Smart Cane Location Guide for Blind Using GPS

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Smart Cane Location Guide for Blind Using GPS

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***Abstract*—Visually impaired have a deficiency in their vision which has limitations in terms of mobility. On the other side, the blind must also run their daily activities. Sometimes, the blind must performs a mobility from one building to another building in some area which has a distance like campus, mall and others. In order to make the visually impaired mobility becomes easier, we created a tool that can help them to detect the location of the destination buildings or inform them where the position of the standing place through the sound as the output information. Prototype made using the GPS module, keypad, earphone and raspberry Pi. The results show that the functional testing tools can detect the location area of interest with a deviation of less than 8 m. Also based on the friendly user testing, this prototype categorized good enough to be used by the blind.**

Keywords— Location Detection Area, GPS, visually impaired

I. INTRODUCTION

Blind is someone who has limited with their vision. They often encounter obstacles in carrying out their daily activities. Limitations in vision certainly cause problems in obtaining information and new experiences, interact with the environment, and the ability to move to another place (mobility) [1].

Orientation is one of the element in moving. Orientation is the use of the senses which still serves to establish a position themselves with relation to surrounding objects. Orientation is the process of thinking and processing information that contains a question where I am, where is my destination and how can I reach the destination. Sometimes blind doubt whether it reached the destination or not.

This day we can used gadget to know the location or even route to the location only use an application in smartphone. However, unlike the blind who have limitations in using a gadget. Blind people need a tool that can easily to use by them and it would be nice if they can be used together with a cane that they used in everyday activities.

Cane is one of the tools which used by blind today to help them in mobility. Cane is a tool for detecting obstacles and leading them toward their destination. However, its function still has limitations, especially in convincing the blind if it has reached the destination or not.

Recently, there are several research which develop smart cane in many ways. Some previous studies of the smart cane to help blind people in the running activity is Anushree Harsure,et al. They make a voice-based navigation tools using ultrasonic sensors [2]. Other research that helps visually impaired mobility-based GPS expressed by Varun Raj S. P. The System uses a portable computer, GPS, external memory, and central microcontroller module. Microcontroller embedded systems is connect to GPS. This system was designed to record travel routes and put them into a database. If the data are compared in accordance with a previously stored system will give a message in voice [3].

Somnath Koley, et al, combines ultrasonics and GPS to provide additional functions such as navigation on cane. Ultrasonics sensors are used to avoid any obstacle while the GPS is used for navigation [4].

Some research on RFID-based smart cane is Ceipidor Biader U., et al on the research suggests a navigation system using the RFID system. In their study, they used a PDA (Personal Digital Assistants) and smart phones, Wireless communication, TTS (text to speech) and database software for mobile devices. RFID read by RFID Reader then sent to the PDA via Bluetooth. Informs ID will be compared with the ID in the database. Users will get navigation information through the PDA [5].

Other studies put forward by M.Saranya with GPS navigation system using Android Phone [6]. Other studies are using GPS and a GSM module to provide position information to the blind [7] .

This paper is part of strands of our research being undertaken. Although this paper is not contributed to the new method, but this paper support research that we do next. In our previous study, we create tools that can detect obstacle using ultrasonic sensors [8] and blind tools of directions of the wind as the mecca instructions [9].

In this paper, there is an idea to create a blind tools that can be used to help their daily activities. Particularly activities that are in a large region in which there are buildings that are further apart and require them to undertake mobility in that region. In the next research we will develop this tool using different method for example based on RF or Bluetooth.

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When blind people in some areas which consist of several buildings in it, they often had difficulty detecting the building they were going. In this study, we intend to create a tool that can be used to detect the buildings contained in a wide area, for example campus, schools, shopping centers and so on.

The purpose of this study is to create an additional device that can be attached to a cane to detect the location of the destination in wide area by using GPS and GPS data storage ordinate several points of interest as well as provide sound output. In this study, the scope is limited to locations within the campus of the Telkom University.

In summary the contribution of this work is to develop blind stick function with a tool that can help visually impaired mobility activity in their daily activities, especially mobility in areas in which consist of several buildings that far apart. By using this tool, the blind can detect their presence in a building in the area that they are unsure if they have arrived to the area of interest or not.

This paper presents the concept of developing smart cane with location detection function in an area. Section 2 is focus on design and implementation of the smart cane detection area. Section 3 is discussing about result and discussion. Section 4 is representing the conclusion.

II. Proposed Smart Cane Detection Location in the Certain Area

Mobility blind in place on a vast area contained buildings inside is usually done by asking people around and traveled with a stick. In fact, they often are not aware of whether it has reached the destination or not.

