Smart Wheelchair for Physically Challenged People

Pallavi Bibhishan Shrikhande[1] Pratiksha Ashok Zagade[2] Jayashri Maruti Sase[3] Pranali Ankush Nagare[4]
[1,2,3,4]Department of Computer Engineering
[1,2,3,4]SPPU Institute, India

Abstract— Smart Wheel Chair is mechanically controlled devices designed to have self-mobility with the help of the user command. This reduces the user's human effort and force to drive the wheels for wheelchair .Furthermore it also provides an opportunity for visually or physically impaired persons to move from one place to another. The wheelchair is also provided with obstacle detection system which reduces the chance of collision while on the journey.

Keywords: Autonomous Wheelchair; Machine Learning; Object Detection

I. INTRODUCTION

World society. Providing aid to those in need has always been moto of the society. One of the most commonly found problems we are dealing with is the issue with the handicapped people. Nearly 1 billion that is 15% of the world population is diagnosed with some disability. Wheelchairs has always been a tool for those who are physically challenged to enable their movement. And smart wheelchairs are the latest outcome of the combination of real time systems and Artificial Intelligence. Smart wheelchairs are controlling the movement of the system, in a study in 2017, the system was implemented by using multi-colony division and cooperation mechanism, the polymorphic ant colony algorithm helps to solve the track planning problem found in most of the smart wheelchairs.

Both the target and obstacle path planning are carried out simultaneously by the adaptive polymorphic ant colony algorithm.

In this research, we aim to create an autonomous wheelchair system with machine learning embedded into the system. The system is powered by a two 24V 18A battery connected in series which is used to run a DC motor of 24V and 350W. The basic structure of the wheelchair was revamped and altered for the placement of the components. Raspberry pi 3B is used as the main chip for the system. The system consists of 2 modes of operation which is altered using a switch. The 1st modeconsist of a manual mode operated using four IR sensors for the forward, backward, left and right motion respectively. The second mode consist of a camera which uses the machine learning principles and runs on constant training of the system in a particular environment. The motors are controlled by BTS7960 motor drivers capable of handling an input of 28V and 43A. the speed of the system is maintained by the motor drivers where the input frequency of the PWM signal is set in the program and given to the motor drivers.

Another approach was seen in a study in the year 2019, [4] a method for detecting a 2-D image of the wheelchair which involves the usage of the Gaussian mixture models (GMMs) and the histogram of oriented Gradients (HOG). The introduced model mainly contains 3 main points: (i) foreground segmentation, (ii) feature vector extraction and (iii) Wheelchair detection. To detect a body moving in the backdrop the GMMs technique are integrated, while the hidden value vectors of the object in motion are detected by the HOG method.

The human motion depends on walking and movement that is an important factor for everyday activities of a being. But people who are handicapped depend solely on wheelchairs. In this paper we ought to present a modified self-driving wheelchair along with machine learning technique that is solely made on the purpose to surpass the traditionally existing solutions

II. LITERATURE REVIEW

- This following paper shows an advancing task developing a robotic wheelchair that can move autonomously beside a third person for assistance. In this study, a Smart wheelchair was proposed that have autonomous features for reaching a target. Generally, people using wheelchairs may wish to go out somewhere independently, but often they are escorted by a third person. Hence it is important to consider on how to reduce the dependence of the subject on a third person and support their movements and provide proper mode of connection between the wheelchair and the third person. Here, while moving along a narrow path the third person may step in front of the wheelchair to open doors and so, creating hinderance to other pedestrians along the same path. To avoid such a situation a long-range laser system is set up to track the third person and detect the surrounding around the wheelchair. When an obstruction is detected along its path, the wheelchair modifies its position accordingly.
- A low cost semiautonomous wheelchair, for the enhanced movement of physically impaired or elderly citizen is presented in this paper. The movement of the wheelchair is carried out with the help of a joystick controller, and a sonar sensor. The permanent magnet DC motors are attached to the wheelchair whose movement is controlled using a pulse width modulation (PWM) control signals. The semiautonomous wheelchair has a total of six ultrasonic sensors, where there are four equipped in the front, one of them placed at the back to prevent any obstruction that may come in the way and one close to the footrest to detect any steps.
- Research in the field of medical and healthcare devices is on the rise, and with an increase in aged persons who have lower physical abilities, there is a need for intelligent devices which could guide them. Our research is to develop an autonomous wheelchair which uses a navigation system based on image processing techniques. In this system when the user heads towards a destination and the wheelchair comes to a crossing, then the system itself instructs an appropriate direction to move. This paper proposes the use of deep learning, a

kind of artificial neural network, for supporting the autonomous driving by the use of a classifier trained on video images with deep learning. The system also includes a visual odometer to generate training data.

– To deal with high cost of autonomous wheelchair system by implementing a cheap and highly durable to navigate bout the surrounding environment. A computer which is Based on Arduino and a robot operating system [ROS] is used to facilitate the motion of the wheelchair by driving the motors sequentially. A low cost RGD-D camera apparatus is used in this system to make the wheelchair as cheap as possible in order to identify the environment around it. The map building and image recognition is done using the depth control vision using the RGB-D camera by laying out laser points. The wheelchairs direction and location are found out by using algorithm called Adaptive Monte Carlo Localization algorithm. Dynamic Window Approach algorithm is one of the algorithms used for tracing the local path of the wheelchair movement. The human interaction with the system is done and carried out by the use of an app that has been altered accordingly.

