Smart Wheelchair System

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Abstract- *A smart trolley (ST) is a power trolley (PT) to which computers, sensors (Proximity Inductive), and assistive technology (Arduino Controller, Bluetooth) are attached. This paper aims to provide a complete state-of-the-art overview of ST research trends. We expect that the information gathered in this study will enhance awareness of the status of ST technology. The proposed system is designed to provide better service for the patients, kids and aged people. It consists of a trolley provided with DC Geared Motors which is controlled through Android App or Voice Command. The trolley is sent and received where it is utilized by providing the needy by medicine, food and other supplies. This makes the aged one or the needy partially independent, still there must be a person to place the supplies on the trolley.*

Keywords- Smart Trolley (ST), power trolley (PT), Sensors, Assistive Technology (Arduino Controller, Bluetooth)

I. INTRODUCTION

The main objective of the project is to serve rebidded people who are completely dependent on their care-taker. Now days there are many home care centers where nurses or some care taker are sent to the needy by hiring them. Usually these home care centers are not afforded by all the people as it becomes a little costlier. This "Smart Trolley For Medication And Health Care" provides an opportunity for the person who in need of medication, food and other supplies time to time on the daily basis making them partially independent by reducing the work load of the care taker. As it comes to a daily basis system the person knows well about the time of the medication and other required supplies for him and accesses the device for himself by using an open source application where one can easily make use of the device. The Smart Trolley consists of a trolley which is the main equipment used for serving the rebidded people or the needy. It can also be used to serve old people having difficulties. The device is operated through an app which is connected to the equipment through Bluetooth. The trolley has three wheels where the rear wheels are operated using motor and the front wheel is ancestor. The trolley is sent from one place to another which is a predefined path metal mounted. On reaching the destination alerts the care taker for the supply. There is enough time provided at the destination to place the supplements on the trolley and the trolley comes back the original place that is to the patient or to the needy. The time taken to travel and the halt time are predefined. There can be as many different paths to travel say room-1, room-2 and so on. The trolley is also provided with shelf where the frequent requirements are kept. Being easy to operate by all age people with various option provided it is adapted easily and bought into use. The operating modes range from autonomous to semiautonomous depending on the abilities of the user and the task at hand.

There are four types

- Machine learning
- Following
- Localization and mapping
- Navigational assistance

A. Machine learning

What makes a wheelchair smart is not just a collection of hardware, but specialized computer algorithms that provide the artificial intelligence needed to make split-second decisions about where the wheelchair is heading, and what might be in its way. Some examples of machine learning in SWs include the use of neural networks to detect obstacles [2], and reproduce pretaught routes,some use obstacle density histograms to combine information from sonar sensors, and joystick input from the user [3]; while others use rule based approaches.

B . Following

The ST can track the companion's body position/orientation using laser range sensors based on Kalman filter and data association estimate the guide's footprint. Based on position data of the footprint, a cubic spline generates a target path for the wheelchair. The wheelchair is controlled so that it can move along the guide footprint at a constant gap between the wheelchair and the guide. In another case, a new methodology was developed [4] that allows a wheelchair, which does not have a prior knowledge of the companion's destination, to move with companions collaboratively using a destination estimation model based on observations of human's daily behaviors. To serve a large group of people with disabilities at the same time, multi-wheelchair formation controls were developed to enable easy communication with companions [5]. Controlling the wheelchairs while maintaining formation is done by plotting a path p defined by the model trajectory, and then calculating a path for each wheelchair (p1; p2) a small distance from p [6], [7].

C. Localization and mapping

A major challenge is the development of a robust, reliable localization and navigation system in both indoor and outdoor environments. Since the ST needs to safely navigate on roads/sidewalks, it is required that the localization accuracy be within a range of a few centimeters. The main challenge for outdoor localization is that the global positioning systems (GPS) are not always reliable and robust, especially in tree covered environments. The GPS measurements are integrated with attitude information from the onboard inertial measurement unit (IMU) to enhance the localization accuracy. Moreover, the developed navigation system also fuses the GPS/IMU measurements with the wheel odometry information through an extended Kalman filter (EKF) design [8], [9]. Utilizing the odometry-enhanced fusion, the SW will achieve high-accuracy localization even in GPS-denied environments [10]–[12]. the time sequence (T1- T5) illustrates the ST advancing into a previously uncharted room, continuously building a map, and keeping a record of obstacles for later reference when they are out of range of vision. Between frames 1 and 2 the pilot turns side to side to collect data.

