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DESIGN OF HEAD OPERATED WHEEL CHAIR

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ABSTRACT:
Electric wheelchairs are designed to handicap people. Unfortunately, these cannot be used by persons with higher degree of impairment, such as quadriplegics, i.e. persons that, due to age or illness, cannot move any of the body parts, except of the head. Medical devices designed to help them are very complicated, rare and expensive. In this paper a microcontroller system that enables standard electric wheelchair control by head motion is presented. The system comprises electronic and mechanic components. A novel head motion recognition technique based on accelerometer data processing is designed. The wheelchair joystick is controlled by the system's mechanical actuator. The system can be used with several different types of standard electric wheelchairs. It is tested and verified through an experiment performed within this paper. Another significant requirement is that a wheelchair has to respond rapidly and operate efficiently to the commands of the user, independently of the method used for giving these commands. For human-machine interaction human motion recognition is also used. In this paper, a microcontroller system that enables standard electric wheelchair control by head motion is developed. The paper describes a wheelchair for physically disabled people developed using head motion and manual operated buttons. The prototype of the wheelchair is built using a PIC micro-Controller, chosen for its low cost, in addition to its features of easy erasing and programming. Automation is the most often spelled term in the field of electronics

KEY WORDS:*RoboticWheelchair, Motion Recognition, Microcontroller System Prototype*

1. Introduction

Handicap are persons who are not able to use any of the extremities. The reasons for such decreased motion possibilities can be different: stroke, arthritis, high blood pressure, degenerative diseases of bones and joints and cases of paralysis and birth defects. Also, quadriplegia appears as a consequence of accidents or age. The patients with such severe disabilities are not able to perform their everyday actions, such as: feeding, toilette usage and movement through space. Depending on the severity of the disability, a patient can retain freedom of movement to a certain level by using different medical devices. There are two types of medical devices that enable independent movement to a person suffering from paraplegia. Those are exoscelets and wheelchairs. Both of these contain electronic systems to enable and improve person's movement ability both in outdoor and indoor conditions. Electronic systems, such as sensors, actuators, communication modules and signal processing units, are used to recognize the activity that the patient is trying to perform and help him carry it out in coordination with the commands given.

The application of the two mentioned devices is different. Exoscelets must provide body support, which makes them more complex. Also, an error in patient's command recognizing process can lead to very serious consequences – fall and, eventually, injury. Wheelchair operation is based on navigation, which, in this case, is defined as safe transport from the starting point to a given destination. The wheelchair, comparing to the exoscelet, are a more general medical device and a much simpler one. Thus, the wheelchairs are used more often . Nevertheless, only patients with healthy upper extremities (paraplegics) can successfully operate standard electric wheelchairs. The patients who cannot use any of their extremities (quadriplegics) cannot operate these . In such cases, when the patient is not able to use the standard control interface, other approaches are used. Through numerous research projects in this area, several different solutions have been developed, such as: SENARIO , VAHM , Rolland , SIAMO , Wheelesley , and omniwheeled platform .

Electronic systems in common for all these projects are sensors, signal processing units, software that translates user's commands into medical device actions. These solutions are dubbed robotic wheelchair. User can control the device via touchscreens and voice commands. Besides these, wheelchair control is also possible by eye movement and electro-miographic sensors. Such interfaces are Telethesis and EagleEyes . Detailed overview of these researches can be found in . For human-machine interaction human motion recognition is also used . In this paper, a microcontroller system that enables standard electric wheelchair control by head motion is developed. A prototype of the system is implemented and experimentally tested. The prototype consists of the digital system (an accelerometer and a microcontroller) and a mechanical actuator. The accelerometer is used to gather head motion data. To process the sensor data, a novel algorithm is implemented using a microcontroller. The output of the digital system is connected with the mechanical actuator, which is used to position the wheelchair joystick in accordance with the user's command.

2. Present Theory And Work

Till now days many physical handicap peoples are survive in the our country. Automatic wheelchair provide the comfort for this peoples. In colleges this type of wheelchair is used for the student. We provide the additional feature (android application operate) for working the chair with the help of this feature any person is operate the chair from the mobile. Powerchairs are generally four-wheeled or six-wheeled and non-folding, however some folding designs exist and other designs may have some ability to partially dismantle for transitfour general styles of powerchair drive systems exist: front, center or rear wheel drive and all-wheel drive. Powered wheels are typically somewhat larger than the trailing/castoring wheels, while castoring wheels are typically larger than the castors on a manual chair. Centre wheel drive powerchairs have castors at both front and rear for a six-wheel layout.Former President Clinton, Dean Kamen and the iBotPowerchair chassis may also mount a kerb-climber, a powered device to lift the front wheels over a kerb of 10 cm or less. Some manual wheelchairs may also be fitted with an auxiliary electric power system.

