Motion Sensing for Wireless Body Area Networks Based on Android Using Wi-Fi Direct Transmission

by Unit Three Kartini

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***Abstract*—Wireless sensor networks (WSN) applications were developed with a wide variety of applications. Wireless body area network (WBAN) was one of the implementations of WSN. The implementation used a sensor that was attached to the body to monitor body motion. In this article, we present our research about motion sensing for wireless body area networks (WBAN) that used Wi-Fi direct transmission. This article proposed a motion-sensing for wireless body area networks (MOSBAN) with Wi-Fi direct transmission based on android to send the value of accelerometer and gyroscope from smartphone to smartphone. MOSBAN is expected can send the value of sensors accurately with Wi-Fi direct transmission. This article presented a comprehensive result of 50 meters distance from smartphone1 to smartphone 2. The validity of MOSBAN is proven by exacted 100% of data transmission using Wi-Fi Direct.**

***Keywords*—Wireless sensor networks, MOSBAN, Accelerometer, Gyroscope.**

I. INTRODUCTION

Wireless sensor networks (WSN) applications were developed with a wide variety of applications. Wireless body area network (WBAN) was one of the implementations of WSN. The implementation used a sensor that is attached to the body to monitor body motion. IEEE 802.15. 6 has provided international standards about the human body range to wireless communication for short-range, low power [1]. The recent year several efforts have increased for diversity application that can be supported by WBAN technology [2]. The development of wireless body area networks was triggered by multiple open issues. Performance that low-cost with also low power has been regulated by IEEE 802.15. [3]. Technology WBAN was very close to daily life, which was embedded on the smartphone. Many hand-held devices have sensors, even the user does not know about that. The accelerometer and gyroscope are one of the most included sensors.

The mobility of WBAN technology was supported by smartphone technology development. Even a smartphone can be used for data processing on the user's smartphone as well as give the signal alarm if there is a heart attack. The system was developed and controlled by smartphones based on android. To confirm the function of the system using three scenarios [4]. The custom-developed software must be installed on the PC to process the ECG and ACC data. The medical web server will be accepted all recorded information to store and display for doctors. To test the system, in this case using 10 healthy volunteers. Information on data was monitored as long as daily activities [5]. Therefore, the accelerometer sensor will be used alternatively for health monitoring in a more complex environment, [6-7]. However, all of the mentioned only partial sensor applications, still not combined yet each other. In [8], the authors presented a transmission power control (AA-TPC) use accelerometer assisted scheme which conducts the fluctuations of link qualities to reduce energy consumption. The system consideration relationship between body movement and link quality. Many researchers have chosen the Android platform for developing applications for many research purposes. However, feedback information is determined in transmission power. Another research [9] presented an analysis of the performance of IEEE 802.15.4 to improve performance networks. However, only for superframe duration, still not implemented yet for sensors networks. Investigation of WBAN's application has been proposed for motion detection and send data with Bluetooth transmission [10]. However, the result is still not validated yet between the transmitter and the receiver.

The system health-care promises that the continuous and reliable gathering and analysis of physiological and behavioral aspects of a patient, and delivers this information to physicians, which are the goal of body area networks (BANs). BANs can tackle health-care monitoring and delivery challenges by wireless technology and mobile and cloud computing through the use of independent sensors and actuators attached to the

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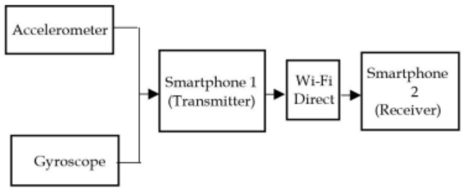

Fig. 1. The block diagram of scheme

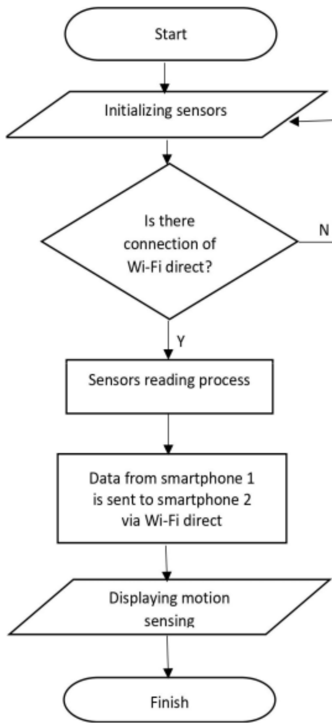

Fig. 2. Flowchart of MOSBAN

body. BANs can achieve what human–computer interaction aims for, i.e., the design of technologies that are flexible to human needs [11].

