Sabertooth Based Smart Electric Wheelchair with Advanced Features

Sharoze Sohail* and Muhammad Saad Saleem

***Abstract*— This paper describes the working of a Sabertooth based high power smart wheelchair. It is focused at removing the wheelchair drive issues by using a compendious motor driver. This driver is programmed and synchronized to allow stable movement in long drives, ramps, and slopes along with over current and heating protection. In addition, it aims at making disabled people independent by decreasing the use of physical, perceptual and cognitive skills. Further, it has been integrated with an Arduino, obstacle avoidance sensors (HC-SRO4), pulse and temperature sensors, and an android app to create automatic controllability and a comfortable drive with added monitoring features**

***Index Terms*— Sabertooth based wheelchair, external aid, technological advancements, android application and health monitoring system.**

I. INTRODUCTION

CURRENTLY mechanical relays and solid state devices (SSDs) are used as motor drivers. Both have their own pros and cons. To start with, mechanical relays are combination of magnetic coils with different switches (e.g. SPDT as the most common).However, when used as H bridges; they have some disadvantages, which lower the priority of their use. In fact, they cannot withstand large currents. When negative transients on the relay coil come, it damages the devices. Likewise, they lack good control over high torques, which is essential to the stability of wheelchairs along with some environmental and audible constraints. On the other hand, available variety of solid state devices made H bridges based on transistors do fast switching but are prone to damage by high currents even working on high side configurations due to high power of wheelchairs and peak currents occurring [2].

The Sabertooth motor driver is an SSD that overcomes all these issues. It can withstand very high currents up to 60A thus, removing the danger of self-damage or killing the devices. In addition, it has independent motor speed and direction control. Similarly, its regenerative braking mode uses the energy dissipated to charge the batteries when the motors are slowed or reversed. Unlike relays, its transistors switch at ultrasonic speeds (24 KHz) to provide noise free and speedy working. To sum up, this simple and efficacious motor driver is the best option for wheelchairs and other robotic purposes. On the secondary level, it will use a capacitive touch screen with an android application to allow smooth control along with the traditional joystick. In addition, joystick being a sensitive part is arduous. Therefore, touch will provide an additional control option.

Lastly, the health monitoring system gives data that adds to the wellbeing of the patient. A recent survey indicated that clinicians have a strong desire for the services that a smart wheelchair can offer. Significant survey results included [10].· Clinicians indicated that 9 to 10 percent of patients who receive power wheelchair training find it extremely difficult or impossible to use the wheelchair for ADL.

When asked specifically about steering and maneuvering tasks, the percentage of patients who reported these tasks difficult or impossible jumped to 40 percent. Eighty-five percent of responding clinicians reported seeing some number of patients each year who cannot use a power wheelchair because they lack the requisite motor skills, strength, or visual acuity. Of these clinicians, 32 percent (27% of all respondents) reported seeing at least as many patients who cannot use a power wheelchair as who can. Nearly half of patients unable to control a power wheelchair by conventional methods would benefit from an automated navigation system according to the clinicians who treat them [11].

II. ARCHITECTURE

The smart wheelchair has a microcontroller at its heart as depicted by the block diagram along with a controller interfaced with the motor driver that controls the motors [3]. Besides, 12 volts power all the devices up. Next, the health monitoring kit, as indicated in the block diagram, is interfaced with the controller and operated through the mobile application. Similarly, Wi-Fi module is connected to the app under the umbrella of controller. Likewise, obstacle avoidance sensor as shown in the diagram communicates with the controller and is used through the mobile application [4].

III. SYSTEM OVERVIEW

The project shown in Fig. 1 will be based on Arduino centralized system where microcontroller will act as a central mind. Further, android app will be manipulated for the coordination between the devices used. In a nutshell, this project will use the incremental model for its implementation shown in Fig. 2. Under this pattern, the interfacing for execution of all modules will be done separately, thus adding function to each previous stage apart from being flexible and economical

Electrical Engineering, Air University Islamabad, Pakistan (correspondence e-mail: Sharozesohail1997@yahoo.com).

