International Journal of Computer Sciences and Engineering Open Access
Research Paper Volume-4, Special Issue-3, May 2016 E-ISSN: 2347-2693

Sparsh Glove: A Gesture-Based Hardware Control for a Multipurpose Wheelchair

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Available online at: www.ijcseonline.org

***Abstract*—** The problems of locomotion exist not only for the aged, but also for the physically challenged, who might still be in the prime of their youth. The earlier versions of the wheelchair demand much of the manual effort to move the wheelchair. This paper presents a Sparsh Glove control system, aiming to resolve these issues, by allowing the user to control a wheelchair using natural gestures. The Sparsh Glove takes advantage of a multitude of sensors to capture hand movements and uses this information to control a wheelchair which also has provisions for seat elevation and various other features. Further, the wheelchair is designed to warn the user whenever there is an obstacle in the path of the wheel, and if there is any obstruction behind the user.

***Keywords*—** SparshGlove, Arduino Uno, Arduino IDE, XBee transceiver, Smart wheel chair,DC motor, Flex sensors, Seat elevation.

I. INTRODUCTION

Several studies have shown that both children and adults benefit substantially from access to a means of independent mobility. While the needs of many individuals with disabilities can be satisfied with traditional manual or powered wheelchairs, a segment of the disabled community finds it difficult or impossible to use wheelchairs independently. To accommodate this population, researchers have used technologies originally developed for mobile robots to create "smart wheelchairs." Smart wheelchairs have been the subject of research since the early 1980s and have been developed on four continents.

Even in the most primitive days of mankind, the sign language has been the fundamental communication method [1]. Whenever we are frustrated with devices, we perform hand gestures to try to show the device what they want it to do. So the sign language or gesturing is something which mankind has learnt to do intuitively.

Manual wheelchair users can propel their wheel's hundreds of rotations just to ambulate along a city block, and sometimes quite rapidly when it comes to, for example, crossing a busy street – a fact that makes measuring those movements difficult. Pain and upper extremity injury is common among manual wheelchair users. Shoulder related injuries have been shown to be present in up to 51% of manual wheelchair users. In addition, the prevalence of elbow, wrist and hand pain has been reported to be 16%, 13%, and 11% respectively [2]. The incidence of carpal tunnel syndrome and rotator cuff tendonitis, for example, is greater than 50% for people who regularly use manual wheelchairs as compared to 3% for the general population [3].

During wheelchair propulsion, users must exert large forces in order to propel the chair forward. In addition, the component of force that is directed in towards the hub does not contribute to forward motion but is necessary in order to provide friction between the hand and the push rim.

The problems which have not been solved even to this day are the limitation of the locomotion in the vertical direction as the user is confined to his seat. User who wants to reach an item that is beyond his reach, needs to get off his wheelchair and reach it, or must depend on other's help. The other problem which came up was, controlling the wheelchair. The joystick controller used was found to be uncomfortable for the old people to use.

This paper presents a design and real time implementation of wheelchair that can be used with ease, by both the old as well as the disabled. It makes use of a Sparsh Glove to control the wheelchair. The Sparsh Glove consists of multiple flex sensors which are used to move the wheelchair in the desired direction using simple hand gestures, and force sensors to elevate the seat of the wheelchair to the desired height and by applying a little pressure. The wheelchair is designed to warn the user whenever there is an obstacle in the path of the wheel and if there is any obstruction behind the user.

Section II gives the related work. Section III describes the proposed gesture based hardware control for a multipurpose

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wheelchair. Section IV presents the implementation details and results. Section V concludes the paper.

II. RELATED WORKS

To make things easier for the old and the disabled in the wheelchair department, many innovative ways of control have been thought of like, control using the head movements [4], moving the wheelchair by blinking the eye [5], voice controlled movement [6,7] and much more. But all these control mechanisms are very complex and very much expensive to implement in actual practice.

Relatively recent developments in the field of glove-based input include the Barrett Hand [8], a wired glove that can control hardware devices, which is a key feature in the design of the project. The Peregrine Gaming Glove [9] provides software calibration, but has no support for macros and no support for multiple simultaneous key presses.