In [12], the authors evaluated the performance of the Wi-Fi Direct system using a testbed and compare it with the conventional Wi-Fi system for real-time data transfer. The system compared between Wi-Fi direct transmission and existing Wi-Fi system. However, only compare the data rate at a distance of 3.5 meters. The authors of [13] have demonstrated Wi-Fi direct transmission on D2D communications in a dense wireless network. The devices are tablets and smartphones can be used by Wi-Fi direct. The scheduling method is used to improve network performance and simulation methods for the validating system. However, to validate real devices still not conducted yet in the article. In [14], the authors have investigated Wi-Fi Direct on a reliable multicast problem. The method was a new algorithm called ELBM. The system tried to overcome collisions from AP and other stations. The system can increase throughput for ELBM algorithm compare with others. However, still, only the simulation method, while the implemented sensor on devices is not performed yet. The Wi-Fi direct based MSNP platform, and have addressed about discoverability and privacy and implemented a Wi-Fi direct networking module, and several typical applications in android have been proposed [15]. Multi-hop mobile and ad hoc network that is developed Wi-Fi direct for the group with specifically routing layer have been proposed by [16]. However, all of the above-mentioned talk about simulation methods and application on android devices only group communication.

This article proposed a motion-sensing for wireless body area networks (MOSBAN) with Wi-Fi direct transmission based on android to send values of accelerometer and gyroscope sensors from smartphone 1 to smartphone 2. MOSBAN was expected can send the value of sensors accurately with Wi-Fi direct transmission. The contribution of this method is the sensors can send the value of motion sensing from smartphone to smartphone via Wi-Fi direct transmission in display and graph form on distance 50 meters

II. The Description of MOSBAN

MOSBAN consists of several parts, namely the transmitter where the accelerometer and Gyroscope sensors are located, Wi-Fi direct, and the receiver. The accelerometer and Gyroscope sensors are located on the first smartphone will be attached to the human arm and function as a transmitter. The accelerometer is a sensor to measure an acceleration of gravity while a Gyroscope is a sensor that utilizes the principle of angular momentum that can maintain its orientation position based on the condition of the position of an object. The second smartphone will conduct as a receiver that receives sensor measurement values from the transmitter and displays them in graphical form. Wi-Fi direct as a transmission media between transmitter and receiver with a distance of 50 meters. The resulting graph is the movement that is censored by the accelerometer and the gyroscope sensors that are attached to the human arm.

III. The Method of MOSBAN

MOSBAN is a scheme that performs motion sensing using the accelerometer and gyroscope sensors that are founded on the smartphone. Then as a transmission medium using Wi-Fi direct and as a receiver also uses a smartphone. The block diagram can be shown in figure 1.

The algorithm of MOSBAN can be explained as follows: first, starting with an initializing accelerometer and gyroscope as data input connect with smartphone 1. Second, the MOSBAN has to check the connection with Wi-Fi direct. If there is no connection, the MOSBAN has to back to the first step and otherwise go to the next step. Third, the MOSBAN will perform to read the process of accelerometer and gyroscope sensors, Fourth, the data from smartphone 1 is sent to smartphone 2 via Wi-Fi direct. Finally, the MOSBAN will display of motion sensing on the smartphone as a receiver. Results

