Artificial Intelligence Based Wireless Smart Wheelchair

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Abstract – Statistics suggests that there are 15,000 new cases of quadriplegia every year in USA. Great people like Stephen Hawking and Max Brito have been suffering from this crippling phenomenon. Our project is an attempt to make lives of the people suffering from this disability easier and simpler. By simpler we mean self-reliant, self-independent which will thereby restore their confidence and bring back their happiness.

The main idea is to implement an artificial intelligence based wireless smart wheelchair which allows movement of the patient's wheelchair depending on the eye movements. The patient sitting on the wheel chair assembly can move in three directions i.e. left, right and straight just by looking directly at the camera. In addition to that the wheel chair will also be able to detect the barriers or obstacles coming on the way with the help of ultrasonic sensors. The real time camera signals are monitored by MATLAB programming. This paper presents the design, development, and implementation of an eye controlled wireless wheelchair based on artificial intelligence which is simple in design, reliable in terms of feasibility.

Index Terms – System-user interaction, Real time iris detection, Wireless smart Wheel chair, Model of Wheelchair, eye controlled wheelchair, ultrasonic sensor, MATLAB software, Webcam, Artificial intelligence.

1. INTRODUCTION

Human beings always have the intension to control every process or incident occurring around them so that they can lead a comfortable life. Many inventions happened due to this instinct of mankind. Controlling some things is also a need of human life. In day to day life man has to do certain basic things that need control over their body or specific body parts. In general to move from a place to another we must have control over our body. The so called handicapped people of the world do not have control over all of their body parts. But there are persons who are so severely paralyzed that they cannot move of their own. This paper includes the wheelchair that can control using voice, eye and joystick. And it monitors the room conditions like temperature or the humidity, fire etc. And according to patient/ user health conditions it will inform the doctor/ analyzer via text message. Also it check the body conditions of the user and according to unnecessary changes in his heart and brain conditions and inform it any changes happen. According to user wish the wheelchair can be made in to a semi sleeper bed. Also for physically handicapped ones the wheelchair will help to have food/medicines and other needy things which can only done by his hand can be done using robotic hand that is being integrated with it. Also it monitors the human presence and informs the user. The present world the medical field is very much focuses about to care the patients, and the patient/ handicapped one are like to leave individually without the help of any others so, this proposed product will be very effective for them.

Moreover, according to WHO there are almost 650 million people or more who are solely physically challenged. Among which, around 70 million are in India. Besides, various reports also show that there is a strong relation between the age of the person and the level of handicap, the latter being commoner in persons of advanced age.

Given the growth in life expectancy in the world (in the countries of the Organization for Economic Cooperation and Development (OECD)it is expected that the proportion of older persons aged 60 years and older will have reached a ratio of 1 person in 3 by the year 2030), a large part of its population will experience functional problems. People suffering from such miserable condition and living a cursed life in this advanced technological century. Science & technology must provide them a better quality of life by making them able to move without others help.

2. RELATED WORK

The first smart wheelchair that is commercially successful in North America is likely to be marketed as a device that can be operated independently indoors, but must be controlled by an attendant outdoors or in unmodified indoor environments. For adults, independent mobility is an important aspect of self-esteem and plays a pivotal role in "aging in place." However, as sensor technology improves, the environments in which smart wheelchairs can safely operate will continue to expand.

1.1. Smart wheelchairs

A smart wheelchair typically consists of either a standard power wheelchair to which a computer and a collection of

sensors have been added or a mobile robot base to which a seat has been attached. Smart wheelchairs have been designed that provide navigation assistance to the user in a number of different ways, such as assuring collision-free travel, aiding the performance of specific tasks (e.g., passing through doorways), and autonomously transporting the user between locations.

There are several advantages to integrating the smart wheelchair technology into the underlying power wheelchair. To avoid obstacles, smart wheelchairs need sensors to perceive their surroundings. By far, the sensor most frequently used by smart wheelchairs is the ultrasonic acoustic range finder (i.e., sonar). Sonar sensors are very accurate when the sound wave emitted by the sensor strikes an object at a right angle or head on.

