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Automated Voice Activated Wheelchair Collision Control Using Ultrasonic Sensor

Unnimaya, G. Soniya, S. Vignesh, R. V. Preetha

Department of Electrical and Electronics Engineering, SRM Valliammai Engineering College, Kattankulathur, Chennai, India

ABSTRACT: Best way of living is of the highest importance and mobility is a critical component for a determined way of living. But several older grown-ups confront several impairments and dysfunction that end up in their movement being jeoparded. Moreover, various of these populaces need a powered wheelchair because they don't have the muscle to manually push forward themselves. If we can supply these people with several level of autonomy, regardless of their ability, without putting the individuals at unnecessary danger. An obstacle avoidance system with ultrasonic sensor for mobility is proposed in this project. The operation is carried out using a microcontroller (ATmega328) interfaced with Arduino Uno. The proposed model is built such that it comes to a halt when it comes across an obstacle. The obstacle is detected by ultrasonic sensor and it sends a signal to the microcontroller. It then stops the wheelchair by actuating the stepper motor (interfaced through motor driver) depending upon the command given to the microcontroller.

KEYWORDS: Arduino Uno, ATmega328, Motor shield L293d, ultrasonic sensor HC-SR04, stepper motor

I.INTRODUCTION

The wheelchair collision avoidance system that is proposed here is designed for people with cognitive impairments. Such systems enable a better life to people with these impairments by increasing the chances of their mobility and a sense of autonomy. The objective of this proposal is the use of ultrasonic sensor to equip a wheelchair, so that people with cognitive and many such disabilities can move around freely. The wheelchair is employed with the omnidirectional mechanism for high level of mobility.

As the proportion of older adults in the population continues to grow, there is a greater need for assistive technology that is accessible and adaptable to user needs. It is reported that, of the 1.5 million people residing in nursing homes, 60-80% have been diagnosed with dementia, primarily Alzheimer's disease. Currently, older adults with such impairments are not allowed to operate powered wheelchairs, since they lack the cognitive capacity to maneuver them safely. Prohibition of powered wheelchair use and the lack of strength required to use manual wheelchairs effectively greatly reduce the mobility of a large number of long-term care (LTC) residents, thus leading to social isolation and depression.

Loss of mobility also leads to increased dependence on caregivers to perform daily tasks. Mobility is an essential component of physical well-being and happiness. It has been reported that 31% of non-institutionalized U.S. adults with major mobility difficulties were frequently depressed or anxious, versus only 4% of those without mobility difficulties.

We believe that enhancing mobility through the use of powered wheelchairs will help improve the quality of life of older adults with cognitive impairment, while simultaneously reducing the burden on caregivers.

II.LITERATURE SURVEY

1. "Collision Avoidance by Observing Pedestrians' Faces for Intelligent Wheelchairs" has been designed by Yoshifumi Murakami, Yoshinori Kuno, Nobutaka Shimada and Yoshiaki Shirai. This paper presents an intelligent wheelchair that can avoid collisions with human pedestrians safely and comfortably. They assumed that the information whether or not a pedestrian has noticed the wheelchair and which direction he/she wants to go can appear in the face direction. Thus, the wheelchair is continuously observing the pedestrian's face in its front area, realizing smooth passing by changing its collision avoidance strategy based on the face information.

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2. "Semi-Autonomous Obstacle Avoidance for Omnidirectional Wheelchair by Joystick Impedence Control" has been designed by Hideo Kitagawa, Tsunemitsu Kobayashi, Tatsuya Beppu and Kazuhiko Terashima. A novel semi-autonomous control method for omnidirectional wheelchairs is proposed. In addition to allowing the normal joystick commands of the wheelchair operator, this method provides a collision avoidance function using external sensors. The wheelchair's motion remains controlled only by the operator's joystick commands, while a collision is avoided successfully.
3. "Fuzzy Controller for Obstacle Avoidance in Electric wheelchair with Ultrasonic Sensors" has been designed by Gang Liu, Lei Zhang, Meng Yao and Chao Zhang. The main features of the electric wheelchair are to navigate freely in an unknown environment and avoid the other objects as obstacles. A combination of ultrasonic sensors is used to facilitate navigation and obstacle avoidance. The fuzzy behavior producer is embedded in an 8-bit chip. The control software implements behavior-based artificial intelligence.
4. "Electric Wheelchair Control for Avoidance of Collision and Downhill Turning" has been designed by Naoki Uchiyama, Hiroki Takahashi and Shigenori Sano. This paper presents a controller design of an electric wheelchair for avoiding collision and downhill turning. The presented method considers the non-holonomic constraints of a typical differential wheel drive system by employing the model reference control, in which command input signals from an operator is modified to avoid collision by using the reference model.

