Smart Guide Extension for Blind Cane

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***Abstract*— Cane is a tool that used by blind people or someone who has visually impaired which is caused by an accident or an illness. Cane helps the blind people to check whether there are any obstacles around them. However, before doing the research, we conducted a questionnaire to the blind people about what kind of extension module that would be implemented on their cane. Based-on the result, they need an extension smart tools for their cane that can give information about hitch, obstacle, hole, and also the direction of compass wind position to guide their way and also inform them Qibla direction. This research designed a prototype named Smart Guide Extension that can detect obstacles, holes and give information about eights wind direction using Arduino. The obstacles and holes module uses 2 PING Sensors, while the 8 direction of the wind information uses CMP compass sensor 511. All the information will be informed through the sound. The results of testing the obstacle data module stated that the buzzer will be active at a distance of 150 cm – 3 cm and the speed of beep sound faster from 1.1 until 0.3 seconds. The test holes modules state that the beep sound active at a distance of 10 – 50 cm. The system can detect eight direction of the compass wind position with deviation angle position about $\pm 3^0$. Based on the questionnaire of trial prototype to the responder, 77.38% of responder stated these tools are user friendly and easily to used.**

Keywords*— *Smart Cane, Smart Guide Extension, cane for blind people, Arduino

I. Introduction

Blind people are a term that commonly used for the people who totally blind or still have residual vision but cannot afford their vision clearly. The occurrence of the problems in the visual system can be caused by many things. Some of them are born in the state of blind, accident, illness, etc. A blind people, usually use a cane to walk or go somewhere as a guide to know the direction and state the condition of the passing road. However, the functions of the conventional cane itself is still limited in directing and informing the obstacle to a blind people especially when they are walking up to the remote destination.

Based on that condition, we conducted a questionnaire to the blind people about what kind of extension module that would be implemented on their cane. The result of the questionnaire stated that they need a smart cane which can give information about hitch, obstacle, hole, and also the eight direction of compass wind position to guide their way while they are walking and also inform them Qibla direction to help them doing prayer.

On this research, we designed a prototype called smart guide extension which can be integrated with an ordinary cane. The research aims to make an UID design of extension module as smart guide extension which can give information about hitch, obstacle, hole, and also the position of the user based-on eight position of wind direction. This prototype is equipped with PING sensor and Compass Sensor CMPS 11. PING sensor designed to read the object, obstacle and hole from a distance 150 – 3 cm. The sensor integrated with Arduino and produced the beep sound through the buzzer as information about the existence of the hitch, object, obstacle and also holes. The closer to the obstacle, the faster of the beep sound. Compass sensor 511 designed to provide information about eight wind positions of the compass and also qibla direction to do a prayer.

II. Theory

A. Visually Impaired

The definition of vision impairment by the Centers for Disease Control and Prevention (CDC) says a visually impaired person's eyesight cannot be corrected to a normal level. It may be said that visual impairment is the functional limitation of the eye or eyes or the vision system. Based on the data from World Health Organizations (WHO) in year 2011 and 2010, over 285 million people in the world are visually impaired, of who 39 million are blind and 246 million have moderate to severe visual impairment. It is predicted that without extra interventions, these numbers will rise to 75 million blind and 200 million visually impaired by the year 2020.

The people who has visually impaired need a tool to guide their way to do the activities. Canes for the blind and visually impaired are one of the most important identification and mobility aids for this kind of people. There are a lot of canes that are already available in the market, but unfortunately there aren't many variants, especially the canes that can determine the direction based on the wind direction and provide information for the blind people about the located of their position.

