Development of Qibla Direction Cane for Blind Using Interactive Voice Command

By gita indah hapsari

Development of Qibla Direction Cane for Blind using Interactive Voice Command

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***Abstract*—Blind person is someone who has visually impairment. Cane is a tool aid used to assist their daily activity. A conventional cane still have limited function in detection obstacle and hole so not all activity are helped using cane. One of difficult experience is to determine the direction of qibla whenever they will pray. This research develop function of cane as a tool that can determine the direction of qibla by voice command interactively. Prototype response to user command in the voice form. Prototype using Raspberry Pi 3 as Processor, HMC5883L as compass sensor, and microphone for voice command input. The voice command from the system is heard using earphone. The test result show the system can recognize the voice command properly in noise free environment. While in noisy environment, system can recognize voice command only 20% and 40% for 10 times testing. This system also can recognize voice command with different types of sound such as male and female voice.**

Keywords*—*qibla; voice command; blind; interactive

I. Introduction

Blind person is someone who has limitation on their vision. They are classified into 2 types, a total blindness and someone who still have low vision but very limited that give them dificulties on recognizing difference in their surounding. Both blind person and visually impaired usually can still rely on other sensing abilities that they have such as hearing, touching or smelling.

In daily activities, visually impaired oftenly use a cane as a tool that helping them to identify their environment. According to Takuma Murakami , "Canes as a tool for someone with visual impairment, that is, overcoming obstacles directly like detecting stairs and determining one of the locations. Another function of the cane is as a protector for a blind person. A good skill of using cane will give a blind person the ability to move in places independently, gain more flexibility and give more understanding to their new environment". [1]

While being a great help in the term of improving their mobility,this conventional or basic cane can not help visually impaired on detecting other parameters that usually important in their daily lives. One of the most difficult activities for blind muslims whenever they are alone is to determine the direction of Qibla for praying. So far, they need to find a mosque and basically they are still need help from normal person to do this.

In our previous research, we developed a feature of qibla direction determination system that could be combined together with the blind cane by using compass and sound output. While this system does provides a good response and proofed to be helpfull for the blind, the use of keypad for user's input still provide less of convenience in practice [2].

Therefore, we developed the previous by adding the voice command feature to make the system more interactive. This development is expected to deliver more user friendly tools for the blind. User could give input in the form of voice commands and the cane will respond accordingly in more interactive way.

Some of the researches used as the source of this study were proposed by Kumar, et.al. In their research, they created a system that can guide the blind using GPS and GSM. The system provides information in the form of sound through the speakers. But this system still does not use voice commands. [3]

A study in 2014 performed by Renupriya A, et.al. has developed a cane functions using RFID. The output is given in the form of vibration and sound. In this study the output provide is already in a sound with the form of instructions. [4]

Other related research has made by Harsha Gawari's which develops GPS-based navigation aids using voice commands. In the study it stated that using voice recognition will improved the convenience for tool users. The system was built using ARM7 as a microcontroller, HM2007 as voice recognition module and AP89085 as voice player [5].

This study was developed based on those systems that have been developed by other researchers mentioned. The blind have a defect in vision and the most common senses that oftenly used is hearing. This is the basic consideration for using sound as the input and output for the system build.

II. Theory

A. Raspberry Pi 3 Model B

Raspberry Pi is a small single board computer that can be used for various purposes such as spreadsheets, games, and

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even can be used as a media center because of its ability to play high definition video. Raspberry Pi is open source (based on Linux). Raspberry Pi can be modified according to the needs of its users. The main operating systems used are Debian GNU / Linux and Python programming languages. One of the OS developers has developed Raspian as the operating system for Debian-based Raspberry Pi. Raspian claimed to be able to maximize Raspberry Pi [6].

Fig. 1. Raspberry Pi 3

B. Compass Sensor HMC5883L

HMC5883L compass sensor is a sensor that is sensitive to rotation and direction. This sensor uses a magnetic field as a reference of its detection. The HMC5883L sensor applies AMR (Anisotropic Magnetoresistive) technology. This anisotropic sensor has high sensitivity, precission and could produces a linear output from the orientation angle changes to its axes [7].

Fig. 2. HMC5883L Device

C. Voice command support software

Judy is an application that can be used as a voice control that does not come with an API as module installed and can run offline. When using Voice Control, there are two systems which function as Speech To Text (STT) and Text To Speech (TTS). The software used is Pocketsphinx (STT) as a software that can interpret human sounds into text and picco (TTS) as software that can convert text to sound. [8]

III. Proposed Development of Qibla Direction Cane for Blind with Interactive Voice Command

The development of this Qibla pointer is using Raspberry Pi as its processor. Raspberry Pi allows voice processing more easily using raspian-based applications. Judy is one of the speech recognition applications selected because of its 'easy to use' properties.

