Obstacle Avoidance and Location Indication System for the Visually Impaired Person

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Abstract — This paper presents a theoretical model with a system providing an assistive guided robot for a visually impaired person. The overall operation of this system works together with OBJECT DETECTION and LOCATION DETECTION. The robot consists of two parts - the HOUSING: is composed of five units: Main Unit (Arduino) , the Obstacle Detection And Avoidance Unit (Ultrasonic Sensors) and the Location Detection Unit (GPS , GSM , and micro SD card adapter); and the HANDLE: is equipped with a Thumb-Controlled Joystick to control the robot and also provides significant force feedback to the hand of the user to help guide their path.

Keywords — Arduino, GSM , GPS , Micro SD card Adapter , Thumb-Controlled Joystick , Ultrasonic Sensors

I. INTRODUCTION

Visually impaired refers to the group of people who are lack of the ability of visual perception. There is a significant impact on their mobility due to this deficiency. This project proposes an assistive-guide robot to help the visually impaired person to travel safely to any unknown environments and to find the location of the blind person using Global System for Mobile communications (GSM) and Global Positioning System (GPS). By using this system, the user can travel anywhere with confidence and independence.

The system is divided into two parts: Objection Detection and Location Detection. In object detection, the robot algorithm is divided into two parts: user control and avoidance unit. User control algorithm applies when no obstacle is detected. The user is able to control the speed and orientation of the robot using the thumb-controlled joystick integrated in the handle. Obstacle avoidance algorithm applies when obstacle is detected.

Throughout the project, an assistive-guide robot that operates for object detection and location detection is designed. During object detection, the robot will avoid any disturbance in its path automatically and it will be mainly controlled by the user control system most of the time. Using location detection system, the control center can easily know where the user will be at any time. Ultrasonic sensors are implemented for obstacles detections. Thumb-controlled joystick will be used to input the user command. Motor driver shield and DC motors are used for the movements of the robot.

Location Detection System is interfaced to the controller to detect the blind person's location. The GPS module sends the location information to the controller continuously. The same data is routed to the GSM modem through the controller. GSM module forwards this information to the predefined mobile number in the Centre after receiving the message. If the person from the Centre wants to know the location of the blind person, he just has to send one message like " INFORM " immediately and he will get the blind person's location coordinates. Moreover, data from GPS is saved in SD card , so that the traveled path of the user can be tracked down easily.

II. SYSTEM DESIGN

Arduino is used as a main board of the robot , which is interfaced with all the components used for the robot. The components used for Object Detection are : thumb-controlled joystick for user control , ultrasonic sensors for obstacle avoidance , speaker for warning alert , and motor driver module with two DC motors for speed and orientation.

Fig 1.An Assistive Guided Robot System

In order to operate location detection system, GPS , GSM and Micro SD card adapter are needed.

III. SOFTWARE DESIGN

As soon as the system starts, the distances are acquired from each sensor, and if the distance from the front sensor is less than or equal the 60 cm that is assigned, the obstacle avoidance will be performed. If not, the user will continuously control the assistive robot using thumb-controlled joystick.

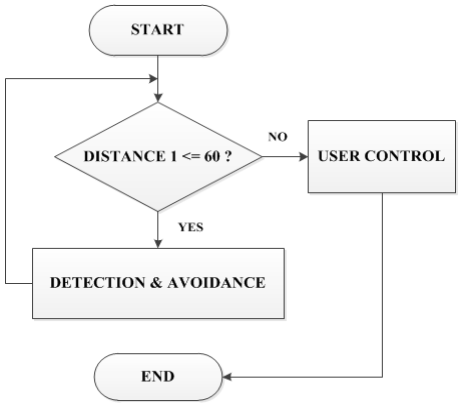


Fig 2. Overall Flow Chart of Object Detection System

Whenever no obstacle is found, the system will be in standby mode and controlled by the user. In order to decide the direction which user desires, firstly it is needed to read the x- and y- direction input data from the joystick. Based on those data , when the input data is from the x-direction , the robot moves forward if the x-value is less than the assigned value '100' , elsewise it moves backward if that value is greater than '140'. In the case of the y-direction, the robot turns right if the y-value is less than '100'. If not, it turns left when that value is greater than '140'.