B. Ultrasonic Sensor PING

PING sensor is an ultrasonic distance sensor which is capable to measure distance in range 3cm – 3m. This sensor is widely used as a proximity sensor in order to detect the distance farther than IR sensor.[1]

PING Ultrasonic sensor can be connected to various microcontrollers with 5V voltage ration. Microcontroller must send pulses through PULSOUT before start to do the measurement then there will be the echo signals which is send back from the receiver sensors. PULSE signal from microcontroller measuring the time between the changes of logic HIGH and LOW, then store it to a variable.[2]

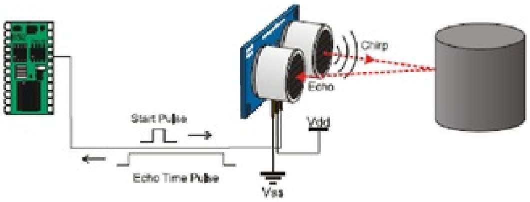

Fig. 1. Ping Ultrasonic Sensor

C. Arduino

Arduino UNO is a microcontroller board, has 14 digital input/output pins, 6 analog inputs, a ceramic resonator 16 MHz, USB connection, power jack, ICSP header, and a reset button. Arduino UNO contains everything needed to support the microcontroller, simply connected to a computer with a USB cable or AC-DC adaptor. Fig 2 shown the physical description of Arduino Uno.[3]

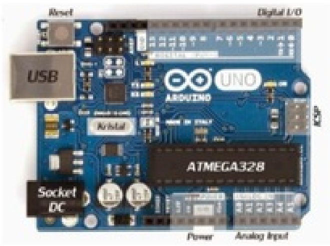

Fig. 2. Arduino Uno

D. CMPS11

CMPS11 is an electronic compass sensor from Devantech as 3rd generation. The module is equipped with a 3-axis magnetometer, 3-axis gyro and 3-axis accerelometer. In addition, this module has Filter Kalman which can be function to eliminate errors caused by the movement of PCB.[4] CMPS produces data output in the range 0-3599, representing 0 to 359,9 or 0 – 255. The output of 3 axis X, Y, Z is derived from the magnetic field components with the Pitch and Roll used to calculate bearing. The weakness of the compass sensor is the deflection. The deflection is the deviation of wind direction caused by the rotation of the earth and make sure that CMPS11 didn't located to any iron objects, because it would interfere the magnetic field and produce error in reading the degree of wind direction.[4]

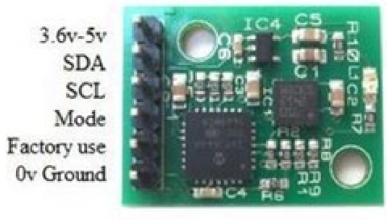

Fig. 3. CMPS 11

E. DFPlayer Mini

DFPlayer mini is an integrated module serial MP3 with WMV hardware decoding. This can be used as a stand-alone module with a battery, a speaker, a push button, embedded with an arduino UNO through RX/TX. Fig 4 shown the DFS Player Mini.[5]

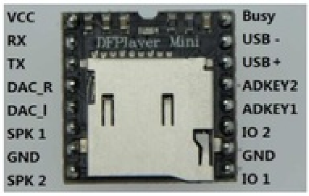

Fig. 4. DFPlayer Mini

F. Likert Scale and Procentage Category

The Likert Scale is a scale which is used to classify the variables and determining one's position in a continuum of attitudes toward an attitude object, ranging from the most negative to very positive position. [12]

TABLE. 1 LIKERT SCALE [12]

No	Alternative answer	Abbreviation	Score (+)
1	Very Good	VG	75
2	Good	G	50
3	Not Good	NG	25
4	Bad	B	0

The Likert scale can be seen on table 1. The statements submitted are positive and negative statements assessed by subjects classified with very Good (VG), Good (G), not Good (NG), and Bad (B).

The validity of the result is measured by following formulas:[12]

$$\textit{Average Score} = \textit{Total Score} \, / \, \textit{Total of Item} \quad (1)$$

Where average score is the average value sought to obtain a percentage category. Total Score is the sum of the total value of questionnaire which is achieved by users in completing the questionnaire. The total of item means a number of questions on the questionnaire which is multiplied by a number of users who is filling out the questionnaires.

