Web based Smart White Canes for Blind or Visually Impaired People on Wetland Areas

Imam Yuwono
Universitas Lambung Mangkurat, Banjarmasin, Indonesia. E-mail: imam.plb@ulm.ac.id

Mirnawati
Universitas Lambung Mangkurat, Banjarmasin, Indonesia.

Mohd Hanafi Mohd Yasin
Universitas Kebangsaan Malaysia, Selangor, Malaysia.

Yuyus Suherman
Universitas Pendidikan Indonesia, Bandung, Indonesia.

Sapto Wibowo
Politeknik Negeri Malang, Malang, Indonesia.

Zainudin Hassan
Faculty of Social Sciences & Humanities, Universiti Teknologi Malaysia (UTM), Malaysia.

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Abstract

The presence of a white cane considerably aids blind and/or visually impaired people in Orientation and Mobility (OM). Their white cane was insufficient to meet all of their demands, such as marking puddles or marsh areas that would be traversed. As a result, the goal of this study is to construct white canes to aid blind and/or visually impaired people's orientation and mobility in wetland environments. This study used Research and Development model with a 4D design, which included processes such as defining, designing, developing, and disseminating. The participants were blind and/or visually impaired people living on wetland areas in South Kalimantan. Interviews, action tests, questionnaires and observations were used to collect data. To test the effectiveness and practicality of developing white canes, they were analyzed using descriptive statistics. This research resulted in a produced stick with an auditory capability that could detect impediments such as potholes, puddles, and fires while moving around and determine the location point using the Global Positioning System. The study findings revealed that the smart white cane created has an effectiveness of 82 percent when used with very effective criteria; however, the practicality is around 70% in practical criteria.

In conclusion, the development of white canes can help blind and/or visually impaired people in mobility on wetland areas especially web based design.

Keywords

Developing White Canes, Orientation and Mobility, Blind.

Introduction

Today's technological advancements are vastly difficult, necessitating folks to act rapidly in order to use the most up-to-date technologies. As a result, technology literacy can be thought of as a human endeavor to keep up with and use technological advances. People are indeed aided by technological advancements, which coincide with breakthroughs in science and technology. These technical advancements are used in all sectors of life, including the creation of environmental identification aids for the blind and/or visually impaired people. Traditional aids, on the other hand, are less adaptable when dealing with the blind and/or visually impaired environment.

Individuals who are blind have difficulties or restrictions in using their sense of sight (Kustawan & Meimulyani, 2013). The result of experiencing visual impairment is not being able to obtain complete information from the surrounding environment. Humans receive around 80% of the information obtained from the environment through sight. However, for the blind, it naturally becomes a barrier to participating in activities that are not available to the broader public. Daily tasks will be affected, particularly mobility-related activities like walking, recognizing someone approaching, locating the door, or perceiving the terrain while walking. Therefore, new tools or innovations are needed in order to help the blind and/or visually impaired people to provide convenience in their activities.

An assistive device for blind and/or visually impaired people using a stainless steel stick, which is white with a sensor in the middle is used (Setiawan, 2017). In general, the stick serves as a guide and facilitates daily activities and can be regarded as a substitute for the eye. However, the stainless steel stick has a weakness in recognizing an obstacle in front of it. The use of canes can affect the orientation and mobility skills of the blind (Rahmawati & Sunandar, 2018); Mirnawati & Damastuti, 2018).

Mobility is defined as the ability to move from one location to another in a safe and efficient manner (Smith & Tyler, 2010); Friend & Bursick, 2012). When moving around, a person must first orient himself or herself to significant items and indicators. Moving in a familiar environment, especially for blind and/or visually impaired people, is a great hardship. They

frequently utilize the old way when leaving the house with a white cane and struggle with the new route (Kiruba et al., 2018). Hole, stairs, humans, animals, walls, and muddy surfaces are all obstacles that the blind and/or visually impaired people experience on their journey. Even though common white canes were used to help, the upshot of this challenge is an accident or damage (Pawaskar et al., 2018). The majority of these white canes are still standard, such as foldable blinds. The usability of white canes for the visually impaired is currently not able to detect objects located on the road if they are distracted by sounds from the surrounding environment; nevertheless, if it rains, the blind and/or visually impaired people are unable to do their own mobility (Johnson et al., 2017; Milati et al., 2019; Sahoo, Wei Lin & Hwa Chang, 2019).

