SELF.M.A.TE WHEELCHAIR

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ABSTRACT

While the needs of many individuals with disabilities can be satisfied with power wheelchairs, some members of the disabled community find it difficult or impossible to operate a standard power wheelchair. To accommodate this population, several researchers have used technologies originally developed for mobile robots to create "smart wheelchairs" that reduce the physical, perceptual, and cognitive skills necessary to operate a power wheelchair. We are developing a Smart Mutatable Advanced Technology (Self.M.A.TE) wheelchair. This paper describes the design of a prototype of the Self. M.A.TE, which has been evaluated on wheelchairs.

KEYWORDS: *smart phone, rehabilitation, disability, smart wheelchair.*

I. INTRODUCTION

With the increase of elderly & disabled people, a wide range of support devices & modern equipments have been developed to help improve their quality of life. Some patients who cannot manipulate the wheelchair with their arms due to lack of force face major problems such as orientation, mobility & safety .There are various kinds of wheelchair which are being manufactured such as :-

1) Manual or self propelled wheelchair-It is normal chair arrangement having wheels which are present on both sides of chair and are dragged by patients manually and Joy-stick operated wheelchair in which joystick is used for operating the wheelchair.
2) Speech Recognition-It recognizes the verbal command given by patient and according to that wheelchair movements are controlled.
3) Image acquisition-It uses camera to detect hand movement and according to it movement occurs.
4) Sensor controlled- In this type of wheelchair sensors like accelerometer sensor and flex sensor are used.

Hence a wheelchair was developed rounding off all possible considerations:

1) It is user friendly technology that operates on variable user friendly modes.
2) Less force is required for operation i.e. single finger/voice/hand movement is enough to operate the wheelchair.

II. LITERATURE SURVEY

The PlayBot project started in the early 1990's to address limitations of assistive robotics of the time. Users controlled such systems through a long series of micro activations, which effectively relied on the user's vision to be an integral part of a closed-loop control system. This could be tedious, frustrating and, consequently, tiring; however it afforded the user some personal freedom. The motivating notion behind PlayBot is that a vision-based robot control system could replace the function of the user's visual system, in order to reduce the user's fatigue and frustration, while providing the same personal freedom. After applying all these 4 steps, we get a filtered image that contains only text regions. This idea continues to motivate the project today.

PlayBot's goals include: i) to use vision as the key sensing modality, as humans do; ii) for perceptual processing be task-directed, as it has been long established that task direction is a key strategy in reducing its complexity; iii) visual search, which we believe to be a critical precondition of most tasks that a smart wheelchair must perform; iv) safety and robustness in non-engineered environments, to minimize the need for caregiver intervention. Many important contributions were made towards these goals, during the early years of this project, including visual attention with A stereo head, gaze stabilization, 3d object search and active object recognition. However, until now, PlayBot did not exist as an integrated smart wheelchair platform.

Current smart wheelchair research projects range in their applications, capabilities and use of sensors. Some projects focus on users with cognitive impairments. The simplest typically employ bumpers and sonar for collision avoidance and sometimes follow lines and select a safe driving direction using joystick input and sonar readings, but often cannot navigate doorways. Some achieve better navigation by employing a laser rangefinder and IR sensors for obstacle-avoidance, wall-following and three-point turns. Many approaches specialize in safe navigation of highly dynamic environments, such as subway stations. Some systems perform landmark-based navigation and employ visual behaviours for greater autonomy. In contrast, PlayBot's goal is to perform visual tasks at a higher level of abstraction. Current approaches employ a variety of interface methods, such as touch-screen or voice recognition interfaces. Others detect eye movements via eye trackers either to guide the wheelchair directly with the direction of gaze, or to select menu items on a display. Facial expressions mimic and gesture recognition has also been used to as input. Additionally, "sip and puff" devices and single switches that are common in rehabilitation technology have also been used for smart wheelchairs. While our project employs a pictorial/iconic interface, PlayBot is not restricted to this: it is conceivable that a user could also construct sentences via such interface devices; for example, by composing sequences of saccades or sips and puffs.

