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Smart Electronic Travel Stick for the Visually Challenged

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Abstract Science and technology has always played a prominent role in comforting human lives. The main objective of this work is based on mollifying the disabilities of blindness by creating a microcontroller based automated hardware that can ratify a visually impaired person to detect obstacles in front of him/her instantly and guide him/her in a proper way to reach his/her destination. The hardware consists of a microcontroller integrated with Arduino Uno board, microcontroller, ultrasonic sensor, GPS module, GSM module, serial driver, buzzer, LED and other additional equipments. It acts as a better navigational tool for the visually impaired. The sensors used in this model provide information about the outside environment. GPS Technology is integrated with pre-programmed locations and it is sent to the desired number through GSM module when required. This presents a design and a system concept to provide smart electronic aid for blind people. The aim of the overall system is to produce an economic and productive navigation aid for the visually challenged which can give them a sense of artificial vision and object detection by providing information about the environmental scenario of static and dynamic objects around them. Ultrasonic sensors are used to detect obstacles from a distance so as to guide the blind perso in the right path.

Keywords: *Arduino Uno, Ultrasonic Sensor, GPS module, GSM module*

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1. Introduction

The project work proposed the design of an innovative and novel concept of a smart electronic guiding stick for the visually challenged. The main advantage of this system is that it can prove to be a very economical solution to millions of blind people throughout the world. The proposed combination of various units makes a real-time system that monitors position of the user and accordingly helps in the navigation process. In order to help the visually challenged people, a study to help them has been proposed which hypothesizes a smart walking stick that alerts visually impaired people over obstacles, pit and water in front of them thereby reducing the probability of accidents. And when they face any unfavourable situation, it has separate module to inform their near and dear ones.

2. Product Description

2.1. Function Tree

The function tree designed above is the SOP diagram that describes the operation of each individual unit by means of individual performances. The main goal of our prototype is to detect obstacle within a certain distance. This objective can be achieved by correlating all the individual units with each other. The entire prototype was first divided into its respective units which were responsible for the working of the product. Like we have shown in the above diagram, the main units of functionality are: providing power supply, sensing high frequency waves, carrying out navigation, controlling unit and MODEM.

The two main constraints of power supply are USB connection from any external source and battery. By any of these two means, we can provide supply to the unit. The sensing of the obstacle is done by transmitting high frequency sonar waves, calculating the time interval between two respective triggers and determining the distance. Thus, the navigation process can be carried out. The controlling unit gathers all the information regarding the working prototype and alert in case of failure. The modem unit is responsible for providing message service to the user in case of emergency as it is interfaced with the GPS tracker that continuously retrieves data from the satellites.

Hence, the above SOP diagram is an effective step towards understanding the functional specification of each individual module as it separates first each module from each other and then it makes us realize why and how these modules are being used by considering the modules as an individual unit.

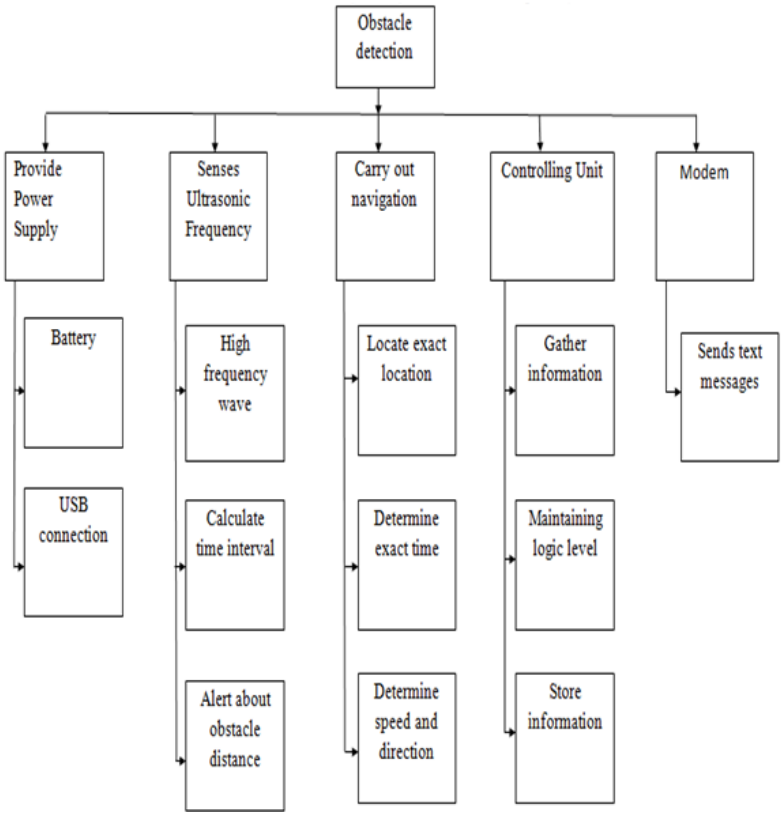

Figure 1. Function Tree (Substract and Operate Method)

