Survey on Outdoor Navigation System Needs for Blind People

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***Abstract*—This paper reports the findings of a survey conducted on a group of blind people living in urban area. Blindness is a problem faced all over the world. There has been many outdoor navigation system proposed by previous researchers. However, sometimes the design has not been made based on the blind people needs. There is a need to study the blind people needs in order to design a practical outdoor navigation system. The study was divided into four parts, (1) Occupation details, (2) Vision Medical History, (3) Outdoor Navigation History, (4) Features and Functions for outdoor navigation system. The result of the findings revealed that blind people requires a blind navigation system that is portable and able to help them cross the roads and avoid obstacles during their outdoor excursions while retaining the blind's identity that is the walking stick and black glasses.**

Keywords—blind; outdoor navigation; sensor

I. INTRODUCTION

Total blindness is the inability to tell light from dark, or the total inability to see while visual impairment or low vision is a severe reduction in vision that cannot be corrected with standard glasses or contact lenses and reduces a person's ability to function at certain or all tasks [1]. According to statistics, as of July 2010; there are around 87,000 blind people in Malaysia although only about 64,000 are registered with the Welfare Department of Malaysia [2].

One of the biggest challenges by blind people is when they are moving outdoors where there are uneven terrains, obstacles such as cars, rocks and holes and not knowing where to go without the ability to see. Traditionally, blind people use walking sticks or guide dogs to help them move around and they are limited to move only around familiar places. Navigation is the science (or art) of directing the course of a mobile robot as it traverses the environment [3]. Inherent in any navigation scheme is the desire to reach a destination without getting lost or crashing into another object. Put simply, the navigation problem is to find a path from start to goal, which meets the task constraints, and to traverse that path without collision.

II. LITERATURE REVIEW

First, confirm that, blind people use the long white cane as a device to help them for indoor and outdoor navigation. Even though it is cheap and requires minimal training for the blind to use it to find their way towards the place they want to go, only tactile information that is within the reach of the cane is available. For instance in outdoor usage where wide sidewalks are common, the use of the white cane can be difficult. Mud and other off-road conditions would certainly aggravate the challenge of using the cane for independent travel.

As technology continues to evolve, several new systems have been created to help the blind people navigate their way around in particular for outdoor excursions. Most of the outdoor navigation of visually impaired people is based on data from the GPS maps and Geographic Information Systems (GIS) such as Wayfinder Access (Wayfinder Systems AB), Trekker and BrailleNote GPS (Human Ware), MobileGeo (Code Factory) and Drishti (University of Florida) [4]. Such systems cannot be used for navigation in the regions where there are not any GPS maps or the maps are not sufficiently precise and detailed.

Some works on GPS navigation includes the System for Wearable Audio Navigation (SWAN) System developed by Georgia Tech [5]. The system uses sensors and tracking chip worn on the head to send data to the SWAN applications on the laptop which computes the user's location and in what direction he is looking, maps the travel route, then sends 3-D audio cues to the bone phones to guide the traveler along a path to the destination.

A few mobile robot researchers have attempted to develop navigation systems using ultrasonic sensing to detect landmarks. Kimoto and Yuta [6] used the standard deviation of ultrasonic range readings to detect a hedge from a moving robot while a combination of vision and ultrasonic sensing was used by Maeyama et al. [7] to detect trees along a path.

Another system using vision-based positioning to guide the blind people has also been proposed. These systems use image processing techniques to enable the system to identify the path to be taken and the obstacles in the path. Galatas et al. [8] designed an assistive–guide robot, eyeDog, as an alternative to the current use of guide dogs for the blind. The system uses

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computer vision to determine the path to be taken and is mounted on a movable platform to move in the desired path for the blind people to follow.

Andò [9] used a multisensory approach to guide the blind people in navigating through certain urban areas. The low-cost device uses a sonar module as well as a passive infrared motion sensor where it will provide information on distance and speed of other moving people within range of 10 m.

Another system designed was an "intelligent" blind stick by Mândru et al. [10] where the blind stick was outfitted with ultrasonic sensors and a piezor buzzer. The piezor buzzer gives an alarm sound that grows more intense as the blind person becomes closer to an obstacle.

Sung et al. [11] also designed a different intelligent guide stick where the guide stick is connected to two DC motors and an ultrasonic sensor which is outfitted on top of a stepping motor that has a range of 180°. When the ultrasound sensor detects an obstacle, the walking stick will activate the DC motors to move the blind person out of the obstacle's path before continuing onwards.