III. SCOPE OF RESEARCH

While the needs of many individuals with disabilities can be satisfied with power wheelchairs, some members of the disabled community find it difficult or impossible to operate a power wheelchair. Moreover cases of patients on wheelchair are just not limited to paralysed patients. The user can be combination of paralysis, blindness, hands and legs fractured, musculoskeletal issues, balance problem, neurological issues, genetic disorders or Amputated legs and hands wherein the existing market products fail to resolve all the issues that reduce the physical, perceptual and cognitive skills necessary to operate a wheelchair.

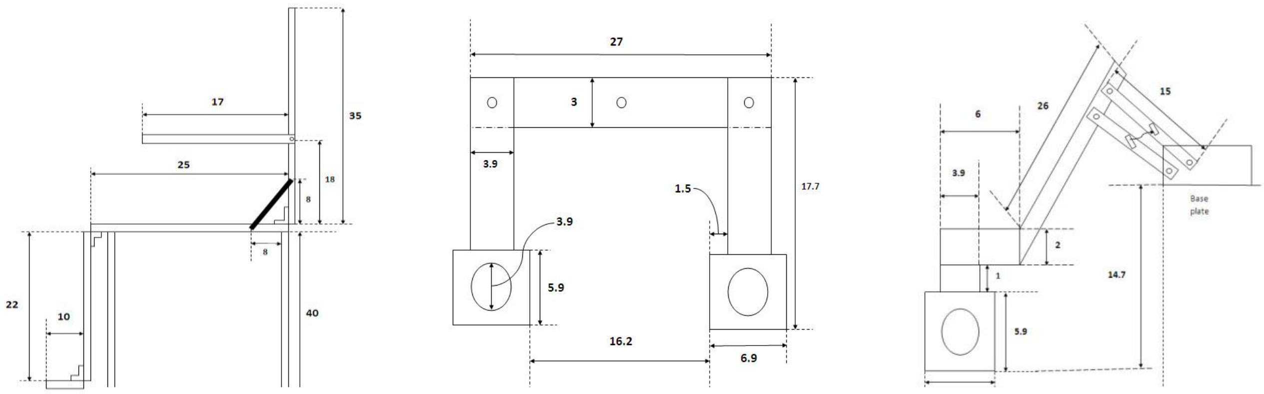
Keeping in mind our aim of helping patients in all aspects, study was conducted to determine how to collaborate easy functioning wheelchair with low cost. Hence a wheelchair was developed rounding off all possible considerations to get a complete package of simple design, low cost and user friendly operations.

- The self propelled part of conventional wheelchair was removed and replaced by smart features. The joystick operative mode was replaced by touch mode wherein user can navigate by giving touch inputs to a smart phone.
- The wheelchair consists of gesture based movement which counters various forms of paralysis or if the patient is unable to control the chair with fingers.
- The third mode is voice incorporated for patients who are physically disabled or have musculoskeletal problems.
- For patients who are blind or have neurological issues, computer controlled mode is available wherein a host computer monitors all the movement of chair. The location of chair with visuals is obtained through smart phone/camera mounted on chair. Also if patient falls ill suddenly while travelling; the location of patient along with his position is sent through GSM to emergency smart phone and PC mode can be enabled just by pairing up with the required id and patient can be taken to a safe place.
- Unlike all wheelchair products in market, this wheelchair does not just travels on flat, rough or slopes. It has reliable mechanism to climb/de-climb stairs without any effort by user or external human. This wheelchair is robust enough to carry the user through urban as well as rural pathways overcoming all types of obstacles.

- The wheelchair consists of three modifiable positions which includes chair position, bed position & relax position. The bed position helps the patient's burden to be reduced while being shifted from wheelchair to bed while sleeping; or in case there is bed shortage at paraplegic centres. The chair position is the conventional position while relax position is for user's comfort to read books, watch TV, etc. A timely medication reminder facility is also made available for patient's personal health care.

