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Development of Qiblat Finder Assisted Device for Visual and Hearing - Impaired Person

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ABSTRACT

For the visual and hearing-impaired person, finding intended direction would be a challenging task due to their inability to sense effectively with their eyes and ears. This study aims to develop a prototype development of a smart qiblat finder to help disabled people finding direction anywhere independently. This smart qiblat finder are developed by using Arduino UNO as microcontroller, compass sensor and Global Positioning System (GPS). To determine the qibla direction, latitude and longitude data form by GPS module while the compass module used to show the qibla direction. As for the positioning of the qibla, the prototype can detect qibla at range 291° until 293° angle to match the place of data collection. Once detected, indicators (buzzer, vibration motor and LEDs) will alert the user with continuous sound, vibrations and lighting sequences. The prototype was tested indoor and outdoor at few locations in university campus and Seksyen 7 Shah Alam Mosque. The result showed high accuracy (99.3% to 100%) in detecting the direction of qibla and successfully alerted the user through buzzer sound and vibration and LED.

Keywords: Arduino UNO; Compass Sensor; Global Positioning System; Qibla direction; visual and hearing impaired

1.0 INTRODUCTION

As technology advances, numerous prayer time and qibla direction services applications are available for smartphone users. Nonetheless, the applications entirely dependent on the internet availability service and focuses on normal able person. Thus, visual and hearing-impaired people could have difficulty in detecting the accurate qibla direction without assistance [2]. According to the National Eye Survey of 1996, around 2.73 percent of Malaysia's population is visually impaired, with 2.44 percent having poor vision and 0.29 percent blind [1]. A National Health and Morbidity Survey done in 2019 [9] reported that one in four adults in Malaysia experienced functional difficulties and 14.9% of them faced visual as well as 7.6% faced hearing difficulties. The visual and hearing-impaired people may not have any working eyesight and hearing to help them navigate about safely without any help. Therefore, disable people which is visual and hearing-impaired difficult to find the qibla direction anywhere without any assistance from others.

Few assistive devices have been built and designed to detect qibla direction for visually and hearing-impaired persons utilising a minimum number of components and programmes. Firstly, International Research Journal of Advanced Engineering and Science (IRJAES) had developed prayer time reminder and qibla direction named as “I-DEVICE” and user can find both information with a few things [3]. GPS technology, when combined with pre-programmed positions, allows the user to choose the best route. Using the Arduino IDE software, all of these components and sensors are controlled by an Arduino Mega 2560 microcontroller with encoded source. This tool is intended to be easy to take around and comfortable to use because it is designed to be portable.

Next, other device called the RHI compass works the same way as an analogue compass works manually and has a weakness very sensitive to metal objects and electronic components [4]. The usage of a compass measurement equipment, such as the analogue and digital compass, in detecting the direction of the wind and the position of the magnetic earth might change from year to year. The HMC 5883L sensor used in this device is a measuring tool that can detect the compass direction in the same manner that analogue and digital compasses can. The information obtained from the HMC 5883L sensor is converted into an easy-to-understand form of data utilising an Arduino Uno microcontroller as a central control.

Furthermore, Aprilianto et al. [5] also developed prototype of walking aids and qibla direction for blind based on ATmega328 microcontroller that embedded a proximity sensor, sound database, and magnetic sensor into a microcontroller system. The goal of this study of walking aid prototype design and determinant of qibla direction is to extend navigational aids that employ sound recognition and determinant of qibla direction that are simple and effective to use. In addition, Asrin et al. [6] developed Qibla Direction Cane for Blind using interactive voice command. This gadget enhances the function of the cane as a tool for determining the direction of the qibla using voice commands. As a compass sensor and a microphone for voice command input, the compass sensor module HMC5883L is used. Earphones are used to hear the system's voice command. The results of the test reveal that the system can correctly identify voice commands in a noise-free setting.

However, there have been limited studies done on combination of visually and hearing aid device to find qibla direction and also for detecting real life location. Therefore, the objective of this study is to develop a device that incorporates location detection and qibla direction that could assist the visual and hearing disabled people to find the Qibla direction independently.