Figure 3 describe the block diagram of the Qibla pointer cane for the blind. . Voice commands are captured using clip on microphone and then processed by Judy application. Once the command is recognized, the processor will select the voice response to be transfered to the earphone. They were issued by the system in the form of user directives such as password requests and option command.

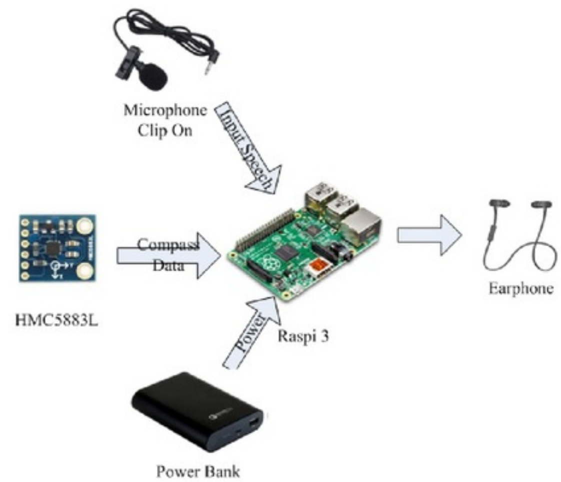

Fig. 3. Block Diagram System

The compass sensor HMC5883L used to determine the direction of the wind. The placement of this sensor must be parallel to ground or at horizontal alignment. This causes the position of laying sensor perpendicular to the cane. The cane must be positioned perpendicular to the ground when user searching for Qibla direction.

Figure 4 shows the HMC5883L sensor placement on the casing box on top view and front view. The mounting of the prototype on the cane is shown in Figure 4. The placement of the prototype is positioned according to the position of the compass sensor. As shown in figure 5, the position of the sensor is placed in a horizontal position in casing. While the prototype is mounted with a position parallel to the cane so that when the prototype is used to find qibla direction, the cane should be positioned perpendicular to the ground surface and compass sensor facing upward.

The flow diagram in Figure 6 shows that the system will issue a password request word to initiate a Qibla direction search procedure. If the password mentioned by the user is recognized then the system will prompt the user to say the word "find qibla". If the password is not recognized then the system will ask for the password again.

Furthermore, if there is a "find qibla" command recognized in 1 minute, then the system will give instructions to place the cane perpendicular to the ground and retrieve data from the compass sensor. If the values generated from the compass sensor are between 116º to 293º, then the system will give command to user to make right rotation movement. And if the values are between 115º to 297º then the system will give command to user to make left rotation movement.

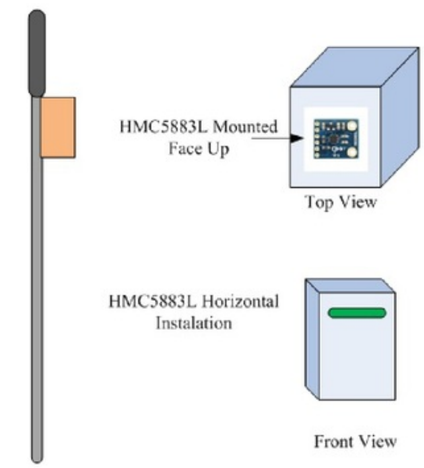

Fig. 4. HMC5883L Position

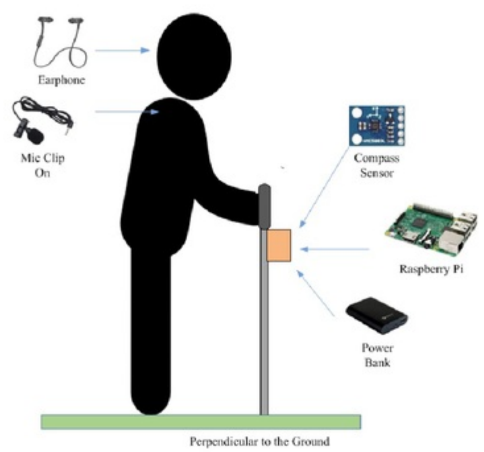

Fig. 5. System Installation

Qibla direction will be obtained if the compass sensor value reach between 294º until 296º. Figure 7 shows the theoritical direction of Qibla in the point of the compass direction. If it is already pointing to the Qibla the system will issue a sound, "You are already headed to Qibla". The system will end with the system command off and if not then the system will return to the initial state.

Implementation of the system consists of several stages:

1. Raspian Jessie instalation on Raspberry Pi
2. HMC5883L sensor configuration on Raspberry Pi
3. Voice command software instalation support which includes speaker configuration, voice response sound recording, Pocketsphink, Pico and Judy installation.

