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Prayer Guide Gyroscope Bracelet for The Deaf Using MPU6050 Sensor

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ABSTRACT The majority of Indonesia's population is Muslim, including more than 13,000 people with hearing impairments. In carrying out congregational prayers, the Deaf find it difficult to follow the instructions of the Imam's movement. The presence of hearing aids cannot be used by all persons with hearing impairments, and hearing aids often cause a buzzing sound, thus disturbing concentration. Therefore, in this study, a gyroscope bracelet will be made to assist people with hearing impairments in following the instructions of the Imam's movement when carrying out congregational prayers. The bracelet worn by the Imam will send a code in the form of a change in angle to the bracelet used by the Deaf congregation. The Z angle is a vertical angle in the gyroscope where the Z angle has an angular velocity of 360 degrees per second. The control system uses Arduino nano FT232RL FTDI FT232. The communication module uses HC-12 SI4463, with a wireless frequency of 433.4 - 473.0 MHz. The sensor for detecting changes in motion is the MPU6050 gyroscope sensor, the vibration indicator uses a micro vibrator motor. The bracelet used by the deaf will read the code from the Imam's device, with a notification in the form of a different vibration on every change in prayer movement. After experimenting with 30 people, the percentage of success was 84% for all prayer positions. Thus, the gyroscope bracelet tool for prayer guides for the Deaf can help the Deaf community in carrying out congregational prayers.

INDEX TERMS Bracelet, Z-angle Gyroscope, Deaf

I. INTRODUCTION

Deaf people are people who have hearing impairments which result in deaf individuals having speech impediments so they are usually called speech impaired. This limited hearing condition causes them to have difficulty in carrying out daily activities ranging from communicating to performing prayer activities in congregation. First, they have to glance at each other during the prayer, especially in the prostration position, they find it difficult to determine whether the Imam has woken up from prostration or not, so that not a few people who are deaf end up ahead of the Imam in moving [1], [2].

The existence of hearing aids in the form of hearing aids cannot be used by all persons with hearing impairments. If a Muslim is a person with conductive deafness (mild level), then he can still use hearing aids, but for sensorineural deaf (severe level) [3], hearing aids will not provide much assistance, even people with conductive deafness (intermediate level) cannot hear perfectly with a hearing aid. In addition, hearing aids often produce a buzzing sound, which interferes with concentration[4][3][5].

Previous research was conducted to design wristbands for the deaf based on the Internet of Think, the tool works to provide notifications to the deaf in the form of vibrations when a danger or natural disaster occurs, the tool uses several sensors to detect danger and uses a wi-fi network. The advantages of the tool are designed to be portable with a light weight and multifunctional in reading hazards. The disadvantage of this tool is that when the speed of the wi-fi network is slow, the transmission of data to the receiver will be slow. Then the tool uses a PIR sensor or proximity sensor to detect movement, but the sensor readings are less accurate[6]. In the next previous studies, the design of the

prayer vibrating bracelet was carried out to assist the deaf in praying in congregation. This tool uses a proximity switch sensor to detect the imam's movement. The tool works when the imam's device sends a command signal to the congregation's device using the HC-05 Bluetooth serial connection. The advantages of this tool can be recharged when the battery runs out. The result shown is that when the Imam makes a movement, the tool on the congregation vibrates very sensitive because the sensor used is a proximity switch sensor which is less effective. Then the vibration for each movement is still the same so that the congregation still has difficulty in distinguishing each prayer movement[7].

Based on the shortcomings of the previous tool, in this study, a Gyroscope bracelet [8], [9][10][11][12] for prayer guides for the deaf will be designed which is an innovation from the problem of congregational prayers that are owned by the deaf. This tool uses a different vibration at each prayer position making it easier for the congregation to distinguish the position of the prayer movement. This research was conducted to obtain and analyze the results of the system response using a motion sensor Gyroscope MPU6050[12][13][14][15] by designing a control system using an Arduino controller and serial communication between the sender and receiver using an HC-12 wireless module[16][17][18][19] with further communication up to 100 meters and with a more minimalist design. The bracelet strap used is made of magnets, the bracelet circle will follow the size of the user's hand so it is more practical to use.

II. RESEARCH METHODOLOGY

A. TOOLS AND MATERIALS

The tools and materials used in this research are Arduino nano FT232RL FTDI FT232, MPU6050 gyroscope sensor, HC-12 wireless module, A32 battery with 12Vdc voltage, vibrating coin and LED as an indicator.

