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Design of Assistive Device For Blind People Based on Arduino Nano With Global Positioning System (GPS) Tracker

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Abstract—There are many people who do not have the ability to see so they have difficulty in carrying out activities. They need the help of others to carry out their daily activities. Therefore, the purpose of this research is to create a blind assistive device based on arduino nano with Global Positioning System (GPS) tracker in order to help blind people carry out activities independently. The method used in this research is experimental method. Based on the test results, this tool is able to detect objects from the front, left, and right at a distance of 100 cm then provide voice instructions through the speaker, and this tool can send the location of its users to certain people through the GSM module (Global System for Mobile Communication). Based on the comparison of location readings between the GPS module and google maps, the location read by the GPS module can be said to be quite accurate. From the distance measurement average error value of 0-2%, so the accuracy level of the system is 98%. The performance constraints of this tool are when conditions in the room GPS module and GSM module are difficult to get a signal because it is blocked by the room.

Keywords: Blind People, Voice Instructions, Ultrasonic Sensor, GPS, Arduino Nano.

1. Introduction

Sight is the most beautiful and most important gift from God to all his creatures, especially for humans. But unfortunately there are some people who have deficiencies so that they are unable to capture the beauty of this world with their own eyes [1]. Blind people are people who experience visual impairment so that they need the help of other people or special tools to carry out activities [2]. The problem that blind people often face is that it is difficult to detect obstacles around them [3]. There are more than 253 million blind people worldwide, and many of them have difficulty moving around on their own. While traditional blind canes are useful aids, using them in crowded or unfamiliar places can be difficult [4]. Another way to help blind people navigate is to have a pet such as a dog, but this is very expensive [5].

In this era of technological development, humans are encouraged to continue thinking creatively. Not only looking for new inventions, but also maximizing existing technology to improve human performance in everyday life [6]. This allows the creation of a tool for blind people to help them navigate in their daily lives [7].

In previous research, ultrasonic sensors were used to detect objects with indicators in the form of buzzers and vibrators. When an object is detected, the buzzer and vibrator will be active [1], [4], [5], [8]. Other researchers use another way to detect objects, namely by using Passive Infra Red (PIR) sensors [9] and using a camera [10], [11]. Other researchers add GPS Modules and GSM Modules in

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order to send the location to the recipient when in an emergency [12].

Based on the above background, this research aims to develop a visually impaired assistive device with features that have not been available in previous studies. This tool uses three ultrasonic sensors to detect objects around with Arduino nano as its microcontroller. There are MP3 modules and speakers that will provide voice instructions to users of this tool when there are objects in front, right, or left. There is a GPS Module (Global Positioning System), GSM Module (Global System for Mobile Communication) and push button which when the push button is pressed it will send a message in the form of SMS (Short Message Service) containing the location of the user of this tool to the number that has been registered. Location sending can also be done when the registered number sends a "track" message to the number on the GSM Module, where this feature is not yet available on the previously made tool. Then after the location is successfully sent, the user of this tool will get a voice notification through the speaker as information that the location has been sent. With this tool, it is expected to help the blind to move freely from one place to another without the help of others.

2. Method

The research method used is an applied research method with experimental techniques [13]. The research flow is presented in Figure 1.

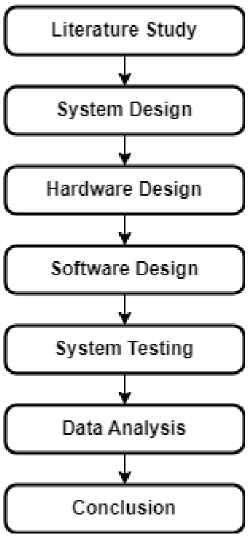

Figure 1. Research flow

2.1 System Design

Block diagrams are used to make it easier to design and understand how the tool works [12]. The block diagram of the assistive device for blind people with GPS tracker is shown in Figure 2.

