Smart Stick For the Blind Using Arduino

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Abstract. The development of technology requires the innovation of a device that can be used to help the blind as a road guide. This device is kind of the white cane to help blind people to scan their surroundings for obstacles or orientation marks. This device is equipped with an ultrasonic sensor, a water sensor, and a pulse heart sensor that will be mounted on a white cane to determine changes in the environment. Ultrasonic sensors are used to detect obstacles in front of it by utilizing ultrasonic wave reflection, water detection sensors to find out if there is a puddle or flooded ahead, and pulse heart sensors to monitor the condition of the user. It works, if there are obstacles and inundation conditions then the use of electronic modules such as the MP3 module is a component that plays an important role for the user, the use of the MP3 module is used to provide direction with sound output, while the GPS module to provide location information from the user.

1. Introduction

Eyes are organs of the visual system that can detect all the changes around the environment. Visually impaired persons have difficulty to interact and feel their environment. They have little contact with surroundings[1]. Physical movement is a challenge for visually impaired persons, because it can become tricky to distinguish where he is, and how to get where he wants to go from one place to another[2], they usually use their hearing senses for navigation assistance in their daily activities, but if they are only use the sense of hearing it will be dangerous for their safety, so it needed to develop an intelligent and smart stick to assist and alert visually impaired persons from obstacles and give information about their location. This blind stick is designed using a heart pulse sensor and various electronic modules that can be connected to the Android device of the closest relative. The use of pulse heart sensors will function as sensing the value of the pulse per minute, this aims to determine the condition of a person's body. Basically when humans are in a panic condition, the heart or pulse will beat more than the normal frequency, there are several things that will happen if someone experiences anxiety, as follows:

- Psychological symptoms: feelings of anxiety, bad premonitions, fear of their own thoughts, irritability, tension, anxiety, and shock.
- Disorders of sleep frequency and tense dreams.
- Impaired concentration and memory
- Somatic symptoms: pain in muscles and bones, heart palpitations, spasms, shortness of breath, indigestion, urinary disorders, humid cold hands.

The design of the device resembles as a general white cane. It is divided into 2 types, a long cane and folding cane. Long cane, designed primarily as a mobility tool used to detect obstacles in the path of a user. Cane length depends upon the height of a user, and traditionally extends from the floor to the user's sternum. It is the most well-known variant, though some organisations favor the use of much longer canes. Folding cane are a convenient way to take the cane anywhere to go. But, this stick type is not good, because the conductivity is less sensitive and less strong when used [3]. Sutarsi Suhaeb [1] was develop a smart cane for blind peoples using ultrasonic sensor, microcontroller ATmega 8535, buzzer, and Vibration DC Motor.
2. Methods
2.1 Ultrasonic Sensor HC-SR04
It is an ultrasonic sensor, also known as an ultrasonic transducer that is based on a transmitter and receiver and mainly used to determine the distance from the target object with the wavelength about 20kHz-20 MHz[8].

Figure 1. Ultrasonic Sensor HC-SR04
This sensor comes with a range between 2cm to 400cm and is used in a wide range of applications including speed and direction measurement, wireless charging, humidifiers, medical ultrasonography, sonar, burglar alarms, and non-destructive testing. It measures accurate distance using a non-contact technology – A technology that involves no physical contact between sensor and object. Transmitter and receiver are two main parts of the sensor where former converts an electrical signal to ultrasonic waves while later converts that ultrasonic signals back to electrical signals. It gives precise measurement details and comes with accuracy (resolution) around 3mm, terming there might be a slight difference in the calculated distance from the object and the actual distance. HC-SR04 contain 4 pins in total[6].

2.2 GPS UBLOX NEO-6M
GPS NEO-6M is one in a million GPS Module that one of GPS UBLOX Series. It can track up to 22 satellites on 50 channels and achieves the industry’s highest level of sensitivity i.e. -161 dB tracking, while consuming only 45mA supply current. Unlike other GPS modules, it can do up to 5 location updates a second with 2.5m Horizontal position accuracy. The u-blox 6 positioning engine also boasts a Time-To-First-Fix (TTFF) of under 1 second. One of the best features the chip provides is Power Save Mode(PSM). It allows a reduction in system power consumption by selectively switching parts of the receiver ON and OFF. This dramatically reduces power consumption of the module to just 11mA making it suitable for power sensitive applications like GPS wristwatch.