The Reusch "Sonic Control" Glove [10] includes nice on-glove displays of volume and bass/treble levels, but is limited to control only the iPod. It also requires the user to press buttons on the glove, and does not sense gestures or pinches. Perhaps the model closest to the vision of the project is the Power Glove Remake [11, 12], which has wireless control, open Arduino architecture, and the ability to map input to multiple devices. Unfortunately, even this notable glove has its limitations and still requires deliberate button presses for its input.

The most recent development is the G-Speak glove input system [13], that provides impressive gesture control, but does not map to a hardware device and requires external sensors, limiting the range in which the user can roam and still provide input to the system.

Another form of controlling the wheelchair which is the most animated topic of discussion this era is the brainwave controlled wheelchair where in the wheelchair is controlled using the bioelectric signals of the brain [14]. Focusing on the physical mechanism of wheelchair, a lot of work has been done to make the wheelchair lighter and to reduce the human effort required.

The most commonly available motorized wheel chair in the market is the joystick controlled wheelchair. Taking into the factor, that the most of the old people have difficulty operating this kind of an input mechanism, the proposed wheel chair model makes use of a simple glove with a multitude of sensors, to capture the simple yet predominant gestures to control the wheelchair.

III. PROPOSED MODEL

The proposed prototype model for wheel chair is based on gestures and can be divided in two parts: The Sparsh Glove part and the wheelchair part.

The Sparsh Glove is fitted with 4 flex sensors and 2 force sensors which are carefully sewn to an ordinary glove. To each of these sensors, a 10k resistor is connected to form a potential divider circuit. The output of this circuit is directly fed into the Arduino Uno microcontroller. The input received from the flex sensors and the force sensors are transmitted wirelessly to the wheelchair using the XBee transceiver. The block diagram of the Sparsh Glove is as shown in Fig. 1.

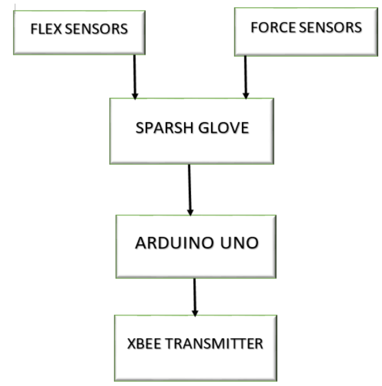

Fig. 1: The Sparsh Glove Block Diagram

The wheelchair compartment comprises of 4 DC motors for the movement of the vehicle, and two DC motors for the seat elevation mechanism. Each of the DC motors is attached with a guide rod which is used to either elevate the seat or lower it. The picture of the proposed model is as shown in Fig. 2. Its 3D model is shown in Fig. 3.

A 12v, 4-AH battery is used to provide the necessary power supply for the motors and for the Arduino Uno microcontroller. The wheelchair is fitted with an infra-red sensor and a buzzer. The block diagram of the control system at wheelchair is as shown in Fig. 4.