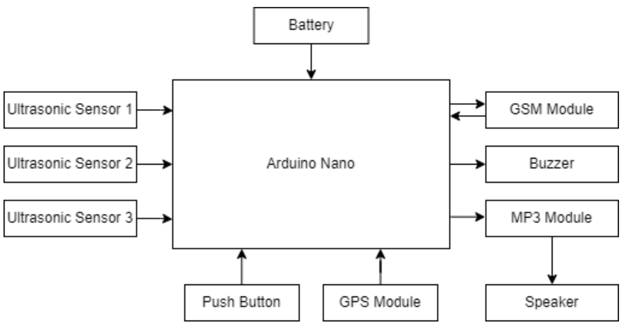

Figure 2. Block Diagram of the Assistive Device for Blind People with GPS Tracker

Based on the block diagram in Figure 2, the battery power input serves as a source of electricity for all components used. The arduino nano microcontroller acts as the brain in making decisions based on data received from ultrasonic sensors, GPS (Global Positioning System) modules, GSM (Global System for Mobile Communication) modules, and push buttons. The ultrasonic sensor acts as an object detector with a predetermined distance which then the sensor reading results are sent to the arduino nano as a place to process data. When the object is detected at a predetermined distance, arduino nano will activate the buzzer and MP3 module which then the speaker will emit sound according to the instructions given. The GPS module plays a role to read the coordinates of the location of the user of this tool. Then the GSM module acts as a medium for sending and receiving messages. When the push button is pressed, arduino nano will instruct the GSM module to send a message in the form of location coordinates to a predetermined number, or when the predetermined number sends a "track" message to the GSM module, then arduino nano will also instruct the GSM module to send a message in the form of coordinates to the number and notify the user of this tool through the speaker that the location has been sent.

2.2 Hardware Design

The components used in making this tool are arduino nano, ultrasonic sensor HCSR-04, GPS module neo 6m, GSM module SIM800L, DFPlayer mini MP3 module, speaker, buzzer, push button, 1k ohm resistor, 18650 battery, and switch. In hardware design, circuit schematics are needed to simplify the process of making the circuit [14]. The circuit scheme for the arduino nano-based blind assistive device with GPS tracker can be seen in Figure 3.

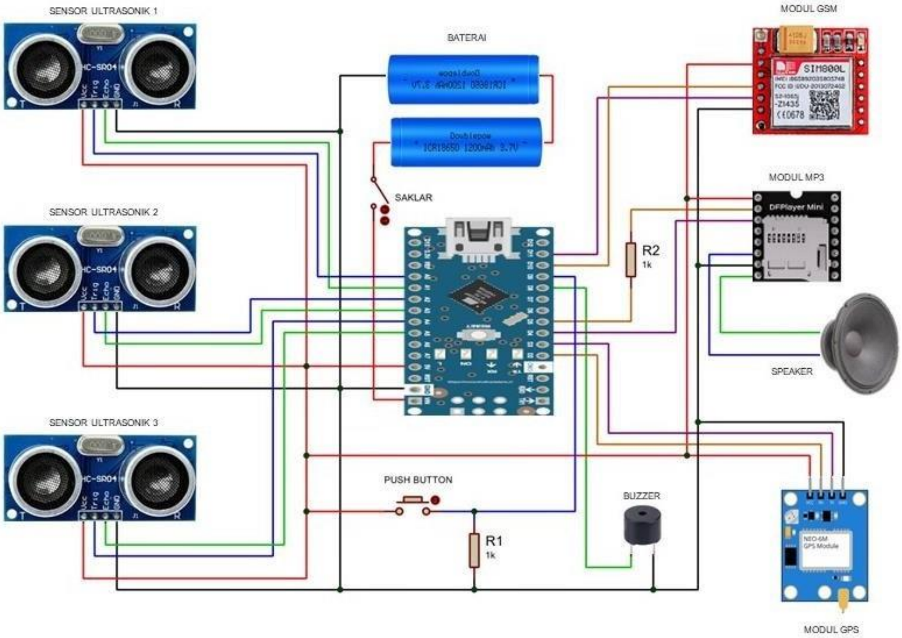

Figure 3. Schematic of the Assistive Device for the Blind with GPS Tracker

2.3 Software Design

The software used in making programs for blind aids is the Arduino IDE [15]. After the program is created, the program is then uploaded to arduino nano via USB type-C cable so that arduino nano will function as an input and output controller in accordance with the program that has been made. Flowchart of the of assistive device for blind people with GPS tracker can be seen in Figure 4.