A problem is set to build an electronic-based stick that can identify barriers in the vicinity and activate an automatic information provider with additional characteristics such as position identification, based on how white canes work manually (Gunastuti et al., 2020). Electronic sensors, such as ultrasonic sensors that recognize items around us by reflecting ultrasonic waves, can be used to electronically perceive fields or obstacles around us. A user can broadcast his or her location over GSM telecommunication network using GPS (Global Positioning System) technology that is integrated into a GSM mobile phone system based on Android. Danger alerts can also be sent using this technique.

Blind and/or visually impaired people in South Kalimantan, particularly those in Banjarmasin, are affected by the aforementioned issues. Wetlands or peatlands characterize the areas of Banjarmasin. In comparison to most ecosystems, wetlands feature a high level of biodiversity (Khairunnisa & Salamah, 2018). Banjarmasin is a basin-shaped lowland area that is swamped by overflowing rivers and rains during the rainy season, while the puddles recede or dry up during the dry season (Soedjoto; 2015). Because white canes have not been sufficient to fulfill the demands of the blind and/or visually impaired people, such as marking puddles or swamp areas that will be passed, the swamp area in Banjarmasin has become a separate obstacle for the blind and/or visually impaired people.

Method

This study employed a Research and Development method (R & D). It used Thiagarajan et al. (1974) research model with the 4D model (Four-D models). The 4D research model includes the following stages: (1) Define Stage, (2) Design Stage, (3) Development Stage and (4) Dissemination Stage. The product developed is in the form of a white cane in wetland areas equipped with Ardunio Uno and GPS. The research subjects are the blind

and/or visually impaired people in wetland areas. The data collection techniques carried out are interviews, action tests, questionnaires and observations.

The interview was done to find problems that must be researched and analyze the needs of blind and/or visually impaired people in conducting orientation and mobility on wetland areas. The action tests were carried out to determine the effectiveness of using white canes in swamps, and the questionnaire was conducted to determine the practicality of using white canes in swamps in orientation and mobility activities and documentation to complete the data from the implementation of the stick, in the form of photos of research activities.

The data on the effectiveness and practicality of sticks can be analyzed using descriptive statistics with the formula:

$$N = \frac{f}{n} \text{ x } 100$$

Information:
P = Percentage
f = Total score obtained
n = Total highest score

The decisions of the effectiveness and practicality of developing white canes on wetland areas uses a five-scale achievement level conversion as shown in Table 1.

Table 1 Effectiveness and Practicality Criteria

No.	Level of Achievement	Effectiveness Qualification	Practicality Qualification
1	81 – 100 %	Very Effective	Very Practical
2	61 – 80 %	Effective	Practical
3	41 – 60 %	Fairly Effective	Fairly Practical
4	21 – 40 %	Less Effective	Less Practical
5	< 20 %	Very Less Effective	Very Less Practical

(Arikunto, 2010)

Results and Discussion

Observations and interviews with blind and/or visually impaired people were conducted during the define stage. The researchers discovered that blind and/or visually impaired people have restrictions in their orientation and mobility, and that white canes that have been utilized in the past have not been able to meet their needs. These data are used to analyze the needs of blind and/or visually impaired people in order to create a design

concept for white canes that would help them with direction and mobility in wetland environments.

The development of white canes in this study began with the needs analysis stage on the design stage. The findings of the needs analysis were used by researchers to develop a design idea for white canes that could be used for orientation and movement in wetland environments. The white cane's design has been conceptualized by the researcher, and it has been presented to the partners for assembly and fabrication.