It can be summarized that previous works have focused on GPS tracking for moving from one location to the other and the use of ultrasonic and vision-based positioning to identify pathway and its obstructions. There are still other issues that hinders the blind from moving outdoors such as crossing the road with cars coming from left and right (assuming no traffic light) and reading off traffic light (e.g. blind people cannot see if the traffic light is green or red). designations.

III. SURVEY DETAILS

The survey has been conducted on 20 blind respondents who are based in Kuching, Sarawak. The initial section of the survey asked participants to identify their gender, age group and basic family status. This information was used to identify the age group of the blind people which might influence some of the answers for certain questions.

From the survey, 90% of the respondents are male and the majority of them are between the age of 22 – 30 years old (40%) followed by 35% participants are above 40 years old. The least participants who responded the survey are from the age 21 years old and below. According to the survey as well, only the above 40 years old are married where two of them have one child and two others have three children. The rest of the participants are currently single.

All questions on the survey elicited written comments from the respondents. Respondents to the survey are from different age group with different vision medical history. Verbal comments during the survey process indicated that while the participants are willing to answer all the survey questions, they also give comments on other problems they are facing as a blind person.

A. Occupation Details

The first question of the survey was "Are you working? If yes, please specify as what". This initial question identified a key finding; to find what type of job that blind people normally get.

As found from the survey, when 50% of individuals surveyed reported that their job is to make chick cage out of wood. Another 20% does other jobs like providing massaging or making food packaging boxes. The remaining participants are still in-training in their chosen job thus normally depend only on the government allowance.

The next survey question focused on the total wage that the participants received every month including the given government allowance; "how much is your total income every month?".

The question serves as a benchmark for the total reasonable cost of the outdoor navigation system that is within a blind person's monthly budget if they wish to obtain the outdoor navigation system. From Fig. 1, half of the participants have a total monthly wage of RM350 or less, not including the cut for the participants' daily necessities followed by 25% participants having between RM 401 – RM 450 monthly wages. The development of the outdoor navigation system must take into consideration of the blind people's limited small budget.

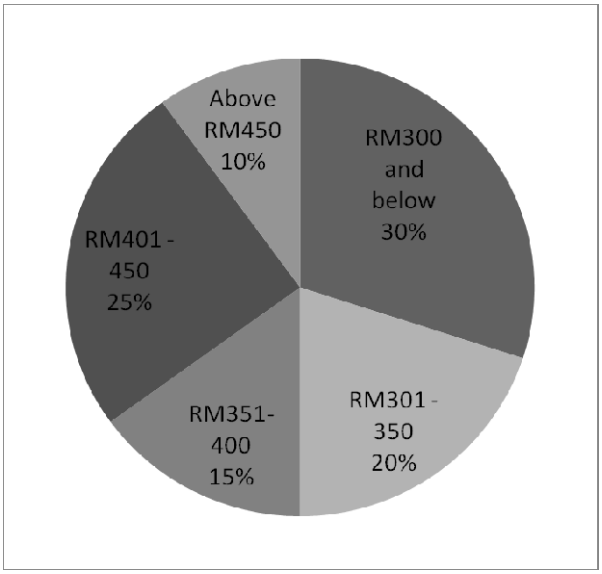

Fig. 1. Survey Participants Wages including Government Allowance

B. Vision Medical History

The following four questions in the survey are related to the medical history of the blind people, in particular their vision problem, which were related to type, cause and age when the vision problem started.

According to Fig. 2, of all the participants, 25% have very terrible vision that they almost can be considered blind while the rest have total blindness on both eyes except for two participants where they are only blind on one eye.

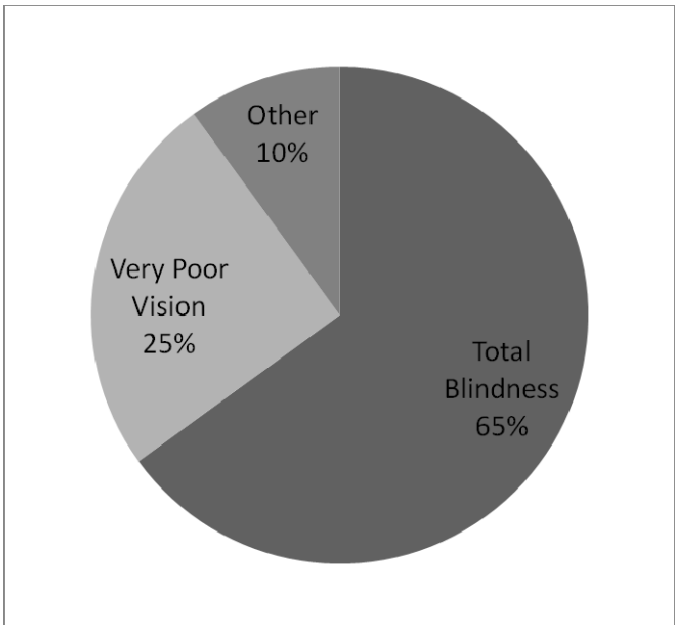

Fig. 2. Survey Participants Type of Vision Problem

More than half of the participants have their vision problem since birth or at most one year old while the rest are older than that when it started, where the vision problems started the least around the age of 22 years old – 30 years old as shown in Fig. 3.