Figure 2. GPS UBLOX NEO-6M

2.3 Modul SIM8001
SIM800l is a GSM module that can be applied with Arduino or AVR as a sender or receiver of data which will be processed by an Android device or microcontroller. This SIM800l module has 16 pins, but what needs to be considered in providing voltage must be using a DC to DC step down module, with the required voltage of 4.6 volts so that the components on the SIM800l can work properly and not damage to the other components [8]. If the indicator lights turn on quickly it can be concluded that the SIM800l has not received a GSM signal, but if the indicator light flashes slowly indicating that the SIM800l has received a signal and is ready to use.
2.4 System Architecture

The design of the electronics for an intelligent and smart cane as seen in Figure 4.

In Figure 4, the electronic circuit design can be seen that the wiring of the supporting components of the blind stick is as follows:

1. Ultrasonic Sensor
2. Pulse heart sensor
3. GPS Neo6 module
4. GSM SIM800L module
5. MP3 module
6. Emergency button
7. Water sensor

2.5 Prototype

Smart white cane is design as shown in Figure 5. The stick uses three sensors mounted on the stick so that it will assist in carrying out daily activities. The ultrasonic sensor is mounted at 85° position, it aims to make the position of ultrasonic sensor will be in a straight position to the detection of objects in front of it, the water detector is placed at the front end of the stick which aims to detect whether the road to be inundated by water or not and it connected to the speaker / buzzer.

Figure 3. Modul SIM8001

Figure 4. Prototype
The emergency button at the top aims to facilitate the user when in dangerous conditions, the GPS module will provide coordinates to the GSM module and later it will be forwarded to the android device, the installation of the pulse hart sensor at the top aims to read the heartbeat of the user so the heart rate can be known that the user condition.

Overall system testing involves all components in the smart stick system that has been well integrated, to find out all the components have worked we can see the results of reading all components on the serial monitor such as ultrasonic sensors, water detection sensors, heart rate sensors, GSM modules, DFplayer and SIM800l modules. In this test declared successful if the sound output can be heard and can send a short message SMS coordinate point to the destination number, here is the system test results data. The initial step of testing is by providing a voltage source for the smart stick using a USB cable connected to the laptop. When the smart stick has got a voltage source, the next step is to upload the program with the help of the Arduino Sketch software. Next, do a test run on the water detection sensor by dipping the tip of the level until it is submerged in water, if the sensor detects a pool of water it will produce a sound output that says "in front of you there is a puddle of water, immediately pull over", the process of testing the water detection sensor is like shown in Figure 7.

Next test the heart rate sensor by placing a finger on the heart rate sensor, so that it will be detected by the BMP value sensor, if the BMP value is achieved it will produce a sound output "you are tired, rest for a while ". The next process is to test the Emergency button, when the button is pressed it will send a GPS coordinate point, if the message received has no coordinates (coordinate point 0) then wait for a while until the GPS module is connected to the satellite, then press the Emergency button again to send SMS reset ".

Figure 4.1. The final result
Furthermore, tests on an ultrasonic sensor as a barrier and obstacles object detector, in this test the sensor can detect objects with a distance of 1-180 cm divided by 2 classifications, the first distance is 1-90 cm if the ultrasonic sensor detects an object then the sound output produced is "The object is getting closer, immediately pulled over" and with a distance of 90-180 cm, if the ultrasonic sensor detects the object then the sound output produced is "in front of you there is an object immediately pulled over". The overall system test results prove that the smart white cane can works properly, but the detection of the heart rate sensor is less precise, because the heart rate sensor uses light, which is the amount of reflected light reduces the amount of light absorbed by the body, so that the detection of the sensor changes significantly when the finger position moves.

3. Conclusion
After several trials of the system on the smart white cane, it can be concluded that:

1. The process of detecting objects using ultrasonic sensors works well and stable by having two distance conditions, 1-90 cm and 90-180 cm.
2. The maximum distance of object detection on a smart stick reaches 200cm
3. The process of connecting the neo6 m GPS module to a satellite requires a considerable time of about 5 minutes, especially if the GPS module is in a confined space.
4. SIM800l modules must monitor the voltage used, on this smart stick using an Arduino 5v voltage. less than the specified voltage, the process of capturing GSM signals by SIM800l will be lost signal (no signal).
5. The use of amplifier modules in the DFplayer circuit can minimize the IC burning in the DFplayer module during long-term use.
6. pulse heart sensor is less stable. This is caused by the working principle of the pulse heart sensor using light, in other words the sensor is sensitive to changes in the intensity of the light it receives, so it affects the sensor detection
7. The time for sending an SMS is about 6-10 seconds after press the Emergency button.

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