Several tools or components are required for the product design and specifications on the creation of white canes in this raw region, such as;

a. Arduino as the Microcontroller to be Used

A smart white cane with the ability to automatically inform the user of many conditions, such as the presence of people/objects, potholes on fire/residual heat from burning the road, and puddles of water, is an intended feature of the instrument that would be built. The notification is sent by human voice, which is informed by the tool and heard by the users.

b. Ultrasonic Sensor HC-SR04 which would Read the Distance

HC-SR04 is an ultrasonic sensor module that can measure distances in the range from 2 cm – 4 m, with an accuracy value of 3 mm. This module contains a transmitter, receiver and control circuit. The working principle of this sensor is using trigger input bit 10us high signal, the module will automatically send 8 times the 40KHz frequency signal and detect whether there is a return signal or not, and if there is a return signal, then the duration of the output high is the time of sending and receiving ultrasonic. Distance = (High signal time) speed of sound (340m/s).

c. GPS (Global Positioning System)

Global Positioning System (GPS) is a navigation system with the help of satellites that serves to determine a position, speed and time. This GPS system consists of an array of 24 satellites orbiting the earth in 6 circular orbits. The satellites are arranged so that at any time there are 6 satellites within range of the GPS system receiver (Abidin, 2002). This GPS system has three important parts, namely the control, space and user parts. The modules used in this GPS, namely (1) Ublox neo-6m GPS module that will know the location of a place where the coordinates of the GPS module are located and 2) SIM800L module is used to send SMS (Short Message Service).