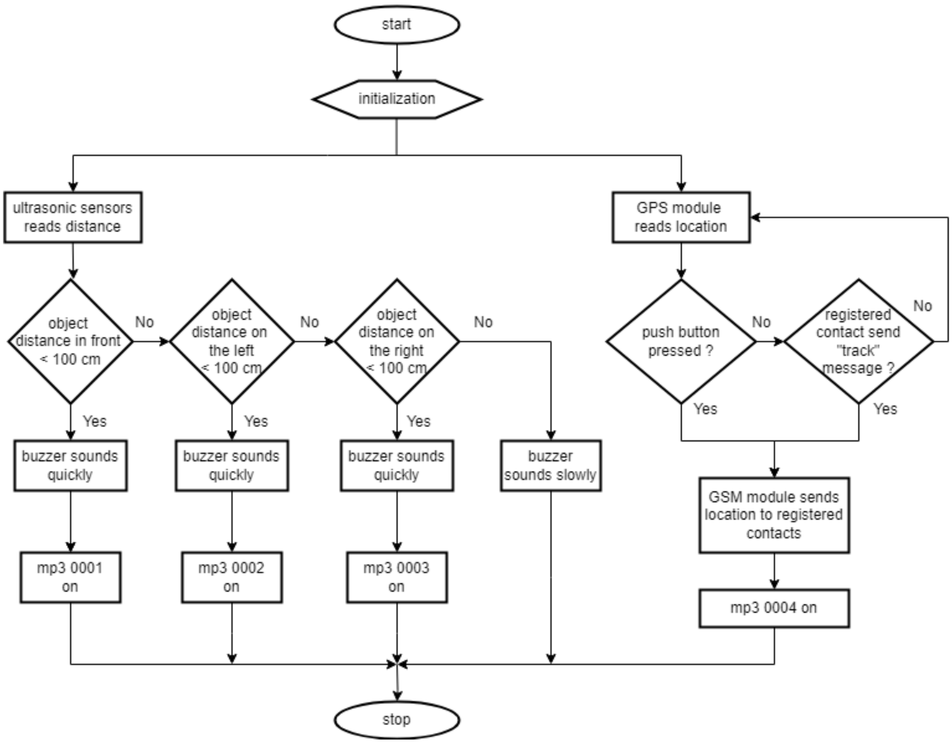

Figure 4. Flowchart of the Assistive Device for the Blind with GPS Tracker

Based on Figure 4, there are four voice instructions that will be issued through the speaker. The contents of the voice instructions can be seen in Table 1.

Table 1. Voice Instructions of the assistive device for the blind

No.	Voice Instruction	Sound Emitted
1	Mp3 0001	There is an object in front of you
2	Mp3 0002	There is an object on the left side
3	Mp3 0003	There is an object on the right side
4	Mp3 0004	Your location has been sent

3. Result and Discussion

The components that have been assembled are then mounted on a box measuring 7x5x2.5 cm. This aims to protect the components and facilitate the installation process on the blind assistance stick. The results of the installation on the box can be seen in Figure 5.

Figure 5. Results of Installation on the Box

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Figure 6 shows the installation of the device on a blind cane. The tool is placed at the top to make it easier for the cane user to operate the tool.

Figure 6. Tool Installation on the Stick

When the visually impaired device is turned on, it needs to prepare first, especially for the GPS module and GSM module. These two modules need to get a signal first before they can be used. As for other components, it only takes 2 seconds of preparation time because its performance does not require a signal from the satellite.