Based on observations of the blind are needed:

- A device that can detect whether the destination location is already up to the destination or not.
- A device that has a device that is used as input
- A device which has a data storage device the destination location
- A tool that can remove a destination location detection information in the form of sound

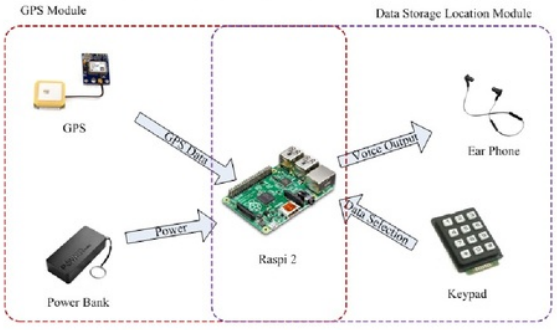

Fig. 1. Block Diagram System

Location detection system of the building consists of two modules as shown in fig. 1, namely:

- GPS Module
- Data storage location module.

GPS module is a module that handles the location detection by GPS. GPS module consists of the communication data from the GPS module with raspberry Pi. While the destination location data storage module is the module that handles the storage of GPS data location of destination, storage of voice files to output information in the form of sound to the speakers and keypads used as input.

The specifications of the prototype is as follows:

- Using the power bank as a power source 4000mAh, 5 Volts that can last for 8 hours
- U-blox GPS module 7 m with a compass as a location marker
- Using 3x4 keypad to enter the location which user want to detect
- Earphone is used to give information such as voice destination location detection
- Raspberry Pi 2 Model B is used as a processor

Blind pressing the button on the keypad to detect the location of their destination. GPS data from the destination location has been previously stored in memory and called by the button on the keypad. Each key detect different locations in the area. Emphasis button keypad, raspberry pi will call the destination location GPS data and compare it with the GPS position of the user. Then the speakers will provide information in the form of interest location detection output sound to the earphone.

Fig. 2 is a schematic of the GPS module. U-blox GPS 7m module is connected to the port Vcc raspberry (red), sda (green), scl (blue), gnd (black), Tx to Rx (orange) and Rx to Tx (yellow). Power bank is connected to the purple line in the form of micro usb slot as a power supply raspberry Pi. Fig. 3 shows the connection between keypad and raspberry Pi. Raspberry Pi pin board which is used for system data storage location connected with the keypad are 4, 17, 18, 22, 23, 24, 25.

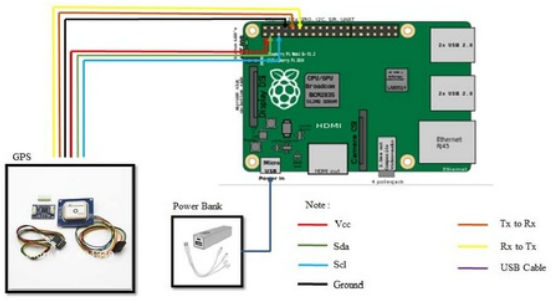

Fig. 2. GPS and Raspberry Pi Configuration

In Fig. 4, if the users do a key stroke to the keypad, GPS module detects the user's GPS location. Raspberry Pi will then ask the user GPS location data to the GPS module. GPS module sends data to the raspberry Pi. User GPS location data and the GPS destination location data will be compared by the location of data storage modules which called by key stroke from the keypad. Location data storage module will call the action on the keypad GPS data stored in memory and then compared with the GPS data. The comparison will be issued in the form of sound to the ear phone. This module runs a working system using the C programming language and compiler using python programming 2.7.

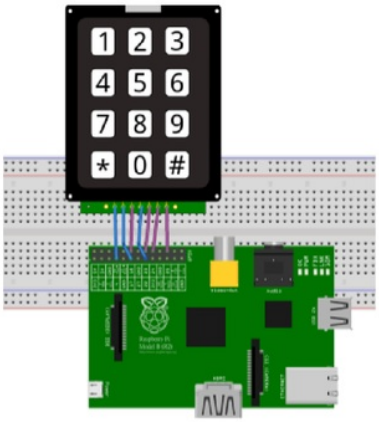

Fig. 3. Keypad and Raspberry Pi Configuration

In building the system, there are several processes that must be performed, there are :

- Installation Raspbian Wheezy
- Installation and configuration of U-blox GPS modules 7m with compass

