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Smart Assisted Vehicle for Disabled/Elderly Using Raspberry Pi

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ABSTRACT

Independent mobility is a key component in maintaining the physical and psychosocial health of an individual. Further, for people e having disabled/elderly, independent mobility increases vocational and educational opportunities, reduces dependence on caregivers and family members, and promotes feelings of self-reliance. Psychologically, a decrease in mobility can lead to feelings of emotional loss, anxiety, depression, educed self-esteem, social isolation, stress, and fear of abandonment. Even though the benefits of powered mobility are well documented, the safety issues associated with operation of powered vehicles often prevent clinicians and rehabilitation practitioners from prescribing powered mobility. So we are introducing an intelligent vehicle for disables/elderly people which uses an array of sensors to help with the movement of the vehicle with minimal human interaction. Functionalities of the proposed system are further enhanced using android interface connect to the vehicle via Bluetooth.

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1. INTRODUCTION

1.1. Theoretical Background

The electric-powered wheelchair was invented by George Klein who worked for the National Research Council of Canada, to assist injured veterans after World War II. Technology has advanced many folds and with this new technology we can now upgrade this old invention into something which has use not only by disabled and elderly but widespread use in hospitals, automation plants and recreational purposes. Robotics Wheelchairs extend the capabilities of traditional powered devices by introducing control and navigational intelligence. Experts predict that the number of people who need wheelchairs will increase by 22 percent over the next ten years. This increasing demand needs that advanced system which are compliant with modern technology be made available in this field. Moreover the price of the similar system available in the market is 10 times the budget of the proposed system. So the proposed system is an affordable reliable and more functional option for the disabled/elderly to use for movement from one place to another with minimal supervision. Figure 1 is a graph displaying results of a survey of the type of wheelchair used by respondents. [14]

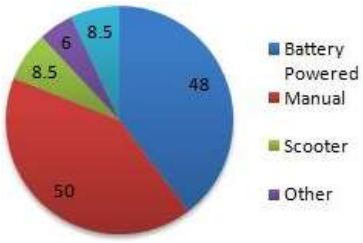

Figure 1. Survey of the type of wheelchair used by respondents

1.2. Motivation

These devices can ease the lives of many disabled people, particularly those with severe impairments by increasing their range of mobility. For handicapped people human found a wheel chair which can be moved by using hands for those who don't have legs. But the peoples who don't have legs as well as hands cannot move their wheel chair self. They need some other person to move their wheel chair. But sometimes such person faces so many problems if they didn't get any person to move their wheel chair. Moreover these people cannot use facilities like bus service and trains due to lack of proper infrastructure. Figure 2 is graph based on a survey displaying number of times disabled people could not use bus along with the reason for it. [14]

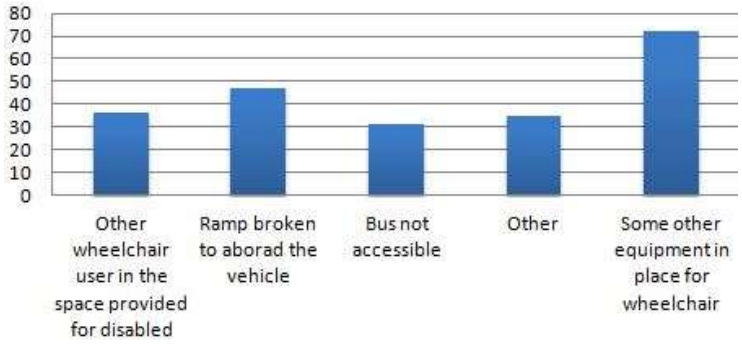

Figure 2. Survey displaying number of times disabled people could not use bus along with the reason

Often accidents occur due to negligence of the person taking care of the handicapped person. These kind of problems and mishaps can be avoided using smart wheel chair like the one proposed in our project.