After obtaining average value score, the value will be processed by the following formula to gain percentage of category value.

$$\text{Percentage Score} = (\text{Average Score} \times 100) / \text{Ideal Score} \quad (2)$$

Where the Percentage Score is the value to determine which category can be reach by the smart cane. The ideal score for this value based on Arikunto's assessment standard is equal with 70.[12] The percentage of category can be seen at table 2.

TABLE 2. PERCENTAGE OF CATEGORY [12]

Category	Percentage
Good	76% - 100%
Fair	56% - 75%
Not God	40% - 55%
Bad	Less than 40%

III. DESIGN AND IMPLEMENTATION SYSTEM

A. *Identification of Design*

The research was beginning from conducting a questionnaire to the blind people about what kind of extension module that would be implemented on their cane. As the result of the questionnaire, they need an extension module that can help them to find the position of eight wind direction especially qibla position which embedded with the sensor module that can give them information through voice and sound.

Furthermore, we conducted a study of the literature in the library and read to other journals on similar research. According to whitney Huang [6] they made a smart cane with ultrasonic sensor that can give information to the blind people about the existence of obstacle around them through a vibrations handle while Mohd Helmy Abd Wahab [7] made a smart cane as assistive cane that can give information for blind people through vibration and voice. According to Prof.R.R.Bhambare [8], they made a smart vision that can give information about their surrounding area with embedded GPS on the system. Sung Yeon Kim and Kwangsu Cho [9] made a research on usability and design guidelines of smart canes for users with visual impairments. The latest technology came from a student from Birmingham City University Waheed Rafiq and Richard Howlett, [10] uses smartphone technology to recognize familiar faces from up to 10 meters away. The cane also features functionally to aid the navigation.

Based-on all the information above, this research will design an UID of prototype that differ from the previous design. On the previous design, the hitch module was package in one cane, meanwhile the new UID design of this research makes separated extension module that can be assembled with ordinary cane. This prototype will help them to find the position of eight wind direction especially qibla position which embedded with the sensor module that can give them information through voice and sound. The prototype UID will be placed the sensor on the top and the bottom of the canes. The module will be installed as a clip on methods on the canes.

We identified the prototype system and analysis of the system requirement which can be seen at table 3.

TABLE 3. SYSTEM REQUIREMENT

No	Hardware	Description
1	Ultrasonic Sensor PING	Distance detection
2	Compass Sensor CMPS11	Detect Eight wind direction of compass
3	DFPlayer	Sound storage
4	Arduino UNO	Central control system
5	Power Supply	Supply power to the system
6	On/Off Button	Activated system
7	LED	Indicator
8	Speaker	output sound
9	Buzzer	Sounding beep buzzer

B. *Design of The System*

We designed the prototype based-on table 1 above. The design system of prototype and the schematic diagram can be seen in fig.1 and fig 2. The compass sensor, DFPlayer mini and ultrasonic PING sensor embedded with arduino as an input whereas buzzer, led, and speaker embedded with arduino as an output sensor. Button on/off functioned to activate the system and also triggered the compass sensor.

Fig. 5. Block Diagram System

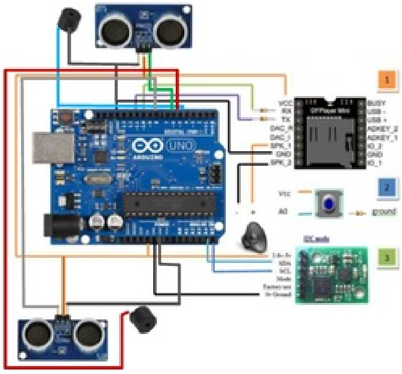

Fig. 6. Schematic Diagram

Based-on the flowchart on fig 7, when the first on/off button is pressed, it will activate the ultrasonic sensor. The beep sound will active if detect any obstacle, holes, hitch around the blind position from the distance 150cm until 3 cm, the speed of the sound beep will be faster when the blind people walk getting closer to the hitch or hole. Meanwhile if the user wants to find out the position where they were standing, pressed the second on/off button to activate the compass and the system (compass sensor will running) will give the information about their position through the speaker.