The smart phone technology has significantly affected the lives of human and hence this technology has been implemented as an integral part of this wheelchair as smart phones are available with at least 4.77 billion members across the globe. Smart features have been included to counteract various difficulties faced by a conventional wheelchair user. Overall this wheelchair system can prove to be beneficial for all grades of people in all fields relating to military, hospitals, paraplegic centre's or even domestically or during disastrous situations like earthquake thereby making a patient totally self-reliant and self-dependent with high reliability, comfort, care, assistance & optimal low cost.

IV. PROPOSED METHODOLOGY



(a) (b) (c)

Figure 1. Mechanical Design (a) Chair dimension (b) Centre bogie (c) Front bogie

Description:

- The basic structure of our project consists of microcontroller, motor driver, smart phone, PC/Laptop, power supply and motors. The main aim of this project is construction of wheelchair having a direction control through voice commands, touches or hand gesture.
- The touchpad comprises a smart phone. When pressure is applied to the capacitive screen of smart phone, an XY co-ordinate location is produced and transmitted with Bluetooth available on smart phone to Bluetooth module (HC-05) available on wheelchair and the wheelchair will move in the desired direction.
- A change in location of the pressure will result in a corresponding change in direction .The touchpad also has a neutral or no movement point which will ensure efficient braking. This is very helpful for paralysed and physically challenged people.
- Similarly, voice commands can be used as input to a decoder which converts a particular frequency of voice into digital bits for controller to process it and take desired action. Using voice operative mode the user can operate the wheelchair using pre-decided voice commands. The voice commands will be transmitted via Bluetooth available on smart phones.
- In hand gesture mode the user will be able to manipulate the wheelchair using hand movements. This is achieved by using accelerometer sensor available on smart phone which are used for gesture gaming.

The data, as above, will be transmitted via Bluetooth. In automatic mode, the wheelchair is controlled by a host PC to traverse the route. This is very helpful to navigate in places such as home or where user is fully paralysed. This feature can also be efficiently used if the patient feels ill and cannot regulate the wheelchair himself/herself. The patient will thereby be leaded to his/her home or paraplegic centre safely.