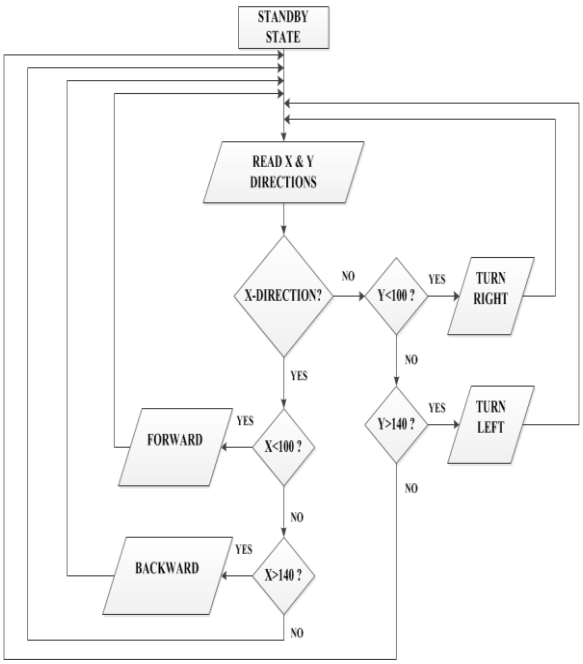


Fig 3. Flow Chart of User Control

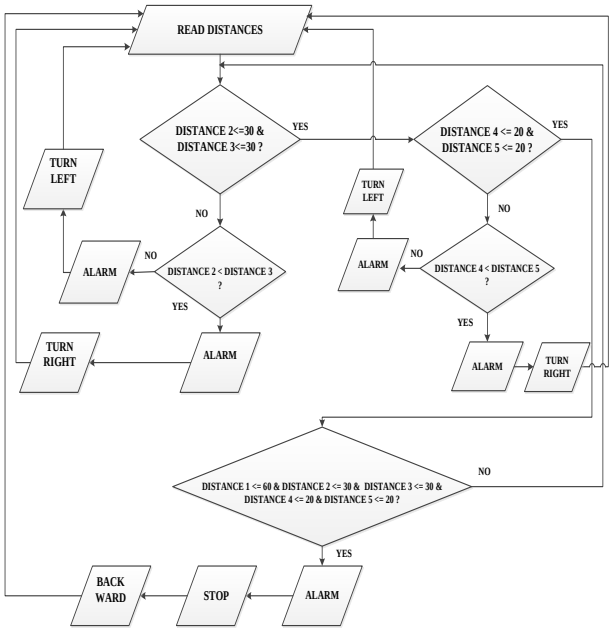
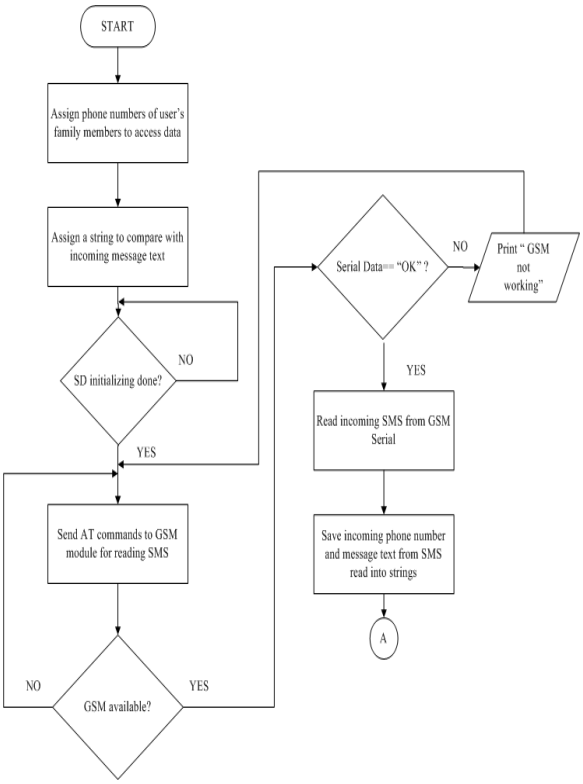


