A Qibla Compass for Visually Impaired Muslims

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***Abstract*—The inability to perceive clearly with the eyes can affect the blind and visually impaired in doing daily activities, especially in determining direction and navigation. In order to provide a non-invasive device, a qibla compass is developed to help them to determine the desired direction. This paper presents the development of a low-cost and easy-to-handle device to detect the Qibla direction for muslims, especially the visually impaired. A magnetic compass is used as the main component to detect the correct angle of Qibla direction. Once detected, a buzzer will alert the user with continuous sound.**

***Index Terms*—Blind People; Qibla Compass; Visual Impaired.**

I. Introduction

Salat is the second pillar of Islam and it is compulsory for a Muslim (people who believe in the religion of Islam) to perform the ritual prayer five times a day. One of the conditions for a valid prayer is facing the qibla; the direction the worshipers must face is at the diameter of the earth that passes the city of Mecca, and specifically towards the Ka'ba. Unfortunately, it is impossible for the blind and visual impaired to determine the correct Qibla direction without any assistance. Hence, in normal practice, they will seek help from the surrounding people in that place to guide them in finding the right direction.

According to the National Eye Survey in 1996 about 2.73% of the population in Malaysia is visually impaired, of whom 2.44% have low vision and 0.29% is blind. This estimation involved 700,000 people who are visually impaired, and 74,000 of them blind [1].

Visual impairment and blindness occur when the retina has limited response to the light, and thus the message cannot be translated to the brain. However, the person is blind since birth, they may have developed a better level of sensitivity of hearing and touch to obtain external sensory information to complement their sense of sight [2].There are some available compasses which help the blind and visual impaired to identify direction. MoonTrail had developed 'braille-compass' named as Brunton Nexus 16B Braille and users can find the direction by touching the graduation on the compass card. Another device called the Digital Talking Compass is compact, and the direction is announced to the nearest of 8 compass points, from northeast to southwest. Langtao and Balachandran also developed an electronic compass for blind or deaf-blind people [3].

The compass comprises of eight opto-switch sensors to differentiate the orientations. Once the desired direction is detected, the corresponding electrical signal will be converted to audio for the blind, or electric pulse for deaf-blind to indicate that the user is facing the correct direction. With the advancement of technology, electronic compasses have been integrated with other sensors, such as gyroscope and accelerometer for localization/navigation for blind people. Electronic travel aids (ETAs) [4, 5], smartphone [6], In situ audio services (ISAS) [7], Radio frequency identification (RFID) [8], for instance, is an electronic aid that helps the blind to identify direction, localization or navigation. However, there have been limited studies done on compasses for the visually impaired to identify Qibla direction. Mahmoud patented a Qibla oriented device, which can be hung around the user's neck to determine the direction of Qibla [9]. It comprises of a compact device that has features like GPS receiver, magnetic direction sensor, directional indicator light, audio directional output, and a longitudinally aligned laser projector. The audio signal acts as the output to produce sound which can help the visually impaired in finding Qibla direction. Motivated by a desire to help the visually impaired, this study aims to develop a Qibla compass to assist the blind and visually impaired in identifying Qibla direction.

II. Designs

The main target for this project is to develop a low cost and practical Qibla finder tool for visual impaired and blind Muslims using a compass. It uses a magnetic compass combined with a simple sensory and actuation system. Compared to the device patented by Mahmoud which implemented sophisticated system [9], this Qibla compass will produce a low cost approach as it uses a much simpler system. The sensory system will detect the exact position of Qibla obtained from the compass once the arrow of the magnetic compass is pointed in the Qibla direction. Based on the 79th Muzakarah (Conference) of the Fatwa Committee of the National Council for Islamic Religious Affairs Malaysia, the degree of diversion allowed from the direction of the Qibla is not more than 3% diversion from the mihrab, and they decided that facing the direction of the Qibla is a matter of opinion (ijtihad) and suspicion (zann) [10].