III.BLOCK DIAGRAM OF THE PROPOSED SYSTEM

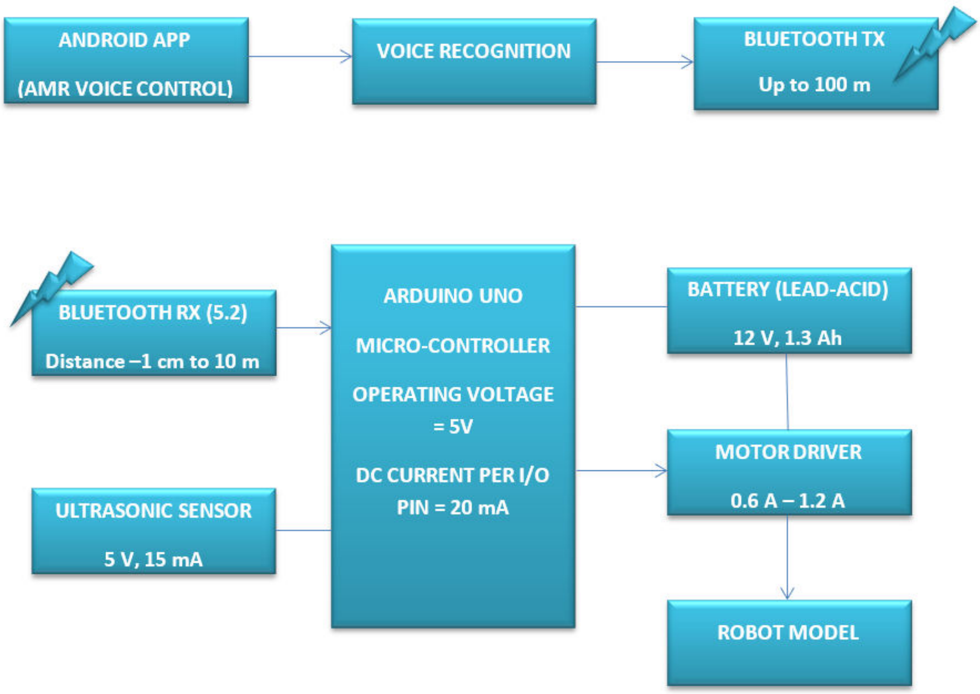

Fig. 3.1. Block Diagram of Proposed System

IV.IMPLEMENTATION OF WHEELCHAIR COLLISION CONTROL USING ULTRASONIC SENSOR

The sonar system is used in HC- SR04 ultrasonic sensor to determine distance of an object like bats do. It offers excellent non-contact range detection from about 2 cm to 400 cm or 1 foot to 13 feet. Its operation is not affected by sunlight or black material. The ultrasonic sensor emits the short and high frequency signal. If they detect any object, then they reflect back echo signal which is taken as input to the sensor through Echo pin. Firstly, user initialize Echo pin as high and push the robot in forward direction. When obstacle is detected, Echo pin will give input as low to microcontroller. Pulse In function is used to calculate the time of distance from the obstacle. Every time the function waits for pin to go high and starts timing, then timing will be stopped when pin go to low. It returns the pulse length in microseconds or when complete pulse was not received. The timing has been considered such that it gives length of the

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pulse and will show "obstacle detected" in shorter pulses. Pulses from 10 microseconds to 3 minutes in length are taken into consideration.