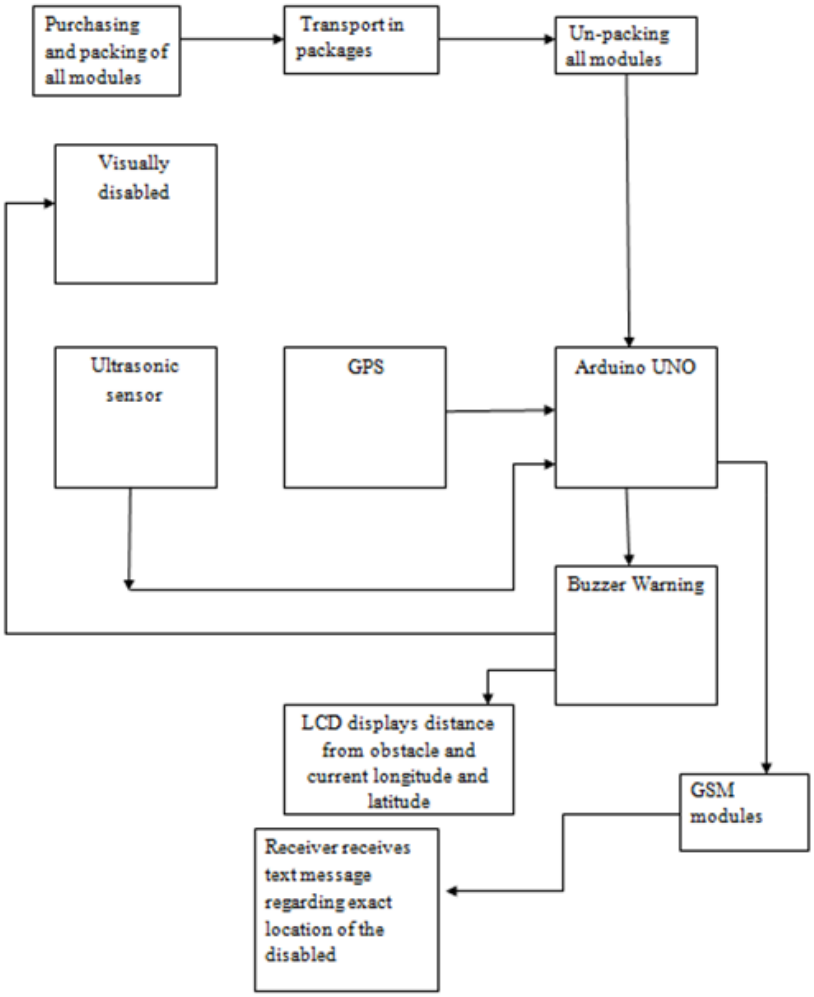

Figure 2. Energy Flow Diagram

2.2. Energy Flow Diagram

The last step towards observing the functional decomposition was the energy diagram. It actually states the role of each unit from the beginning of the design till the end. As shown in the figure, the arrival of each unit begins with purchasing of each module. Then it was transported and unpacked. Then came the task of specifying all the individual modules and the pre-requisite knowledge regarding all the modules were gathered. The blueprint was made how to perform the desired task.

As shown in the figure, the Arduino Uno is the heart of the system as all the individual units are interfaced with the Arduino. The ultrasonic sensor and the GPS unit act as the input to the Arduino as it gives the obstacle information and user information respectively. The LCD, GSM unit and the buzzer unit basically are the outputs from the Arduino. The buzzer unit alerts the user regarding the obstacle; the GSM unit provides message service to the dear ones of the user in case of emergency or failure.

The energy diagram can be one of the suitable methods for observing the functional decomposition of the product as it demonstrates the presence of each module starting from its arrival till the service is served to the user and it describes how the modules are interlinked with each other and work together to achieve the desired goal.