2.0 PROJECT METHODOLOGY

2.1 SYSTEM DESIGN OF SMART QIBLA FINDER

This section will go through the Smart Qibla Finder's as is the system design and implementation for the visually and hearing-impaired. The Global Positioning System (GPS) module, compass module, and Arduino microcontroller are all used in the system. The system's algorithm uses Arduino IDE to write its code.

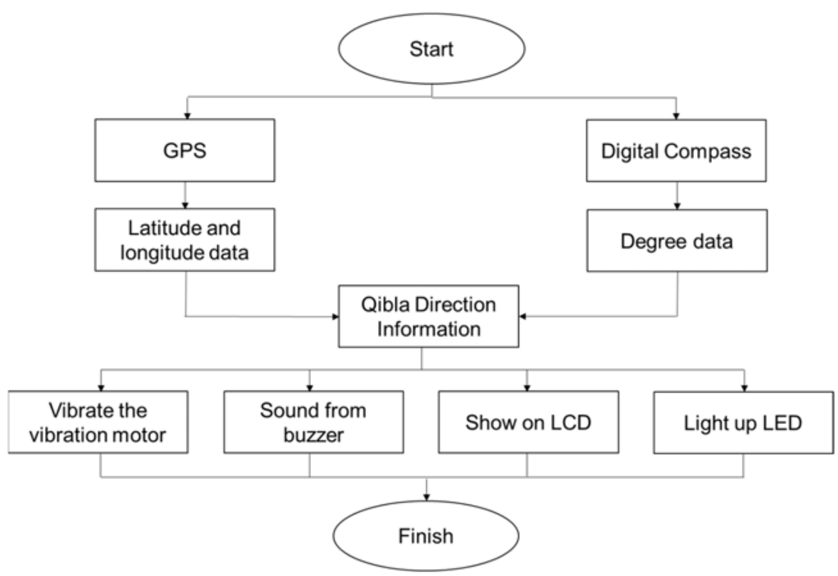

Figure 1: General scheme of the research system

Once the power is switched on, the GPS and digital compass would provide latitude and longitude data as well as direction in angle, respectively. Once the input data (location and direction) are finalized, indicators such as the buzzer, vibration motor and Light Emitted Diode (LEDs) will alert the user with continuous sound, vibrations, and lighting sequences.

2.2 DESIGN PROCESS AND PROTOTYPE DEVELOPMENT

Firstly, the initial design and electrical components of qiblat system were determined. The Arduino Uno which is an open-source microcontroller board used and Arduino IDE was used to program the board. Next, a GPS system was embedded via GY-NEO6MV2 sensor and programmed on the same board. The compass sensor (HMC5883L) was also used to detect rotation and direction by using magnetic field as reference. The data from both sensors (GPS and compass) were then processed by the microcontroller and the longitude and latitude data for location and direction angle will be the feed information as output indicators. The indicators used were LED, vibrator and buzzer. LED is a semiconductor device that emits light when an electric current is passed through it. For normal users, they would see the LED lights up when the device detects the accurate angle of Qibla direction. Meanwhile, the visual impaired person would know the qiblat direction by feeling the vibration from vibrator motor and buzzer. A vibrator motor is a micro-direct current (DC) motor that vibrates with no sound. This vibration motor will vibrate once the angle of Qibla direction is accurate as system design as a feedback output for user alert the device detected. Buzzer is an electronic component that can convert electrical signal into sound signal of the diaphragm inside the buzzer. Buzzer is used in the system design as a feedback output to alert the user when the device detected accurate angle of Qibla direction in front of the user.

Once all the hardware were determined, the detailed design was developed. The upper and lower casing cover size specifications and components arrangement were visualized and finalized by the Computer Aided Design (CAD) software as shown in Figure 2. The cover size was determined based on the size of the electrical components and its arrangement. For ergonomic purpose, this prototype considered fit for one hand use and lightweight for easier handling by elderly and disabled persons. Next, the covers were fabricated by using a 3D printer. The material for 3D Printing was made from polylactic acid (PLA). The electronic components for both prototypes are similar which were the red and green LED, buzzer, vibration motor and compass sensor. Once all the hard components were obtained, the electrical systems were assembled and attached to casing cover in Figure 3.