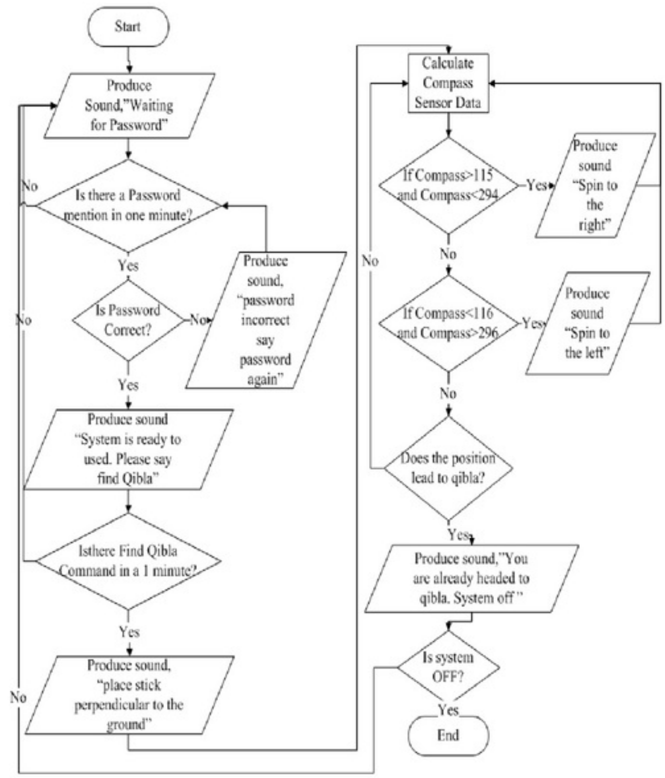

Fig. 6. Flowchart of Qibla direction Cane with Voice Command Interactive

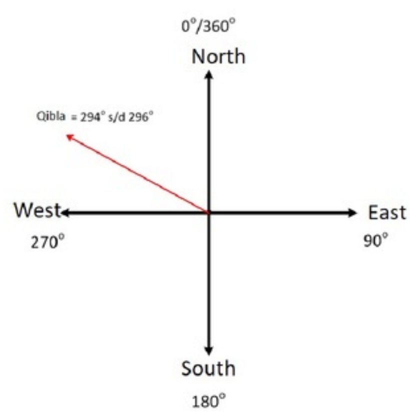

Fig. 7. Qibla Direction

This prototype used Raspberry Pi so the implementation way is to make voice command is different from Arduino. Pocket sphink is one of the software that can be used to interpret voice command. We used Pocketsphink to recognize voice command with speech to text. While voice response, we make a voice recording and play it according to the voice command. Pocket sphink instalation process was done in several process as described below:

1. Run pocket sphink instalation command as shown in Figure 8.

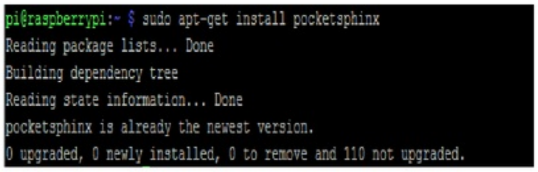

Fig. 8. Pocket Sphink Installation

2. Create voice command files in the form of text files as described in Figure 9. These words will be recognize by the system as commands and it will limit recognizable vocabulary.

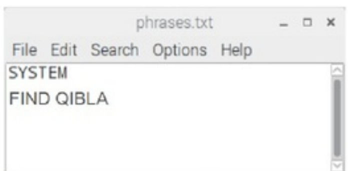

Fig. 9. Voice Command Text File

3. Open pocket sphink sites to upload files that has been created before (Figure 10) with the link http://www.speech.cs.cmu.edu/tools/lmtool-new.html.

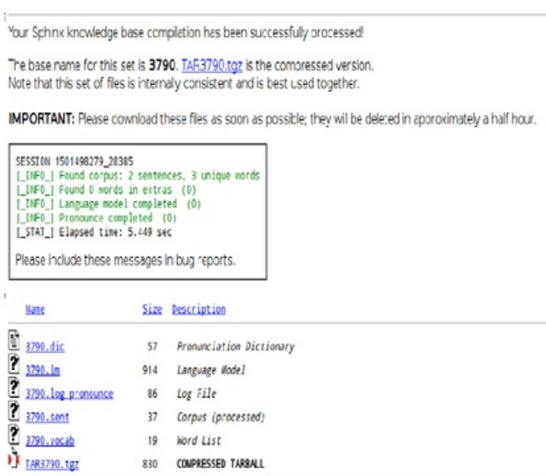

Fig. 10. Uploading file to pocket sphink

4. Next copy the link address that already exixt n pocketsphink site to be stored in Raspberry Pi directory file. Then go to terminal and download file. The result of extracted files are shown in figure 11.

