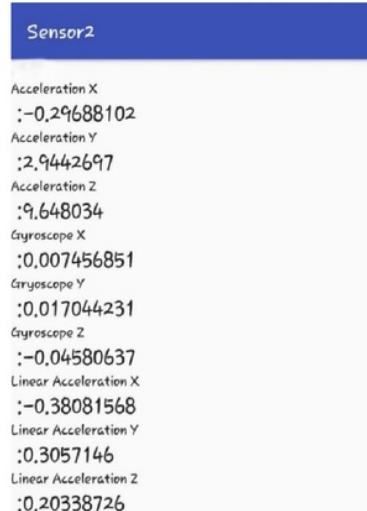


Figure 5. Numerical value

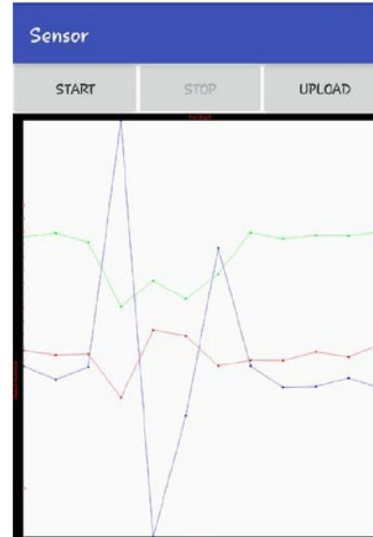


Figure 6. The graph of the movement

5. Conclusion

With the preliminary results, the application has been able to detect the movement and orientation of the user. The numerical data then can also be shown in a graph. The graph can be continuously changing while the user makes any movement.

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