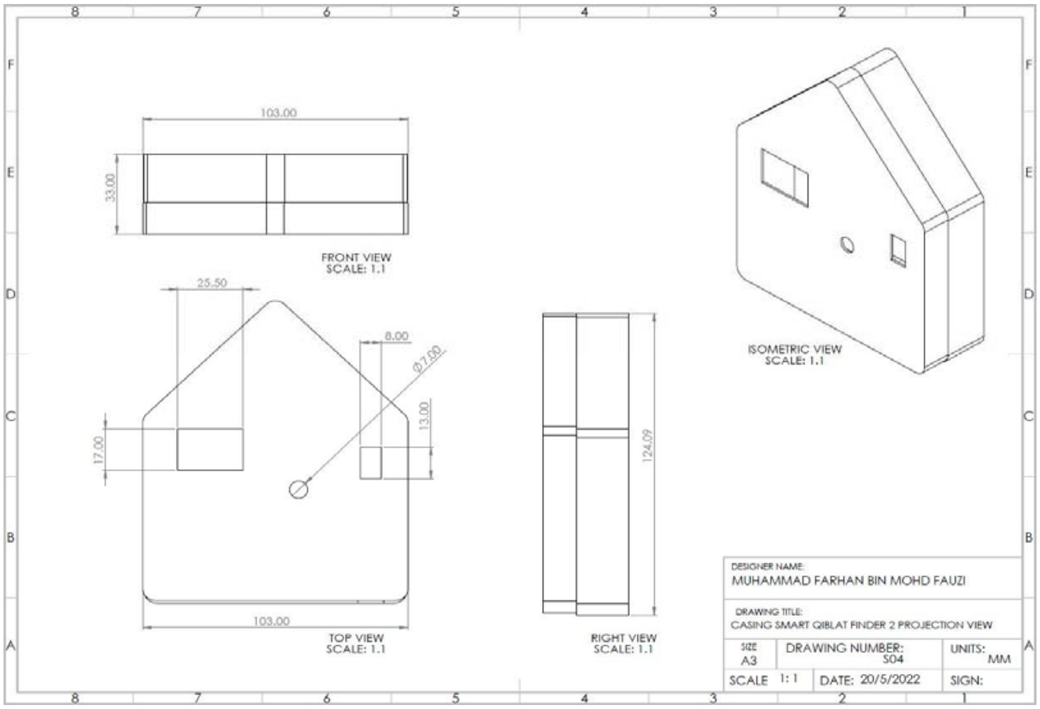

Figure 2: CAD assembled data for upper and lower qiblat finder casing covers

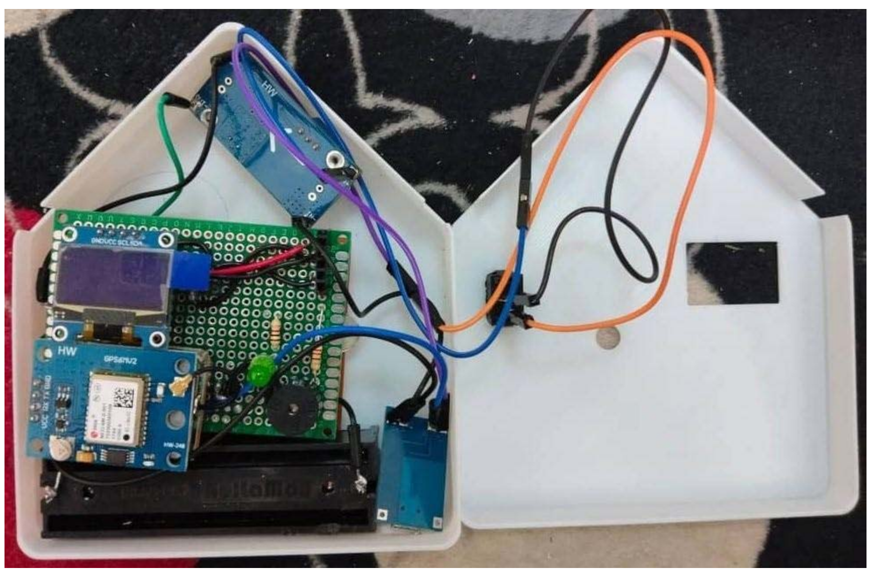

Figure 3: Electrical circuit setup for qiblat finder

2.3 PROTOTYPE VERIFICATION

After the prototype was completed, it had to be tested to ensure its workability. Six different locations were chosen and the test was performed indoor and outdoor. Three types of data which were the prototype position accuracy at different location type, location accuracy and angle accuracy between Qibla direction in smartphone and prototype. The participants involved were 10 volunteers, consist of five male and five female of various ages. The volunteers would be asked to wear a headphone with loud noise to imitate hearing impaired people and cover wearing eye cover to imitate visually impaired person. The prototype was put in front of them on flat surface and the participants would rotate the prototype to get the range angle of 291 until 293 degrees (qiblat direction) until the indicators would be functioned (LED on, buzzer on and vibrator vibrates). At the same time, the compass app in smartphone was used to determine same qiblat direction (Figure 4)

Figure 4: Procedure to obtain protype position

The difference of the angle when the indicators work and the display in compass app would indicate the accuracy level of the prototype. After each trial, the participants would answer questionnaire to understand the participants response.

3.0 RESULTS AND DISCUSSION

3.1 PROTOTYPE POSITION ACCURACY

Various tests of two different scenarios successfully done to verify the prototype position accuracy by detecting the angle difference of the prototype with the smartphone. The smartphone was positioned at 293 degrees angle based on the Qibla direction device. Table 1 showed that the indoor angle differences was smaller than the outdoors output at all locations except for the hockey turf and the mosque. This finding is concurrent with a study done by Lubis et al [4] where the angle difference was from 2 to 7 