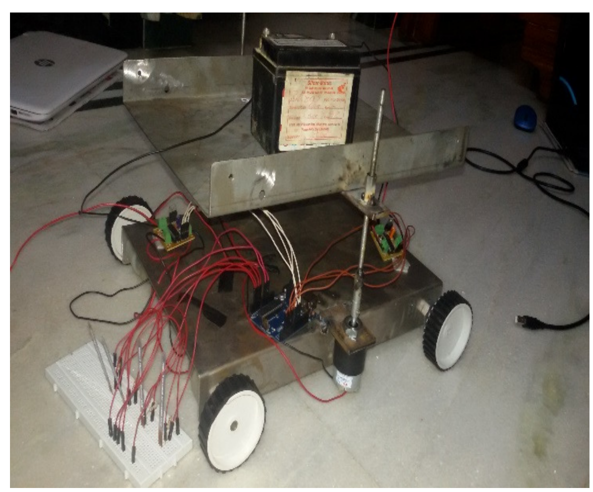

Fig. 2: The Proposed Prototype Model

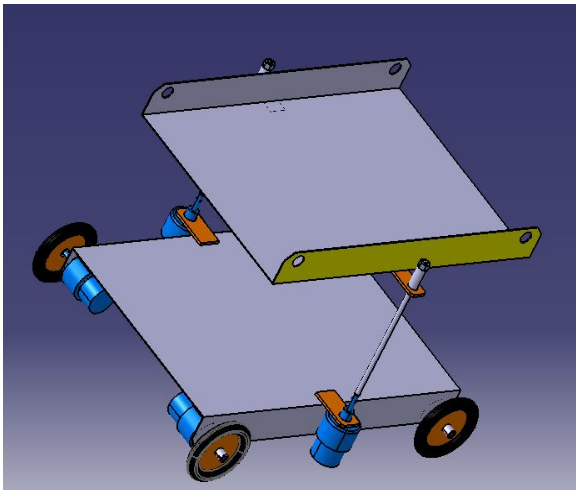

Fig. 3: The 3D Model of Prototype

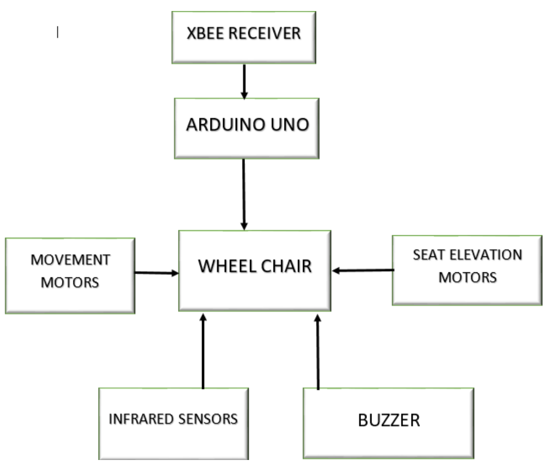

Fig 4: Wheelchair Block Diagram.

IV. IMPLEMENTATION & RESULTS

The glove itself is nothing more than regular winter wear glove bought at a winter care goods store. When fitted with all of its sensors, a sophisticated hand gesture capture device is created. The wheelchair is made of 2 slabs of mild steel and consists of a total of 6 DC motors, 4 of them for the movement and 2 of them for the seat elevation mechanism. The flowchart of the design flow is as shown in Fig. 5. The user will be given an access to the power supply and once the supply is given, the Arduino Uno continuously checks for the inputs from the flex sensors and the force sensors.

