Smart Cane Using ESPectro with GPS Tracking System

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Abstract: A blind person has a physical limitedness on the sense of vision. Therefore to facilitate their mobility, they usually use a cane. However, the cane has a deficiency in terms of function. The deficiencies of the cane are it cannot detect an out of range obstacle and blind’s family is unable to track the blind’s location. Based on these problems, this research will develop a smart cane for a blind person using ESP8266 as a microcontroller and it has sensors and buzzer to facilitate and provides assistance to its user. To assist in tracking the location, this smart cane utilizes GPS to determine the location and send it via SMS. The method used in this research is the design of hardware and software, tool making, and testing tool. The expected results of this research are to create a smart cane for a blind person which can assist their daily activities. A blind person can avoid a collision because this smart cane will notify the person through the buzzer and it can also notify their family if they are lost.

1. Introduction
Eyes are one of the senses which is very important for humans because it serves to record the circumstances or conditions that are all around, so people can find out things that he saw. Anyone can do a variety of activities more easily if they have normal eyesight. However, not everyone was born with a normal eye, there are also experiencing a vision disorder since birth [1].

A very common eye defect among communities around the world is blindness. According to the World Health Organization (WHO), there are a total of 285 million people in the world are experiencing vision problems i.e. as many as 39 million people are blind and 246 million more who have a low vision [2]. One of the problems often encountered by the blind is the limitation of activity and mobility. Blind people desperately need tools to detect obstruction so they could walk anywhere without worry of going to crash into objects in front of them. Therefore to facilitate their mobility, they usually use a cane [3][4].

The blind cane is one of the important facilities for the blind who used to walk. The sticks used will give the response when an object is exposed to the other end of the stick. However, the stick could not provide information to the user if the object is outside the range of the cane, so users could not prepare themselves when faced with objects that are before them. The other deficiencies of the cane are blind’s family is unable to track the blind’s location [3][5][6].

Based on these problems, this research will develop a smart cane for the blind use ESPectro which is this board using ESP8266, and then it will be installed the ultrasonic sensor, touch sensor, GPS+GPRS module, and a buzzer to facilitate it’s the user. To assist relatives to the blind's location, the smart cane will use the GPS system as the determination of the location and it will send through SMS and can also be seen in real time on the makestro cloud.
2. Methods

2.1 Research Methods
The methods used in this research with the title “Smart Cane Using ESPectro with GPS Tracking System” has several stages described in the flowchart in Figure 1.

![Flowchart of Research Methods](image)

**Figure 1.** Flowchart of Research Methods.

In this first stage, the selection of components to be used in smart cane is to use modules such as:

2.1.1. **ESPectro V3 Board.** ESPectro V3 board in Figure 2 is one of the microcontroller board made by PT. DycodeX Nusantara Technology which is this board uses ESP8266 as the core [7]. ESPectro V3 has come the ability to auto-and manual flashing [8]. ESPectro also has a programmable LED, RGB LED, and button.

![ESPectro V3 board](image)

**Figure 2.** ESPectro V3 board.

2.1.2. **Ultrasonic Sensor HC-SR04.** The ultrasonic sensor is a sensor that works based on the principle of the reflected sound waves, the sensor produces a sound wave that is then reflected back by the time difference as the basis for measuring distances. Ultrasonic signal emitted by the transmitter. The signal has a frequency above 20 kHz, a frequency usually used to measure the distance of objects is 40 kHz [3]. Figure. 3 is the Ultrasonic sensor HC-SR04 used in this research.
2.1.3. **Touch Sensor TTP223B.** This module is a capacitive touch switch module. Under normal circumstances, low output module; Low power consumption. When a finger touches the corresponding position then the module output becomes high and if not touched for 12 seconds then the module will switch to low power mode. Figure 4. It is the physical appearance of the touch sensor module TTP223B.