2.3. Rough Diagram

Before deducing the actual prototype physically, we went for a rough structure of how the prototype would look like. Besides looking good, it also fulfilled all the mathematical equations of center of mass so that the product would be a stable one.

3. Technical Feasibility

The main objective i.e. detection of either a stationary or a moving obstacle is done with the help of Ultrasonic sensor. Hence, we must need to know the working principle of ultrasonic sensor. We need to understand how ultrasonic waves are transmitted and regained back at receiver.

Step 1: We need to supply a short 10uS pulse to the trigger input to start the ranging, and then the module will send out an 8 cycle burst of ultrasound at 40 kHz and raise its echo.

Step 2: The Echo is a distance object that is pulse width and the range in proportion .The range can be calculated through the time interval between sending trigger signal and receiving echo signal.

Formula: uS / 58 = centimeters or uS / 148 =inch

Range = high level time * velocity (340M/S) / 2.

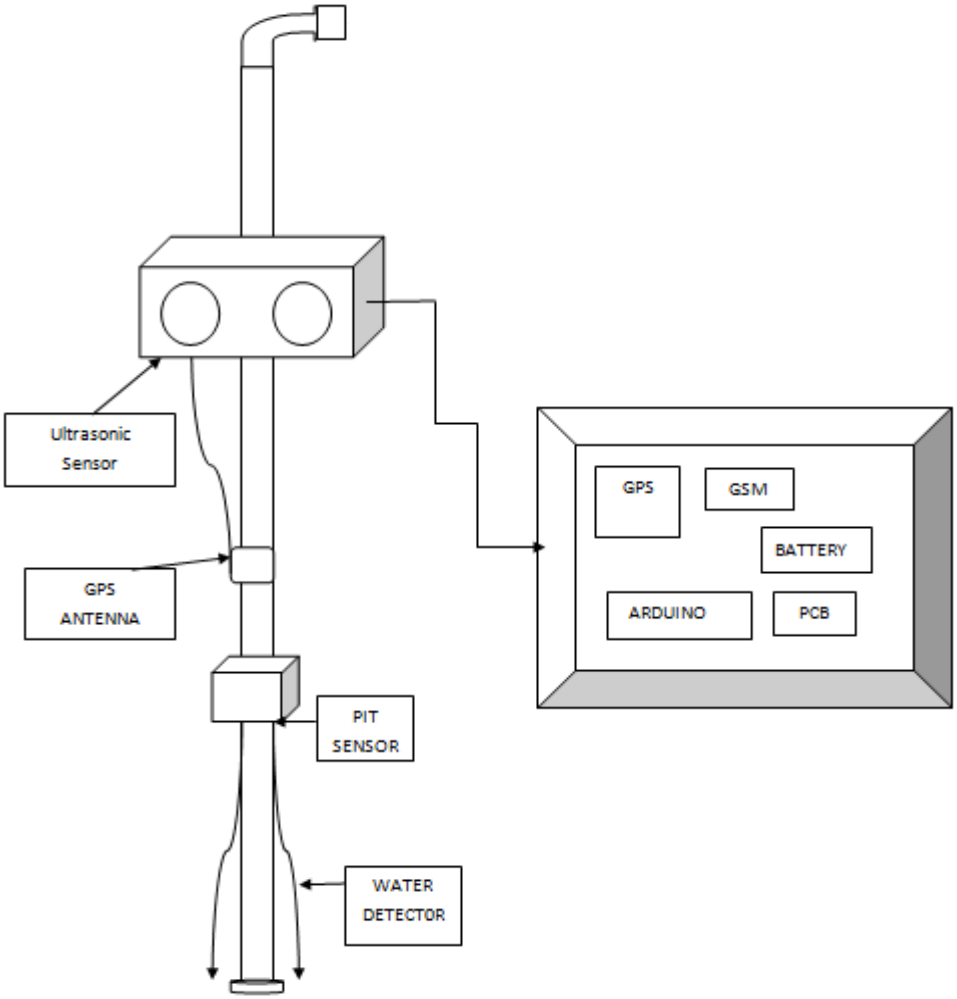

Figure 3. A rough sketch of the final product

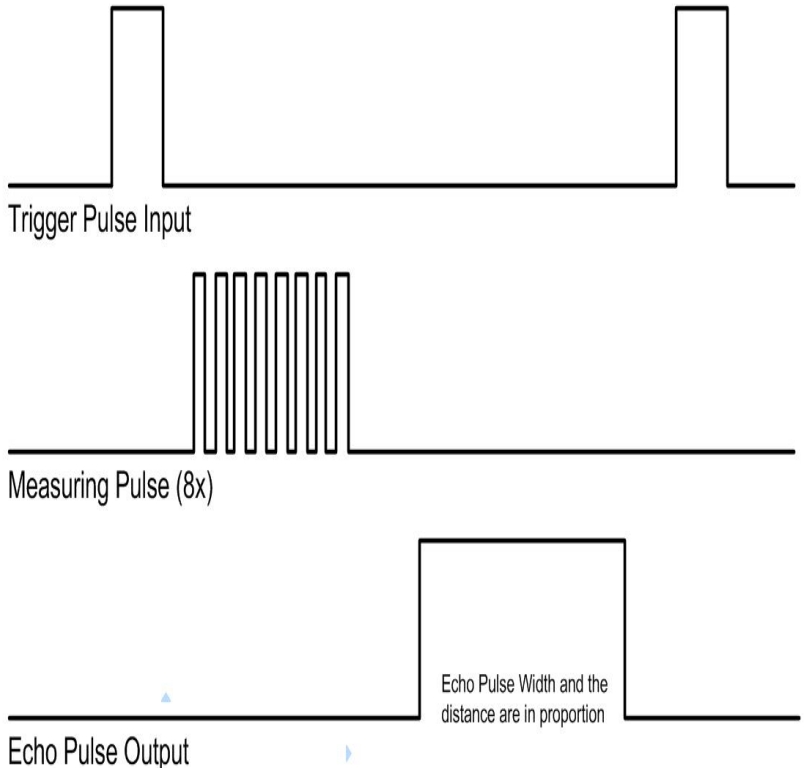

Figure 4. Timing Diagram to explain the working of an Ultrasonic sensor [3]

Step 3: It is suggested to use over 60ms measurement cycle, in order to prevent trigger signal to the echo signal.

4. Final Product

In the prototype that we have designed, the brain of the system is Arduino Uno. Modules like GSM Module, GPS module, ultrasonic sensor and water sensor are interfaced with the Arduino. 12 volts battery supply is provided. After getting the supply, the circuitry elements get on. The ultrasonic sensor triggers a SONAR wave within a distance of 3 meters. It continues its search for obstacles. At the same time, the GPS module continuously retrieves data regarding the location from the satellites. If an obstacle is detected, then the Arduino commands the buzzer unit to beep so as to alert the user. It beeps for 3 seconds. If the user is not concerned ,then the codes are written in such a manner that the near person of the user will get a short message service. A water sensor is also present there that detects the presence of water on road and alerts the user by beeping the buzzer connected with it.