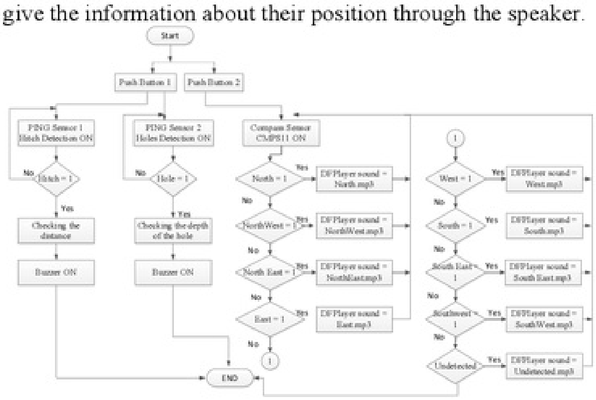

Fig. 7. Flowchart System

C. *Implementation System*

The Implementation User Interface Design on the prototype is the stage where the design of prototype is implemented on ordinary cane. On fig.8 and fig.9 we can see the User Interface Design of the blind cane. The compass sensor placed on top of the cane, while the hole and hitch detection placed on the bottom of cane.

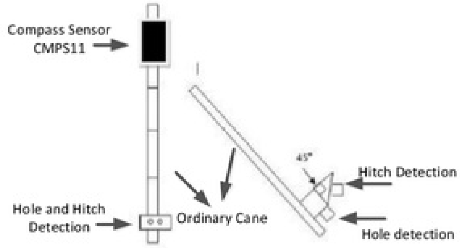

Fig. 8. Design UID on Cane

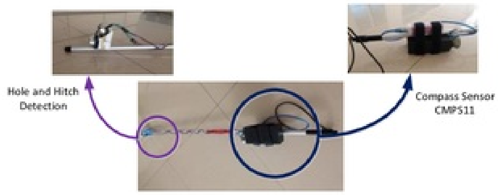

Fig. 9. Implemented Smart Guide Ekstension

IV. Testing System

A. *Authors and Affiliations*

After finishing designed the prototype, we do some scenario to test the prototype. The scenario are testing the hitch detection module, testing the holes detection module, testing the position of wind direction, and testing the UID of prototype.

The tested of hitch and holes detection can be seen at fig. 10 and fig.11. This test aimed to ensure that the design of the hitch and holes detection can work well.

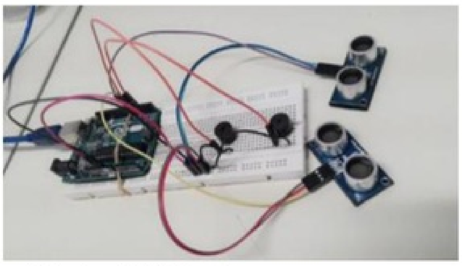

Fig. 10. Scenario Testing of Hitch Detection

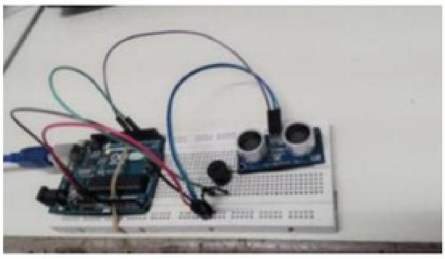

Fig. 11. Scenario Testing of Holes Detection

The testing result of hitch detection stated that the smart cane can detect any hitch around the blind people started form distance 150 cm until 3 cm. The speed of the sound beep stated from 1.1s – 0.3s. The result of the testing can be seen in the table 4.

