The ASVI - Assistance System for Visually Impaired

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Abstract: The ASVI- Assistance system for visually impaired incorporates the use of a mobile robot obstacle avoidance system as an assisting device for the visually impaired. During operation the mobile robot moves in front of the user at a prefixed distance and guides the user through auditory signals. Just as electronic signals are sent to a mobile robot's motion control system, auditory signals can guide the visually impaired around the obstacle. An Android phone is used to provide the direction to the destination from the current location of the user. The user can steer the mobile robot to the desired direction as per the navigation from the phone manually with the help of a hand held joystick. The robot's obstacle avoidance system will steer the robot avoiding obstacles safely.

Keywords: Visually Impaired, Ultrasonic Sensor, Infrared Sensor, Assistance System for visually impaired (ASVI), Arduino.

Introduction

The term blindness is used for complete or nearly complete vision loss. Visual impairment may cause people difficulties with normal daily activities such as driving, reading, socializing, and walking. People with complete blindness or low vision often have a difficult time self-navigating outside well-known environments. In fact, physical movement is one of the biggest challenges for the visually impaired. Because of this, many people with low vision bring a sighted friend or a trained guide dog to help navigate unknown environments.

There are various tools that have been developed for the visually impaired. IDog [1], the Guide dogs provide the impaired person with the highest degree of mobility and independence, but require expensive training and selective breeding. Navbelt [2], provides information not only about obstacles along the traveled path, but also assists the user in selecting the preferred travel path. The Navbelt consists of a belt, a portable computer, and ultrasonic sensors.

Guidecane [3], the GuideCane during operation, the user pushes the lightweight GuideCane forward. When the GuideCane's ultrasonic sensors detect an obstacle, the embedded computer determines a suitable direction of motion that steers the GuideCane and the user around it. The steering action results in a very noticeable force felt in the handle, which easily guides the user without any conscious effort on his/her part. RGB-D camera [4], instead of using several sensors, a consumer RGBD camera is used to take advantage of range and visual information. In particular, the main contribution is the combination of. It constitutes of a camera that hangs from the user's neck, and a laptop carried in a backpack. ROVI-[5], in this system, the white cane is attached to a mobile platform which will has an array of sensors used to detect obstacles. The mobile robot will be given a predefined target to move. The sensors will always look for any obstacles along the path. It will avoid by an angle once the obstacle is detected. The deflection from original path due to presence of obstacle will be controlled by microcontroller. It will also provide instruction to the wheels to return to the original path once the obstacle has been avoided. The feedback signals from the optical encoders attached to the wheels are important to determine the distance travelled by the wheels.

Almost all the existing systems incorporate high performance microprocessors or mini computers or even laptops to process the input. This increases the cost involved in the project. Also most of the existing systems can only navigate the user to a prefixed target.

Proposed System

The proposed system works on the similar principle as the guide stick [6] concept. But instead of the user holding the stick connected to the robot, the user will have a joystick in his hand, to steer the robot moving in front of him at a particular distance. The proposed system can navigate the user to any location and also detect potholes and prevent the user from tripping over. When an obstacle is encountered, the robot will move around the obstacle and emit sound signals that will guide the user around the obstacle [7].

It is observed that for visually impaired people to navigate the shape of the obstacle does not matter, instead the user just wants to move around the obstacle. As the robot moves by its own, unlike the guide cane concept the user will also be warned about potholes, thereby increasing the safety of the user.

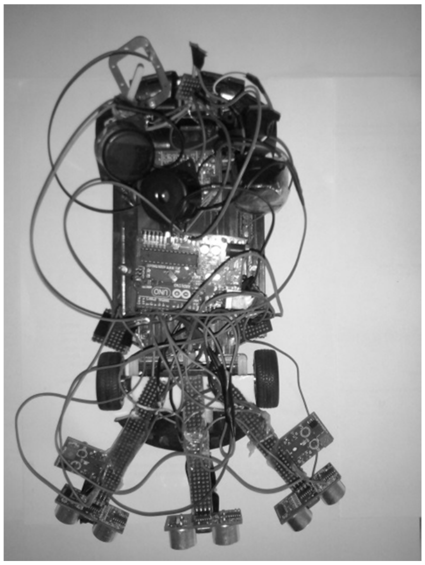

Fig 1. ASVI Prototype

Since audio signals are used to steer the user around the obstacle, the navigation is more precise than the various existing systems in which there are chances that the user brushes past the obstacle [8]. As the robot moves at a distance from the user, there is always a minimum distance between the user and the obstacle. As the robot can be controlled by a joystick, the user can steer the robot to any particular direction depending on the navigation from an android phone if necessary. The proposed system consists of an Arduino board, ultrasonic sensors, infrared sensors, potentiometer, motor driver IC, DC Motors, buzzers.

The Arduino board has a processing speed of 16 MHz. This processing speed is enough for processing the data received from the ultrasonic as well as infrared sensors. The Arduino needs a 5V supply to work.