Figure 7 contains the results of testing the preparation of the GPS module to obtain satellite signals. This test is carried out 5 times indoors and outdoors to compare whether the signal is easier to get indoors or outdoors. The indicator light on the GPS module will blink when the GPS module has received a signal.

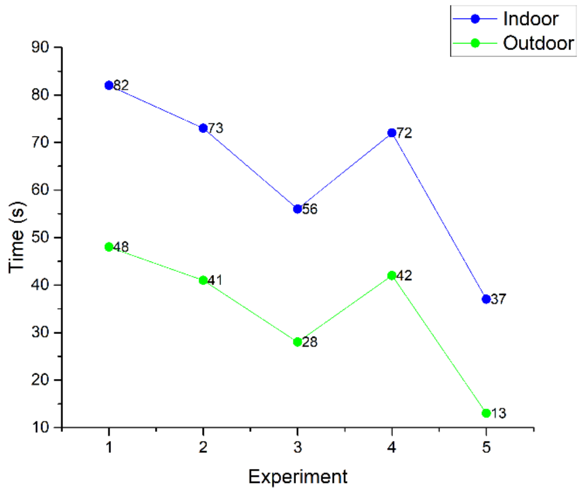


Figure 7. Test Result of GPS Module Preparation

Figure 8 contains the results of testing the preparation of the GSM module to get a signal. This test is carried out 5 times indoors and outdoors to compare whether the signal is easier to get indoors or outdoors. The indicator light on the GSM module will blink with a 3 second pause when the GSM module has received a signal.

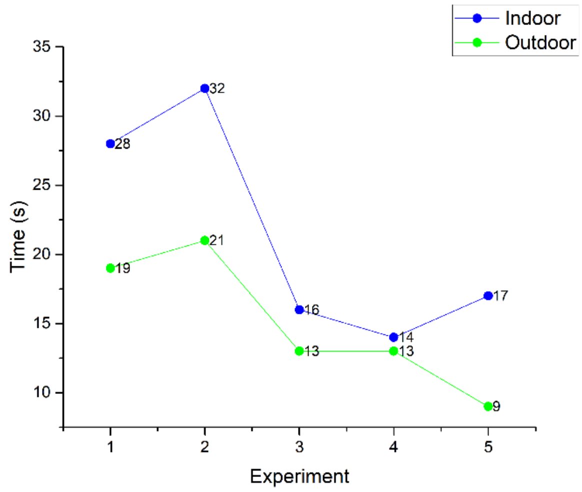


Figure 8. Test Result of GSM Module Preparation

Based on the test results in Figure 7 and Figure 8, it shows that the GPS module and GSM module have difficulty getting a signal if they are indoors. These two modules are faster to get a signal if they are outdoors.

Table 2 contains the results of the ultrasonic sensor testing. This test aims to test how accurate the distance read by the ultrasonic sensor is. Testing was carried out 4 times with distances of 25 cm, 50 cm, 75 cm, and 100 cm. The object used for distance measurement is a wall. The ruler is used as a reference to determine the sensor measurement distance. From the test results we calculate the average error value of 0-2%, so the accuracy level of the system created is 98% for the accuracy of distance measurement.

Table 2. Ultrasonic Sensor Testing Results

Standard Measurement	**Sensor Read Result**			**Error**			**Sensor Reading Time**
	Front Sensor	**Right Sensor**	**Left Sensor**	**Front Sensor**	**Right Sensor**	**Left Sensor**	
25 cm	25 cm	24 cm	24 cm	0%	4%	4%	1 second
50 cm	50 cm	50 cm	50 cm	0%	0%	0%	1 second
75 m	75 cm	74 cm	74 cm	0%	4%	4%	1 second
100 cm	100 cm	100 cm	100 cm	0%	0%	0%	1,5 second
Average of error				0%	2%	2%	-
Accurate value				100%	98%	98%	

Table 3 contains the test results of the GPS module. This test aims to test how accurate the location coordinates are read by the GPS module. Testing is done four times with different locations. Google maps is used as a comparison of the results of the location coordinate point reading.