This can take one of three forms: integrated with the hub of hand-propelled wheels, so that any force on the pushrims is magnified by the drive system, or mounted under the wheelchair and controlled as for a powerchair, but with the motive force either transmitted to the main wheels via a friction drive system, or delivered directly through an auxiliary drive wheel. Some experimental all-terrain powerchair designs have been produced with tracks rather than wheels, but these are not in common use. Other experimental designs have incorporated stair-climbing abilities and Dean Kamen'siBOT design featured both stair climbing and the ability to 'stand' on its upended chassis via the use of advanced gyroscopic sensors. The iBOT was at one time a production model, but is no longer marketed.

a. Robotic Wheelchair Overview

Project a wheelchair intelligent navigation system is developed. In this case, robotic wheelchair provides two modes of operation: automatic and semiautomatic. While in automatic mode, the interface accepts user's commands. Upon command reception, the wheelchair defines its current position and the destination position. Then, the route from the starting point to a destination is defined. The wheelchair follows this route until the command is successfully performed. While moving according to the route, the wheelchair avoids obstacles, using the environment information gathered through ultrasound and infrared sensors. When in semiautomatic mode, user can interfere with the performance of the activity that the wheelchair defined according to the previous user's command. In this mode, the user can directly navigate the wheelchair over a specific route. VAHM project yielded autonomous wheelchair toprovide independent movement to patients that are not able to control standard electric wheelchair. Software architecture is divided in three levels: physical, local and global. Human-machine interface is used to interpret user commands. The local level implements detection of walls and other obstacles.

The global level enables route or object following, movement control, obstacle avoidance and route planning. The result of the project titled Bremen Autonomous Wheelchair is the robotic wheelchair Rolland. This wheelchair is developed so that the help of rout planning devices is used. It is characterized by fine tuning of the movement speed and automatic passing through door. Electronic system to navigate electric wheelchair is also developed within the SIAMO project. In this case, basic characteristics are: novel human- machine interface, ultrasound, infrared and video sensors, and advanced control and navigation systems. The user can give commands to this robotic wheelchair by face expressions. Wellesley is developed as a general purpose medical device. As such, the wheelchair offers several different operation modes. Each of these modes gives the user different privileges while operating the wheelchair. Namely, the wheelchair can be controlled by joystick (where the function of every joystick movement can be redefined), by several mechanical switches (the combination of which represents a predefined command) and by blowing tube (where the detection of air speed is enabled).

b. Motion Recognition

Motion recognition is a process in which a receiver recognizes user's motion. In this context, motions are expressional movements of human body parts, such as: fingers, hands, arms, head, face, legs. The purpose of these movements can be information transfer or the interaction with the environ- ments. Motion recognition is applicable in various fields: enabling children to interact with a computer, understanding sign language, medical devices development, navigation and manipulation of the virtual environment, tracking psychophysical condition of the driver in order to reduce the number of accidents, lie detection, etc. There are many different motion recognition approaches, of which the most common are based on hidden Markov models and based on artificial intelligence (fuzzy logic and neural networks) Besides in theoretical approach, motion recognition techniques also differ in devices used for implementation. Namely, in order to recognize significant motions, the information on these motions must be known at all times. In order to acquire these informations different recording systems are used. Standard input devices, such as keyboard or mouse are not suitable for this kind of human-machine interaction. Thus, the devices that record position and attitude of human body parts, skin susceptibility, face expressions and so on, are used. Motion recognition is a very intuitive way to interact with electronic devices, but there are technical difficulties. First of all, there is no standardized library in the field of motion recognition. Thus, in most cases the user has to define a personal motion library, the library of personalized motions. When using personalized motions, it is very hard to gather a large set of sample moves, needed for statistic methods application, such as hidden Markov models. A difficulty is also a fact that the recognition has to be done online (immediately) in order for such interaction to make sense. This fact affects the resources of the receiver – its characteristics have to be considered, such as processing power and, consequently, battery capacity. The most common motion recognition approach is based on computer vision techniques. These techniques are limited by their hardware (the cameras are necessary) and high processing power requirements (video processing). Inertial sensors, characterized by low power and low prices, have become available in recent years.