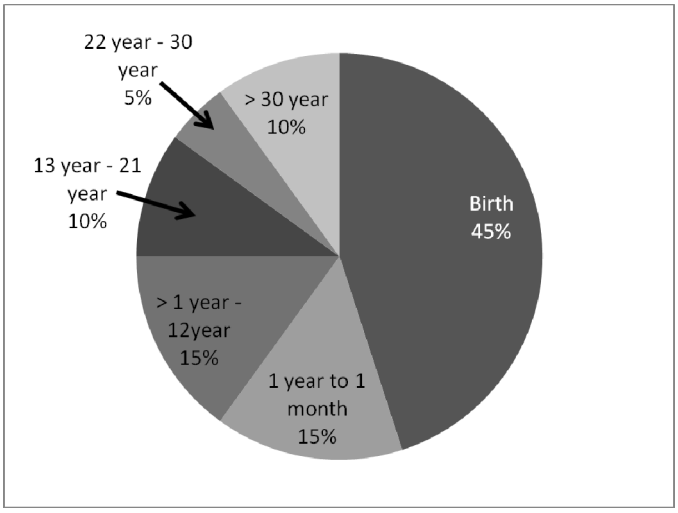

Fig. 3. Survey Participants Age When Vision Problem Started

In Fig. 4, most of the vision problem cause is due to genetic defect while 30 % of the participants are not sure of the cause of their vision problem. The remaining participants' vision problems happened due to disease such as high fever and diabetes or head injury. The type of vision problem as well the age they have the vision problems will affect what features and function they want the outdoor navigation system to have. All participants have indicated they have no other disabilities.

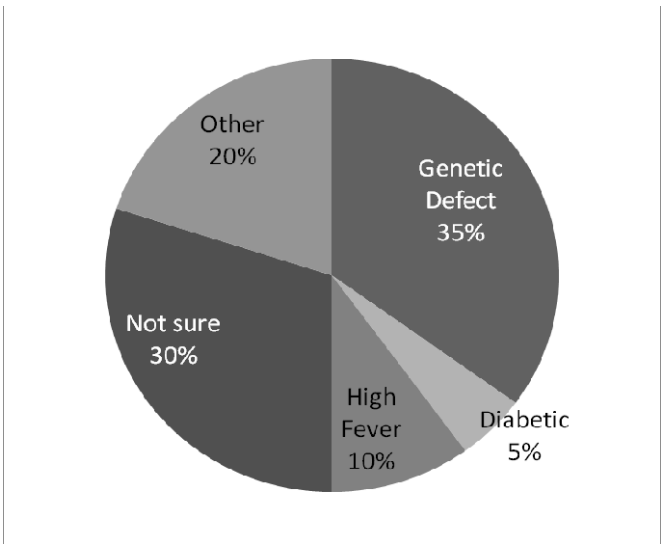

Fig. 4. Survey Participants Vision Problem Cause

C. Outdoor Navigation History

The next five questions on the survey focused on the blind peoples' perceptions and experience of navigating outdoors. Questions were related to frequency of outdoor excursions in both familiar and unfamiliar areas, methods used to navigate during the excursion as well as problems faced were asked to the participants.

The questions were worded in such a way as to attempt to gather information to understand how often the blind people like to go outdoors, their current method to move around the outdoors as well as the problems they are facing now using their current method of navigation.

The survey shows that majority of the blind people participating, which is 65%, likes to go outdoors more than twice every week, 25% prefers going outdoors weekly or once a month while the rest prefer to stay indoors as shown in Fig. 5. While in Fig. 6, data shows that the blind that rarely went outdoors or prefer indoors are mostly blind since birth or at most around the age of one year old. The blind rarely or never went to unfamiliar outdoor locations as only 5% often went to unfamiliar outdoor locations in a year.