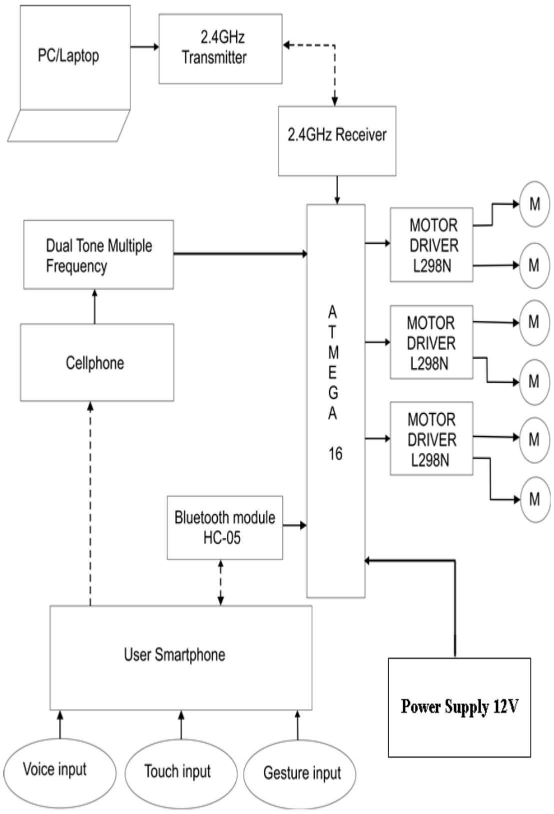


Figure 2. Main Block Diagram

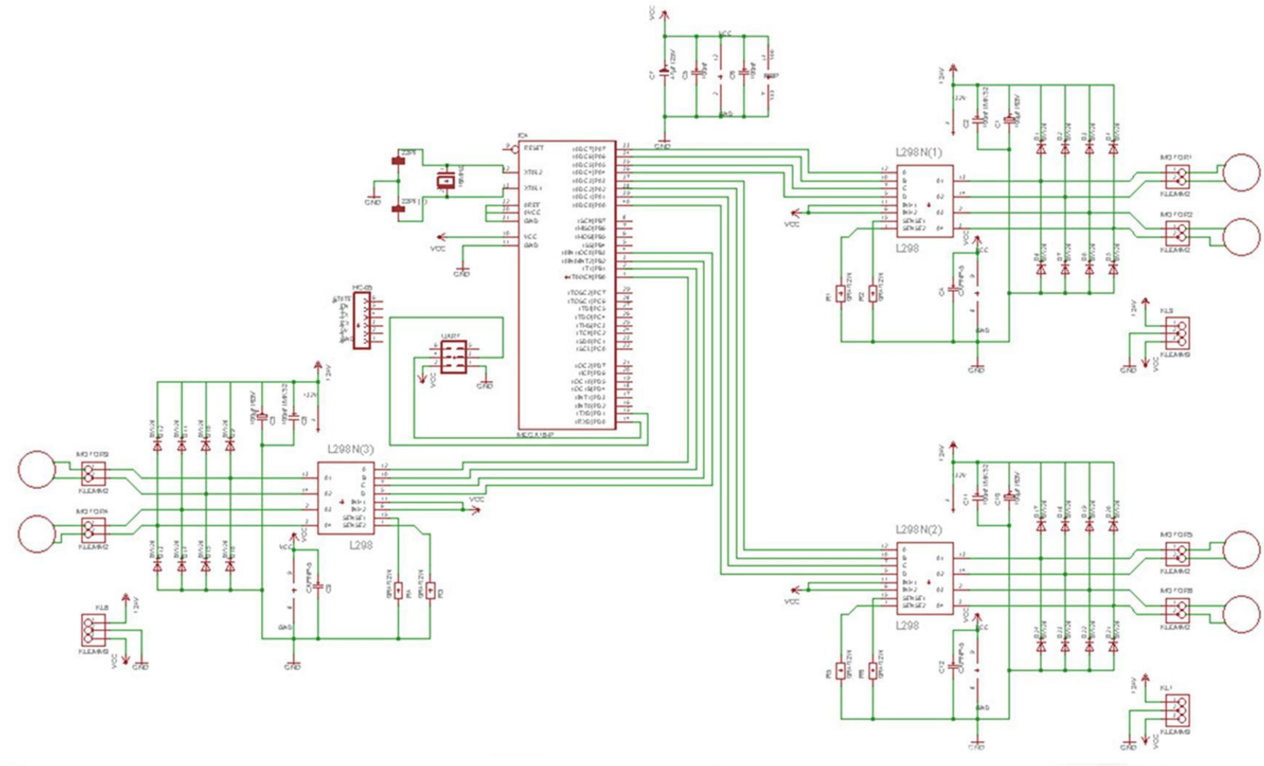


Figure 3. Hardware Schematic

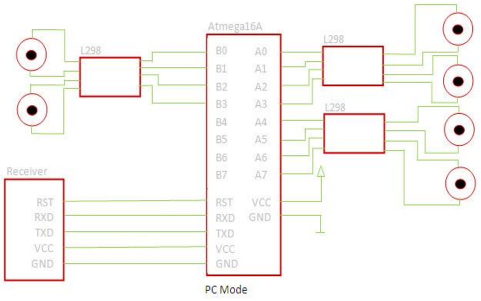


Figure 4. Simplified schematic of PC mode

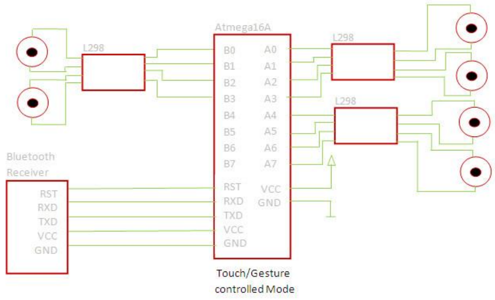


Figure 5. Simplified schematic of touch/gesture mode

Design Challenges

1. Minimal weight and size.
2. Reliable long term operation of all critical systems.
3. Ability to survive and operate in abrasive and dusty environment.
4. Safe utility in extreme radiation and thermal conditions.
5. Efficient power utilization and transmission.
6. Ability to manoeuvre in majority of terrains on Mars.
7. Modular systems that can be utilized across other missions.