3. Head Motion Recognition Algorithm

Since a set of possible motions in this case is very small, the number of available commands is also very limited. Thus, the control system that we propose allows the user to give only four different commands: "forward", "backward", "left" and "right". This means that the set of motions to be recognized has only four members. The implemented algorithm relies greatly on this fact. The meaning of each of the commands is relative and depends on the present wheelchair state, Fig. 2. Namely, we define six different wheelchair states: "state of still", "moving forward – 1st gear", "moving forward – 2nd gear", "moving backward", "rotating left" and "rotating right". If the wheelchair is in the "state of still", the command "forward" will put it in the state "moving forward – 1st gear", and the command "backward" will put it in the state "moving backward". On the other hand, if the wheelchair is in the state "moving forward – 1st gear", the command "forward" will put it in the state "moving forward – 2nd gear", and the command "backward" will put it in the state "state of still", i.e. stop the wheelchair. Analogously, if the wheelchair are in the state "moving backward", the command "forward" will stop it.

Head motion recognition is based on the force measurements yielded by an accelerometer attached to the head. As mentioned, there are only four members of the motion set, which represent head leaned in four possible directions. This means that the algorithm needs to estimate when the head is leaned in one of the four directions. In other words, it is sufficient to read only the accelerometer data of two axes: in this case, x and y. The position of the accelerometer and the axes are defined in Fig. 3. The thresholds are accelerometer output values that the user defined at system startup. These represent the angles in all four directions by which the head needs to be leaned in order to issue a command to the system. These thresholds define borders of a region in three-dimensional space (Fig. 4) and the algorithm operation is based on estimating the head position relative to this region.

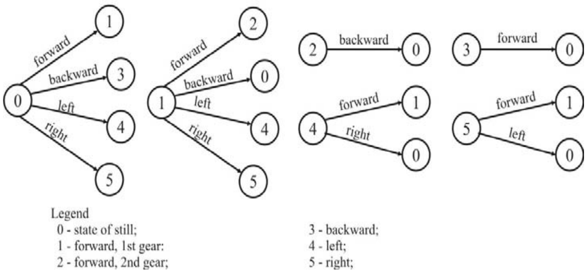


Fig 1.Wheelchair state diagram and relative meaning of user commands.

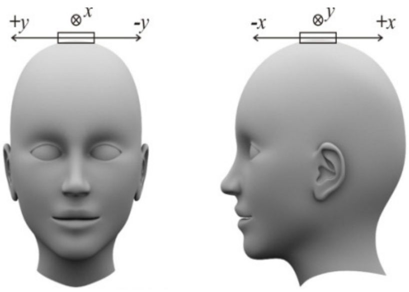


Fig 2.The position of the accelerometer relative to the head and the definition of the space axes and their directions.

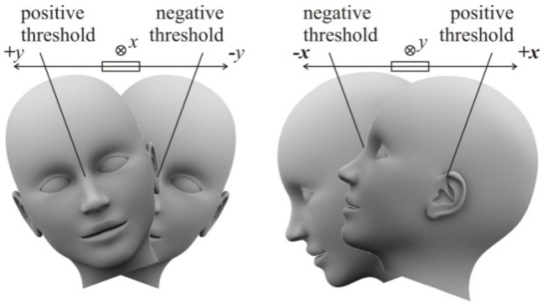


Fig 3.An example of threshold setting

The algorithm is implemented through several steps of operation. The motion data processing is done online, i.e. the command is estimated while the user moves the head. The algorithm description that follows assumes that microcontroller has read the current result of the accelerometer measurements. In the following paragraphs, the algorithm operation is described. Eliminating gravity component. When in gravitational field, the accelero- meter shows acceleration of the Earth's gravity (except if it is in free fall). Thus, in order to get the actual state of the accelerometer, gravitational component has to be removed. In this case, this is done in two steps. First, on startup, the gravity is measured. Because of this, it is required that the patient remains calm for the first period after turning on the system.