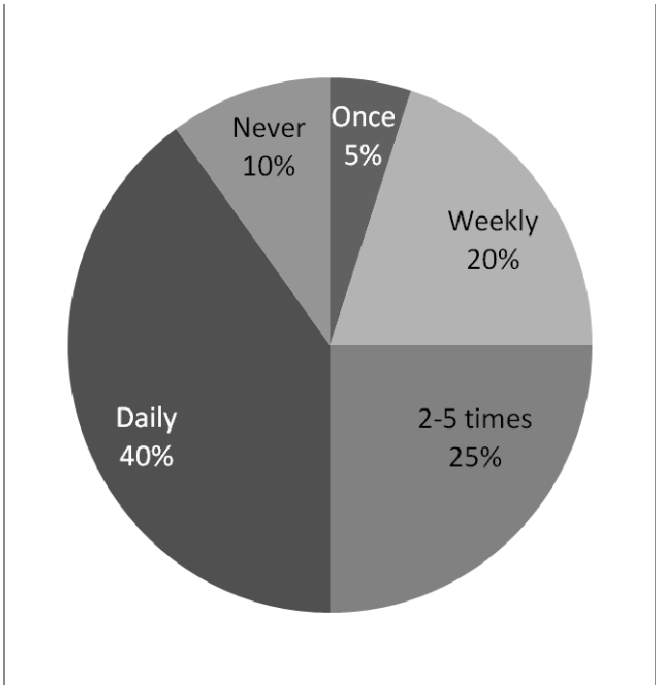

Fig. 5. Survey Participants Outdoor Trips Per Month

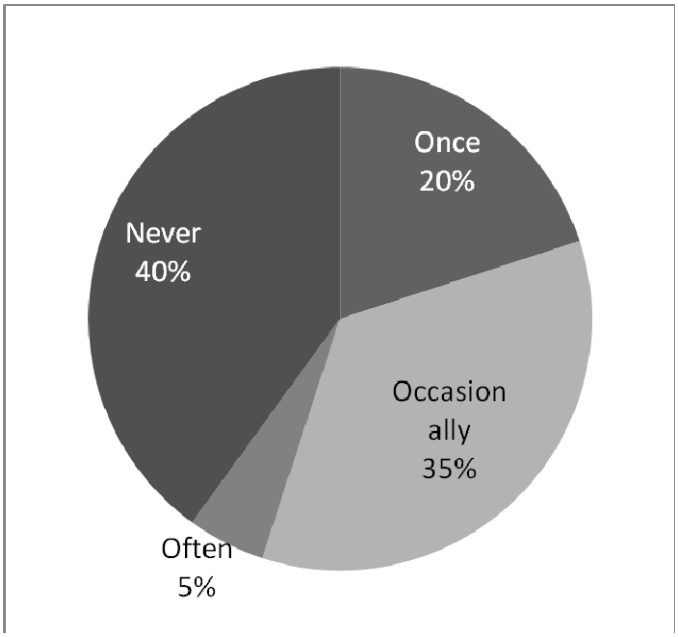

Fig. 6. Survey Participants Unfamiliar Area Outdoor Trips in a Year

Data in Fig. 7 shows that 75% of them prefer to use the traditional walking stick to navigate outdoors while the rest used a guide or memorizing the routes to navigate themselves when they are outdoors. Thus, when designing the outdoor navigation system, the fact that the blind people prefer to have something similar to a walking stick must be taken into consideration.

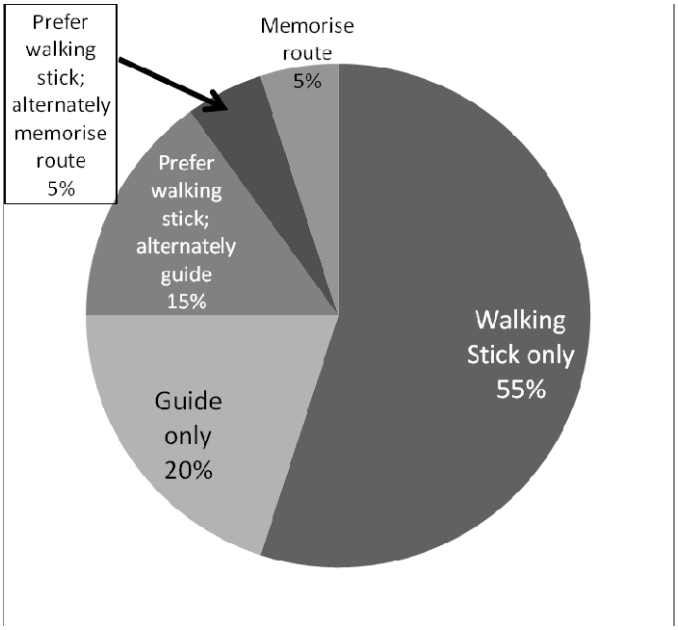

Fig. 7. Survey Participants Preferred Outdoor Navigation Method

According the results of the survey as in Fig. 8, the most common problem faced by the blind people when navigating outdoors are crossing the road safely and detecting obstacles such as static objects, people and holes on the pathway. Several of the participants also worried for their personal safety when navigating outdoors such as from pickpockets, accident areas, or dogs. The participants also complained that the public transports are always late and the needs of disabled people while on public transports were neglected. Minority of the blind people doing the survey worries that they might get lost, there are not enough roads for pedestrians and there are no handrails to help guide the blind.