As for the actuation system, continuous sound will be produced from a buzzer to notify the users that they are facing the Qibla direction. Sound is more practical to be used as compared to vibration force. This is because vibrations can confuse certain users as compared to sound, especially with a buzzer. Besides that, the device also uses LED to notify the non-blind user on the exact direction of Qibla. They only need to press the button continuously until the device produces continuous sound and the LED lights up. Below are the operating procedures of the device:

i. Hold the device firmly by ensuring that it is parallel to the ground and stay still for about 20 seconds.
ii. Slowly revolve your body together with the device while pressing the button at the right side of the device.
iii. When sound is produced by the buzzer, stop for a moment while pressing the button.
iv. If the buzzer sounds continuously for more than 5 seconds, release the button and you have successfully facing the Qibla. If not, repeat from ‘Step I’.

A. Component Assembly

The assembly of the whole system can be divided into four stages:

i. Compass assembly
ii. Sensor assembly
iii. Battery pack assembly
iv. Board assembly

The magnetic compass is the main component of the system. Compass assembly is done to determine the functionality of the compass itself. In order to detect the Qibla direction, the compass arrow was marked in a manner to allow detection by the sensor. For sensor assembly, a transmitter and a receiver are used and placed on top and at the bottom respectively. The battery pack assembly requires the wires to be soldered onto the designated battery contact. A 23A size battery is used and placed in the battery case, and the battery pack is hidden using the battery cover. Lastly is the board assembly, where the components, such as buzzer, resistor and wires, are soldered onto the PCB board. Figure 1 shows the designated Qibla compass.

Figure 1: Qibla compass for blind people

All the components for the sensory and actuation system need to be assembled and fit into a designated casing together with the magnetic compass. The design of the Qibla compass casing is divided into top and bottom casing design, and has been through several alterations after receiving reviews from the tester before coming out with the final design.

B. Casing Design Development

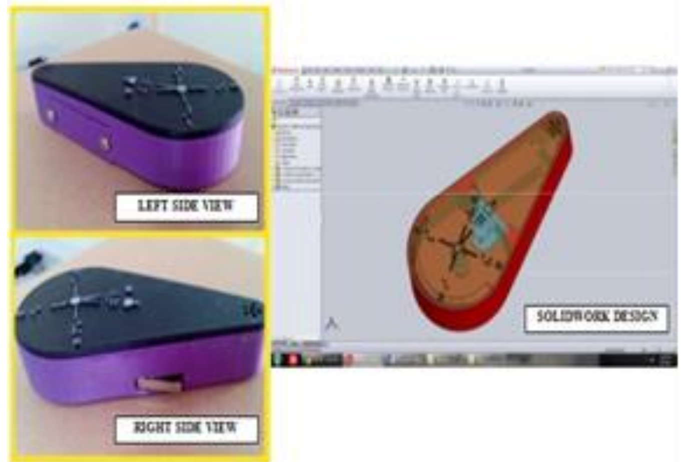

Figure 2: The first design of the casing

The initial design focuses on fitting all the components into the casing without considering the comfort of the user when handling the compass. Figure 2 shows the initial casing design.

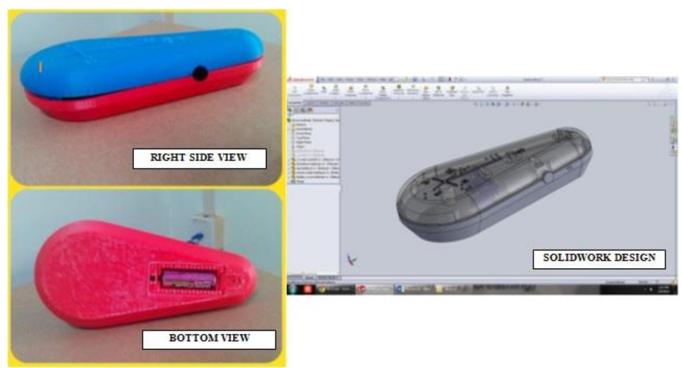

Figure 3: The second casing design

After receiving reviews from visually impaired users on the first design, changes were made by replacing the initial design with a with fillet design for comfort when holding. An additional part was also added to support the sensor holder. Figure 3 shows the second casing design of the Qibla compass. After considering the comfort and grip of the user, a chamfer was made at the bottom casing. Due to the changes made, the battery position was moved to the middle with an additional new switch.