1.3. Aim of Proposed Work

This project "The Smart Assisted Vehicle for Disabled/Elderly" aims to resolve the above mentioned issue. In this project we are going to make a wheel chair which can be controlled automatically using minimal as well as manually. This wheel chair controlled manually through head of the person sitting on it. He/she just need to move his/her hand into the direction it wants to move by using accelerometer. In automatic control user just need to press keys for saved destination. Then the wheel chair will automatically move into the direction specified in the mobile app using the motor. This chair also provide the another feature i.e. it can store user's current location on the cloud. The proposed GPS Based Wheelchair Operation allows emergency contact of the said user to locate the user from their GPS location stored on the cloud that could be seen in Figure 3. The vehicle also has added feature of panic button which is a very useful and effective feature for the user. This feature with a push of a button sends SOS signal to all the emergency contacts of the user along with their current GPS location coordinates. Mobile connectivity through Bluetooth module gives ample scope of extensions in the project which can be added once all the basic functionalities are implemented successfully.

Figure 3. The proposed GPS Based Wheelchair Operation

1.4. Objective of Proposed Work

The objective of this project is to design and develop a working prototype of a smart assisted wheelchair that can be controlled using a mobile app connected via Bluetooth to move forward, backward, left and right.[13] The proposed system also has auto sensing capabilities to avoid collision with obstacles in the path using infrared sensor[10]. Apart from these smart movement control the wheelchair has embedded GPS module so that the current location of the user can be stored on the cloud. These GPS coordinates can be viewed by any of the emergency contact of the user to monitor their current location.

2. LITERATURE SURVEY

A dynamic vision sensor (DVS) detects temporal contrast of brightness and has the fastest response time compared to conventional frame-based sensors, which detect static brightness per every frame.[9] It calculates the accurate distance in real time only with spatial information of the reflection. The proposed design can eliminate environmental noises by using pattern matching based on time-domain analysis [1].

Automatic Video-Based Human Motion analyzer for consumer surveillance system describes a flexible framework for semantic analysis of human behaviour from a monocular surveillance video, captured by a consumer camera [12]. Successful trajectory estimation and human-body modelling facilitate the semantic analysis of human activities and events in video sequences [2].

Obstacle Detection for Visually Impaired [11] Using Raspberry Pi and Ultrasonic Sensors is a wearable device in the form of a waist belt that has ultrasonic sensors and raspberry pi installed, detects obstacles around the user up to 500cm in three directions i.e. front, left and right using a network of ultrasonic sensors [3]. Autonomous Car, building a monocular vision autonomous car prototype using Raspberry Pi as a processing chip. An HD camera along with an ultrasonic sensor is used to provide necessary data from the real world to the car. Many existing algorithms like lane detection, obstacle detection are combined together to provide the necessary control to the car [4].

Smart Surveillance System model describes a small portable monitoring system for home and office security, uses Raspberry pi (model B), Gyro sensor and Raspberry pi camera to monitor when motion detected, the Raspberry Pi will control the Raspberry Pi camera to take a picture and sent out an alert email with the image to the user according to the program written in python environment [5]. Android Based Home Automation system describes concept of Home Automation via Android device using Wi-Fi as communication protocol and Raspberry Pi as server system. The server is interfaced with a relay circuit board that controls the appliances running in Home. The communication with server allows the user to select the appropriate device [6].

Dynamic ultrasonic hybrid localization system for indoor mobile robots proposes autonomous navigation of indoor mobile robots using multiple ultrasonic distance measurements and an extended Kalman filter (EKF). The ultrasonic sensor subsystem is composed of several ultrasonic transmitters (Txs) attached to the ceiling at known positions and several ultrasonic receivers equilaterally located on the top of the mobile robot [7]. Wireless interfacing of Raspberry Pi using Bluetooth describes a smart phone based remote control to communicate with Raspberry Pi, via designing an Android Bluetooth application from which it connects with Raspberry Pi's Bluetooth and display files on projector which is connect with Raspberry Pi [8].