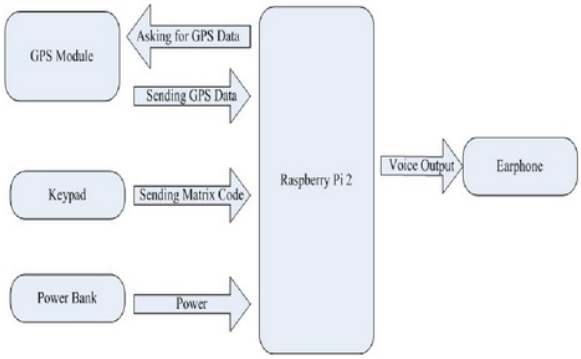

Fig. 4. Block Diagram System Configuration

GPS module used is U-Blox GPS 7m module that supports GPIO on Raspberry Pi. The installation steps are as follows:

- Connect to the GPS module pin GPIO raspberry Pi as in Figure 2.
- Then configure U-blox GPS module 7m by installing GPS on raspberry Pi library via CMD
- Configure UART serial Raspberry Pi Raspberry Pi ends with Reboot.

Raspian device uses a voice recorder that stored in the memory and be connected directly with the keypad. Sound recordings in the form of MP3 files contains the information of destination location detection. Data base system GPS location data storage purposes (Figure 5) and voice information data is processed using the MySQL configuration steps as follows:

1. Ensuring have entered a terminal and install a MySQL server with the command "**apt-get install mysql-server**"
2. Once the install is complete, go to my sql server with the command "**my sql -u root -p**"
3. Ensuring already entered to the terminal and install MySQL server then make a table of GPS with the command "**create database_GPS**;"
4. Make a table to store GPS data destination location with the command "**create table data_GPS**"

395	-6.97348133333333	107.632702333333
396	-6.9734825	107.632701666667
397	-6.97348616666667	107.632705
398	-6.97348466666667	107.632697666667
399	-6.973486	107.632698166667
400	-6.97348483333333	107.6326975
401	-6.9734885	107.632701833333
402	-6.97348916666667	107.6327015
403	-6.973499	107.632704
404	-6.97349666666667	107.632700833333

Fig. 5. My SQL Server Database

The keypad is used to call the location database objectives to be detected. Keypad configuration relationship with the location data of interest are shown in Table I.

TABLE I. KEYSTROKE FUNCTIONS

Keypad Button	Function
1	School of Applied Science location (FIT) Detection
2	School of Communication and Business (FKB) Location Detection
3	ATM Detection Location
4	PSBN Mosque Detection Location
9	Power Off
#	User Guide In Voice

GPS data that goes into the raspberry Pi-shaped NMEA protocol. NMEA protocol is the standard protocol of GPS

readings, as in Fig. 6. The data in the form of NMEA protocol GPS is then parsed into data that can be processed in the raspberry pi. Data is parsed is $ GPGAA as name / GPS protocol address, latitude and longitude as coordinate point.

```
$GPGGA,161229.487,-6,97360
,N,107.632576,W,1,07,1.0,9.0,M, , , ,0000*18
```

Fig. 6. NMEA Data Format on GPS Module

In the program, GPS data from the destination location is determined based on the Google map and then add a deviation value of the latitude and longitude to determine the area of the destination location as shown in Table 2. For examples the FIT building area bounded by the coordinate -6.972751, 107.63259 until -6.972856, 107.63269. If the coordinate is converted into latitude and longitude distance then it will be approximately 11.6887806 m distance of the latitude and 11.132172 m distance of the longitude.

TABLE II. THE COORDINATE OF DESTINATION LOCATION AREA

Location	Coordinate Latitude and Longitude in Program	Latitude Distance (m)	Longitude Distance (m)
FIT Building Area	-6.972751, 107.63259 until -6.972856, 107.63269	11.6887806	11.132172
FKB Building Area	-6.97233, 107.6327 until -6.97240, 107.63283	7.7925204	14.4718236
ATM Area	-6.972965, 107.633145 until -6.973115, 107.633282	16.698258	15.2510756
PSBN Mosque Area	-6.90680, 107.60218 until	11.132172	4.4528688

III. RESULT AND DISCUSSION

A. *Testing The Prototype*

After designing and implementation the prototype, we do some test to the prototype. The test of GPS module is done by test the code and see the result of GPS data that obtained. Fig. 7 showed that raspberry Pi can read the data from GPS module properly especially in outdoor. The data from module then compared to the Google Maps to know the accuracy of GPS data from U-Blox GPS 7m module.