degrees, while Asrin et al [6] reported the deviation between 5 to 9 degrees of qiblat direction in his study. The probable justification is that the flatness and sturdy surface would stabilize the sensor's reading process thus smaller angle difference. In addition, the compass sensor's heading accuracy could be affected by "hard-iron effects," which are caused by adjacent magnetic items. As a result of hard-iron effects from adjacent ferrous elements with residual magnetism, the earth's magnetic field will be weakened or increased, causing heading errors [7].

Table 1: Angle difference at different locations testing

Location	Open Space		Angle Difference (error)	
	Indoor	Outdoor	Indoor	Outdoor
Hockey Turf	293°	291°	12°	4°
Kolej Mawar's Field	292°	291°	8°	7°
Taman Tasik Seksyen 7	292°	293°	6°	2°
Engineering College	291°	292°	5°	9°
Pusat Islam UiTM Shah Alam	293°	293°	6°	4°
Masjid Kristal Seksyen 7	293°	293°	10°	9°

3.2 ACCURACY OF QIBLAT DIRECTION

The angle accuracy was determined by comparing the angle obtained the prototype with the app value which was 293°. By referring to Table 2, the prototype was able to detect the actual angle at all location indoor and outdoor.

Table 2: Qiblat angle difference

Location	**Open Space**		**Angle Difference (error)**	
	Indoor	Outdoor	Indoor	Outdoor
Hockey Turf	293°	291°	100	99.31
Kolej Mawar's Field	292°	291°	99.66	99.31
Taman Tasik Seksyen 7	292°	293°	99.66	100
Engineering College	291°	292°	99.31	99.66
Pusat Islam UiTM Shah Alam	293°	293°	100	100
Masjid Kristal Seksyen 7	293°	293°	100	100

3.3 LOCATION DETECTION

From Table 3, it was proven that the GPS sensor managed to detect the location accurately at all outdoor locations and zero data indoors. Irsan et al [8] used same GPS sensor in his study and found acceptable small difference in locations points when compared to phone GPS data. Meanwhile, the zero value of indoor data happened because transmitted location data were blocked by the building/premises structure. Thus, the finding agreed that the sensor could accurately determine the location.