Fig 4. Flow Chart of Obstacle Avoidance

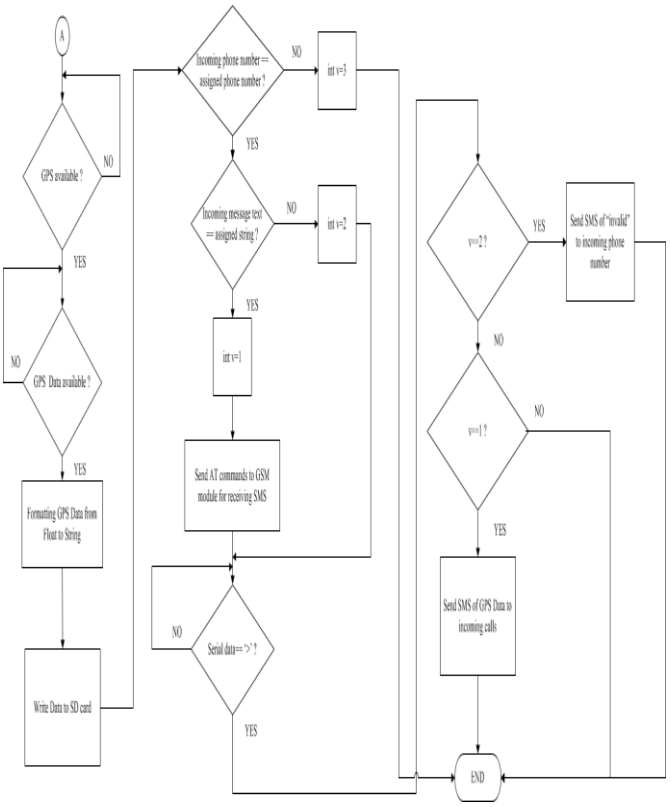
Whenever the obstacle is detected, according to the data, the distances of the two 45 degrees sensors are compared whether less than or equal to the 30 cm limit. If the condition does not satisfy, those two distances will be compared each other in order to turn to the direction with the larger distance. If the distance2 is larger than distance3, the robot will turn left. Otherwise, it will turn right. But when the condition meets, the distances of the two 180 degrees sensors are compared whether less than or equal to the 20 cm limit. If the condition does not satisfy, whether turning left or right is decided by the same routine as it does in the 45 degrees sensors. If all distances from the sensors are less than or equal to the assigned limits, at first, the robot will stop immediately and then, go backward until it finds its path without obstacle. After every condition, the system will update the data of the distance ranging.



(a)

First of all, phone numbers of user's guardian or family members are assigned in the program. Also a particular message is assigned as string type to compare with incoming message text. As long as initializing SD module has not done yet , the program keeps on checking whether initializing is done or not . After that, to initialize GSM module , it is needed to send AT commands to it. If done , we need to figure out GSM's availability . If it is available, the data from serial is checked whether equal to "OK" or not. If not, the AT commands are sent again since GSM is not working. When "OK" is return, incoming SMS is read. Then, incoming phone number and message text are separately saved as string. After that, checking GPS satellite and data availability is needed to be done. That data is formatted into string type when the data is received. After that, the formatted data is saved into SD card in order to show the traveled path. Next, the resemblance of the incoming and assigned phone number is verified. If it is not the same, integer variable is set as value 3. In the case of resemblance, incoming and assigned message texts are checked equal again. If no difference is found, variable value is set as 1. If not, it is set as 2.

After that, AT commands are sent to GSM for sending SMS. Then, it is needed to check until ">" is included in data.



(b)

Fig 5. Flow Chart For Location Detection

Finally, sending whether the location information or "invalid" to incoming phone number is decided according to the assigned value of above variable.

IV. HARDWARE DESIGN

In figure 6, the ultrasonic sensors are served as the main components for the obstacle detection. The trigger and echo pins of the sensors are connected to the digital output pins of the arduino. The PWM output ports of the arduino are connected to the trigger pins and the echo pins are connected to the digital ports .As long as no obstacle is found, this assistive robot is manually controlled by the user. It sends two inputs which are X-axis and Y-axis from the joystick. They are connected to the analog pins. The sensors and joystick are operated at 5V. The PWM pins 5 and 6 for inputs 1 and 3 of motor driver shield. For the inputs 2 and 4, the digital ports 34 and 36 are used. 5V is applied to operate motor driver, and then 12V is supplied through the shield to the DC motors.

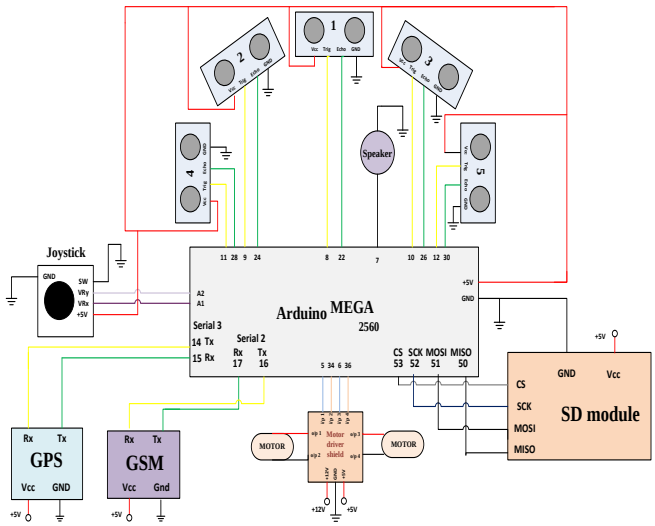


Fig 6. Block Diagram for Combination of Object Detection and Location Detection Systems

As it can be seen in figure 6,the GSM and GPS modules are interfaced to the arduino board with the respective hardware serial ports. Each pair of Tx and Rx pins on both modules are reversely connected to those corresponding hardware serial pins on Mega. Pins of SD card adapter are assigned to the SPI pins of the arduino board. All of these modules are operated at 5V supply.