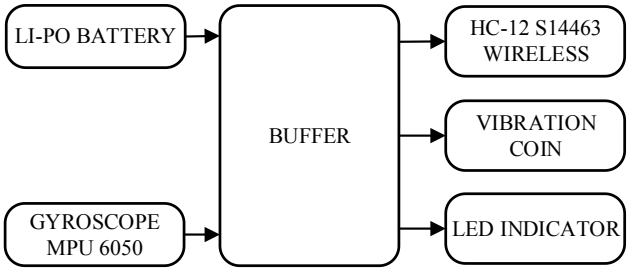

FIGURE 1. The Block Diagram of Gyroscope Bracelet

B. BLOCK DIAGRAM

In FIGURE 1 it can be seen that the tool uses a voltage source throughout the circuit using a 12 Vdc battery, then the MPU6050 Gyroscope sensor will read the prayer movement in the form of an angle value which will then be processed by the Arduino nano on the analog pin. To communicate the congregation device with the imam device, the HC12-SI4463 module circuit is used which will capture the data sent by the HC12-SI4463 module owned by the Imam bracelet and then the data will be read by the Arduino nano on the vibrating bracelet to be further converted into vibrations and LED color emission as a sign that the Imam's instructions have changed. The wireless module of the imam will send a command signal to the wireless module of the congregation. When the command signal has been received, the coin indicator will vibrate and the LED will be ON.

C. HARDWARE DESIGN

At this stage, the process of designing a Gyroscope bracelet for prayer guides is carried out for the deaf. The manufacture of the Gyroscope bracelet begins with designing a schematic circuit on the Imam's and congregation equipment, then selecting the supporting components of the system. On the Imam device, the SCL and SDA pins of the MPU6050 gyroscope sensor enter the A4 and A5 Arduino nano pins which are used as inputs. In the wireless module[20][21], the RX and TX pins are used as serial data to enter digital pins 2 and 3 on the Arduino nano. On a common device, the HC-12 wireless module[22][23][24] RX and TX pins go to digital pins 2 and 3 on Arduino nano[25][26][27] then for the LED indicator and vibrating coins enter digital pin 13. Schematic images can be seen in FIGURE 2 and FIGURE 3.

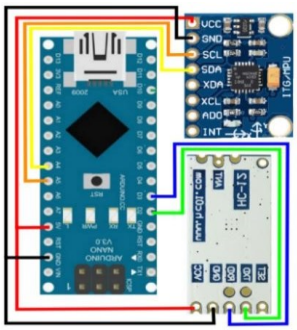

FIGURE 2. Schematic of the priest's device

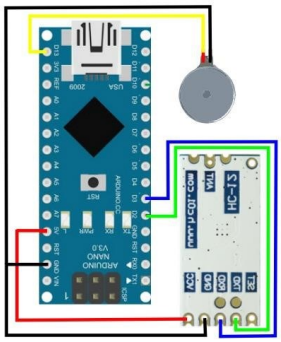

FIGURE 3. Schematic of the maximum device

D. TOOL DESIGN

In this stage, the process of making the Gyroscope Bracelet is carried out using existing tools and materials. Before making the casing and splicing the scrip on the tool, a custom casing is made with acrylic material. It can be seen in FIGURE 4 that the imam's device consists of an Arduino nano module which is used to control the overall process on the device, then there is an MPU6050 gyroscope sensor as a prayer movement reader for the imam and there is an HC-12 wireless module for serial communication of the imam's device and the congregation's device.

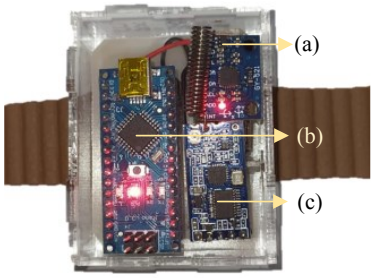

FIGURE 4. Imam's Device. (a) indicates MPU6050, (b) indicates Arduino NANO, and (c) indicates HC12

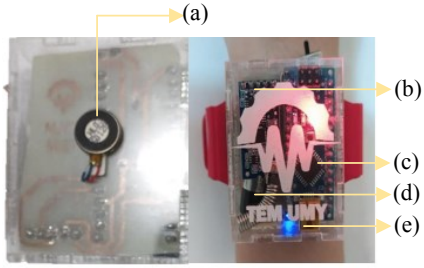

FIGURE 5. Congregation's Device. (a) indicates vibration coin, (b) indicates wireless HC12, (c) Arduino NANO, (d) Battery, and (e) LED Indicator

The Congregation device as shown in FIGURE 5, there is an Arduino nano as the overall control of the tool, there is also a battery as a voltage source and there is a vibrating coin and an LED as an indicator that signals a change in prayer position. In addition, there is an HC-12 wireless module as a receiver for command signals from the Imam's device.