The ultrasonic sensor used is HCSR04. It has 4 pins +VCC, GND, Trig, Echo. The trigger pin of the ultrasonic sensor must be made high for 10 microseconds for the ultrasonic sensor to be triggered. The transmitted ultrasonic signal reflects back after striking an object if present. The frequency of the pulses reflected by the object and detected by the receiver is recorded. This is used to calculate the distance of the sensor from the obstacle. The number of pulses detected by the detector when divided by 58.2 gives the distance of the object from the sensor in centimeters. In our proposed system the ultrasonic sensors are used to detect the obstacles in front of the user. These ultrasonic sensors will give the distance data to be processed, to the Arduino. The Arduino calculates the distance in cm. The program in the Arduino is such that when the distance is below a particular threshold, the necessary commands to steer the robot away from the obstacle is executed.

The infrared sensor also has a transmitter and receiver. It has 3 pins, +VCC, GND, Signal pin. If the transmitted beam is received, then signal pin is high, else low. The infrared sensor is generally used in a line follower robot. But the infra red rays are also reflected by a smooth non black floor surface. So this property of the infrared sensor is used to detect the presence of potholes. In the absence of the surface ie: in the presence of a pothole, the transmitted ray will not be reflected back, thereby setting the signal pin low. The user must be allowed to move only if the surface if the surface is flat for the reason of safety. So the checking of the presence of the pothole is set as the first condition. Only if the infrared sensor is high then the rest of the program is executed. Else the stop command is executed.

The system uses 2 DC Motors. One for the forward and backward movement and another for the left, right movement of the robotic system. The motors are driven by a motor driver IC L293D.The robotic system can manually steered depending on the users need, and also is automatically steered in the presence of an obstacle.

Triggering the sensors

The ultrasonic sensor send a sound wave only if the trigger pin is made high for a duration of 10 micro second. So in order to trigger the ultrasonic sensor, the triggerport should be made high accurately for a duration of 10 micro seconds. The infrared sensors do not need any trigger.

Obtaining data from sensor

Both the ultrasonic sensors as well as the infrared sensors work by the echo principle. The sent wave is reflected back from an obstacle. The infrared sensor receives the sent signal in the presence of an obstacle and the range can be adjusted by a

potentiometer. So the input from an infrared module is either Logic 0 in the absence of the obstacle or a Logic 1 in the presence of an obstacle.
The ultrasonic sensor's echo pin gets the reflected wave in pulses. So the frequency of the pulse varies with the distance. If the distance is far, then the frequency of echo pulses is less and vice versa.To calculate the distance in cm, the duration of the pulses is measured and divided by 58.2 .

Working with the input from Sensors
The infrared sensors produce only 2 types of outputs either logic 1 or 0. But the ultrasonic sensors distance has range of upto 400cm. So ultrasonic sensors distance must be calculated and a prefixed distance must be set, below which the necessary action must be taken.
This project uses ultrasonic sensors and infrared sensors instead of an RGB-D camera or stereo camera to navigate the visually impaired person. This change in design reduces the cost of the system and also does not need a high performance processor.
The robot can be manually steered by a joystick shown in Fig 3 to enable the user to be navigated to a desired location using the help of voice navigation from an android phone. The proposed system uses an Arduino board, L293D motor driver IC, DC motors, logic gates, HC-SR04 ultrasonic sensors and infrared sensors.

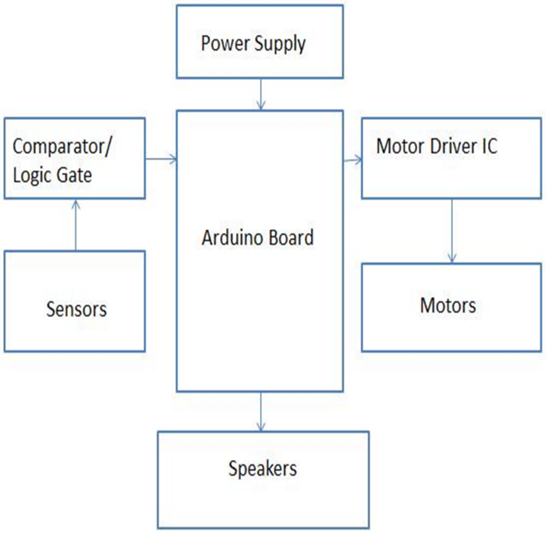

Fig 2. Block Diagram of the proposed system

Fig 3. Joystick module

Performance Analysis
A performance analysis was conducted and it was found that, since auditory guidance is used, the precision with which the user navigates around the obstacle is much higher than in the existing systems using physical guidance. Also since the robot moves at a distance from the user and the ultrasonic sensor's range is high, the user always maintains a safe distance from the obstacle. It was found that the robot cannot detect vehicular movement, therefore it is not to be used in environments with

vehicular traffic. It can be used in environments where there is a special walk way or pavement for walking. Since the robot has infrared sensors, any pothole can also be detected and the user can be steered around it. The robot cannot tackle staircases. The training time required is minimal. The user just needs to become familiar with the sounds emitted and the amount he should turn.