TABLE 4. HITCH DETECTION TESTING DATA

Distance (cm)	Output	Speed Beep Sound (ms)
3 – 30	Sound 1 on	0.3
31 – 60	Sound 2 on	0.5
61 – 90	Sound 3 on	0.7
91 – 120	Sound 4 on	0.9
121 – 150	Sound 5 on	1.1
151 -	off	No sound

The testing result of holes detection stated that the smart cane can detects any holes around the blind people. The sound beep will be activated, if the canes detect a hole that has a depth from 10cm until 50 cm. The result of this testing can be seen at table 5.

TABLE 5. HOLES DETECTION TESTING DATA

Depth (cm)	Output
3 – 9	No sound = off
10 – 50	Beep sound
50 -	No sound = off

The result of testing holes detection, stated that the sound will be active when detect a holes which has a 10cm – 50 cm depth.

Fig. 12 is the figure of testing the position of wind direction. Analog compass is used as a determinant of the real direction of the wind. The compass module is testing on the track of 8 ways of the wind direction. While the system tested the CMPS 11 module, the system will generate a raw data in the form of degrees to determine the direction of the wind position. The result will compare with the degrees in the analog compass.

Compass module is designed by providing restrictions deviation angle until 3^0 degrees. It purposes to protect the user to keep in line on their track, so the user wouldn't get lost from their track to the destination.

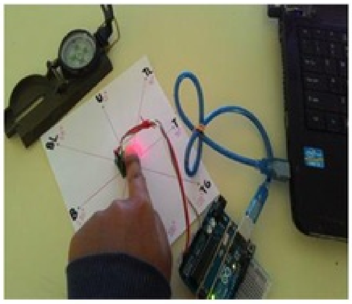

Fig. 12. Scenario Testing of Position of Wind Direction

The result testing scenarios of compass module system can be seen in table 6. The response time to determine of wind direction is about 4.7s for deviation angle of 1^0-2^0 degrees and 5.5125s for deviation angle of 3^0 degrees. If the user made a move over than 4^0 outside the track, then the system will inform the user with a voice that "you are not in the right track." [11]. Qibla direction stated when the user finds the west direction of their position.

TABLE 6. DATA OF DEVIATION DEGREES [11]

Wind direction	Deviation $1\text{-}2^0$	Result	RT (s)	Deviation 3^0	Result	RT (s)
North (U) 0^0	358^0-359^0	x	-	356^0-359^0	√	5.12
Northeast (TL) 45^0	44^0-46^0	√	5.12	42^0-45^0-48^0	√	6.12
East (T) 90^0	79^0-92^0	√	5.53	79^0-90^0-93^0	√	5.67
Southeast 135^0 (TG)	134^0-136^0	√	3.45	132^0-135^0-138^0	√	4.3
South (S) 180^0	179^0-181^0	√	4.32	177^0-180^0-183^0	√	6.46
Southwest 225^0 (BD)	222^0-227^0	√	5.5	222^0-225^0-228^0	√	6.03
West(B) Qibla 270^0	269^0-271^0	√	4.3	267^0-270^0-273^0	√	5.11
Northwest 315^0 (BL)	312^0-317^0	√	5.43	312^0-315^0-318^0	√	5.28

√ = detected, x = undetected, - = no response time because the system cannot detect the direction, RT = response time

B. Testing UID of Prototype

After integrated the system to the conventional cane, the next step is testing the smart cane to the user. The smart cane tests were performed in the foundation of social rehabilitation PSBN Wyata Guna Bandung. The smart cane tested by 6 respondents and gave a feedback by filling the questionnaire orally. [11] The test can be seen at Fig 13.

Fig. 13. Testing the UID Prototype

C. *Evaluation of Prototype*

After testing UID prototype, we asked six users to fill out a questionnaire which is consisting of 10 questions. The questionnaire aimed to measure "how friendly" and "useful" the system which is embedded on the smart-cane. The result can be seen in table 7 below.