D. Navigational assistance

An elegant application of semi autonomous obstacle avoidance was accomplished by Rofer et al. 2009 13] for a rear wheel drive ST, where the front active castor wheels are always rotated by motors to match the orientation of the current driving direction. Viswanathan et al 2011. [13] run multiple processes in a distributed fashion on a Nimble Rocket TM that serve people with visual impairments particularly well.

Collision Detector: detects frontal collisions and stops the wheelchair if an object is detected within a distance of approximately 1 meter, preventing motion in the direction of the obstacle through the controller.

Path Planner: given a global map of the environment and initial position estimate, visual odometry produce the optimal route to the specified goal location. The trajectory is analyzed to determine deviations from the optimal route as well as upcoming turns

Prompter: uses a Partially Observable Markov Decision Process (POMDP) to determine the optimal prompting strategy. Specifically, this module estimates the users' ability level to navigate to the goal independently based on past errors, and responsiveness to prompts in order to select appropriate audio prompts to assist the users in navigation. In each operating mode, a huge number of achievements have been made to improve the ST's functionality. Due to current sensor capabilities limiting autonomous navigation to indoor environments, combining all of the above advancements can result in autonomous navigation through all environments.

II. WORK PLAN

A. SMART TROLLEY / WHEEL CHAIR FOR MEDICATION AND HEALTH CARE

- The program is loaded into the arduino Uno and it is interfaced with smart phone using Bluetooth module (HC-05)
- The electronic hardware such as L298 Driver, HC- 05 Bluetooth module, Ultrasonic sensor, Buzzer, DC Motor, Inductive proximity sensor are interfaced with arduino
- The input is given through open source application and the trolley operates accordingly
- The trolley comes to the original position after carrying necessities
- The trolley is operated for different cases and required changes can be done accordingly

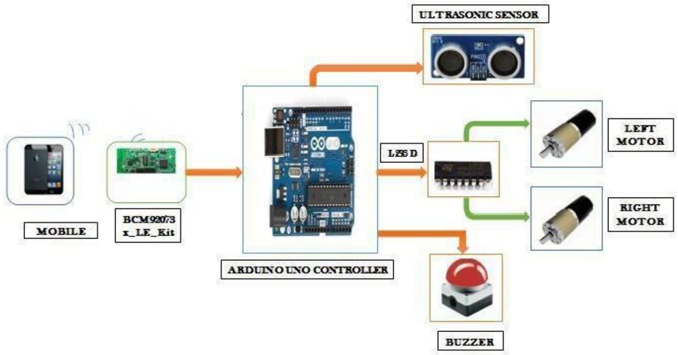

Fig.1

The block diagram consists of Arduino Uno, HC-05 Bluetooth module, Ultrasonic sensor, Buzzer, L298D Driver and Motor. The entire circuit is interfaced with mobile phone using HC- 05 Bluetooth module. The input is given through mobile phone and is processed by arduino Uno. The L298D driver drives the motor according to the input given to the processor. The buzzer is provided for two purpose, one on reaching the destination and another on case of any obstacle in the path. The ultrasonic sensor detects the obstacle and the path is detected by proximity inductive sensor.

B. TROLLEY/WHEEL CHAIR WITH HEALTH MONITORING SYSTEM USING IOT

The controlling of the Trolley/wheelchair is through an android application which is connecting via Wi-Fi module and through a manual joystick which is fixed on the hands of the chair, using these two will decrease the dependency of user on another person. We have also equipped our chair with infrared sensors which will help to avoid accidents happening due to obstacles. Sensors will respond to the nearing obstacle and eventually commands will be forwarded to the microcontroller (ATMega328) enabling desired further motion. This system also includes a health monitoring system which monitors health of the user and forward that to the application.