The end of this period is signalized by the diode B5 (Fig. 9). Then, after every measurement, that amount is subtracted from the accelerometer output signal. Thus, the gravitational component of acceleration is eliminated in correspondence the position and attitude of the control unit attached to the patient's head. Reading and filtering of the accelerometer output. Output voltage changes, which appear as a result of head motion not intended to issue a command lead to errors. Namely, the system can wrongly recognize and start executing an unwanted command. Such changes are sudden, so they can be removed using a low-pass filter. In this case, the filter is software implemented to remove the high frequency changes in the accelerometer signal. Threshold setting. Since this is a system intended for patients with severe disabilities, it has to be as adjustable as possible. Because of this, the threshold setting according to patient's possibilities is enabled. The thresholds are set up upon start-up. After corresponding signalization, the patient moves the head first in +x direction, and then in +y direction. Axes and directions are defined relative to the position and attitude of the control unit attached to the head of the patient. In Fig. 3, the axes and directions are shown. As it can be seen, the x axis change resembles the head movement forward-backward and the y axis change resembles the head movement left-right. In this context, positive movements are backward and right, respectively. In Fig. 4, an example of threshold setting is shown. This operation can be done during system operation. The threshold setting operation is started by pressing the C0 pushbutton (Fig. 9) and holding it until the patient moves the head in the corresponding position, relative to the +x axis.

When the button is released, the system memorizes the threshold and turns on the B6 (Fig. 9) diode. This means that the procedure for setting the +y axis threshold can commence. Now, the pushbutton C1 (Fig. 9) needs to be pressed and held until the patient moves the head in the corresponding position, relative to the +y axis. Issuing commands. Every command consists of three consecutive motions. In order to issue one of four available commands, the user needs to: (1) lean the head over a threshold; (2) return the head to the starting position; (3) repeat the movement (1). In order to be able to issue the next command, the user needs to make the fourth motion, which is not part of the actual command. Namely, after (3) the user needs to return the head in the starting position. An example of issuing a command is shown in Fig. 5. The other commands are issued analogously. These motions need to be performed within a time frame. In this example, the time interval is 2 s. Namely, if the user leans the head forward (in order to, for example, read) the system will recognize the motion (1) of the command "forward". Nevertheless, if the user remains in that position longer than two seconds, the motion (1) is neglected, and the system waits for the next motion of interest.

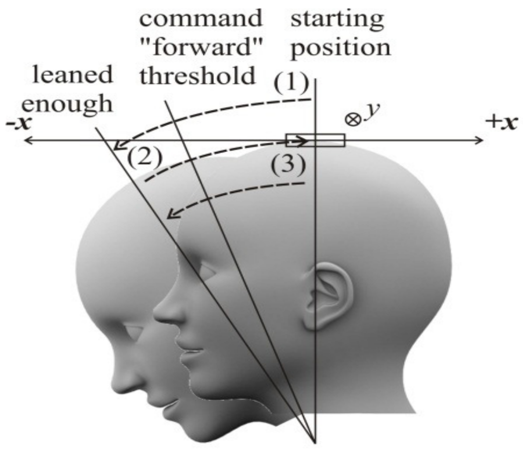


Fig 4.An example of issuing a command – "forward".

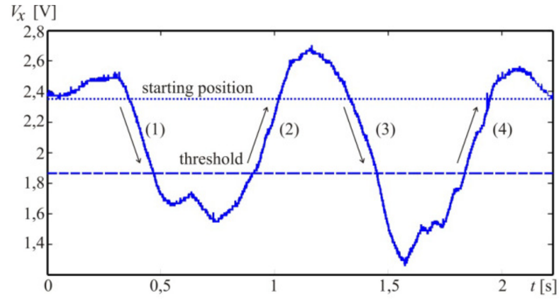


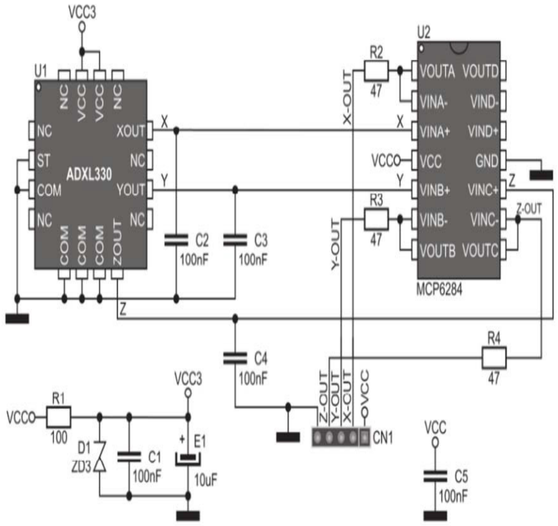
Fig 5. Accelerometer x axis data while issuing the command "forward".