3. PROPOSED MODEL

The proposed system is an intelligent vehicle for disabled/elderly people which uses an array of sensors to help with the movement of the vehicle with minimal human interaction. This is done using a RASPBERRY PI which acts as the heart of the system and controls the whole system centrally. The micro-controller is responsible for all the tasks to be carried out by the system like connection of the wheel chair to mobile via the Bluetooth module, display of any relevant message or system status through LED or be it the control of motion of the wheel chair through the motor connected to the PI. Further the functionalities of the

proposed system is extended by updating the current location of the system using the GPS module of the mobile connected to the system. This location detail of the system is stored on the cloud and updated after every 15 minutes using a cron perl script.

In addition the connection of mobile phone enables an SOS signal button or Panic button using which the user of the system can send distress calls to any emergency contact using user's Android mobile. Additional features like using the camera of the mobile to see the current surrounding of the user or using mobile camera input to map a path or automatic movement of the vehicle or using the mobile mic and operating system to implement speech based system is possible in the near future.

In addition to all these the main aspect of the proposed system is the cost of production. Range of smart wheel chair with functionalities similar to the one proposed in the system starts around 1 lakh Rupees whereas our proposed system is made with a budget of Rs. 20,000 which can enable people of lower income groups to use and witness high end technology and engineering at an affordable price.

Objectives of system design:

1. If Distance between a obstacle and vehicle less than thershold value stop the vehicle.
   Mathematically,
   If $D_{obstacle}$ < Threshold => Stop Vehicle
2. If the color detected by web camera is red (i.e. traffic light is red) stop the vehicle
   If Color $_{traffic\ light}$ = Red =>Stop Vehicle

Block Diagram:

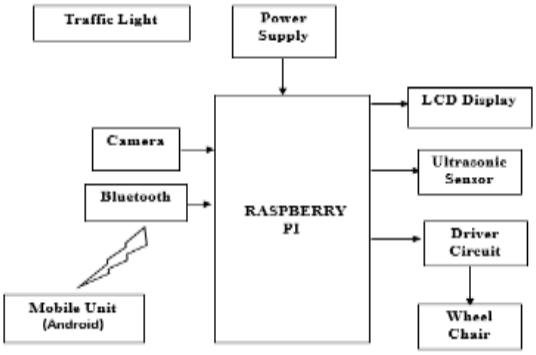

Figure 4. System Design

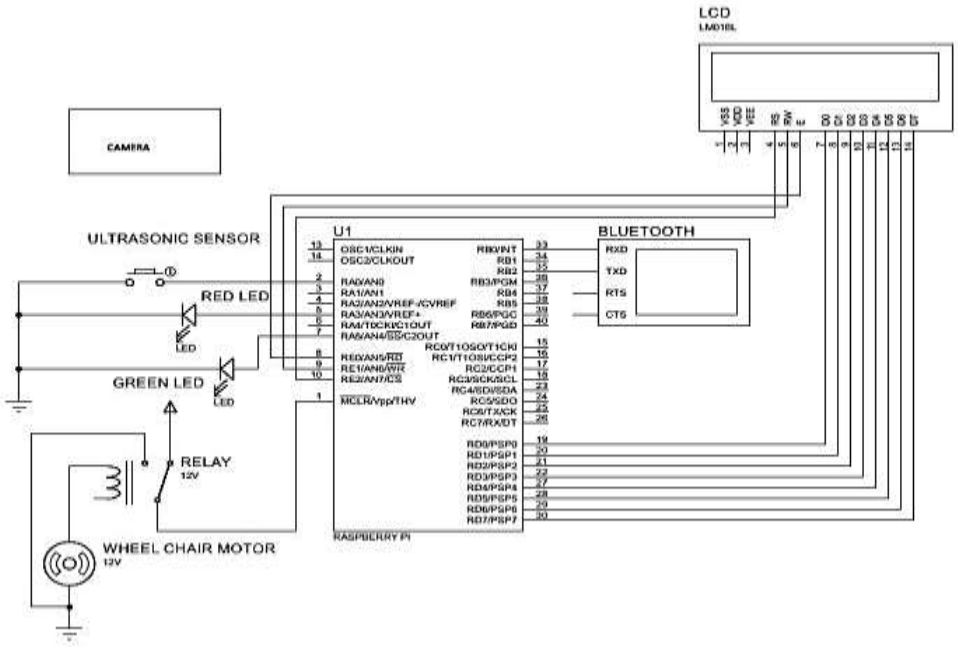

Figure 5. Components Details

Component	Used For	Pin connection
Wheel Chair Motor	Motor used to move the wheel chair without any external help	Connected to pin 1 through a RELAY of 12V
Ultrasonic Sensor	Detect any obstacle in path	Connected to pin 2
Green LED	System indication display	Connected to pin 7
Red LED	System indication display	Connected to pin 5
Bluetooth module	Establishing a connection between the wheel chair and corresponding android app	Connected to pin 33 and 35
LED	Display of any information	Connected to pin 19-30 and 8-10

4. RESULTS AND ANALYSIS

The Smart Assisted Vehicle for Disabled/Elderly supposed to be equipped with ample of sensors which will help users to compensate their lack of senses. Proposed wheelchair is equipped with ultrasonic sensor to detect and avoid any obstacles in the path, without user's intervention. Wheelchair is equipped with camera which will recognize the traffic signal and guide user accordingly. Web camera which is used to take images continuously and if it encounters a traffic signal it analyses the signal and informs the microcontroller about the traffic signal which in turn controls the vehicle accordingly.

Wheelchair works on latest version of Raspberry Pi 3, which will maintain the working coordination of all other sensors. Raspberry Pi is connected to user's Android device via Bluetooth, which acts as a joystick to control the mobility of vehicle. The microcontroller connected with the Bluetooth module kit recognizes the command sent from Android Device and controls the vehicle movement automatically. Further, using GPS location of user, tracked by user's Android device, vehicle can notify user's family about his current location, so that in case of emergency they can track him easily. Family member can also set the perimeter for user's vehicle so that user's vehicle won't be able to operate outside its radar. Vehicle is also equipped with panic button, so that in case of emergency, user can immediately contact his family or friends.

The algorithm of Smart Assisted Vehicle is supposed to be robust so that it can perform and react to all the tasks in real time. Coordination between ultrasonic sensor, camera, android device and wheelchair's motor is maintained by Raspberry Pi. Also with latest feature of IoT inbuilt in Raspberry Pi, vehicle can keep updating cloud server with user's current location, which can be seen by user's family members and friends. With fully built Smart Assisted Vehicle, user can be able to ride from one place to another with minimal supervision.

Modifications using mobile unit like emergency contact list, heart rate monitor and user authentication will be added to further enhance the vehicle functionality.

Few of the applications of proposed system are listed below:

Applications:

1. Useful for Disabled to overcome their limitations of mobility.
2. Useful for Elderly to help travel with assistance via app.
3. Useful for patients with injury to help travel during the recovery period.
4. Fit band integration to access health status update of the user is possible.
5. Supervision of the user can be done by entitled person like family member etc.
6. Smart panic alarm to alert all the concerned people about emergency faced by the user.

5. CONCLUSION

Proposed wheelchair is equipped with ultrasonic sensor to detect and avoid any obstacles in the path, without user's intervention. Wheelchair is equipped with camera which will recognize the traffic signal and guide user accordingly. Web camera which is used to take images continuously and if it encounters a traffic signal it analyses the signal and informs the microcontroller about the traffic signal which in turn controls the vehicle accordingly.

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The calculation of Smart Assisted Vehicle should be strong with the goal that it can perform and respond to every one of the undertakings continuously. Coordination between ultrasonic sensor, camera, android gadget and wheelchair's engine is kept up by Raspberry Pi. Likewise with most recent component of

IoT inbuilt in Raspberry Pi, vehicle can continue refreshing cloud server with client's present area, which can be seen by client's relatives and companions. With completely manufactured Smart Assisted Vehicle, client can have the capacity to ride starting with one place then onto the next with insignificant supervision. Further modifications using mobile unit like emergency contact list, heart rate monitor and user authentication can be added to the existing system to further enhance the vehicle's functionality.

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