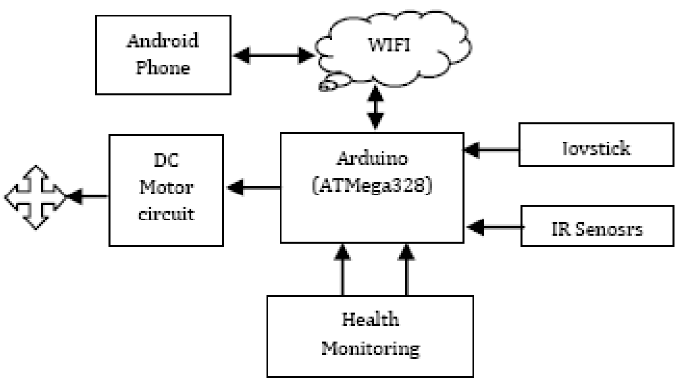

Fig.2

C. SMART MOBILE HEALTHCARE SYSTEM BASED ON WBSN AND 5G

The basic functions of a smart healthcare application include ECG waveform and display pulse and oxygen in blood [26], body temperature [27], [28], etc. Also through smart phone screen or printed paper media, indication as well as simple user interface through buttons. More features, such as patient record storage through convenient media, multiple levels of diagnostic capabilities are also assisting doctors and people without specific trainings to understand how to use smart IoT healthcare application and their indications conditions.

Smart wireless body sensors networks (WBSN) are applications that measure Pulse and Oxygen in Blood. Results can be saved for future reference and track of multiple people with individual profiles can be kept, this application has access to the following:

Wireless network communication, Full network access, allows the application to create network sockets and use custom network protocols. The android interface receives data from WBSN through Wi-Fi, ZigBee or Bluetooth, so this permission is required to send data through the Web. The access to Bluetooth, ZigBee or Wi-Fi settings, allows the application to configure the local device, and to discover remote devices. Network allows the application to view information about network connections such as which networks is connected.

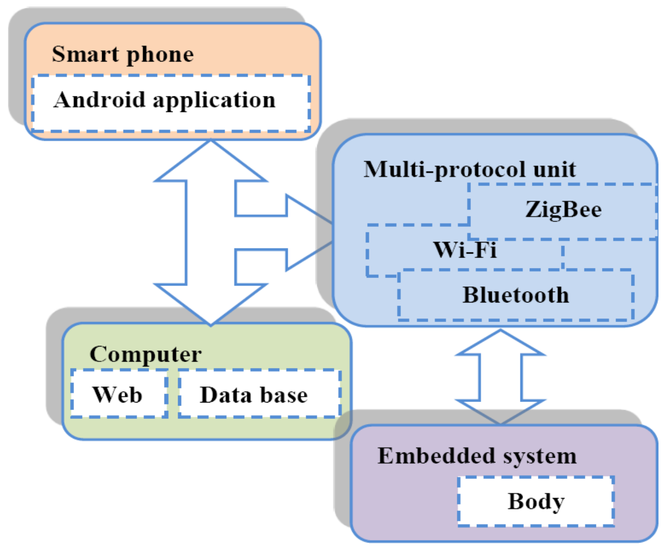

Fig.3

D. SMART TROLLEY/WHEELCHAIR FOR DIFFERENTLY-ABLED PEOPLE USING BIO-SIGNALS

Rehabilitation devices have been an integral part of the differently-abled people's life since time immemorial. Various mechanical rehabilitation devices have been developed so far. We aim to construct a Trolley/wheelchair which would be controlled by eye winking and would enable those unable to move their limbs to control and manoeuvre their wheel chair.

