Design and Development of Navigation System by using RFID Technology

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Abstract—**In this modern era, independent mobility for blind and partially sighted people is an important objective to achieve. There are many assistive way to help visually impaired people namely, Guide Dog, White Cane as well as the tactile paving which is a very common assistive tool throughout the world, support the visually disable person walk in the correct path from one place to another. Therefore, RFID technology is introduced in this project to support the visual disable people more efficiently in outdoor activities. The system has been developed based on the integration of RFID wireless technology and voice system which assembled on the traditional white cane in order to help the visual impairment to identify the surrounding landmark via verbal notification. The tactile detection by RFID system composed by RFID system integrated on traditional white cane and RFID TAG which installed on the tactile paving where the TAG stored unique information uses to navigate/notify the user once they scan/tap the tactile paving by the designed white cane. The proposed RFID integrated white cane is successfully designed and evaluated the range of RFID tag which can be detected.**

Keywords-visually impaired person; RFID; navigation

I. INTRODUCTION

According to the visual impaired and blindness statistical report released by the World Health Organization, new estimates has been made in the few years back, year 2010, the visual impaired and blindness in the globe, where overall population involved in prevalence of visual impaired is 285 million,246 million having low vision whereas, 39 million are blind [1]. The data of eye prevalence stated above shows that the large amount of eye disease patient throughout the world cannot be just ignored. In Malaysia, there is a number of visual impaired or the blind in the nationwide which cannot be abandoned yet needed to support in terms of assistive facilities and etc.

In this modern society, there are many types of assistive equipment, tools or robot which developed by the motivated engineer or scientist worldwide to help the visually disable people in terms of improve their quality of life as well as bring convenient into their daily life in terms of independency. The assistive equipment and tools developed are GuideCane, NavBelt, Echolocation, My 2nd Eye, SMART EYE and etc [2-9]. Besides that, one of the developed assistive robot for the blind is RoboCart [10 - 11] which designed to help the blind in shopping mall. Without the state of the art assistive technology, the visual impaired or the blind commonly rely on the conventional white cane to detect the surrounding obstacle and sense the road in front of them. Although the conventional white cane not as convenient as the assistive tool but still the cane is at least affordable and important in their daily life.

On the other hand, the most common assistive technology which has been widely used throughout the world is the tactile paving. Tactile paving is a kind of texture ground surface which install on the floor to help the visual disable people to distinguish direction, location, and potential hazardous environment. However, the visually disable people sometimes will face difficulties to detect the surrounding area or identify the correct path from one place to another by using their conventional white cane although they walk on the tactile paving. In this situation, they only able to identify the surrounding area by asking stranger around them, otherwise they tend to involve in hazardous situation.

Thus, wireless voice navigation system may bring benefits for the blind where the navigation system assist the blind in point-to-point navigation by giving verbal direction, additionally the surrounding area or point of interest can be identify by a preset voice as well. By integrated wireless technology system in the conventional assistive tools, it will greatly help the visual disable people, bring convenient into their outdoor activities. In the present research, blind navigation is developed to assist the visual disable for indoor and outdoor environment. Moreover, several wireless navigation for outdoor environment have been proposed or already exist in the market but the characteristic are similar with indoor navigation system yet, integrated with different technologies[8]. The major wireless technologies are GPS, GPRS, GSM, Ultrasonic, Bluetooth and RFID technology.

The proposed study using GPS technology in navigation system where the user able to search the desire route by voice via Java Application installed on a mobile phone, the blind will be navigate to the destination through Text-To-Speech function available in the Java Application. From the research, the limitation of GPS technology is insufficient accuracy, but this problem can be solved by an alternative method which is integrated with RFID technology in the system, which is low

cost and improve accuracy [12]. Moreover, an assisting navigation system using both Bluetooth and RFID technology was researched in the study, a combination of RFID and Bluetooth reader modules in a control system integrated on the conventional white cane, where the RFID reader reads the RFID-Tag to get the information of surrounding area while the Bluetooth receiver receive zone coordinate of current location in a covered area from the Bluetooth-Track/dongle, both received information are transform into voice format by sound control circuit embedded in the control board to notice/alert the user by voice [12].