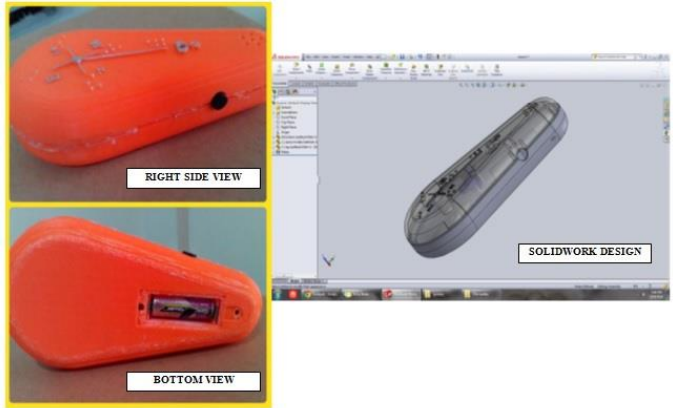

Figure 4: The third casing design

For the third design, as shown in Figure 4, only the bottom casing was altered with fillet design. The position of the components is fixed, but certain dimensions had to be changed.

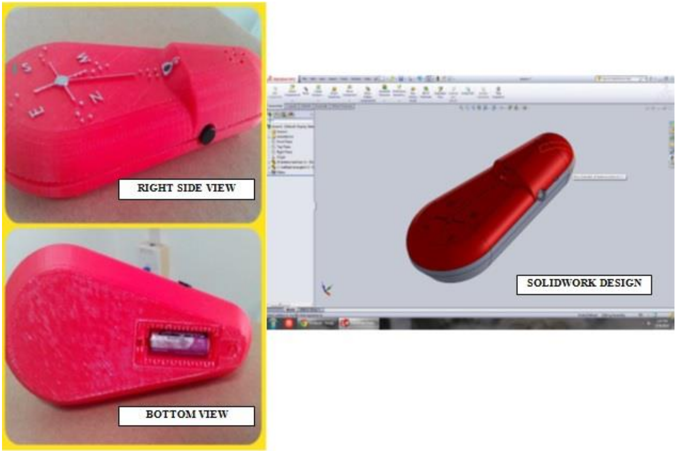

Figure 5: The fourth casing design

For the top casing, the position of the components remains the same. Only the LED is inclined to make it more attractive, and provide a better feel for the user. As for the bottom casing, the shape and components' positions are maintained from the second design, because there is interference when the battery is placed at the bottom. Besides that, changes were made at the battery slot and battery cover to ensure that the compass is stable on flat surfaces. Figure 5 shows the fourth casing design.

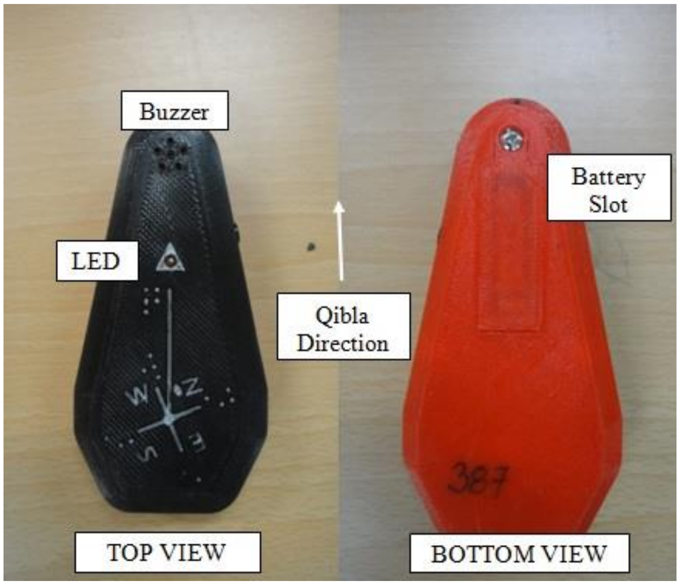

Figure 6: Qibla compass final design

In the final design, the top casing is flat, unlike the previous one. The bottom casing is maintained, as its design provides a good grip.