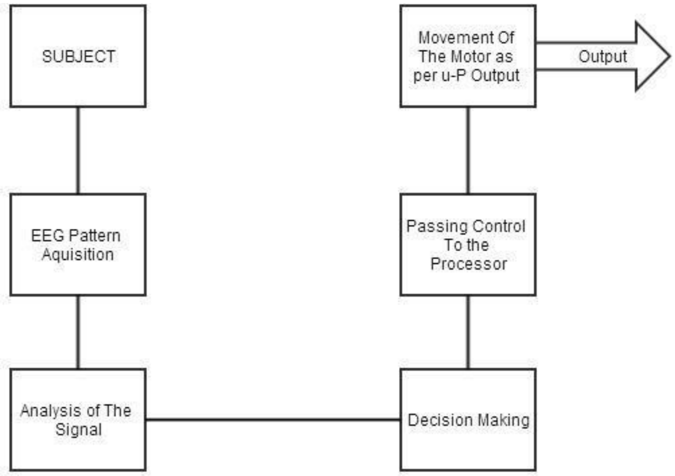

Fig.4

This project is one small step forward in the vast avenue of "Human Machine Interface" (HMI). There are various biological signals emitted from the human body viz. EEG, EOG, EMG etc. In this project our main focus is on the acquisition and analysis of EEG waves so that it can be used as an input to drive a D.C motor which in turn drives the subject's wheelchair.

The idea is based on the fact that whenever we wink or close our eyes, our eyeball moves in the upward direction in the socket and thus a substantial potential difference is obtained in our EEG pattern thereby making the data set computable for further calculations.

One point to be noted here is that the project deals with the sheer control of wheelchair in the four cardinal directions i.e. forward backward right and left and does not Endeavour to develop any other sort of motions.

V. LINE FOLLOWING TROLLEY

The main objectives of the line following trolley is

A. Save man costs

Wages are one of the major costs of operating a business, especially in hospitality industry which involves plenty of personalized services. Replacing men by machines for simple jobs like delivery could reduce costs incurred. Time can also be saved for staff to travel around.

B. Provide accurate and reliable services

The trolley can travel on a fix route and locate the positions where it is required to stop. For example, a trolley can travel on a hospital floor and stop in front of each room. The positioning is accurate and the route is rather fixed. As routine work is quite simple and standard, a programmed machine is able to finish the job without having human careless errors. This provides reliable services for users.

C. Adapt to different purposes

The machine should have a flexible design for adapting to different usages. For hospitals, the machine can be used to carry bed sheets, towels, toiletries and clothes. For hospitals, food can be delivered to patient's table with satisfied temperature if heating plates are installed on the machine. In this case, the machine can be served as temporary oven as well. For elderly care centers, machine can be modified into a bigger size with powerful motor for transporting heavy medical equipment like blood pressure machine and electrocardiogram machine. A trolley can simply satisfy different purposes conveniently. Therefore, a model car is used to demonstrate instead of using a real trolley with high power motors for carrying heavy load. It is believed that the same idea can be adapted to different kinds of usage with some modification. Most of the design is based on the idea of human following robot, which the trolley can follow human with luggage loaded.

There are two kinds of algorithms are used for developing line following trolley

A. Linear model Algorithm
B. PID Control Algorithm

A. Linear model Algorithm

There are two sensors**.** The line can be sensed by both the sensors. If both sensors sense the line, the robot goes forward. The robot turns left if the left sensor detects the line, and vice versa (below Fig)