After determining the time, it converts it into a distance. If the distance of the object is moderate then speed of wheelchair gets reduced and will gradually stop. This methodology is built with an Arduino development board on which microcontroller is placed. The movement of the wheelchair will stop whenever there is an obstacle present on its path which can be detected by ultrasonic sensors. Ultrasonic sensors give time in length to the microcontroller as an input for further actions. Additionally, a Bluetooth system with 2.402 GHz to 2.480 GHz frequency range is connected with an android app externally for navigation of the wheelchair.

SENSOR FOR OBSTACLE DETECTION:

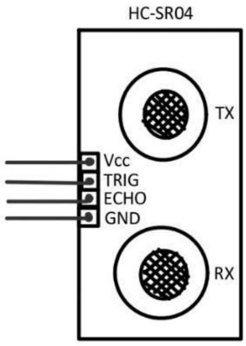

Fig. 4.1. Ultrasonic Sensor HC-SR04

V. RESULT AND DISCUSSION

V.I. SIMULATION

The proposed plan has been successfully simulated using the software tool suite Proteus Design Suit which is used primarily for electronic design automation.

In the setup, the ultrasonic sensor HC-SR04 is connected through the Echo pin to the A0 pin of the Arduino Uno board with microcontroller ATmega328. Since the traction of the wheelchair is carried out by a stepper motor (driven by L293D motor drive), the course of action of the stepper motor can be shown by connecting two Light Emitting Diodes (LEDs) across the output pins of the Arduino board (I04 and I05).

Once the simulation starts running, the virtual terminal will show the motion of a wheelchair with normal speed without any obstacle. The diodes will glow as the Echo pin in the Ultrasonic sensor goes high and continues to glow till the wheelchair faces an obstacle and the motor stops running.

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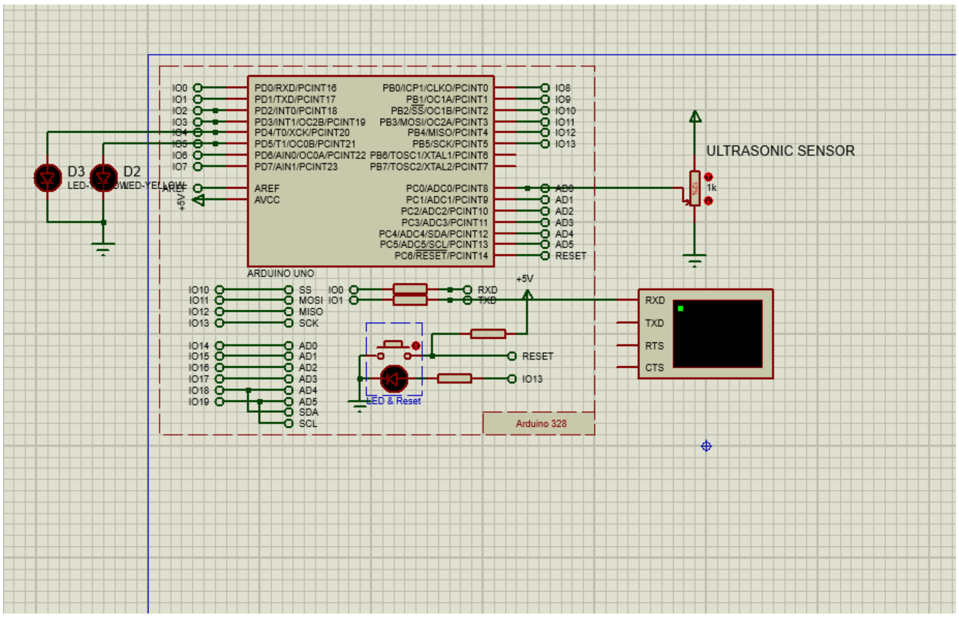