**Figure 4.** Capacitive Touch Sensor MPR121.

2.2 **System Specifications**

The design and realization of the system of "Smart Cane Using ESpectro with GPS Tracking System" have the following specifications:

- ESPectro with the ESP8266 chip as the main controller microcontroller.
- Ultrasonic HC-SR04 sensor for detecting obstacles.
- Indicators buzzer sounds voltage 3.3 Volt.
- TTP223B touch sensors are used as sensors when smart cane grip.
- GPS as the user's location signal transmitter.
- A Push button that serves as an emergency button to send SMS when the blind gets lost.
- SMS (Short Message Service) to provide news when the blind get lost in the form of text to the intended number.
- Makestro cloud, the cloud to store locations for visually impaired relatives to see the blind spot in real time.
- LiPo battery 3.7 V as a voltage source.
- Source code with C language for ESpectro board.

2.3 **Program Design**

When the condition of the smart cane is turned on, the system will immediately detect the distance so that at that time also will respond to value to the distance in accordance with the distance measured by the sensor. If the distance is detected more than 100 cm then the buzzer will not sound. However, if the distance is less than 100 cm is detected then the buzzer will sound. When the smart cane is detached and dropped then the buzzer will sound, it is useful for the visually impaired no trouble to look for smart cane when dropped or detached. For the GPS system used, the GPS module will continuously update the smart cane position and this data will be sent to the cloud so that the relatives can track the location in real time. If the blind person feels lost, the smart cane will automatically send an SMS requesting help by pressing the emergency button provided. This system has a block diagram that refers to Figure 5 and for simplicity, the system is full of flowcharts that can be seen in Figure. 6.
Figure 5. Block Diagram of Smart Cane Using ESPectro with GPS Tracking System.

![Block Diagram]

Figure 6. Flowchart of Smart Cane Using ESPectro with GPS Tracking System.

3. Results and Discussion

3.1. Research Results
Smart cane design was created for the visually impaired which is able to detect obstacles as shown in figure 7. The shape of the stick is made as a blind stick in general, with a white stick and red colours.

![Physical smart cane]

Figure 7. Physical smart cane.

The design of the casing or storage components and sensors used a black box with a plastic material and in this box had two push button such as one as the power on/off button to turn on the entire system.
of smart cane and one of the had the function to send emergency SMS if blind people feel lost and need help. Figure 8 was the photographs looked physical storage components and buttons on the smart cane.

![Figure 8. The black box to store the components and buttons on the smart cane.](image)

Smart grip cane shows the presence of copper in which copper is associated with the touch sensor. This is useful when the smart cane out of the grasp users automatically buzzer will sound. This meant that blind people have no trouble to find out the smart cane when falling.

3.2. Ultrasonic Sensor Testing

Ultrasonic sensor has been mounted on a black case on a smart cane bottom. These sensors are used to detect objects in front of the smart cane. The buzzer will automatically go off when the ultrasonic sensors to detect objects that are less than 50 cm in front of the smart cane.

Ultrasonic sensor HC-SR04 is used as a sensor that detects objects or obstacles in front of smart cane with a distance of less than 50 cm in front of the sensor then the buzzer will sound automatically. The difference in sound from a buzzer also depends on the distance of the object detected by the sensor. Can be seen in table 1 the results of ultrasonic sensor testing of objects that are in front of it.

| No. | Distance (cm) | Buzzer | Note |
|-----|---------------|--------|------|
| 1.  | 154           | Off    | Buzzer off because the distance is more than 50 cm |
| 2.  | 34            | On     | Buzzer on because the distance is less than 50 cm |
| 3.  | 46            | On     | Buzzer on because the distance is less than 50 cm |
| 4.  | 75            | Off    | Buzzer off because the distance is more than 50 cm |
| 5.  | 23            | On     | Buzzer on because the distance is less than 50 cm |
| 6.  | 134           | Off    | Buzzer off because the distance is more than 50 cm |
| 7.  | 200           | Off    | Buzzer off because the distance is more than 50 cm |
| 8.  | 78            | Off    | Buzzer off because the distance is more than 50 cm |
| 9.  | 80            | Off    | Buzzer off because the distance is more than 50 cm |
| 10. | 10            | On     | Buzzer on because the distance is less than 50 cm |
| 11. | 120           | Off    | Buzzer off because the distance is more than 50 cm |
| 12. | 22            | On     | Buzzer on because the distance is less than 50 cm |
| 13. | 35            | On     | Buzzer on because the distance is less than 50 cm |
| 14. | 12            | On     | Buzzer on because the distance is less than 50 cm |
| 15. | 25            | On     | Buzzer on because the distance is less than 50 cm |
| 16. | 150           | Off    | Buzzer off because the distance is more than 50 cm |
| 17. | 340           | Off    | Buzzer off because the distance is more than 50 cm |
| 18. | 42            | On     | Buzzer on because the distance is less than 50 cm |
| 19. | 200           | Off    | Buzzer off because the distance is more than 50 cm |
| 20. | 59            | Off    | Buzzer off because the distance is more than 50 cm |
From the test results of ultrasonic sensors that did, it can be seen that the ultrasonic sensors are successfully working as expected because when the obstacle is within a distance of less than 50 cm from the smart cane then the buzzer sounds, and if the obstacle is within a distance of more than 50 cm then the buzzer will not sound.