Meanwhile, University of Science and Technology of China proposed a system to navigate the blind by providing information about their surrounding by RFID technology. The system composed with mobile phone, remote server RFID Tag as well as RFID Tag reader. In the study, the RFID Tags has been categorized into several types which information tag stored the road condition or information of current location while Cue Tag stored specific location (e.g. shop and etc) whereas guidance tag stored information of hazardous condition (e.g junction, railway, etc). The RFID Tag reader installed on the white cane and connects wirelessly to mobile phone through Bluetooth interface [13]. Mobile phone transforms the information from the Tag into voice format to navigate the blind by voice.

Besides that, the National Rehabilitation Centre for the Disable in Japan developed a navigation system composed by RFID Tag reader and a colour sensor build-in on the white cane [14]. The system design to scan the particular colour tape on the ground to navigate the blind move in the desire path whereas the RFID Tag provide the information of surrounding area in voice. The navigation system integrated with vibrator and voice to notify or alert the blind. Although many navigation system had been developed in different types of wireless detection technologies, but they share the same goal which is assist the visually impaired or the blind move conveniently from one place to another.

In this project, the assistive navigation device is designed and developed for visually disable or the blind in order to navigate them from one place to another conveniently by verbal direction. The modification of the conventional white cane has been made by implement the assistive navigation device on the white cane which the device composed of RFID Tag Reader and a sound control system embedded in the device. A special tactile paving has been designed where RFID Tag installed underneath the pavement to provide information of location and surrounding environment. The RFID Tag stored current location and direction in order to guide the user move inside the pavement as well as the correct direction.

II. ELECTRONIC WHITE CANE

A. Robot Construction

In order to transform a normal white cane into electronic white cane, microcontroller is needed so that all the connected hardware able to communicate with each other. In this project, RFID reader is use to read the RFID TAG and in order to play voice file to the user, voice module is needed. The purpose of combination of RFID system and voice module is to play a particular voice file to user under a particular condition. The main hardware/module used in this project are Arduino Uno R3 Microcontroller, MiFare High Frequency 13.56MHz RFID reader module and WTV020 voice module. Figure 1 shows the illustration of developed electronic white cane integrated with RFID.

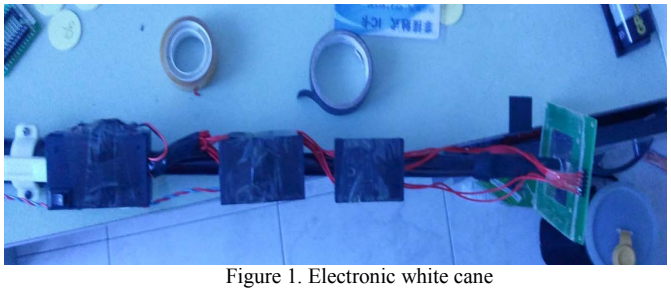

Figure 1. Electronic white cane

The developed RFID detection system is depicted in Figure 2. The overall ideal of this project is to let the user identify the landmark or point of interest around them so that they do not have to seek for help from other people. The role of the RFID TAG is to store the information which will give the user about the location which has been going through. To identify point, the user has to scan the RFID TAG by the electronic white cane which the cane is assembled with the system shown in the block diagram. The RFID antenna will power up the RFID TAG embedded on the tactile paving and extracts the information inside and notifies the user through verbal by using voices module.

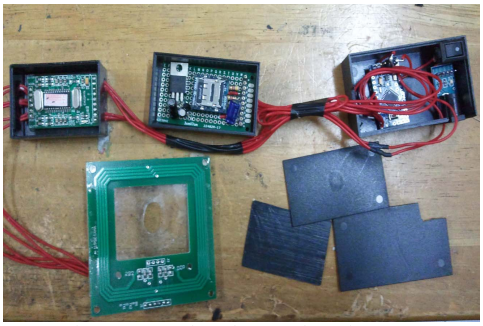

Figure 2. Developed RFID detection system

III. SYSTEM CONFIGURATION

A. RFID detection system

The design and development of tactile detection is to prevent deviation when the blind moving on the tactile paving. Verbal direction will be navigating the blind along the journey by simply swing the designed white cane near to the tactile pavement. The RFID Tag reader located on the bottom of white cane activates the Tag installed in the pavement to extract or receive the unique information. The received information transform into voice by control circuit board in the system to notify the blind about the information of location

and direction. The RFID detection system is developed the design schematic diagram which is shown in Figure 3. The pins assigned for modules connection are remain the same while two extra regulators are introduced in the final system due to the lack of suitable voltage supply which needed to power up the RFID module and voice module.