V. IMPLEMENTATION

In the robot's housing , there are two layers. The upper layer is equipped with the components of location detection and the another one is with those of object detection.

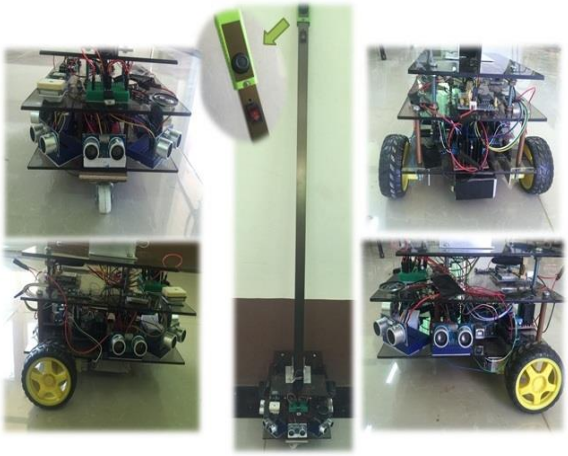


Fig 7. Implementation of an assistive robot

The power switch and thumb-controlled joystick are implemented in the handle of the robot.

VI. TESTS AND RESULTS

The robot performs the user control until obstacle is found. Otherwise, the obstacle avoidance behavior is performed by the robot itself. The tested result from serial monitor of the user control and obstacle avoidance is shown in figure 8.

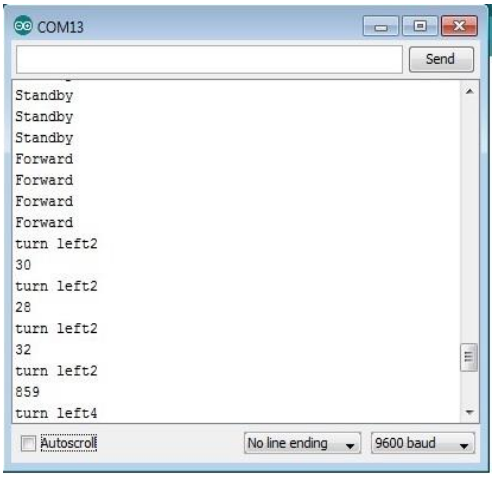


Fig 8. Object detection result from serial monitor

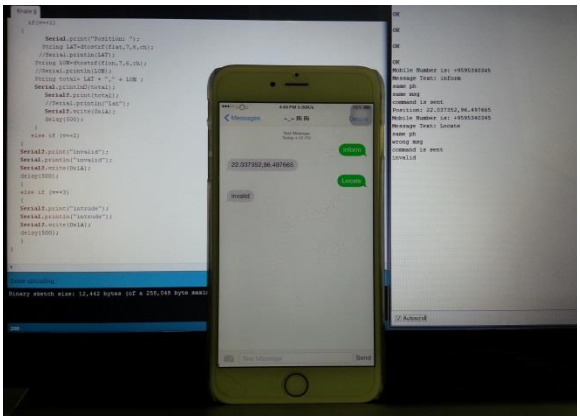


Fig 9. Acquiring user's location from location detection system

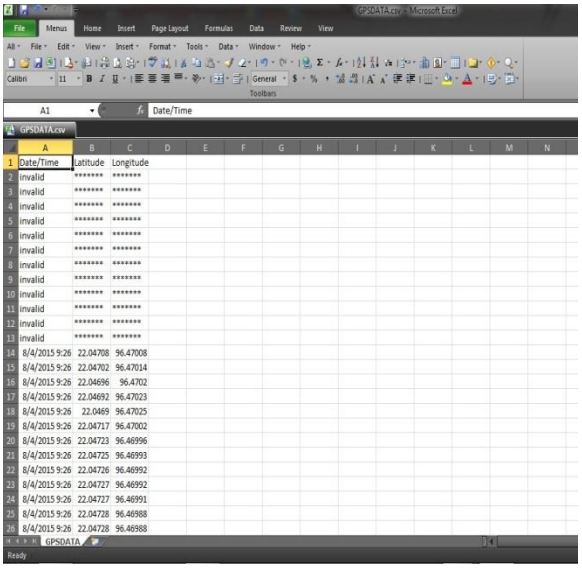


Fig 10. Saved data in SD card as a CSV file

Whenever the message is received from the center, the GSM module send back the current location of the user as shown in figure 9. Every updated user's location from GPS module is saved into the SD card.

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