III. Validation Procedures

In order to determine the accuracy, the device is compared with the known Qibla direction at mosques, and that direction is assumed to be correct. The Qibla compass deviation angle and percentage of deviation towards the Qibla direction from the mosques will determine the device accuracy.

In order to obtain the angle of deviation, a reference compass is used as comparison by placing it on the polar graph, as shown in Figure 6 below. The data is collected based on the polar graph. A praying mat with compass is used as the reference by aligning the praying edge with the mosque's saf. Figure 7 shows the experimental setup to measure the angle of deviation.

Figure 6: Position of the actual Qibla direction and reference compass on polar graph

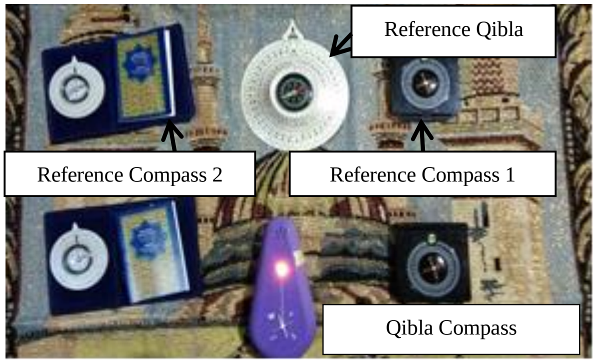

Figure 7: Mosque Qibla direction, reference compass 1 and 2, and Qibla compass placed for validation at the mosque

The measurement was done at three selected mosques; Mosque A, Mosque B and Mosque C which are situated around Johor Bahru.

IV. RESULTS AND DISCUSSION

Table 1, Table 2 and Table 3 shows the result of the validations done at three different mosques.

Table 1
Deviation from Qibla direction in Mosque A

Mosque	Deviation angle from the North (°)	Percentage of deviation (%) $\left[\frac{Angle\ of\ Deviation}{360°} \times 100\right]$
Qibla Compass	2.02	0.56
Reference Compass 1	4.54	1.26
Reference Compass 2	9.29	2.58
Mobile Phone Application	2.48	0.69

Table 2
Deviation from Qibla direction in Mosque B

Mosque	Deviation angle from the North (°)	Percentage of deviation (%) $\left[\frac{Angle\ of\ Deviation}{360°} \times 100\right]$
Qibla Compass	6.35	1.76
Reference Compass 1	6.73	1.87
Reference Compass 2	7.69	2.12
Mobile Phone Application	6.33	1.75

Table 3
Deviation from Qibla direction in Mosque C

Mosque	Deviation angle from the North (°)	Percentage of deviation (%) $\left[\frac{Angle\ of\ Deviation}{360°} \times 100\right]$
Qibla Compass	7.10	1.97
Reference Compass 1	7.21	2.00
Reference Compass 2	5.37	1.50
Mobile Phone Application	5.13	1.43

Based on the results obtained from the three mosques, the percentage of deviation for all mosques is less than 3%, which is acceptable, based on guidelines determined by the Fatwa Committee of the National Council for Islamic Religious Affairs Malaysia. The measurement of deviation angle for device validation process shows that the Qibla compass is able to perform well, and it is proven that the device is reliable

V. CONCLUSION & RECOMMENDATIONS

As a conclusion, with only using a magnetic compass as the main component, a low-cost and easy-to-handle Qibla compass was successfully designed and developed in order to assist visual impaired and blind people. With this device, blind and visually impaired people can perform prayers anytime and anywhere without asking other people. The objective and scopes of this project were fulfilled.

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