[6].

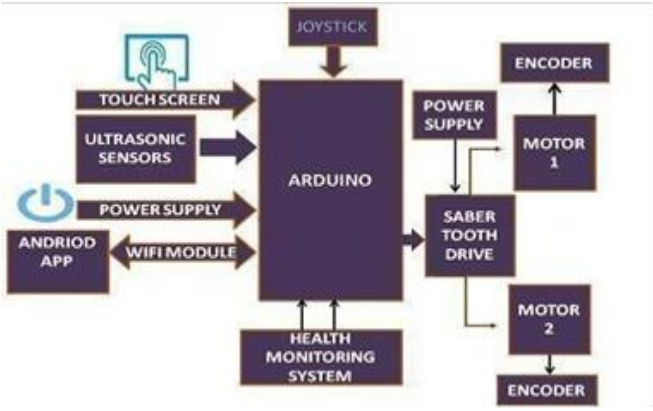

Fig. 1. Block Diagram for Proposed System.

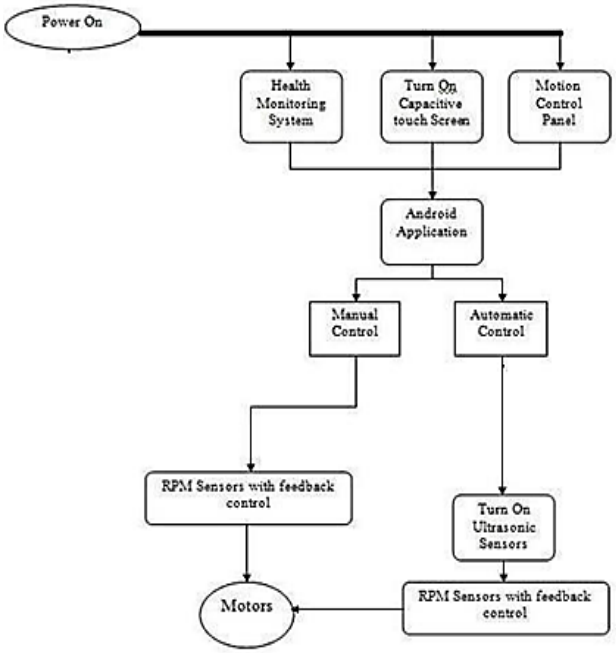

Fig. 2. Flow Chart of system.

IV. Hardware Requirements

Sabretooth is a state of the art programmable device that can be operated in various modes. They include analog input, R/C input, simplified, and packetized serial modes. It can supply a continuous current of 60A and voltage up to 24V. Packetized serial mode is utilized in this project [8].

A. Health Monitoring Sensors

Pulse detection and temperature sensors are interfaced and the data is received on the mobile app. They give information about the heart rate as well body temperature and humidity. Thus, adding to the wellbeing of the patient.

B. Complete Connections

Feedback sensors have a fundamental role in motor control system. They provide data on current, speed, position and direction of a motor. This gathered information is then processed through the controller to give a response. A Hall Effect tachometer is used as a feedback sensor. The mechanical information is delivered to controller as signals, which then change it to digital for working through its ADC. Then, PWM is adjusted accordingly to control the speed of motors [5, 9]. Motors act as the cornerstone in the working of a wheelchair. Their selection is dependent on the force and impact with consideration to the load.

A joystick is an input device that works on the information of angle and direction device. It is good choice for controlling motors, servos, etc. When using the 5V power supply, the default analogue output for its mid points is 2.5V. With the direction of the arrow, the voltage goes up to 5V and on the opposite side to 0V (see Fig. 3 and Fig. 4).