Table 7. Questionnaire

No	Questionnaire	Rating			
		VG	G	NG	B
1	The prototype informed you about the existence of the hitch	6			
2	The prototype informed you about the eight position of wind direction	2		4	
3	The process of the response time of smart cane is good and fast		2	2	2
4	The prototype informed you about the existence of the holes	6			
5	The position of the button is easy to use.	6			
6	The beep sound of the buzzer can be heard clearly		4	2	
7	The voice from speaker giving information heard clearly	6			
8	This prototype is easy to use.	2		4	
9	This prototype is heavy to lift		3	2	1
10	The user can distinguish the beep sound		4	2	
	Total point	2.100	750	400	0
		3.250			

*VG = very good, G = good, NG = Not Good, B = Bad

The result on the table above is processed by Likert Scale. Based on table 1 above, the first column (VG) has value equal with 75, second column (G) equal with 50, the third column (NG) equal with 50, and the last column (B) is equal with 0. All the total answer of the questionnaire of the column will be multiplied with the value of each column. The total score for this questionnaire is equal with 3250 and the total of item is equal with 60 (10 questions multiply with the number of user). The average score is 54.17.

$$Average\ Score = \frac{2100+750+400+0}{60} = \frac{3250}{60} = 54.17$$

After we calculate the average score, we calculate the percentage score of the questionnaire result. The Percentage Score for the smart cane based on the equation below is equal with 77.38%.

$$Percentage\ Score = \frac{54.17 \times 100}{70} = 77.38\%$$

Based on the table 2 above, we can categorize the smart cane into "Good" category. It means that this smart cane is on the level category of row 76% - 100%. [12] So that, it can be stated that this smart cane is friendly enough and useful for the user.

V. Conclusion

Based on the testing and analysis result, it can be stated that, the smart guide extension for blind cane can be implemented as an extension module for a conventional cane. The UID result testing categorized the prototype into "Good" category which means that the smart guide extension is friendly enough and useful for the user. Besides that, the system can be inform the direction to the user with response time to determine of wind direction is about 4.7s for deviation angle of 1^0-2^0 degrees and 5.5125s for deviation angle of 3^0 degrees. While the system reads the data over 4^0, the system will inform the user with a voice that you are not in the right track. The qibla direction is stated when the user finding the west position from the user.

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References

[1] R. B. Widodo, Embedded System Menggunakan Mikrokontroler dan Pemrograman C, Yogyakarta: Andi, 2010. (references)

[2] L. Wardhana, Belajar Sendiri Mikrokontroler AVR Seri ATmega8535, Yogyakarta: Andi, 2006. (references)

[3] Arduino, "Arduino UNO," Arduino, 2006. [Online].

[4] CMPS11-Tilt Compensated Compass Module.

[5] User Manual -DFRobot.[Online].

[6] Huang, W. Mc Namara, H. Molodan, D. Rizzo, R. Pasarkar, A. Smart Cane. (references)

[7] Mohd Helmy Abd, W. Talib. A. Herdawatie A. Ayob J. Smart Cane : Assistive Cane for Visually-impaired People. IJCSI International Journal of Computer Science Issues, Vol.8, Issue 4, No 2, July 2011. in press.

[8] Bhambare, R.R. Koul, A. Mohd Bilal, S. Pandey, S. Smart Vision System For Blind. International Journal of Engineering And Computer Science ISSN: 2319-7242. Volume 3 Issue 5, May 2014, Page No. 5790-5795, in press.

[9] Kim, S. Y., & Cho, K. (2013). Usability and design guidelines of smart canes for users with visual impairments. International Journal of Design, 7(1), 99-110 , in press.

[10] Steve, A. Waheed, R & Richard, H. XploR. Birmingham City University. June 2015. (references)

[11] Kartika, Linda. Hapsari, Gita Indah. Mutiara, Giva Andriana. Smart-Cane for The Blind with Wind Direction Position based-on Arduino . Annual South East Asian International Conference, November 12th , 2015. In press

[12] Arikunto, S. (2010). Prosedur Penelitian : Suatu Pendekatan Praktik. (Edisi Revisi). Jakarta : Rineka Cipta. (references)

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