Fig. 5.1. Simulation Circuit Design

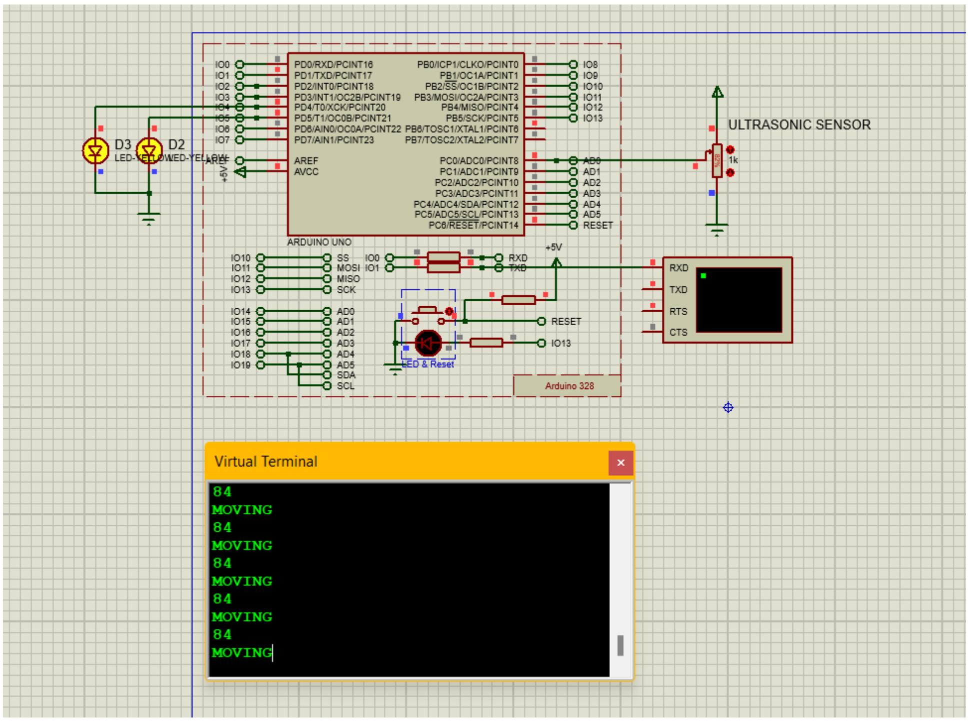

Fig. 5.2. Simulation of the wheelchair initially (when no obstacle is in path)

When the obstacle enters 50% (or 50 cm) into the wheelchair's path, the wheelchair still continues moving, but when it reaches the threshold, i.e., 30% (or 30cm) the ultrasonic sensor sends the low signal through the Echo pin to the motor driver and the stepper motor stops according to the command.

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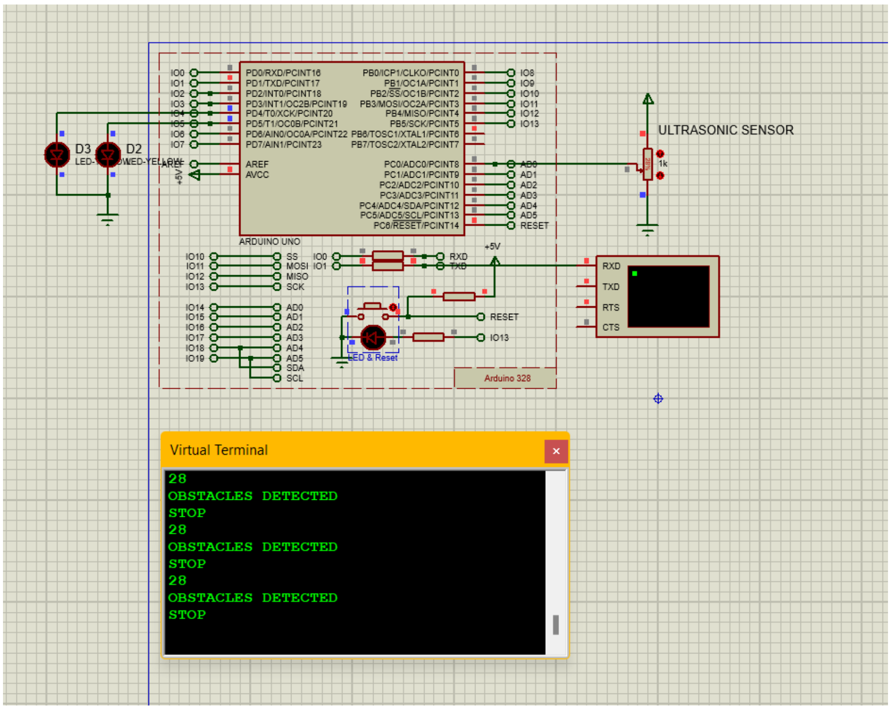