III. METHODOLOGY

The contraption moves according to how the user switch either to manual mode or automatic mode. Now, if the user switches to manual mode, then the (4) infrared sensors for forward, reverse, left and right movements are activated. The infrared sensors wait for the user input for further manoeuvring based on the given input. If the user switches to automatic mode, then the system runs using regression model. The input for the system is provided from an external device, the target location and path to be followed is given by the external device. The user gives input based on the indoor location in which the wheelchair was trained with proper obstacle detection, speed control, etc. Once the user gives a specific desired location, the wheelchair moves using automatic mode between the rooms detecting all obstacles in its path using real time object detection with reference to the indoor map that has been trained beforehand and conveniently moves without the assistance of a third person. Finally, when the preferred destination is reached the wheelchair gradually stop and wait for the users next input.

Fig. 1: The chassis of the wheelchair

A. Mechanical Construction

The chassis of an ordinary foldable wheelchair is remodelled in such a way where a support axis is engineered between the two set of wheels using steel rods which connects the direct current (DC) motors to the wheels as given in Fig. 2. The wheels are hooked up to the motor using a chain and sprocket system to turn the wheels as given in Fig. 2. The base of the wheelchair consists of custom-made battery holder which houses a set of (2) 12V heavy duty batteries which is required to power the wheelchair. The base also consists of a housing unit which holds the raspberry pi computer and the motor drivers to drive the motors. The (4) infrared sensors are attached to the side handles of the wheelchair having two on each side, forward and reverse movement on one side and right and left movement on the other. The pi cam is attached to a 50mm bag buckle clip with adjustable strap for easily removable mechanism.

B. Hardware

The Hardware components that are used are given below:

– Raspberry Pi 3 Model B: It is the fundamental board of the wheelchair system with an affordable price. It was chosen because of its capability of complex software computation, Computer Vision processing and digital control for driving motors.
– BTS7960 Motor Driver: It is a fully integrated high current H bridge module for motor drive applications. It communicates to the DC motor using PWM signals from the raspberry pi.
– Pi Camera: It is able to make use of the graphics processing capability of the Broadcom CPU
– Infra-Red (IR) Sensors: It is used for the manual movement of the wheelchair. It is also used because of its high accuracy and low cost
– DC Motors: It is used for the displacement of the wheelchair.
– 12V Battery: It is used to power the wheelchair.

C. Software Packages

– The program used in this system is based on python packages given below:

- "TensorFlow" package: an open-source package for machine learning applications such
- "NumPy" package: It enables us to carry out arithmetic and scientific programming which allows us to add support for big multi-Dimensional arrays and matrices, along with a large collection of mathematical functions.
- "Motor" package it allows the raspberry pi to drive the motors using suitable PWM signal through the motor driver.
- "time" package helps to facilitate the multiple delays required by the system.
- "Pi Camera" package allows the Raspberry Pi to access the attached camera and capture real-time frames.

IV. RESULTS

As a conclusion, the machine learning principle was infused into the system. The system operates in manual and automation mode. The speed calibration was done perfectly which enabled the motion of the wheelchair in forward, backward, left and right movements. The future scope includes a new innovative method for the healthcare facility. The system enables the users to be assistant free and helps to create a system without any assistance.

The response time of the IR sensor was analyzed and recorded. The wheelchairs movement in all the four direction was repeated for 10 test cases and the average of the response time is recorded below.

DIRECTION	RESPONSE TIME
FORWARD	0.8s
BACKWARD	0.75s
LEFT	1s
RIGHT	1s

Table. 1: Response time analysis

A comparative study was made for recognition rates of the other existing models and tabulated below, where the proposed model consists of highest recognition rate compared to other traditional models due to the usage of the regression training model.

FORMER IMPLEMENTATIONS	RECOGNITION RATES
[1]	80.2%
[2]	90%
[3]	87%
Proposed Model	94%

Table. 2: Comparative study of recognition rate

V. FUTURE SCOPE OF SMART WHEELCHAIR

- Internet of things: A world where physical objects are seamlessly integrated into the information network, and where the physical objects can become active participants in business processes. Services are available to interact with these 'smart objects' over the Internet, query and change their state and any information associated with them, taking into account security and privacy issues. Smart wheel chair can be part of internet of things and help the patients in their profession and other household work like bill payment etc.
- Home Automation: Patients home and environment can be automated using the raspberry pi to extend the comfort of the patients. E.g. Doors could be controlled from the wheelchair Lighting controls can be mounted on the wheelchair.
- Vital Signs Monitoring: Vital signs and patient monitoring can be done in real time, Patient can store and access his medical records
- Indoor mapping: An image of the plan of the house or hospital can be stored in the controller and automated movement of the wheelchair to the defined destination within the mapped region is possible.
- Feedback system: The speed of the motor needs to be controlled if a wheel does not move due to physical restraints, the controller needs to know else it will power the other wheel which leads to faulty operation. The cont roller can come to know the status of the wheel by a feedback system.
- Solar battery chargers: With the advancement in the technology, the light weighted solar panels can be installed on the wheelchair which will charge the different batteries being used on the wheelchair.
- Stair climbing facility: The smartness of the wheelchair can be enhanced by adding a provision to climb up the steps keeping the weight of the wheelchair and condition of the patient in mind.
- Body massager: As a patient might spend a lot of time on the wheelchair itself, a massager can definitely
- be very useful for the relaxation of the body

VI. CONCLUSION

- This Smart wheelchair improve the quality of life to the disabled persons.
- The system can be successfully implemented to move the wheelchair left, right, forward or stay in the same position.
- His project totally aims at social purpose.

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