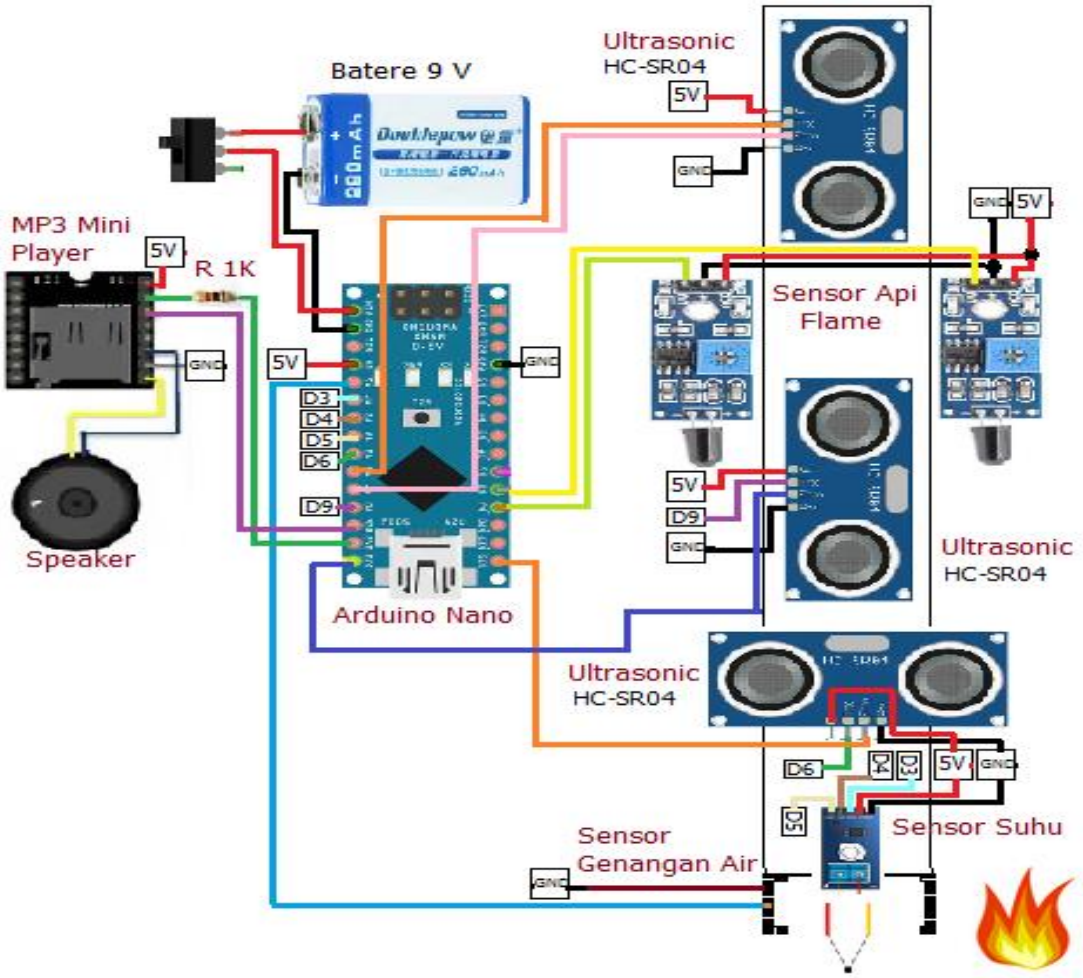


Figure 1 Schematic of the Electronic Circuit System

Information:

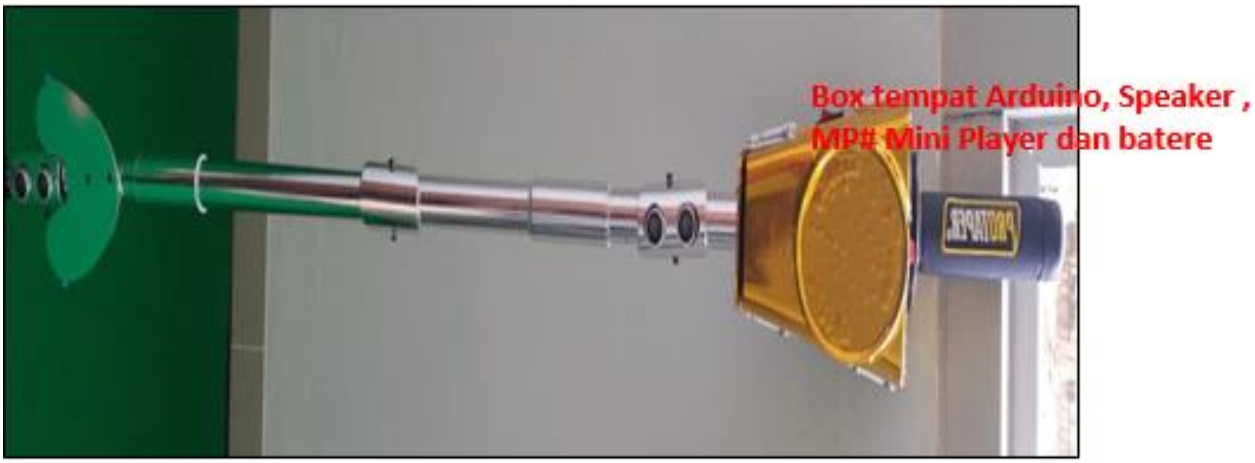
1. Arduino Nano is the main controller which has 13 digital pins and 8 analog pins.
2. Ultrasonic sensor, serves to detect obstacles at a certain distance that has been set in the program.
3. The MP3 mini player is equipped with a micro-SD which has previously been filled with sound files as information about obstructions from certain directions. The output of the MP3 player is a headset.
4. The emergency button is placed on the white cane so that it makes it easier for the user to reach it when an emergency occurs. The emergency button status is used by Arduino to send emergency information via SIM800L via SMS to the HP number that has been set in the program. The SMS sent is a link to google maps with the coordinate parameters obtained from the results of the GPS module reading.