The components were first divided into some modules such as the power supply, GSM unit, GPS unit, microcontroller and lcd interfacing. The modules were first designed individually as per the circuit diagram. We used a pointed circuit board, pushed the resistors, regulators, diodes, capacitors etc into it and using the aluminium wire and with the help of the shouldering iron, we shouldered the parts.

After the modules were designed on the pointed circuit board now they had to be connected to each other. These connections were based on circuit diagrams. The individual modules were then connected using rainbow wires for more of clarification about the connection.

5. Suggested Improvements

- Increasing the range of the ultrasonic sensor and implementing a technology for determining the speed of approaching obstacles.
  The sensor that we are using can detect obstacle up to 30 cm range. But for moving obstacles 30 cm range is quite problematic. So, the range of the ultrasonic sensor should be increased at least up to 3 meters.
- Using an additional IR proximity sensor
  The ultrasonic sensor that we are using is absorbent by many materials like rubber, plastic. In that instance, we can go for an IR sensor for precise navigation and obstacle detection.
- Using the GPS along with GSM and voice kit
  Instead of using individual module we can go for GSM, GPS in a single module. We can use voice kit for informing the user about his/her current location.
- Provision for voice control using speech recognition
  Speech recognition methods can be used so as to provide easier user accessibility to the operator. In this instance, frequently visited places are stored in a database module and it is linked with the Arduino so that the user can go to the desired location by simply saying its name.
- Synchronization with various navigation software applications available on the internet so that new, un-programmed destinations can also be chosen.
  Various navigation software are being developed for better navigation of the user. It can be done in such a way that un-programmed places can be reached.
- Opportunity of using pulse sensor (IoT)
  Pulse sensor can be used for solving the safety issue of the user such as in any instance if the user gets

panic or in case of any unhealthy circumstances, the user can automatically inform his/her dear ones with message service or via call.

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