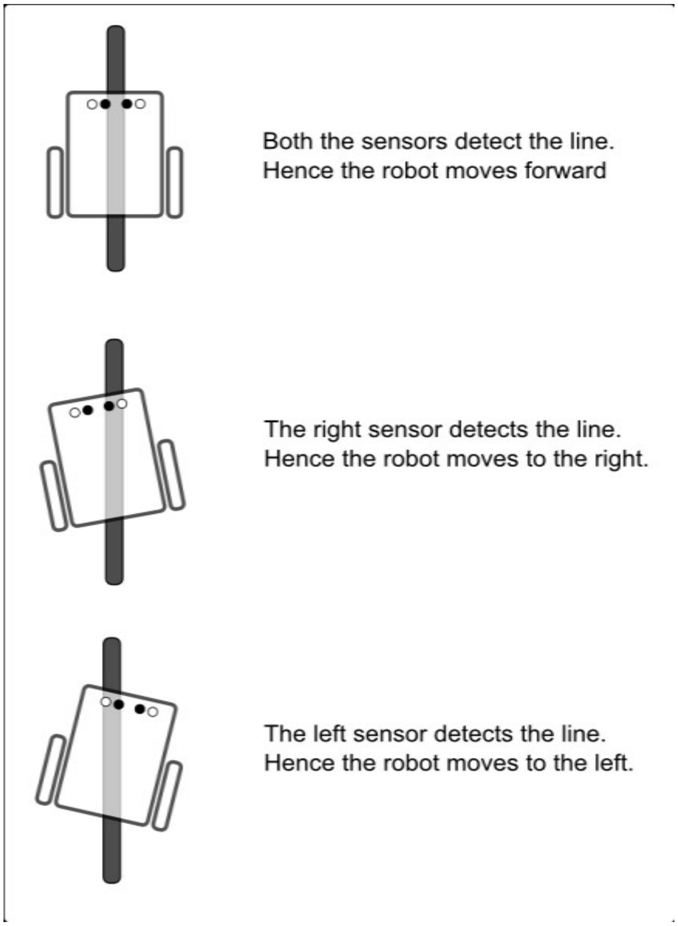

Fig.5

B .PROPORTIONAL INTEGRAL AND DERIVATIVE (PID) CONTROL ALGORITHM

A more practical algorithm is called PID control. It is a common loop feedback control used in many control systems. It needs not to sway very much in order to keep its center in line with the track as well. The robot would move more smoothly and stable. Therefore, it improves efficiency and saves power. The mechanism is to unceasingly calculate the error value and tries to reduce the error over time by adjusting some controllable items, which means the motors of the robot in this case. Error represents the distance between the acceptable setpoint and the actual position of the robot from the line.

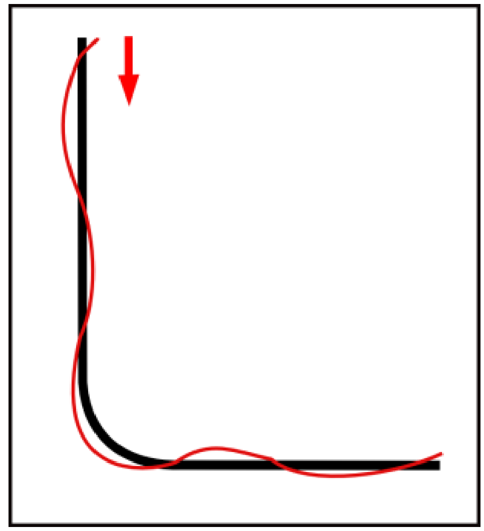

FIG. 6

SYSTEM STRUCTURE

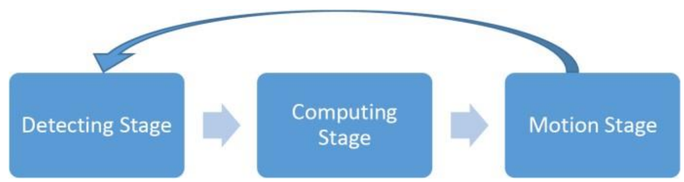

Fig.7

Detecting stage represents the process that how the robot recognizes the line which it has to follow. IR sensors are responsible to detect the line and translate the voltage into signals. Then signals are sent to the microprocessor for calculation. In computing stage, the microprocessor runs the dedicated programme and computes the movement it should be done in order to keep the trolley on the track. Lastly, the motion stage states what movement the robot would do. It depends on the results done in computing stage. After the robot makes a movement, the sensors continue to keep tracking the line, which takes back to detecting stage. It is a loop of process which runs continuously, so that the robot keeps following the line until it is told to stop

VI. FUTURE WORK

A study conducted by Worcester Polytechnic Institute (WPI)[15] showed that users who are accustomed to their wheelchairs have little to no tolerance for the failures of “new features,” which means full autonomy plays an important role in users’ acceptability. Overall, people are open to using a robot that assists them in performing a task in an environment with other humans. These”Co-robots” provide their user with independent mobility. STs have to be safe and their operations must be reliable under any conceivable circumstance. This is especially true for STs, where the user has a disability and may be quite frail. To emphasize these trends, we propose and discuss the following future directions which would be the priorities for ST research.

A. Autonomous Navigation

Current PT users still have many difficulties with daily maneuvering tasks , and would benefit from an automated navigation system. Future ST users will be able to select from several autonomous or semi-autonomous operating modes, using the input methods they are most comfortable with. They will direct their ST to navigate along preprogrammed routes with little physical or cognitive effort indoors and out, passing through doors and up-and-down elevators. The ST will communicate with the user when it is appropriate in order to reduce anxiety, and build an individualized profile. These profiles will track such variables as preferred input method, wheeling speed, turning speed, and amount of verbal feedback, just to name a few.