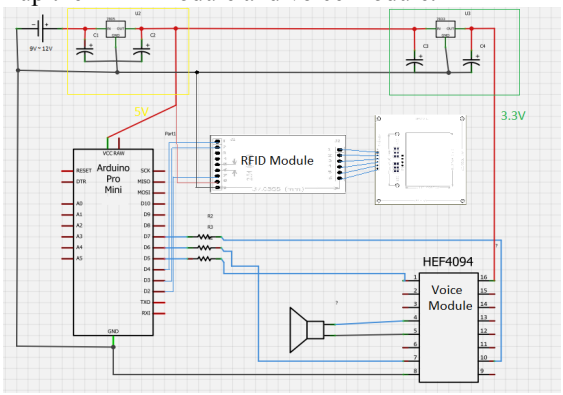

Figure 3. RFID detection schematic diagram

From Figure 3, voltage regulator L7805 is use to convert the input voltage from 9V battery or 12V DC supply to usable 5V for ARDUINO Pro Mini microcontroller. Furthermore, according to the specification of voice module, another voltage regulator LM1117T is needed in order to supply usable 3.3V to the board itself. From the block diagram shown in Figure 4, the whole system consists of input part which is the RFID TAG reader, the controller part which composed by microcontroller as well as the voice processor module and the output part is either earphone or speaker.

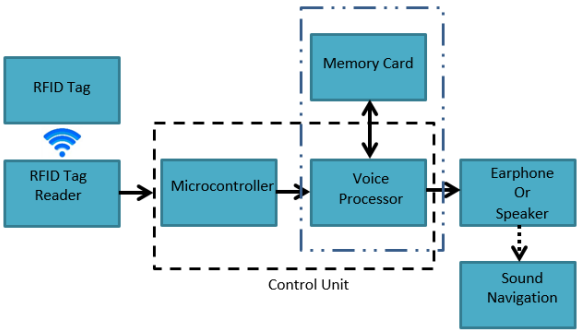

Figure 4. RFID Navigation system

B. Experimental Setup

In order to optimize the best RFID reader which will be used in electronic white cane, the experiment setup to evaluate the distance of RFID system to detect the RFID TAG when the user tap their white cane on the tactile paving embedded with the TAG is conducted. Figure 5 shows the setup for reading range experiment where the distance between the RFID TAG and antenna is measured by ruler in cm. The antenna used in this project is in square shape, the coil is around the square. This analysis will carry out the experiment to analyse the reading range based on the position of antenna, where the position is at the side of antenna and centre of the antenna. Furthermore, the RFID TAG will be located on the ruler and move from far left to the right near to the antenna and record the reading distance when a voice file is played. In order to avoid parallax, check the ruler right on the top of RFID TAG.

In addition, the size of RFID antenna also is an issue which might affect the reading distance between the RFID TAG and RFID antenna. Two size of RFID antenna are evaluated in this experiment. Figure 6 shows the size of the two antennas used where the size of big antenna is 70 mm x 70 mm while the size of small antenna is 24 mm x24 mm. The distance of detection of TAG for each size of antenna is determined in this experiment.

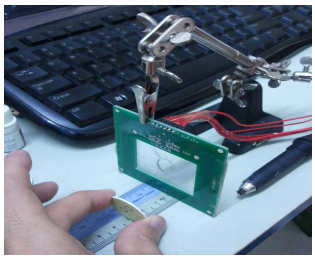

Figure 5. Experimental setup for RFID reading range

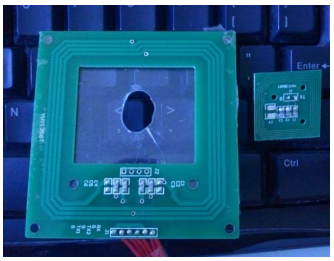

Figure 6. Illustration of RFID reader size

Besides, since the RFID TAG will be installed on the tactile paving at outdoor, there is a possibilities which the RFID TAG might be covered with leafs, abandon paper and etc. Thus, an analysis about the effect of obstacle is carry out in order to analyse the reading performance of the system. In this experiment, three materials which is paper, cardboard and steel will be used to cover on the top of RFID TAG at a fix position. RFID antenna will approaching the TAG and measured distance.