The next test is GPS area location test based on table II. Testing is done by bringing prototype around the destination location and take it until the system detects the user is not located in those areas. Results of testing on table III showed there is the deviation between calculations and test results about less than 8 meters.

```
pi@raspberrypi:~/PA $ sudo python GPSfix.py
21:31:32: -6.9203915,107.590094
21:31:33: -6.92039333333,107.5900855
21:31:34: -6.92039883333,107.590086
21:31:35: -6.92039983333,107.590089667
21:31:36: -6.92039933333,107.590088667
21:31:37: -6.92040016667,107.590091333
21:31:38: -6.92040233333,107.590095167
^CTraceback (most recent call last):
  File "GPSfix.py", line 7, in <module>
    sentence = serialStream.readline()
  File "/usr/lib/python2.7/dist-packages/serial/serialposix.py", line 44
ad
    ready,_,_ = select.select([self.fd],[],[], self._timeout)
KeyboardInterrupt
pi@raspberrypi:~/PA $
```

Fig. 7. Read and Parsing The GPS Data

TABLE III. THE GPS MODULE TEST RESULT

Location	Latitude Distance (m)	Longitude Distance (m)	Result
FIT Building Area	11.6887806	11.132172	FIT is detected with a distance about 12 m
FKB Building Area	7.7925204	14.4718236	FKB is detected with distance about 15 m
ATM Building Area	16.698258	15.2510756	ATM is detected with distance about 15 m
Mosque Building Area	11.132172	4.4528688	Mosque is detected with distance about 10 m

The data storage destination location module test is done by integrate the module with GPS module. The test is done by pushing the keypad button in certain area. The result of test is shown in table IV. The result show that each button in keypad working properly suitable to their function.

TABLE IV. THE DATA STORAGE LOCATION MODULE TEST RESULT

Key stroke and description of key's function	User Position	Output Sound
1 (Detection FIT Location Area)	Outside FIT area	" You are not in the FIT area"
	in FIT area	" You are in the FIT area"
2 (Detection FKB Location Area)	Outside FKB area	" You are not in the FKB area"
	in FKB area	" You are in the FKB area"
3 (Detection ATM Location Area)	Outside ATM area	" You are not in the ATM area"
	in ATM area	" You are in the ATM area"
4 (Detection PSBN Mosque Area)	Outside Mosque area	" You are not in the Mosque area"
	in Mosque area	" You are in the Mosque area"
# (User Guide)	Anywhere	User Guide in voice

B. Testing Prototype to the User

This test aims to test the ease of use of the prototype by the blind. In this test, we invited eight people with visual impairment to use the prototype which embed to a cane as shown in Fig. 8. The questionnaire which given to blind is to measure how easy and useful the system.

Fig. 8. Testing Prototype to the User

Table V show the questionnaire that given to blind and the result score. The result score is processed by Likert Scale. Likert Scale 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 [10]. The value point of likert scale can be seen on table VI.

The formula to measure the validity of result is

$$Average_Score=Total_Score/Total_of_Item \quad (1)$$

TABLE V. RESULT OF QUESTIONNAIRE

No	Questionnaire	Rating			
		VG	G	NG	B
1	This prototype is easy to use.	4	2	2	
2	The use of keypad in this prototype is easy to use	4	1	3	
3	The voice from speaker giving information heard clearly	2	4	2	
4	The prototype inform you the right destination location	4	2	2	
5	This prototype is not heavy		2	4	2

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

The combine of table V and table VI, (1) will be processed together with (2) to yields the conclusion of the performance of the system.

TABLE VI. LIKERT SCALE

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

Total Score is the sum of the total value of questionnaire were achieved by users in completing the questionnaire. Total of Item is a number of questions on the questionnaire which is multiplied by a number of users who filling out the questionnaires [10]. The total score is equal with 1925 and the total item is equal with 40.

$$Average_Score=1925/40 = 48.125$$

Next, calculate the average value score with following formula. Likert Scale stated that the ideal score is equal with 70.

$$\%_Score=(Average_Scorex100)/ideal_Score \quad (2)$$

$$\%_Score=(48.125x100)/70 = 68.75\%$$

Based on table 7 from Likert Scale, the result of questionnaire can be categorized as 'Fair'. The result showed that it still need improvement especially in dimension and weight since we can see in the table V that the prototype is heavy to use for the user.

TABLE VII. PERCENTAGE OF CATEGORY

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

IV. CONCLUSION

The prototype can be used as a tool aid for blind to detect an area especially in Telkom University by only using portable additional tools on a cane. The deviation area accuracy is less than 8 meter for each area.

Based on the result of user testing, the prototype is categorized into "fair" category which mean the prototype is friendly enough to use by the blind. This research still needs improvement, especially on user testing to involve more users in the testing process.

In this study we offer a location detection method for blind people without using gadget considering their limitations in using gadgets. In the future development of this prototype we need to enhance the accuracy and connect it to the map system so the blind can use portable tool aid with the simple procedure of use.

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