If there was a walkway and a predefined map of the environment then the robot can be programmed more efficiently taking into consideration the road crossings etc. The area covered by the sensors is shown in Fig 4. Even though the area covered is lesser compared to the existing designs, it is ensured that the path the user will take behind the robot will be obstacle free. Fig 5 is a screen shot of the serial monitor feature in the Arduino software. This feature helps us to observe calculated distance value by the ultrasonic sensor data. This also helps us in calculating the error with the actual distance value.

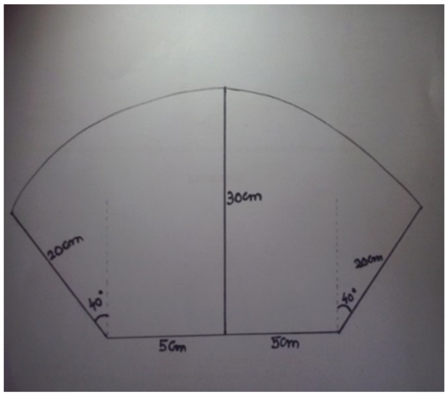

Fig 4. Area covered by sensors

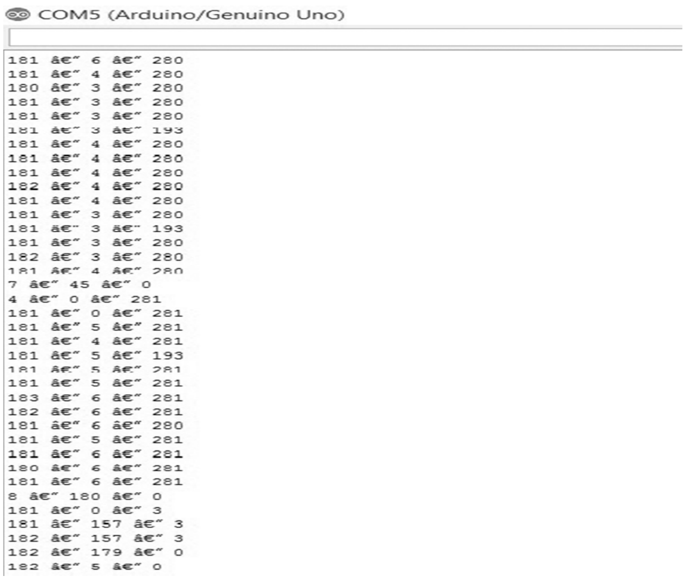

Fig 5. Sample Output in Serial Monitor

Conclusion

The ASVI works using the similar hardware as compared to the existing systems, but the brain of the system is just an Arduino. The ASVI offers solution to a few shortcomings

- ASVI can be steered manually so, the flexibility of usage is increased, which is absent in the pre-existing systems.
- ASVI can also detect potholes thereby increasing the safety of the user.
- ASVI does not need a laptop or a high specification microprocessor for processing the inputs, thereby reducing the cost
- ASVI uses sound guidance which is more accurate than other forms of physical guidance.

ASVI can be further developed by incorporating an inbuilt GPS navigation system, so the user can concentrate more on the robots voice assistance rather than the robot's and the phones navigation. ASVI can also be designed to detect staircases.

References

[1] Georgios Galatas, Christopher McMurrough, Gian Luca Mariottini*, FilliaMakedon “iDog : An Assistive-Guide Robot for the Visually Impaired” 2011

[2] ShragaShoval, Johann Borenstein, and YoramKoren “Auditory Guidance with the Navbelt—A Computerized Travel Aid for the Blind” IEEE transactions on systems , manand cybernetics—Part C: Applications and review VOL. 28, NO. 3, August 1998

[3] Iwan Ulrich and Johann Borenstein “The GuideCane—Applying Mobile Robot Technologies to Assist the Visually Impaired” IEEE transactions on systems ,manand cybernetics—Part C: Applications and review VOL. 31, NO. 2, March 2001

[4] A. Aladrén, G. López-Nicolás, Member, IEEE, Luis Puig, and Josechu J. Guerrero, Member, IEEE “Navigation Assistance for the Visually Impaired Using RGB-D Sensor With Range Expansion” IEEE systems journal 2014

[5] Navigation A. Allan Melvin, B. Prabu, R. Nagarajan , Bukhari Illias “ROVI: A Robot for Visually Impaired for Collision- Free” Proceedings of the International Conference on Man-Machine Systems 2009

[6] Sung Jae Kang', Young Ho, Kim', In HyukMoon ”Development of an Intelligent Guide-Stick for the Blind”Proceedings of the 2001 IEEE Seoul, Korea. May 21-26, 2001 International Conference on Robotics 8, Automation

[7] Edwige PISSALOUX “A Characterization of Vision Systems for Blind People Mobility”. IEEE SMC 2002

[8] Jack M loomis, Reginald G Golledge, Roberta L Klatzky ”Navigation System for the Blind: Auditory Display Modes and Guidance” Presence, Vol. 7, No. 2, April 1998, 193–203 MIT