In Fig. 6 the output signal of the accelerometer x axis is shown when the user issues the command "forward". The values of the starting position and the threshold are marked, as are all motion of which the command comprises. Light signalization. In order to make the system more user friendly, enable faster learning and understanding of the system, LED indication is implemented (turning of and on of the B7 diode, Fig. 9). The system informs the user on its current state through LED signalization. It is already mentioned that the user has to lean the head over a threshold in order to start a command. During this movement (marked (1) in Fig. 5), the B7 LED blinks the first time. This informs the user that the head is leaned enough over the threshold. This means that the user can start the next movement, the second part of the command. Second threshold pass, in the opposite direction (the movement marked in lights up the same LED second time. Now the user can start the third part of the command, the movement marked with in Fig. 5. There is no light signalization during the third pass of the threshold, because then the command is finished (this implies that the threshold is passed the third time). Turning around. In this algorithm implementation, there is an intermediate step between the state of still and wheelchair rotation to any of the directions. Issuing a command "left" or "right" while in the state of still, the system goes into left rotation mode or right rotation mode, but the rotation does not start.

When the wheelchair is in the left rotation mode, the rotation to the left will start when the user passes the left threshold. It lasts as long as the user keeps the head in the position below the threshold, and it stops when the user returns the head in the starting position. Analogously, for the rotation to the right. In this way, the user has the greatest possible resolution when choosing the driving direction. Both turning modes are finished and wheelchair is again in the state of still, when the user issues the opposite command, e.g. the left rotation mode is finished when the command "right" is issued. Unpredicted situations. The system recognizes unpredicted situations: falling of the head caused by unconsciousness, detachment of the sensor from the head and shaking of the head caused by a seizure. In case of detection of any of these situations, the system stops the wheelchair putting them in the state of still and blocks command issuing. In order to unblock the system, to continue normal operation, the help of another person is required. Namely, the pushbutton C2 (Fig. 9) has to be pressed.

4. Microcontroller System Prototype

The prototype of the microcontroller system comprises: sensor board with an accelerometer ADXL330, development board EasyAVR4 with Atmega16 microcontroller and a mechanical actuator. The accelerometer board schematic is shown in Fig. 7. This accelerometer measures linear acceleration in all three axes within the ±3g range. The integrated circuit contains polysilicium sensor and the circuits required to shape the signal. The output signal voltages are proportional to the acceleration. The mechanical actuator, shown in Fig. 8, is designed and produced within this paper. The actuator is supposed to put the wheelchair joystick in the position that corresponds the user's command. The actuator is powered by two HS-424 servomotors. During the work on this paper, we first tried to use the direct way of controlling the wheelchair motors. However, different manufacturers use different communication protocols or different messages within the same protocol. Often, these protocols are proprietary and, thus, unavailable to the public. So, in order to perform direct control of the wheelchair motors, the protocol and the messages need to be decoded. Such operation is highly time consuming and it does not offer modularity, since different wheelchair types use different protocols. Otto Bock Bx00 wheelchair family is taken into account during the design and production of the mechanical actuator. The dimensions of interest were measured on different types and then, the actuator is produced so that it fits to all of them. Also, it can be easily modified for more wheelchair types.



a. The prototype schematic

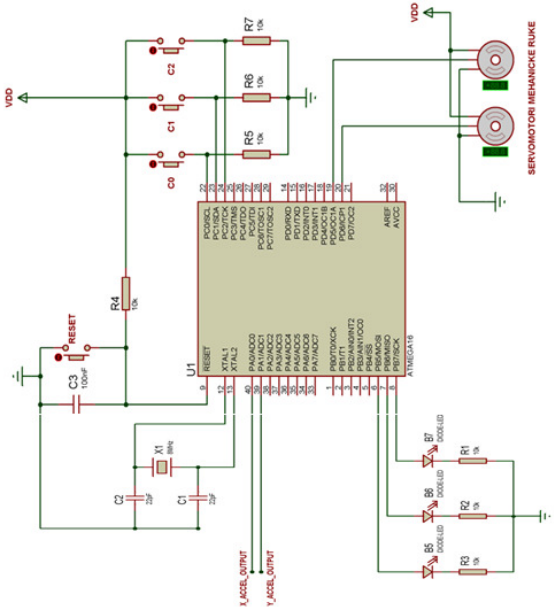


Fig. The prototype schematic

5. Advantages

1. Helpful for physical handicap people.
2. Reduces the human activities.
3. Reduces the physical strain.
4. User friendly.
5. Increase the time of working.