(a) (b) (c)

Figure 7. Experimental TAG covered with (a) Paper (b) Cardboard (c) Steel

IV. Experimental Results

Table 1 shows the average of reading distance between RFID antenna and RFID TAG at the side is around 2.4 cm while 3.7 cm at the centre. From the table, the reading clearly shows that the position of antenna greatly affect the reading distance of the system. Figure 8 show the relation of reading range with reading position. From this result, the reading at the centre position is the best with can make around 3.7 cm range. Thus, in order to read the RFID TAG effectively, the TAG should be read at the centre of antenna when the user tap their white cane to scan the point of indicator. Besides, the experiment to determine the size of the RFID also conducted.

Table 2 shows the relation between the size of antenna with the reading range of the antenna. From the result obtained, it clearly shows that the readable distance for big antenna is

better compared to the small size of antenna, which the readable distance for big antenna is around 3.7 cm while the readable distance for small size antenna is around 1.0 cm. This experiment practically proved that bigger size of antenna provides greater reading performance, but in this project, which the antenna is assembled in the bottom part of white cane, 70 mm x 70 mm antenna is the optimum size for this application.

TABLE I. RELATION OF READING RANGE WITH READING POSITION

No. of reading	Position	
	Side reading range(cm)	*Center reading range(cm)*
1	2.5	3.5
2	2.4	3.6
3	2.4	3.5
4	2.3	3.7
5	2.4	3.6
6	2.6	3.8
7	2.4	3.7
8	2.4	3.6
9	2.5	3.8
10	2.3	3.9
Average (cm)	2.42	3.67

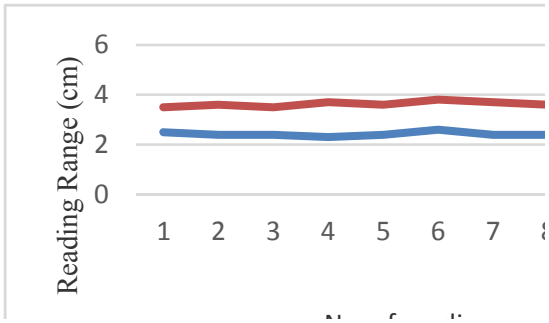

Figure 8. Relation of reading range with reading position

TABLE II. RELATION OF READING RANGE WITH RFID SIZE

No. of reading	Reading range (cm)	
	RFID reader 24mmx24mm	*RFID reader 70mmx70mm*
1	0.9	3.5
2	1.1	3.6
3	1.2	3.5
4	1.1	3.7
5	1.1	3.6
6	1.0	3.8
7	0.9	3.7
8	0.9	3.6
9	1.0	3.8
10	1.2	3.9
Average (cm)	1.04	3.67

From Table 3, the reading performance of the system will reduce when the RFID TAG covered with obstacle where readable distance without obstacle is around 3.7cm. However, if there are objects covered the RFID TAG, the reading distance decrease to 3.0 cm for paper or cardbord. For steel, there is no detection of TAG. The RFID reader fail to read the TAG even in very close distance. Thus, although the system performance is reduced by decreasing the reading range between the RFID antenna and RFID TAG embedded on the tactile paving, this tactile detection by RFID system still perform quite well in this experiment.

TABLE III. RELATION OF READING RANGE WITH MATERIAL COVERED

No. of reading	Reading range (cm)		
	Paper	*Cardboard*	*Steel*
1	3.0	2.9	No Detection
2	3.0	3.0	No Detection
3	2.9	2.9	No Detection
4	3.0	2.9	No Detection
5	2.9	3.0	No Detection
Average (cm)	2.96	2.94	No Detection

V. CONCLUSION

In this paper, the performance study of electronic white cane which integrated with RFID detection system is designed and evaluated. The best antenna size to carried out with the electronic white cane which have been chosen in the design is 70 cm x 70 cm which can detect the RFID TAG until 3.7 cm without any object covered at the center of the antenna. In addition, a hard materials such as steel or wood which are covered on the RFID TAG also will give an effect to the antenna not to detect and read the TAG.

In the future, the investigation of the orientation of RFID on the tactile paving in order to ease the visually impaired person to navigate from one tactile to others is planned. Then, the navigation system with the RFID network by using voice system will be conducted.

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