3.3. GPS Testing
At this stage of validation trials connection range and accuracy of GPS tracking using GPS + GPRS Thinker Ai A7 conducted at 2 different locations with each condition inside and outdoors. Table 2 is the result of data obtained while testing the validation range GPS connection.

| No | Location                  | Range       | Time Required          | Explanation |
|----|---------------------------|-------------|------------------------|-------------|
| 1. | Jl. Jatiwangi, Margaasih  | Affordable  | 7 minutes 40 seconds   | Outdoor     |
| 2. | Jl. Jatiwangi, Margaasih  | Affordable  | 10 minutes 18 seconds  | Indoor      |
| 3. | FPTK UPI                  | Affordable  | 13 minutes 23 seconds  | Outdoor     |
| 4. | FPTK UPI                  | Affordable  | 18 minutes 10 seconds  | Indoor      |

Can be seen in Table 2 test range GPS connection, that the time required by the module Ai Thinker GPS + GPRS A7 to obtain the latitude and longitude of data vary depending on location and signal strength are common in the area. To get the accuracy of data in areas with good signal strength, it takes less time compared to areas that have poor signal strength [9]. In addition, the factor of the carrier used in this module also greatly affect the speed of the module to get an accurate location [10].

3.4. Cloud Computing Testing
When testing cloud computing tools, long time required is equal to the current range of testing a GPS connection which can be seen in Table 2. This is because the program has been designed to automatically download data upload latitude and longitude of the position of the tool obtained by the module Ai Thinker GPS + GPRS A7 to the makestro smart cane cloud so that location can be viewed in real time. Figure 15 is a view of the makestro cloud while performing GPS tracking.

Figure 9. Display the makestro cloud when making GPS tracking.
3.5. SMS Testing
Emergency SMS testing is done by pressing the emergency button that is on the smart cane. Then, the module AI Thinker A7 GPS + GPRS will automatically send an SMS request for aid to a prearranged number on the program. As fast or SMS length can be up to the recipient depending on the signal strength in the smart cane and mobile receiver, other influencing factors also strongly influenced by the operator used. Figure 16 shows the contents of the SMS received requests for assistance. The content of the SMS is also can be set as desired.

4. Conclusions
Based on the study “Smart Cane Using ESPectro with GPS Tracking System” has been done, it can be concluded that this study develops a walker for the visually impaired in the form of a stick of intelligent (smart cane) that can detect obstacles in front of him by way of sounding the buzzer as a warning if the obstacle is less than 50 cm. Smart cane can help users when smart cane falls and loss of grip then automatically buzzer will sound to let users know where the smart cane because cane smart paired touch sensors. To help relatives trace the location of the blind in the blind, smart cane is using GPS as determining the location of which can be seen by relatives in real time in the makestro cloud.

Disadvantages owned by cane's smart of them if they are crowded place then the resulting sound less audible buzzer. Then, GPS is used require relatively little long time to get an accurate position of the smart cane because of many factors affecting among other things used in the module carrier and signal strength exists at that location.

Smart cane is still not perfect so that improvements are needed in order for the system have complex functional value. Some suggestions that could be developed include the use of technologies such as the use of cameras to record in front of the object can then inform the user through earphones and their waterproof features so smart cane can still be used even if it is in rainy conditions. GPS module development necessary to make the time to track the position can accurately be shorter than the previous one.
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