Table 3. GPS Module Testing Results

Experiment	**Location**	**GPS Module Reading Results**		**Google Maps Reading Results**	
		Latitude	**Longitude**	**Latitude**	**Longitude**
1	Jl A. Yani	-6.979032	108.473822	-6.979036	108.473815
2	Jl. Ciperna	-6.9817827	108.475282	-6.9817825	108.475288
3	Jl. Pemuda	-6.729172	108.546100	-6.729177	108.546105
4	Jl. Pantura	-6.741847	108.560866	-6.741840	108.560862

The test results show that the coordinate points read by the GPS Module are only slightly different from the google maps reading. Therefore, it can be said that the results of reading the location coordinates by the GPS Module are quite accurate.

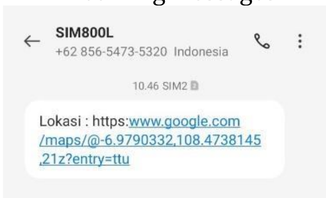
Table 4 contains the results of testing ultrasonic sensors to detect objects accompanied by indicators from buzzers and speakers. Tests were carried out on all sensors with objects in the form of walls, trees, people, and vehicles. The test results show that the ultrasonic sensor and its indicators can work properly.

Table 4. Object Detection Test Results

Experiment		Object Status	Buzzer Status	Speaker Status
Object	Sensor			
Wall 	Front Sensor	Detected	Quick Sound	Mp3 0001 On
	Left Sensor	Detected	Quick Sound	Mp3 0002 On
	Right Sensor	Detected	Quick Sound	Mp3 0003 On
Human 	Front Sensor	Detected	Quick Sound	Mp3 0001 On
	Left Sensor	Detected	Quick Sound	Mp3 0002 On
	Right Sensor	Detected	Quick Sound	Mp3 0003 On
Trees 	Front Sensor	Detected	Quick Sound	Mp3 0001 On
	Left Sensor	Detected	Quick Sound	Mp3 0002 On
	Right Sensor	Detected	Quick Sound	Mp3 0003 On
Vehicle 	Front Sensor	Detected	Quick Sound	Mp3 0001 On
	Left Sensor	Detected	Quick Sound	Mp3 0002 On
	Right Sensor	Detected	Quick Sound	Mp3 0003 On
No object 	Front Sensor	Not Detected	Slow Sound	*Standby*
	Left Sensor	Not Detected	Slow Sound	*Standby*
	Right Sensor	Not Detected	Slow Sound	*Standby*

Table 5 shows the results of the location delivery test. Location delivery testing is done in two ways, namely by pressing the push button on the tool made, and by sending a "track" message to the GSM module via the recipient's cellphone. Based on the location delivery test results, it can be said that this feature works well.

Table 5. Location Delivery Test Results

Experiment	GPS Module Status	GSM Module Status	Recipient Status
Push button pressed	Send location to arduino nano	Send location to registered number	Incoming Messages 
Registered number sends "track" message	Send location to arduino nano	Send location to registered number	Incoming messages 

4. Conclusion

The design of assistive device for blind people based on arduino nano with Global Positioning System (GPS) Tracker was successfully made. From the test results it can be stated that this tool is able to work as expected. This tool is able to detect objects from the front, left and right at a distance of 100 cm and then provide voice instructions to the user of this tool through the speaker. Based on the comparison of location readings between the GPS module and google maps, the location read by the GPS module can be said to be quite accurate. From the distance measurement average error value of 0-2%, so the accuracy level of the system is 98%. The performance constraints of this tool are when conditions in the room GPS module and GSM module are difficult to get a signal because it is blocked by the room. With this tool, it is expected to help the blind to move freely from one place to another without the help of others.

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