Currently, only two smart wheelchairs are based on manual wheelchairs-

i. The Collaborative Wheelchair Assistant (manual) [18] controls the direction of a manual wheelchair with small motorized wheels that are placed in contact with the wheelchair's rear tires to transfer torque to the rear wheels.

ii. The SPAM uses pushrim-activated, power-assist wheelchair hubs in place of traditional rear wheels [19-20].

a) Manual Wheelchairs

These are the type of devices that help a person to move him without any assistance of battery. There are three types of manual wheelchairs namely self-propelled, attendant propelled, and wheelbase. A single-arm drive enables the user to turn either left or right while the two-armed drive enables user to move forward or backward on a straight line. Another type of wheelchair commonly used is a lever-drive wheelchair. This type of chair enables the user to move forward by pumping the lever back and forth [1].

b) Electric Wheelchairs

A power chair can be used by someone who hasn't got the dexterity or mobility, perhaps, to drive a mobility scooter due to arm, hand, shoulder or more general disabling conditions, and do not have the leg strength to propel a manual chair with their feet. Powered wheelchair can offer various powered functions such as tilt, recline, leg elevation, seat elevation, and others useful or necessary to health function [1].

c) Standing Wheelchairs

'Redman power chair', it is the world's highest quality standing wheelchair. People with spinal cord injury can reap the health benefits of standing wheelchair. Physical benefits of standing wheelchairs are

- Decrease urinary tract infection problem
- Improver blood circulation around the body
- Standing exercise greatly improve bowl function
- Wheelchair helps distribute your weight and improve healing bed sores
- Decrease the amount of muscle stiffness
- Increase bone density

d) Pediatric Wheelchair

These types of wheelchair provide a key-enabling technology to young children who would be unable to navigate independently in their environment. Standard powered wheelchairs are still heavily dependent on the cognitive capabilities of users. Unfortunately, this excludes disabled users who lack the required problem-solving and spatial skills, particularly young children. For these children to be denied powered mobility is a crucial set-back; exploration is important for their cognitive, emotional and psychosocial development [3].

e) Stair Climbing Wheel Chair

The stair-climbing wheelchair exists at present can be grouped into 3 categories: - continuous stair climbing wheelchair, intermittent-stair climbing wheelchair and auxiliary stair climbing wheelchair. Continuous stair climbing wheelchair has only one set of supporting device, the wheelchair relies on this supporting device for continuous motions. In Intermittent stair climbing wheelchair the process of climbing stairs of is similar to the people climbing up and down stairs, it is also called walking stair climbing wheelchair. Intermittent stair climbing wheelchair is one of the supporting devices that elevate the wheelchair and other set of support system. In auxiliary stair climbing wheelchair, the attachments rely on another device installed on the wheelchair and it needs assistance to help realize the function of climbing stairs. Stair lift requires wide stair way which is very expensive [4].

3. PROPOSED MODELLING

Proposed method is controlling of the wheelchair by the eye movement tracker. Eye movement controlled wheelchair is to enable complexly paralyzed patient to make their life more accessible and to provide them opportunity of independence and movement. However, to steer own wheelchair through a conventional joystick is difficult for people experience total paralysis in all four limbs ,such as muscular dystrophy , spinal cord injury , amyotrophic lateral sclerosis, etc. The idea of eye control is of great use to not only the future of natural input but more importantly the handicapped and disabled. People who are unable to walk and are using wheel chairs exert great amounts of energy using physical strength to turn a steer the wheels. With eyesight Bering their guide, the disabled would save being their guide, the disabled would save energy and

could use their hands and arms for other activities. To design a system that detects the image input. To design or create a browser which is used for mainly visibly impaired people. The signals pass the motor driver to interface with the wheelchair itself. The motor driver will control both speed and direction to enable the wheelchair to move forward, left and right. Camera captures the image. Focus on eye in image by open cv code. Pupil detection will be done by open cv code .Raspberry pi board use in this research. Raspbian OS install the open cv and USB camera configuration. The position of pupil. Then the different position will be use the different motion for wheelchair. Like motion of wheelchair left, right, and forward. Result of digital image will be send to GPIO pins. And that pins are connected to motor by NPN transistor to control the motion of wheel of motors.

The principle behind this prototype is based on eye movement technology. The need to design this application is specifically for physically paralysis people. This system designed by Linux operating system. In Linux environment any application is able to run at a quite faster rate. Linux based raspberry pi module will be very efficient to overcome the requirement. There are many Linux based OS is sufficient for my research work and has some advantage to use this. Linux is user-friendly. For a beginner it is an absolute test. We decided to use the web camera to detect the eye movements which will be further processed to drive the motors. For the simplicity and to make a prototype, we are going to design a small, motorized, wooden platform and we will attach the web camera on the chair. We will use wireless communication to communicate between the camera and the Arduino microcontroller by Bluetooth. The Arduino microcontroller will be placed on the wheel chair which will be connected to the motors, driving the wheel chair in the direction the person sitting on the chair desires to move in.