Fig. 5.3. Simulation of the wheelchair when an obstacle is in a 30% vicinity (or 30 cm)

V.II. OUTPUT THROUGH THE VIRTUAL TERMINAL

- When the wheelchair is in motion and no obstacle is faced within 30% of its vicinity:

Fig. 5.4. Output when there is no obstacle

- When the wheelchair faces an obstacle that comes anywhere at a distance of 30% from the wheelchair:

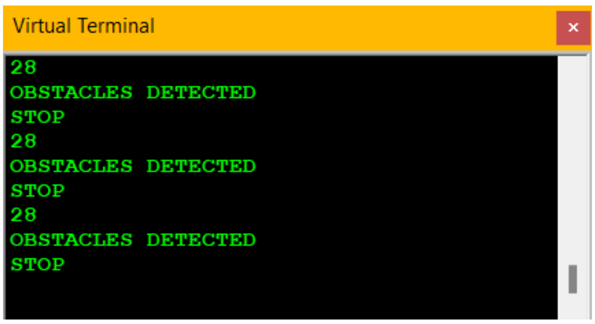

Fig. 5.5. Output when wheelchair faces obstacle

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V.III. SOURCE CODE:

To run the Arduino Uno board, a source code is created to run the whole simulation. The source code is in C++ and easily understandable.

V.IV. HARDWARE IMPLEMENTATION

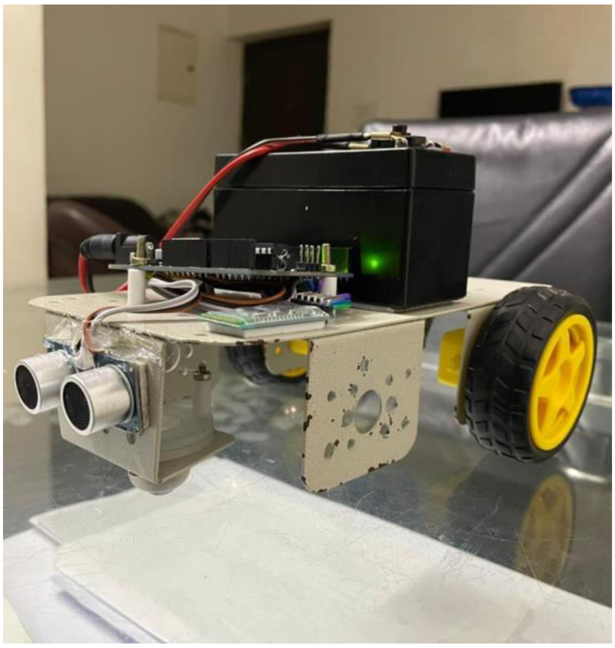

Fig. 5.6. Prototype hardware of the proposed system

V.V. APPLICATION INSTRUCTIONS

The different directions of motions possible are: forward, backward, left, right and stop. In achieving the task, the controller is loaded with program using the Arduino programming language and Arduino development environment.

- First make sure Bluetooth module is paired with the android mobile. The default password for pairing is “1234” or “0000”.
- When the user says “GO”, AMR Voice application sends the data in form of string “*GO#” to Bluetooth module connected to the circuit. When microcontroller detects “GO”, the motor attached to the wheelchair moves FORWORD.
- When the user says “BACK” AMR Voice application sends the data in form of string “*BACK#” to Bluetooth module connected to the circuit. When microcontroller detects “BACK”, the motor attached to the wheelchair moves REVERSE.
- When the user says “LEFT” AMR Voice application sends the data in form of string in form of string “*LEFT#” to Bluetooth module connected to the circuit. When microcontroller detects “LEFT” the moves the motor attached to the wheelchair LEFT side.
- When the user says “RIGHT” AMR Voice application sends the data in form of string “*RIGHT#” to Bluetooth module connected to the circuit. When microcontroller detects “RIGHT” the moves the motor attached to the wheelchair RIGHT side.
- When the user says “STOP” button which is in the Centre of remote the AMR Voice application sends the data in form of string “*STOP#” to the Bluetooth module connected to the circuit. When microcontroller detects “STOP” the wheelchair gets stopped.
- Click on “DISCONNECT” icon to disconnect the paired Bluetooth module.