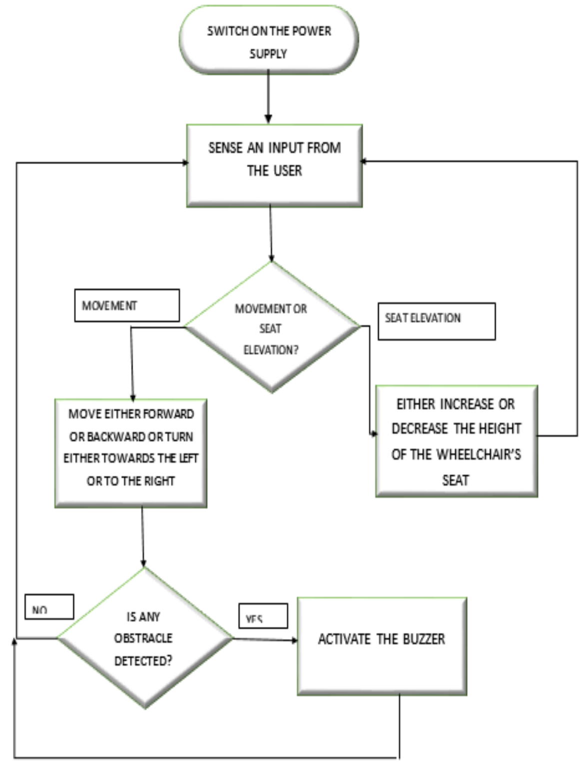

Fig 5: Flowchart of the design

Once the user bends one of his fingers the message is sent to the Arduino where it checks whether it is an input for the wheelchair movement or an input to either elevate or lower the height of the wheelchair depending on what the program is written on the Arduino IDE. Depending on the gestures obtained from the Sparsh Glove the wheelchair moves in the desired direction. The infra-red sensor continuously monitors for any obstruction behind the user and once it senses any, the buzzer beeps to warn the user of an obstruction. The control features given is that if index finger is bent, the wheelchair moves forward. If the middle finger is bent the wheelchair is programmed to move backwards. If the ring finger is bent, then the wheelchair turns towards the right and once the little finger is bent the wheelchair moves towards the left. The two force sensors are used in order to control the seat elevation part of the wheelchair. Giving a small pressure to one of the force sensors, will elevate the seat while the other one is responsible for lowering the height of the wheelchair.

V. CONCLUSION

The Sparsh Glove system was developed to demonstrate the possibility of intuitive, simple, glove-based input simple enough for anyone to use it. The innovative feature is: addition of seat elevation mechanism for a wheelchair to overcome the problems of adjusting the wheel chair to table heights and to resolve troubles reaching heights.

The weight of the wheelchair prototype was relatively heavy because it was made up of mild steel. This can be easily rectified with aluminum replacement. The battery used can also be replaced with self-recharging solar batteries. A much better glove can be used to make sure that the user can easily wear and remove the glove without causing any damage to the embedded sensors. A silicon skin can be used in order to protect the external sensors form any kind of moisture or damage.

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REFERENCES

[1] Vaishali S. Kulkarni, and Dr. S.D.Lokhande, “Appearance Based Recognition of American Sign Language Using Gesture Segmentation”, (IJCSE) International Journal on Computer Science and Engineering, Volume - 02, Issue- 03, **2010**, pp. **560 - 565**.

[2] Koontz, A.M., Boninger, M.L., Baldwin, M.A., Cooper, R.A., and O'Connor, T.J.,"Effect of Vinyl Coated Pushrims on Wheelchair Propulsion Kinetics", RESNA Conference Proceedings, **1998**

[3] http://www.postgazette.com. Accessed April, 1999

[4] Aleksandar Pajkanović, and Branko Dokić : “Wheelchair Control by Head Motion," Serbian Journal of electrical engineering, Volume-10, Issue-1, **2013**, pp. **135-151**.

[5] Kohei Arai and Ronny Mardiyanto, “Eyes Based Eletric Wheel Chair Control System”, International Journal of Advanced Computer Science and Applications, Volume - 2, Issue- 12, **2011**, pp. **98-105.**

[6] G Azam and M T Islam, “Design and Fabrication of a Voice Controlled Wheelchair for Physically Disabled People”, International Conference on Physics Sustainable Development & Technology (ICPSDT-2015), Volume – 01, **2015**, pp. **81 – 90**.

[7] S. D. Suryawanshi, J. S. Chitode and S. S. Pethakar, “Voice Operated Intelligent Wheelchair”, International Journal of Advanced Research in Computer Science and Software Engineering, Volume - 3, Issue - 5, **2013**, pp. **487 – 490**.

[8] http://www.youtube.com/watch?v=Ywo6WR9NUpE.

[9] http://www.engadget.com/2009/12/18/peregrinegaming-glove-modeled-calibrated-anddemoed-onvideo/.

[10] http://fibretronic.com/news/Reusch%20Sonic%20Control%20Glove.

[11] http://en.wikipedia.org/wiki/Power_Glove.

[12] http://www.instructables.com/id/Power-Glove-20thAnniversary-Edition/.

[13] http://www.readwriteweb.com/archives/minority_report_in_your_living_room_gestural_inter.php.

[14] Kamlesh H. Solanki, Hemangi Pujara, “Brain wave controlled robot", International Research Journal of Engineering and Technology (IRJET), Volume – 02, Issue – 04, **2015**, pp. **609 –-612.**

[15] http://hillcrestlabs.com/products/loop.php
http://www.youtube.com/watch?v=RnWPoaLU1i4.

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