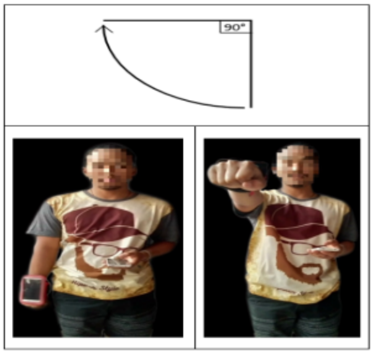

Fig. 3. Forward arm motion

Fig. 4. Screenshots display of forward arm motion (a) Transmitter (b) Receiver

The results of the MOSBAN test were taken in 2 arm motions, namely movements with an angle of 90 degrees and 180 degrees. The testing has distance 50 meters between the transmitter and receiver and there is no obstacle to the outdoor environment. The results of the data have taken 6 times in the same environment. In figure 3 shows a picture of forwarding arm motion, this movement starts from the ready position then moves the hand forward until straight ahead which forms an angle of 90 degrees.

Figure 4 shows the results of the comparison between transmitter and receiver. For figure 4 (a) is a screen capture image on the transmitter from forwarding arm motion, while figure 4 (b) is a screen capture image on a forward arm motion receiver

TABLE 1. CONFORMANCE LEVEL OF ACCELEROMETER DATA TRANSMISSION FROM FORWARDING ARM MOTION

Item	A0x1	A0x2	%	A0y1	A0y2	%	A0z1	A0z2	%
1	1.09	1.09	100%	4.56	4.56	100%	10.75	10.75	100%
2	1.70	1.70	100%	7.59	7.59	100%	18.90	18.90	100%
3	0.23	0.23	100%	11.34	11.34	100%	9.24	9.24	100%
4	-0.84	-0.84	100%	-2.14	-2.14	100%	1.35	1.35	100%
5	-2.86	-2.86	100%	-7.14	-7.14	100%	5.56	5.56	100%
6	-2.84	-2.84	100%	-7.17	-7.17	100%	6.25	6.25	100%

TABLE 2. CONFORMANCE LEVEL OF GYROSCOPE DATA TRANSMISSION FROM FORWARDING ARM MOTION

Item	G0x1	G0x2	%	G0y1	G0y2	%	G0z1	G0z2	%
1	0.97	0.97	100%	0.20	0.20	100%	0.04	0.04	100%
2	-2.06	-2.06	100%	0.91	0.91	100%	0.64	0.64	100%
3	-4.86	-4.86	100%	1.25	1.25	100%	-0.22	-0.22	100%
4	-0.31	-0.31	100%	1.57	1.57	100%	-5.67	-5.67	100%
5	1.90	1.90	100%	2.83	2.83	100%	-2.56	-2.56	100%
6	-8.03	-8.03	100%	-0.29	-0.29	100%	0.21	0.21	100%

side. Both images show matching results. Table 1 shows 100% matching results. This shows that sending data from the transmitter to the receiver is very good. Let denote A0x1, A0x2 are the x-axis accelerometer on the transmitter and the x-axis accelerometer on the receiver, respectively. Let us denote A0y1, A0y2 are the y-axis accelerometer on the transmitter and the x-axis accelerometer on the receiver. Let also denote A0z1, A0z2 is the z-axis accelerometer on the transmitter and the x-axis accelerometer on the receiver, respectively.

Table 2 shows 100% matching results. This shows that sending data from the transmitter to the receiver is very good. Let denote Gx1, Gx2 are the x-axis gyroscope on the transmitter and the x-axis gyroscope on the receiver, respectively. Let us denote Gy1, Gy2 are the y-axis gyroscope on the transmitter and the x-axis gyroscope on the receiver, respectively. Let also denote Gz1, Gz2 is the z-axis gyroscope on the transmitter and the x-axis gyroscope on the receiver, respectively.

In figure 5 shows an image of moving your arms up, this movement starts from the ready position then moves your hands up until straight up to form an angle of 180 degrees. The distance between the transmitter and the receiver is 50 meters for 90 degrees and 180 degrees of arm movement, respectively.