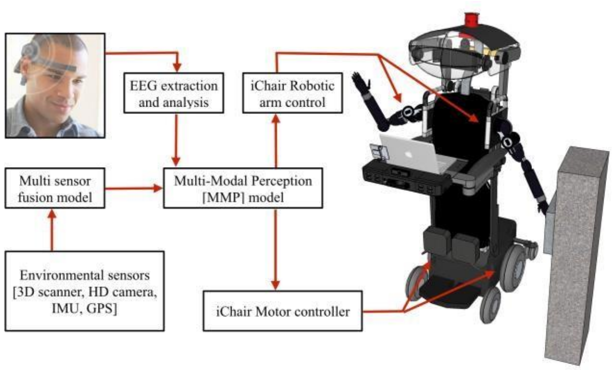

Fig.8

One of the downsides of the earlier work in STs and autonomous driving [16] has been that the environment had to be permanently modified in order for the wheelchair to navigate independently. Future research plans should focus on developing novel navigation algorithms to allow STs to autonomously and safely navigate in complex environments. These are not trivial tasks since they require online calibration and sensor fusion of multiple sensor sources including laser scanners, camera, IMU, encoder and GPS, etc. Fortunately, the navigation algorithms developed for STs could inherit the advanced performances of previous works on autonomous navigation for the robots and or autonomous cars.

B. Human-Smart Wheelchair Interaction Model

The human-ST interaction model plays a vital role in the formation of a ST. The reinforcement learning technique [17], [18] could be utilized to build an efficient interaction model between user and ST. The developed model may take into account sensor feedbacks, such as from Emotive sensors and various environment sensing sensors including Oculus virtual reality sensors, laser scanners, cameras and global positioning system (GPS). The ST uses these control signals to navigate and operate its robotic arms. Human user thinking will be captured and analyzed through an advanced signal processing model. The output signals will control the operations of the ST including wheel motors as well as robotic arms. A shared control scheme could be developed to allow effective collaboration between user and ST, as well as to adapt ST's assistance to the variations in user performance and environmental changes.

A real-time Multi-Modal Perception (MMP) model should be used to deal with uncertainty in sensing, which is one of the most enduring challenges. The perceptual challenges are particularly complex, because of the need to perceive, understand, and react to human activity in real-time. The range of sensor inputs for human interaction is far larger than for most other robotic domains in use today. MMP inputs include human thought, speech and vision, etc., which are major open challenges for real-time data processing. Computer vision methods processing human-oriented data such as facial expression and gestures recognition will need to be developed to handle a vast range of possible inputs and situations. Additionally, language understanding and dialog systems between human users and STs have to be investigated MMP can obtain an understanding of the connection between visual and linguistic data.

C. Smart Wheelchair with Smart Home

SWs will be integrated into the smart home, providing a seamless user experience and control over all household appliances. When the users are outdoor a retractable roof will provide shelter from the elements, and additional safety at night while driving in traffic. Optical stereoscopic and spherical vision imagery will be combined with infrared laser data to produce a virtual point cloud matrix of the user's surroundings. Objects in the matrix are identified using machine vision, visual tracking, and gesture recognition algorithms. Localization information from the IMU and GPS, onboard data collected, and Bluetooth beacon data flooding public spaces, will all help guide the SW to a particular destination. It is a 3D rendering of a standing SW with a retractable roof and robotic arms that will allow users with disabilities of all types to independently perform many more daily living activities. We believe that given liability concerns, SWs in the future should be treated like PEVs that are registered and insured. Users should be certified, or licensed, for operation after passing a standardized wheelchair skills test .

VI. CONCLUSION

The proposed systems are made ease and helpful for the old age patient especially physically challenged people. This provide independent patient mobility for indoor tasks, such as moving to and placing a person on a toilet or bed, and lift assistance for tasks, such as accessing kitchen or other tall shelves. The smart mobile for healthcare system aims to help patients to consult anywhere doctors, and doctors to follow up patient's requests and data transformation using WSBN. Keeping in mind to serve the needy in user friendly manner, a simple android application is used for communication and control the trolly/wheel chair

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