System Explanation

a) Initialization of Pins, Sensors and Serial Communication, is the stage to declare sensor pins that are used as Input or Output, Serial communication with MP3 Mini Player

b) Read Distance Sensor A and Distance B are specifications for detecting objects/people in front with an angle of 30 to the right and to the left. There are 2 ultrasonic sensors SR-HC04 for detection of this distance, at the top and bottom of the stick. If one or both of these sensors read objects/people at a distance below 150 cm, the Arduino will activate the MP3 Mini Player, to run the MP3 file with the sound "There's Something in Front."

On the development stage, the development of white canes in wetland areas has become an orientation and mobility aid for blind and/or visually impaired people. As shown in Picture 1, the length is 1.5 m and the placement of several sensors.



Picture 1 The Arduino, Speaker, Mini Player, and Battery

The next stage is to analyze the effectiveness and feasibility of the white canes developed by testing their use in orientation and movement on wetland areas. The researchers compared the capacity of blind and/or visually impaired people to do orientation and mobility by conditioning barriers and places when using an ordinary white cane and when using a smart white cane produced during the dissemination stage. Diagram 1 depicts the findings of a study on the efficiency of white canes.

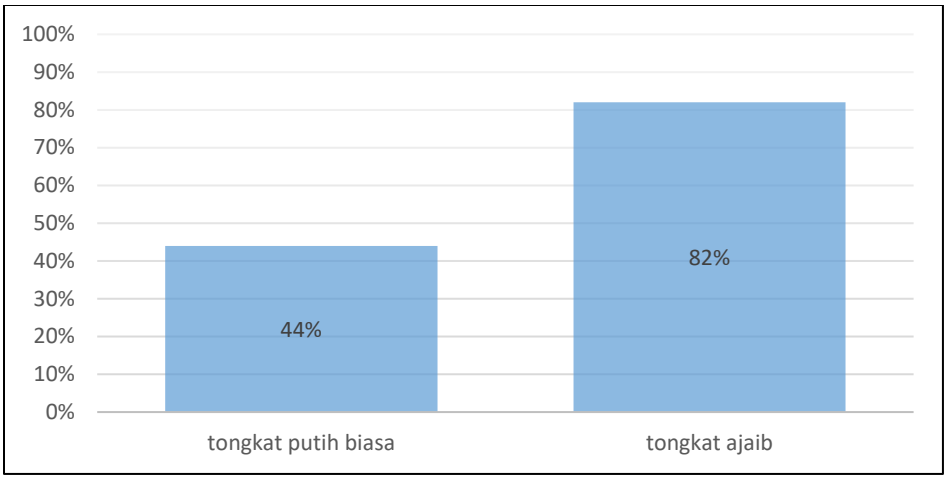


Diagram 1 Effectiveness Testing Result

Diagram 1 shows that the effectiveness of using an common white canes in mobility on wetland areas by people with visual impairments is around 44% with the criteria of "quite effective" while the use of an innovated white cane in carrying out mobility in a swamp environment reaches 82% with the criteria of "very effective". The results of the practical use of white canes are seen in Table 2.

No.	**Statements**	**Response**	
		Yes (1)	No (0)
1.	The white cane is easy to use.	v	
2.	The white cane is safe to use when walking.	v	
3.	The audio on the white cane is clearly heard.	v	
4.	The device in the white cane does not interfere when used.		v
5.	The white cane is light.		v
6.	The white cane is easy to carry.		v
7.	The white cane can detect puddles.	v	
8.	The white cane can detect fire.	v	
9.	The white cane can detect potholes.	v	
10.	The size of the white cane is just right and comfortable.		V
11.	The white cane can detect where you are.	v	
Percentage of Effectiveness		70%	
Criteria		**Practical**	

The white canes developed were categorized as "Practical" based on the results of the questionnaire; however, blind and/or visually impaired people believed that the white canes developed were still difficult to carry anywhere because the size and equipment contained in the sticks were still quite large and related to notification of coordinate points at the location. This is a great way for blind and/or visually impaired people to find out where they are.