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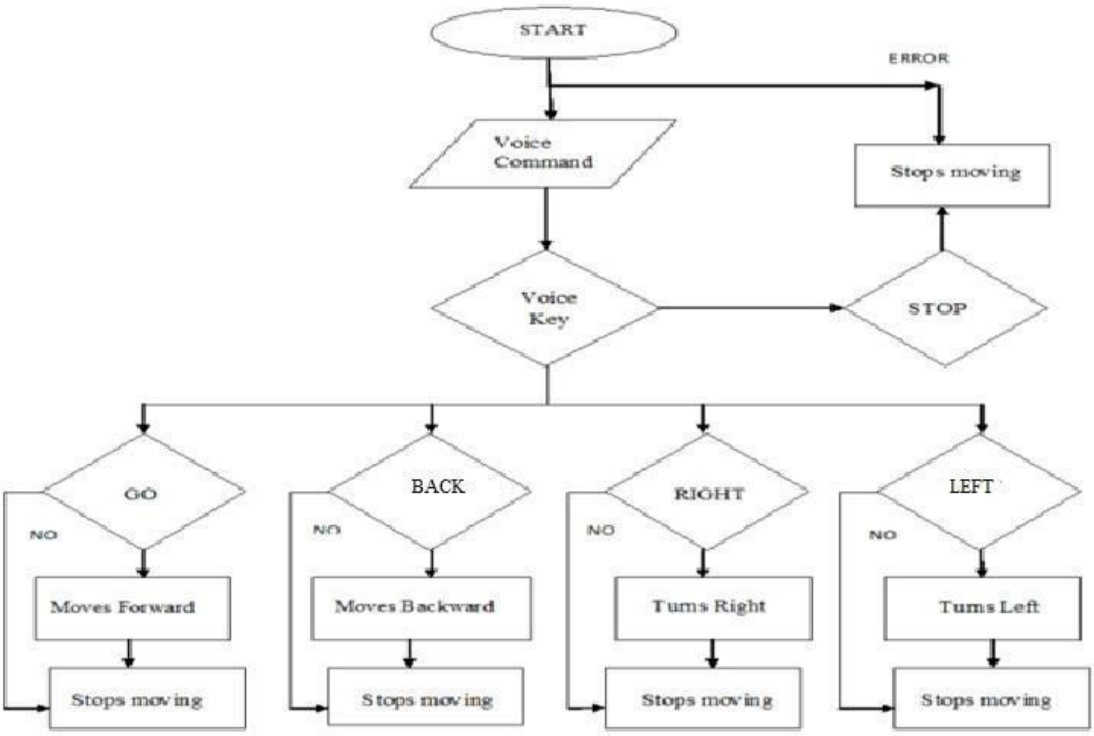

Fig. 5.7. Flowchart of the proposed system

VI.CONCLUSION

This project developed an obstacle avoiding wheelchair to detect and avoid obstacles in its path. The wheelchair is built on the Arduino platform for data processing and its software counterpart helps to communicate with the wheelchair to send parameters for guiding movement. For obstacle detection, ultrasonic distance sensor was used that provided a wider field of detection. The wheelchair is fully autonomous and after the initial loading of the code, it requires no user intervention during its operation. When placed in an area with obstacles, it stopped when encountering an obstacle and the change of course of path can be done. In order to optimize the movement of the wheelchair, we have many considerations for improvement. However, most of these ideas will cost more money and time as well. In the future, cameras can be used to detect the obstacle; however, it is better to get CCD or industrial use ones to get clear and fast pictures.

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