There are two major components from the system design standpoint –

a) Eye-Detection and motion tracking.

b) Arduino controlled Wheel Chair.

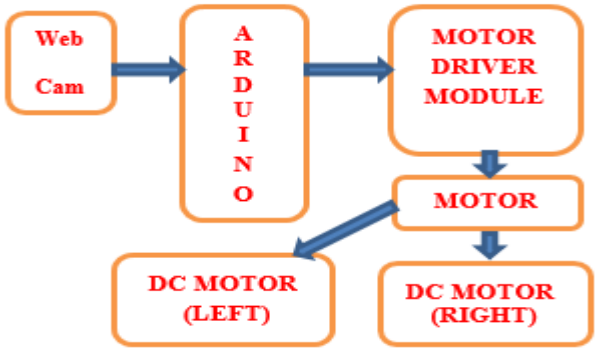

Figure3.1:-Block Diagram Showing Component Assembly

4. METHODOLOGY AND HARDWARE REQUIREMENT

The wheel chair model design illustrated here is a well-equipped and flexible motorized wheelchair for paralytic and motor disabled patients to drive the wheelchair without straining any of their physical posture. The System's functional block diagram is illustrated in below figure-

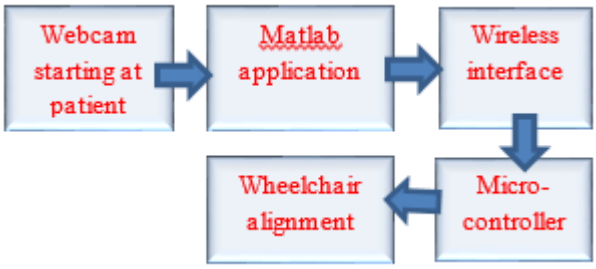

Figure 4.1: Block Diagram

The gaze movement is tracked autonomously and the wheelchair is directed according to the eye position.

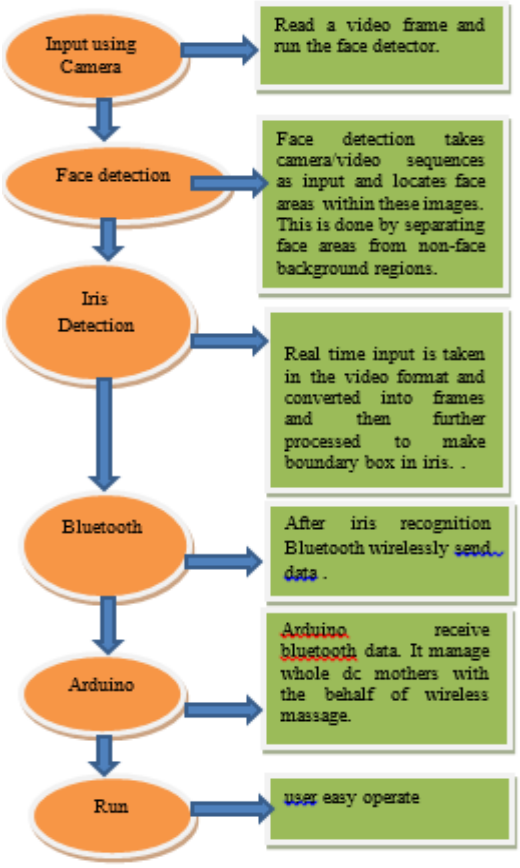

Figure 4.2: Flow Chart Showing The Methodology In Details

It is an eco-friendly and cost-effective wheelchair that dissipates less power and can be fabricated using minimum resources. System has been designed taking into consideration the physical disability, thus it won't affect the patient physically. Obstacle and ground clearance sensing is performed to ensure patient's safety. Audible notification for the obstacles has been provided.

The hardware requirement for this wheel chair assembly is very simpler which gives a perfect solution for all those previously designed complex module in the past.

1.2. Hardware Requirements

a) Bluetooth

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup.

b) Arudino

Arduino is an open source, computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.

c) Ultrasonic Module

An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object.