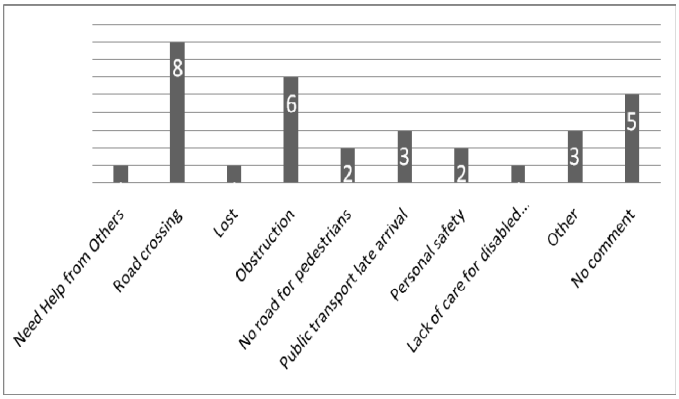

Fig. 8. Frequency of Outdoor Navigation Problems by Survey Participants

D. Features and Functions for outdoor navigation system

The last question of the survey regards what features and functions that the blind people want in an outdoor navigating system.

The results in Fig. 9 shows that there are three main functions that the blind wanted the system to have which are detect obstacles and give warning, inform the current location

as well as direction the blind is currently facing and finally capable to guide the blind person to cross the road safely. The blind people also wanted the system to be multilingual in language and voice interface and guide them to their destination safely. As shown in Fig. 7, a majority of the blind people prefer to use walking sticks. Thus, some of the blind people requested that this to be taken into consideration as well as having dark glasses as part of the design since this two things are the symbols of a blind person. Other suggestions include the system to allow 3G Video call to ask for help, reading sign boards and goods information and have personal security features available for the blind person to use.

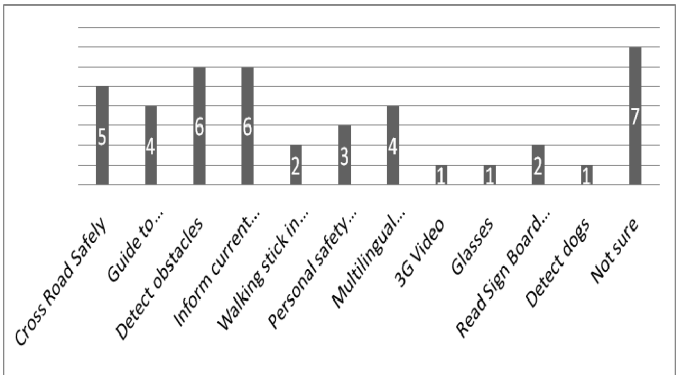

Fig. 9. Outdoor Navigation System Features & Functions Wanted by Survey Participants

E. SURVEY RESULT CONCLUSION

The data gathered from the survey helps us understand the budget limitations when they want to obtain a good outdoor navigation system. Data also shows that the blind people main trouble in navigating outdoors are crossing roads and detecting obstacles in front of them. Since the blind people shows high preference of using walking sticks when navigating outdoors, the outdoor navigation system must have a feature that is similar to a walking stick as well detecting obstacles, informing current direction and location and able to guide the blind person to cross the road safely.

The blind people also included several other suggestions to help other problems such as:-

a) asking to increase the government monthly stipulation to at least RM500

b) increase security where the blind people are commonly located when outdoors

c) increase awareness to help the blind more

d) increase the number of cheap public transports

e) specialize public transport for the blind to reach their working place

f) Add special features to public buses such as intercom telling the current bus stop location and have a special device to help detect if there is any blind people waiting at the bus stop.

CONCLUSION

In conclusion, the result of the findings revealed that blind people requires a blind navigation system that is portable and able to help them cross the roads and avoid obstacles during their outdoor excursions while retaining the blind's identity that is the walking stick and black glasses. The research for the most suitable outdoor navigation system for the blind is one that can be taken into consideration as it can help not only the blind in Malaysia, but the blind worldwide.

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