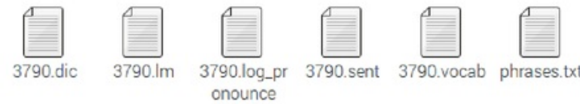

Fig. 11. Result file from Pocketsphink

5. After that we install Pico with **$sudo apt-get install libttspico-utils** and Judi instalation **$sudo apt-get install jasper-judy**.

IV. Testing the System

HMC5883L compass sensor test are performed using sampling procedure by directing the compass towards various wind direction and comparing it using manual compass. Table 1 shows the comparative results of compass and compass sensors. These tests shows an average deviation of up to 6.75° between the sensor and conventional compass.

TABLE I. Test of Compass Sensor

Sample	HMC5883L Value	Compass Manual Value	Deviation	Spin Direction
1	360°	355°	5°	Left
2	270°	264°	6°	Right
3	180°	187°	7°	Right
4	90°	99°	9°	Left

Voice command tests are performed by testing voice commands in certain circumstances. This is done to determine the effect of noise on the introduction of voice commands. Testing is done with pronunciation of "system" and command "Find Qibla" clearly and loudly 10 times. The responses then observed to see whether the password or command could be recognized or not. Tests are conducted in quiet environments and busy environments.

Table 2 shown that out of ten experiments performed, a 100% truth level is obtained from the password pronunciation of "System" and "Find Qibla" in quite environment. While in a crowded environment the truth level of "system" password pronunciation is 20% and the "find qibla" command yields a 40% truth level. This indicates that the system is still vulnerable to noise and will work properly if it is operated in a noise free environment.

TABLE II. THE RESULT OF VOICE COMMAND TESTING IN NOISY AND FREE NOISE ENVIRENTMENT

Sample	Testing Voice Command to the Environtment							
	Free Noise Environtment				Noisy Environtment			
	Pronounce "System"		Pronounce "Find Qibla"		Pronounce "System"		Pronounce "Find Qibla"	
	T (True)	F (False)	T	F	T	F	T	F
1	√		√			√		√
2	√		√			√	√	
3	√		√		√		√	
4	√		√			√	√	
5	√		√			√		√
6	√		√			√		√
7	√		√			√		√
8	√		√		√		√	
9	√		√			√		√
10	√		√			√		√

TABLE III. THE RESULT OF GENDER-BASED VOICE COMMAND TEST

Person	Gender	Testing Voice Command			
		Pronounce "System"		Pronounce "Find Qibla"	
		True	false	true	false
1	Male	√		√	
2	Male	√		√	
3	Male	√		√	
4	Female	√		√	
5	Female	√		√	
6	Female	√		√	

Voice testing also conducted on individual voice differences. This experiment uses 6 sound samples, 3 males and 3 females, performed in a relatively quite place while each of them give command using loud voices. The system respond then observed to know the reaction to this variation of parameters. This procedure is done to see whether the recognition system could be affected by gender or not. The test results in Table 3 show that the voice command recognition system is not influenced by gender-based type of voice

Integrated test was performed by activating the tool and observing the function and procedure performed by the prototype whether it is in accordance with the designed procedure or not. Table 4 shows the sequence of action which is apply to the prototype.and the response of the prototype according to the action. The result show that prototype can work properly and give the right response for every action.

TABLE IV. THE RESULT OF THE RESPONSE SYSTEM TEST

Action Step	**Response of The System**
Turn on system	System sound "Waiting for Password"
User do nothing until 1 minute	System sound "Waiting for Password"
User said "Find Qibla"	System sound "Password incorrect. Please say password again"
User said "System"	System sound "System is ready to use. Please say Find Qibla"
User do nothing until 1 minute	System sound "Waiting for Password"
User said " Qibla"	System sound "Command is false. Please say again"
User say "Find Qibla"	System sound "Please Place Cane perpendicular to the ground" system show compass data in terminal
Compas Data > 115	System sound "Spin to the right"
Compas Data < 294	System sound "Spin to the right"
Compas Data > 296	System sound "Spin to the left"
Compas Data < 116	System sound "Spin to the left"
Compas Data 294-296	System sound "You are already headed to qibla. System off "

V. CONCLUSION

Based on the test results it is conclude that HMC5883L compass sensor can be used to determine the direction of Qibla with an average deviation of 6.75°. The system works well as long as the environment is free of noise. Voice commands can be recognized properly when the system is running in a quiet environment. In a crowded environment, the system does not work properly. This is demonstrated by the results of 10 tests which state that only about 20% and 40% of commands can be recognized. Overall, this system can be used by any type of gender as long as the environment is noise free, which commonly suitable for praying activity.

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