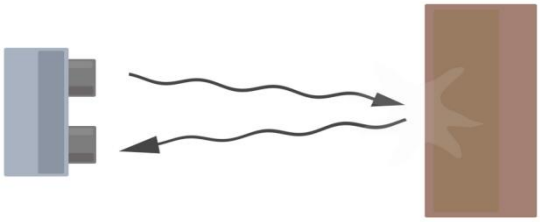

Figure: Diagram of the basic ultrasonic sensor operation

5. RESULTS AND ANALYSIS

1. Initialization: - Initially we set up the wireless communication that will be used later for the interface between MATLAB and the controller, the video capture and the program variables.

2. Image and Video Processing: We then take continuous video frames and sample the input and save it as the screen shots. Each frame is then converted into the black and white frames. For the accurate results, we perform contrast stretching on each frame to make the dark region darker and bright region brighter. This will enable the detection of the eyes better.

3. Estimation: Now, after working on the each frame we try to detect the eyes. This we do by estimating the position of left as well as the right eye. Thus, we set the threshold and detect the position of the eyes which can be used for the further processing.

4. Detection: Now, in this step we actually detect the eye movements. The idea is to compare the current position of the eye with the previous position. Thus, the difference in the coordinates will help us to predict the motion in the particular eye. But sometimes, it may be possible that only one of the either eye will be detected. In that case, we will give preference to the eye that is detected currently.

5. Error Handling: To avoid detection errors, we incorporated an error handling mechanism, which specifies a threshold for the height and width of a valid eye, by calibrating it for the user. If the detection results give a height and width value lesser or greater than the threshold, the value is voided and not considered for the decision making.

6. Motion: Now after detecting the eye movements, we have to come up with a decision algorithm that will help the controller to drive the motors accordingly:

a) Valid Left:- The decision to turn left will be considered as valid if the eye turns left and stays there for a cycle. This action

will be detected as a left turn request. After that, the patient will turn right to again look forward. Thus, this signal should be considered as void.

b) Valid Right: Similarly, the decision to turn right will be considered as valid if the eye turns right and stays there for a cycle. This action will be detected as a right turn request. After that, the patient will turn left to again look forward. Thus, this signal should be considered as void. c. Valid Straight: The signal to go straight is when a person looks left and right or right and then left. This will be detected as to go straight.

7. Safety Considerations: Given the application of the system, we incorporated a safety mechanism, wherein based on the blink detection the wheel chair halts. If the user wants to halt the wheel chair in case of an emergency, he can blink thrice, causing the wheel chair to halt. 8. Serial Communication: Now according to the detected command, the MATLAB application will transmit 0, 1 or 2 for left, right and straight respectively to the controller which will drive motors.

6. CONCLUSION

The idea of eye controls of great use to not only the future of natural input but more importantly the handicapped and disabled. One of the main goals for Eye Movement controlled wheelchair is to enable completely paralyzed patients to make their life more accessible and to provide them opportunity of independence and movement. This system embedded on Raspberry pi. This thesis aim is wheelchair controlled by eye movement. Then the camera capture the image and focus on eye in image .the center position of pupil will collect then the different value of X,Y coordinates will be set for different commend, like Right, Left ,Forward and stop. Then signals pass to the motor driver. It controls speed and direction of DC motor. DC motor move Right, Left, Forward and stop.

7. FUTURE SCOPE

The highlighting merits of mind controlled wheel chairs are that they respond to signal commands much faster and that persons who have lost their ability to speak may able to use them. A bci based wheelchair is being developed for severely disabled and challenged person to move them independently, without any human assistance, even though there are many number of ways for make functioning a wheelchair for example, voice controlled, using gestures, using eye movement or using joystick etc. since they cannot be used by stroke patients or paralyzed patients .

A thought based wireless wheelchair controlling system is being constructed for paralyzed and disabled people to make their daily life, a problem free. Essene algorithm is proposed in which two methods are there, namely, attention metric method and blink strength method.

The attention signal is used for making sidewise movements of the wireless wheelchair through clockwise rotation and eye blink strength is used for achieving forward and backward movements. The level analyzer technique is implemented in signal processing and the wheelchair can be controlled by arm microcontroller. The wheel-chair controlling system can be further improved by removing artifacts and noise level accurately in brain wave signal processing and focus on additional improvement of the identification of irregular eye blink so that the wheelchair can be operated and controlled efficiently without any collision.

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