The white cane is a component of the visually impaired and blind and/or visually impaired people's identity that cannot be detached. This identity also serves as a symbol of independence for persons who have lost their vision. Individuals who are blind and/or visually impaired people have vision impairment and poor visual performance that cannot be repaired by refractive correction (glasses or contact lenses), surgery, or medical treatment. There is a functional limitation of the visual system in this condition, which can be characterized by irreversible vision loss, a limited visual field, lower contrast sensitivity, increased susceptibility to glare, and a reduced capacity to perform daily tasks (De Carlo et al., 2006; Meutia & Ridho, 2019).

Mobility activities, which can be defined as moving from one place to another, are one of the challenges that blind and/or visually impaired people will confront. The creation of white canes is based on the findings of the needs analysis gleaned from the evaluation activities. The evaluation activity entails gathering a large amount of data in order to learn about the limitations, potentials, and needs of blind and/or visually impaired people, including their orientation and mobility (Yuwono et al., 2017). The purpose is to fulfill blind and/or visually impaired people's demands for direction and mobility in swamps, therefore white canes were created using Arduino, sensors, and GPS. Additionally, the employment of Arduino technology in white stick construction to assist them in overcoming orientation and mobility issues (Alshajajeer et al., 2018); Orlando, 2019).

By harnessing ultrasonic waves released in the sensor, blind and/or visually impaired people can identify obstructions around the stick using ultrasonic sensor technology based on the Arduino microcontroller (Andreas & Wisnu, 2016). Sensors and sound systems are designed to help visually impaired persons navigate more easily (Alam et al., 2015); Noshwin., et. al, 2017; Gbenga, Shani & Adekunle, 2017). Detecting objects at a predetermined distance with an output in the form of sound, the tool successfully issued information in the form of a human voice recorded after the ultrasonic sensor reading conditions (Milati et al., 2019).

Because the Arduino and ultrasonic devices give numerous elements on the stick that can inform blind and/or visually impaired people, the result of the white cane innovation is regarded effective in assisting blind and/or visually impaired people with orientation and mobility, especially in swampland. Arduino has an ultrasonic sensor with a receiver and transmitter to assist users in detecting roadblocks and barriers (Purnomo et al., 2018). The installation of a GPS capability to assist blind and/or visually impaired people in determining their whereabouts. GPS works by using an Arduino device on the emergency button on the stick by sending emergency information via SIM800L via voice SMS to the

HP number that has been set in the program (Rusito & Setiyawan, 2020). In the implementation of the trial by comparing the ability of blind and/or visually impaired people in orientation and mobility by conditioning obstacles and locations when using an ordinary white cane and when using a white cane which was developed.

Rocky roads, potholes, leftover heat from burning, uphill roads, downhill roads, speed bumps, puddles, encountering someone on the road, and meeting an object on the road are all conditioning hurdles. The trial findings demonstrate that in the end, the produced white canes were able to identify the majority of the conditioned obstacles and determine the position of the spots where they were located, resulting in a white cane effectiveness of 82 percent with very effective criteria. When compared to a standard white cane, the percentage reduction in collision rate when using an ultrasonic walking stick is 90.1, indicating that the ultrasonic walking stick can be trusted for use by blind people (Sudhakar, 2018). However, the practicality of the stick is only around 70% with practical criteria. The specifications of the development of the smart white cane have not been easy to carry and are not comfortable for use by blind and/or visually impaired people because the size of the white cane is still relatively large.

Conclusion

The process of creating a white cane begins with a needs analysis, which is followed by product conceptual design. The conceptual design is then submitted to the partners for development of the finished product based on the needs analysis. In addition, blind people were used in a trial and error process for further examination. The trial results suggest that the smart white cane developed is 82 percent effective, which meets the criterion for being very effective. Meanwhile, the practicality of the smart white cane developed was only around 70% with the criteria of being quite practical, due to limited funds so that it was not sufficient to fulfill the manufacture of more practical white canes. Thus, the white cane that was developed can assist blind people in mobility in wetland areas.

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