Figure 6 shows the results of the comparison between transmitter and receiver. For figure 6 (a) is a screen capture

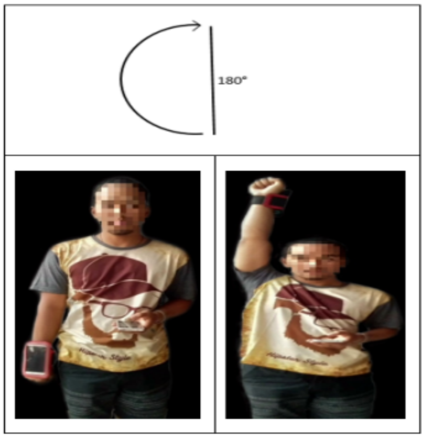

Fig. 5. Up arm motion

Fig. 6. Screenshots display of up arm motion (a) Transmitter (b) Receiver

TABLE 3. CONFORMANCE LEVEL OF ACCELEROMETER DATA TRANSMISSION FROM UP ARM MOTION

Item	A1x1	A1x2	%	A1y1	A1y2	%	A1z1	A1z2	%
1	1.68	1.68	100%	7.15	7.15	100%	5.38	5.38	100%
2	1.17	1.17	100%	5.30	5.30	100%	13.02	13.02	100%
3	0.67	0.67	100%	6.98	6.98	100%	18.98	18.98	100%
4	-0.74	-0.74	100%	4.29	4.29	100%	12.35	12.35	100%
5	-0.49	-0.49	100%	-0.67	-0.67	100%	2.56	2.56	100%
6	-1.21	-1.21	100%	-4.50	-4.50	100%	-5.98	-5.98	100%

the image on the transmitter from up arm motion, while figure 6 (b) is a screen capture image on an up arm motion receiver side. Both images show also matching results.

TABLE 4. CONFORMANCE LEVEL OF GYROSCOPE DATA TRANSMISSION FROM UP ARM MOTION

Item	G1x1	G1x2	%	G1y1	G1y2	%	G1z1	G1z2	%
1	0.32	0.32	100%	0.13	0.13	100%	0.14	0.14	100%
2	-1.27	-1.27	100%	0.40	0.40	100%	0.10	0.10	100%
3	-4.90	-4.90	100%	1.40	1.40	100%	0.33	0.33	100%
4	-4.26	-4.26	100%	1.19	1.19	100%	-1.66	-1.66	100%
5	-1.49	-1.49	100%	4.17	4.17	100%	-3.59	-3.59	100%
6	-1.64	-1.64	100%	6.13	6.13	100%	-0.93	-0.93	100%

Table 3 shows also 100% matching results of data transmission for up arm motion. This shows that sending data from the transmitter to the receiver is very good. Let denote A1x1, A1x2 are the x-axis accelerometer on the transmitter and the x-axis accelerometer on the receiver, respectively. Let us denote A1y1, A1y2 are the y-axis accelerometer on the transmitter and the x-axis accelerometer on the receiver, respectively. Let also denote A1z1, A1z2 is the z-axis accelerometer on the transmitter and the x-axis accelerometer on the receiver, respectively.

Table 4 shows also 100% matching results of data transmission for up arm motion. This shows that sending data from the transmitter to the receiver is very good. Let denote G1x1, G1x2 are the x-axis gyroscope on the transmitter and the x-axis gyroscope on the receiver, respectively. Let us denote Gy1, Gy2 are the y-axis gyroscope on the transmitter and the x-axis gyroscope on the receiver, respectively. Let also denote Gz1, Gz2 is the z-axis gyroscope on the transmitter and the x-axis gyroscope on the receiver, respectively.

V. CONCLUSIONS

This article presents a comprehensive result of 50 meters distance from smartphone 1 to smartphone 2. The MOSBAN test was taken in 2 arm motions, namely movements with an angle of 90 degrees and 180 degrees, respectively. The validity of MOSBAN is proven by exacted 100% of accuracy data transmission from smartphone 1 to smartphone 2 using Wi-Fi direct. The MOSBAN scheme will be compared with other methods in the next research.

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