The Shrimp rover is highly suitable for planetary exploration missions because of its unconventional wheel order, in-built passive adaptability and good ability to climb obstacles. It is a spatial multi-body system and a multi-variable, multi-parameter coupled non-linear system. Thus, kinematic and dynamic analyses for such systems are complex and time consuming. We propose the use of RecurDyn, a multi-body dynamics analysis software. Compared to other such softwares, it overcomes shortcomings like excessive simplification, low solving efficiency and bad solving stability. A potential application of this software in realistic modelling and dynamic simulation of the Shrimp rover is presented. Simulation results obtained from RecurDyn have been used to analyse the rover capabilities and select the actuators for the rover design. Simulation results are also validated experimentally. Thus, it is observed that an accurate and a reasonably fast simulation tool like RecurDyn has great potential in the field of space robotics.

4.1. Shrimp theoretical structure

4.1.1. Main body

We began the construction with a reasonably accurate (up to 0.5 mm accuracy) cut-out of 2mm thick aluminium plates, which form the top cover and the base plate of the rover. The shape of these twin plates is a square with a triangle appended on one of its sides. Thus, it's a pentagon, with the vertex of the triangle forming the rear of the rover. Fixed between the two plates, on either side, is an aluminium block, which has a pair of ball-bearings set into it. This block joins the two plates, serves as a column for load bearing and provides mounting points for the parallel bogies. The bearings on these blocks prove to be a revolute joint between the bogie and the main body. There are 2 other such blocks for mounting the front fork, while a plain, bearing-less block for supporting the rear fork.

4.1.2. Parallel bogie

It consists of a set of links, which form a couple of two wheels, mounted on a support that can freely rotate around a central pivot. We used C-section links to build the frame of the bogies. The C-section allows for the frame to be sufficiently light without compromising on its strength and rigidity. We used two different cross-section sizes for the C-section links such that amongst the two, the smaller one could be perfectly inserted inside the bigger one. The frame was so formed that no adjacent links were of the same cross-section, thus, permitting us to create a freely rotating revolute joint by merely using a rivet. It is advised to exercise caution during the manufacture of the two bogies, because they need to be greatly identical. Any mismatch between the twins will give rise to non-uniform travel of rover.

4.1.3. Front and rear forks

The front fork consists of a 4 bar mechanism robustly mounted on 2 aluminium blocks. In all, 4 bearings are used to move the fork. The front fork has a servo mounted on it, to assist in the steering process. It does so by rotating the wheel about an axis passing through the wheel centre perpendicular to the ground. The rear fork is a fixed link, at the end of which a wheel is mounted.