Table 3: Location detection at different locations testing

Location	**Prototype GPS coordinate**		**Actual GPS coordinate**	**Accuracy (%)**
	Indoor	**Outdoor**		
Hockey Turf	0, 0	3.067611, 101.496643	3.067422, 101.496884	100
Kolej Mawar	0, 0	3.067536, 101.495736	3.069673, 101.496100	99.93
Taman Tasik Seksyen 7	0, 0	3.078106, 101.491022	3.078218, 101.491511	100
College	0, 0	3.069124, 101.497851	3.073072, 101.497071	100
Pusat Islam UiTM Shah Alam	0, 0	3.068247, 101.503074	3.068240, 101.503497	100
Masjid Kristal Seksyen 7	0, 0	3.071262 101.481599	3.071434, 101.481881	99.94

4.0 CONCLUSIONS

The prototype assistive device for visual and hearing-impaired person to determine independently the qiblat direction and to detect real location through GPS system was developed and tested. The position error of the prototype to point the qiblat angle (293°) is relatively small and could be improved by rectifying the hard-iron distortions thru a specific calibration process that takes readings of the magnetic fields around it. The error could be due to uneven level surface during compass calibration. Nonetheless, the system feedback managed to provide output to the indicators and alert the user. The actual indoor and outdoor location was successfully determined with the GPS system with 99 to 100% detection accuracy. Although the prototype's function were successfully tested, further improvement could also be done on the design such as smaller size by using compact printed circuit board and integration of wireless internet (wifi) for better communication.

REFERENCES

[1] K. M. P. Dunque, A. R. See, D. S. Putra, R. da Lin, and B. Y. Li, "Obstacle Detector and Qibla Finder for Visually Impaired Muslim Community', *IFMBE Proceedings*, 79 (2021), 55–71.

[2] L. A. Ghani, Pejabat Mufti Wilayah Persekutuan - Kiblat, Mufti of Federal Territory, Malaysia, 2020. https://www.muftiwp.gov.my/en/unit-falak2/149-soalan-soalan-lazim-falak/4023-kiblat (accessed Jan. 07, 2022).

[3] H. Arrosida, D. Shahab, A. Sudaryanto, and S. Bagus Setyawan, "I-Device Islamic Device for Blind as Prayer Time Reminder and Qibla Direction Indicator with Voice Output ", *International Research Journal of Advanced Engineering and Science*, 4(2019) 117–120.

[4] S. Lubis , P. Harahap, F. I. Pasaribu, W. S. Damanik, M. Al Siregar, I. Siregar and E. S. Hasibuan, "The Design and Qibla Direction by Using the Hmc 5883 L Sensor as a Compass Rhi in the UMSU Science Laboratory (OIF)", *Budapest International Research of Exact Science*, (2020), 376-381

[5] R. A. Aprilianto, Pujiyanto, N. Anita, Z. P. Mashdiq and Y. Primadiyono, "Prototype of Walking Aids and Determinant of Qibla Direction for Blind Based on Microcontroller ATmega328", *International Conference on Educational Research and Innovation (ICERI 2017)*, (2017),77-81

[6] A. Asrin, G. I. Hapsari, G. A. Mutiara, "Development of Qibla Direction Cane for Blind using Interactive Voice Command", *2018 6th International Conference on Information and Communication Technology (ICoICT)*, (2018), 216-221

[7] N. Knezek and B. Buffett, Influence of Magnetic Field Configuration on Magnetohydrodynamic Waves in Earth's Core, (2018) [Online]. Available: http://www.elsevier.com/open-access/userlicense/1.0/

[8] M. Irsan, R. Hassan, M. K. Hasan, M. C .Lam, W. M. H. W. Hussain, A. H. Ibrahim and A. S. A. M. S. Ahmed, "Novel Prototype for Safe Driving Using Embedded Smart Box System", *Sensors*, 22(5), 1907 (2022)

[9] Institute for Public Health (IPH), National Institutes of Health, Ministry of Health Malaysia. National Health and Morbidity Survey (NHMS) 2019: Vol. I: NCDs – Non-Communicable Diseases: Risk Factors and other Health Problems (2020)