6. FUTURE SCOPE

Smart wheelchairs will remain fertile ground for technological research for many years to come. Smart wheelchairs are excellent test beds for sensor research, particularly machine vision. Smart wheelchairs also provide an opportunity to study human-robot interaction, adaptive or shared control, and novel input methods, such as voice control, EOG, and eye-tracking. Furthermore, smart wheelchairs will continue to serve as test beds for robot control architectures.While there has been a significant amount of effort devoted to the development of smart wheelchairs, scant attention has been paid to evaluating their performance. As shown in the very few smart wheelchair researchers have involved people with disabilities in their evaluation activities. Furthermore, no smart wheelchair has been subjected to a rigorous, controlled evaluation that involves extended use in real-world settings. Conducting user trials with smart wheelchairs is difficult for several reasons. Some wheelchair users do not show any immediate improvement in navigation skills (measured in terms of average velocity and number of collisions) when using a smart wheelchair on a closed course in a laboratory setting.

This could be because the smart wheelchair does not work very well or the wheelchair user was already so proficient that little improvement was possible. Users who have the potential to show large performance gains, on the other hand, often have little or no experience with independent mobility and may need a significant amount of training before they are ready to participate in valid user trials. The primary obstacle to conducting long-term studies is the prohibitive hardware costs associated with constructing enough smart wheelchairs. Long-term studies are necessary, however, because the actual effects of using a smart wheelchair for an extended period of time are unknown. Some investigators (e.g., The CALL Center) have intended their smart wheelchair to be used as a means of developing the necessary skills to use standard wheelchairs safely and independently.

Most investigators, however, intend their smart wheelchair to be a person's permanent mobility solution or have not addressed the issue at all. It is possible that using a smart wheelchair could actually diminish an individual's ability to use a standard wheelchair, as that individual comes to rely on the navigation assistance provided by the smart wheelchair. Ultimately, for some users (particularly children), smart wheelchair technology will be effective "training wheels" that can be used to teach the most basic mobility skills (e.g., cause and effect, starting and stopping on command), and for other users, smart wheelchairs will be permanent solutions. The distinction between using a smart wheelchair as a mobility aid, a training tool, or an evaluation instrument is also worthy of study. Each of these functions is unique and requires very different behavior on the part of the smart wheelchair. As a mobility aid, the smart wheelchair's goal is to help the user reach a destination as quickly and comfortably as possible. The user is not provided feedback in order to avoid distractions and to prevent collisions. As a training tool, on the other hand, the goal is to develop specific skills. In this case, feedback is likely to be significantly increased and the extent to which the smart wheelchair complies with the user's input will be a function of the actual training activity. Finally, as an evaluation instrument, the smart wheelchair's goal is to record activity without intervention. In this case, the user would likely have no feedback or navigation assistance.

7. CONCLUSION

There are several barriers that must be overcome before smart wheelchairs can become widely used. A significant technical issue is the cost versus accuracy trade-off that must be made with existing sensors. Until an inexpensive sensor is developed that can detect obstacles and drop-offs over a wide range of operating conditions and surface materials, liability concerns will limit smart wheelchairs to indoor environments. Another technical issue is the lack of a standard communication protocol for wheelchair input devices and wheelchair motor controllers. There have been several efforts to develop a standard protocol but none has been adopted by industry. A standard protocol would greatly simplify the task of interfacing smart wheelchair technology with the underlying wheelchair. Even if these technical barriers are overcome issues of clinical acceptance and reimbursement still remain.

8. REFERENCE

1] Vinay J. Shetty1, Maruti Laxman2, Manjunath S. Magdum3, Shweta B. Sidnal4, SoumyaParaddi international Advanced Research Journal in Science, Engineering and Technology Vol. 2, Issue 6, June 2015.

2] Serbian journal of electrical engineering Vol. 10, No. 1, February 2013, 135-151.

3] Mr. Oak C.P. Electronics and telecommunication engineer for programming of the wheelchair.

4] www.google.com