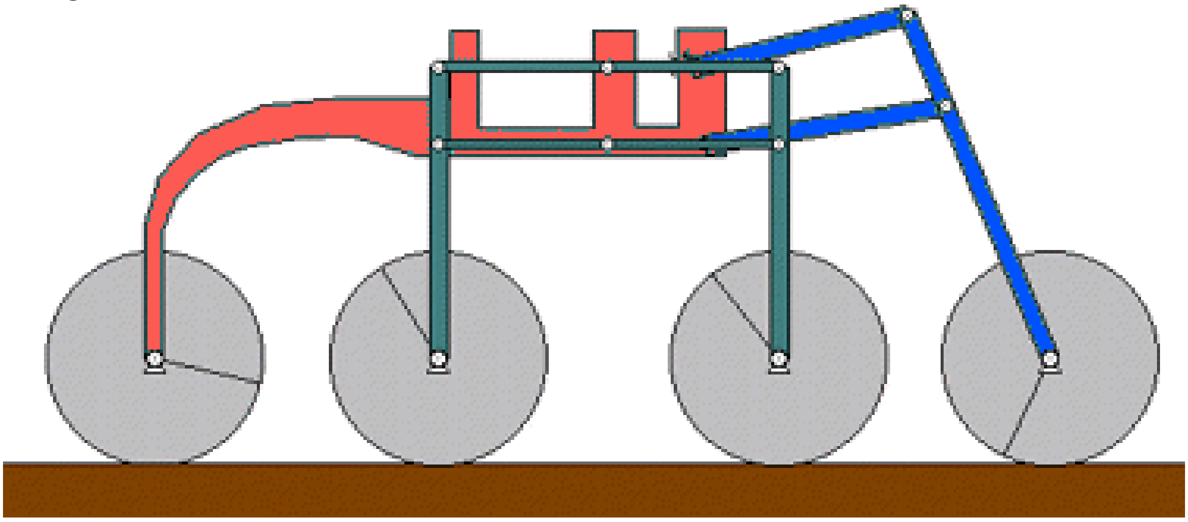


Figure 6. SHRIMP rover structure. RED: Main body, GREEN: Parallel bogie, BLUE: Front fork

V. EXPERIMENTAL RESULTS

- According to the structural design and mechanism the wheelchair is able to climb stairs and trespass small obstacles like stone, pot holes etc. easily. As per the height adjustment mechanism, user should be able to adjust height manually whenever it is required.
- In touch mode when an input is given from a smart phone, the Bluetooth module available on wheelchair will receive the input and the wheelchair will move in the desired direction. A change in location of the pressure will result in a corresponding change in direction .The touchpad also has a neutral or no movement point which will ensure efficient braking. This is very helpful for paralysed and physically challenged people.
- In personal computer/laptop mode, inputs are given from PC through an application installed on a computer. The receiver attached to the wheelchair will receive the inputs and the chair will move in the desired direction. If ‘w’ or 8 on keyboard is pressed then wheelchair will move forward, if ‘6’ or ‘d’ is pressed then wheelchair will move right, if ‘4’ or ‘a’ is pressed then wheelchair will move left, if ‘2’ or ‘s’ is pressed then wheelchair will move backwards, if ‘s’ or ‘5’ is pressed then wheelchair will stop. Also it can be controlled with the help of mouse movement in the desired direction. This feature will help efficiently if the patient feels ill and cannot regulate the wheelchair himself/herself. The patient will thereby be leaded to his/her home or paraplegic centre safely by monitoring in-charge.
- In gesture mode when an input is given from a smart phone, the Bluetooth module available on wheelchair will receive the input and the wheelchair will move in the desired direction. When phone is tilted forward the wheelchair will move forward, if left tilt is given the wheelchair will move left and so on.
- Similarly, voice commands will be used as input to a decoder (DTMF) which converts a particular frequency of voice into digital bits for controller to process it and take desired action. Using voice operative mode the user will be able to operate the wheelchair using pre-decided voice commands. The voice commands will be transmitted via Bluetooth available on smart phones.

(a) (b)

(c) (d)

Figure 7. Implemented Prototype (a) Chair configured to rest position (b) Base of Self.M.A.TE wheelchair (c) Side view of Self.M.A.TE wheelchair (d) Top view of Self.M.A.TE wheelchair

VI. CONCLUSION

This innovative project will come in handy for various people around the world who can't walk or are partially handicapped & are blind. The design structured for this wheelchair is a comfortable one where the patient will have no issues with comfort. Overall this wheelchair has the ability to travel anywhere with no human efforts except giving it direction controls. It operates on battery which can be recharged. We have described the system which is driven by the latest up growing technologies and advanced algorithms. Though main focus is on human-machine system interface, further advancements can be done through more research. The interface and software can be modified and re-developed according to the need in future. Further advancement in the wheelchair are possible by decreasing the power requirements of the wheel chair or finding a way to automatically charge the battery with the help of motion of the wheel chair or solar panel .

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BIOGRAPHY

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