E. DATA RETRIEVAL

Gyroscope Bracelet data in the form of compatibility between the X and Z angle range of the Gyroscope MPU6050 sensor and the Imam's movement by doing a movement test. The movement test was carried out by 30 people with data on the Imam's height between 155 cm to 170 cm. After getting the results from the trial, an analysis of the response of the motion sensor to the Imam's movement was carried out to find the range of Z and Y angle data from the gyroscope sensor. The analysis is carried out by looking at the LED indicators and vibrating coins that are functioning properly.

III. RESULT

Following are the results and analysis of the discussion on research on the design of a prayer guide gyroscope bracelet for the deaf. Before testing the tool, take data on the X and Z angle range of the MPU6050 gyroscope sensor. Data is generated

TABLE 1
First Experiment Data (Volunteer height 170 cm)

Accelerometer Position	Prayer Position (°)				
	Holding Arms	Bow down	I'tidal	Prostration	Sit
X	(-20) - (-5)	30 - 55	40 - 75	40 – 65	10 – 30
Z	60 - 65	(-6) – (-15)	(-5) - 5	(-5) - 10	- 5 – (-15)

TABLE 2
Second Experiment Data (Volunteer height 158 cm)

Accelerometer Position	Prayer Position (°)				
	Holding Arms	Bow down	I'tidal	Prostration	Sit
X	(-5) – 10	40 – 60	50 – 80	35 – 60	15 – 30
Z	10 - 25	(-60) – (-65)	(-100) – (-120)	(-150) – (-160)	(- 180) – (-200)

TABLE 3
Third Experiment Data (Volunteer height 165 cm)

Accelerometer Position	Prayer Position (°)				
	Holding Arms	Bow down	I'tidal	Prostration	Sit
X	10 – 25	55 – 80	65 - 90	20 – 35	(-5) – 15
Z	50 - 60	20 – 30	0 - 15	20 - 30	40 – 60

from a sample of 3 people with a height between 158 - 170 cm, this data will be used as a reference value when the Imam's device performs the movement. Imam's experimental data can be seen in TABLE 1, TABLE 2 and TABLE 3.

The data used three experiments on Imam with different heights, namely 170 cm, 158 cm and 165 cm. Due to the difference in height for each imam, it causes a different angle range value for each prayer movement position.

The difference in each position of the prayer movement, will produce a different range of angles. The signal in the form of a change in movement position will be captured by the gyroscope sensor, which will be processed by Arduino and received by the general device. The Congregation device receives a Movement change signal which is converted into a vibration and an LED indicator lights up. Notifications in the form of vibrations, are different for each prayer position, depending on the duration of the vibration. For example: on the holding arms position, the tool vibrates for one second, while in the Bow down position, it vibrates for 2 seconds. Vibration notification data can be seen in TABLE 4.

TABLE 4
Vibration Notification Data

Position	Vibration (second)
holding arms	1
Bow down	**2**
I'tidal	**1**
Prostration	**3**
Sit	4

B. DATA COLLECTION RESULTS

The data collection process was carried out directly by conducting prayer movement trials with indicator displayed on LED and vibrating coins. The Imam's movement data will be sent directly to the congregation device for processing. The total data obtained are 5 prayer positions with each position of 30 motion response data, as follows in TABLE 5.

TABLE 5
Results of Data Collection

Accuracy on Position (%)				
Holding arms	Bow Down	I'tidal	Prostration	Sit
70	90	86,6	90	83

TABLE 5 is the result of trial data conducted on 30 different people with different angle ranges in each position. After the test, the percentage of success was 70% in the holding arm position, 90% in the bow down position, 86.6% in the I'tidal position, 90% in the prostration position, and 83% in the sitting position. The overall success percentage of the five tested positions with a success rate of 84%.

IV. DISCUSSION

Comparison of this research with previous one is found in the sensors used. Previous research used a proximity sensor (HC-04) to capture movement, causing inaccurate readings of changes in the position of prayer movements. While in this study, a gyroscope sensor (MPU6050) was used which reads changes in the angle of each movement, so the success rate is higher.

The failure in several experiments was caused by several factors, such as: The movement did not include within a predetermined angle range, as well as different heights for each person. From these shortcomings, it is hoped that further research will use motion sensors that are more precise in reading angles and add the y-axis as a parameter.

V. CONCLUSION

The conclusion that can be drawn from this research is that the Gyroscope Bracelet has been made that can help the deaf in performing congregational prayers with a success rate of 84%. The difference in vibration notifications goes well according to a predetermined angle range. The success rate can be increased by increasing the range of trial angles on the Imam.

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