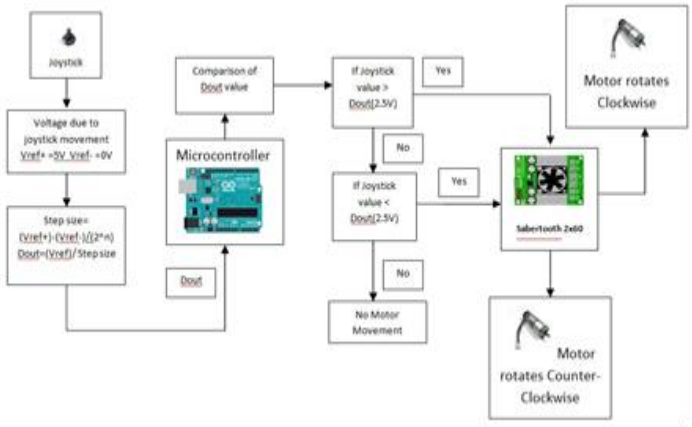

Fig. 3. Code Flow Chart of Joystick.

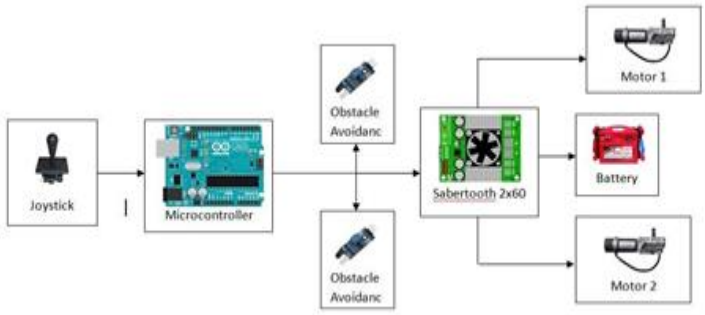

Fig. 4. Complete Connections.

V. Android Application

Android application was developed based on Java networking. In this project, Android application was communicating with an IP camera and a Microcontroller, which in this project's case was Arduino. The necessary concepts regarding networking will be discussed in this section of the report.

The term network programming refers to write a program that executes network between multiple devices. All the devices must be connected to each other, in simple words all devices should be on the same network. The java.net package contains classes and interfaces that provide low-level communication between server and client. Java.net library supports two network protocols which are mainly discussed in Transport layer of the TCP/IP stack.

UDP stands for user datagram protocol. This protocol is connectionless and allow the data to be divided in data grams. These data grams can be transferred from one host to another.

TCP stands for transmission control protocol which allows effective and better data transfer between host and the client. This protocol uses various error check and correction algorithms that confirm the authentication of the data transferred.

To cut the long story short, UDP protocol was used for the data transfer between application and the ESP - 32 module for a couple of reasons. Firstly, it is a connectionless protocol that allows the wireless transfer between the clients. Moreover, it sends data as data grams which guarantees error free data. The mechanism for the connection establishment was socket programming as it allows the data transfer connection authentication and association between the server and the client. Socket is an IP address assigned to both the server and the client. Client creates a socket and then sends requests to the server for the connection. The ESP-32 module acts as an access point which provides networking connections to all the connected devices. As a matter of fact, the Android Application as well as the microcontroller could be connected to the same access point using the maneuvering of the similar internet protocols. Thus, the socket networking was used to develop the connections between all the devices connected under the umbrella of Internet of Things (IoT) [9].

VI. Experimental Analysis and Results

The major problem with other wheelchairs was that they could not move on a ramp due to high torque and current. It was analyzed that ordinary wheelchairs were either unable to move on a ramp or in another case burnt the motor driver. However, with the same degree of inclination the Sabertooth wheelchair was able to move with an ease.

We used variable resistor joystick, which give accurate and good results, but the center point of both the resistors is not same due to factory manufacturing. That is why we had to compensate this error in coding. Joystick was placed on the wheel chair so that any person can run it without the help of others (see Fig. 5).

Brushed dc motors are used which are specially made for wheel chair. We used tachometer to measure the rpm of both the motors. One motors rpm was less than the other was although both the motors are of same company and of same model. This may occur due to manufacturing fault. This error was compensated with the help of encoders.

A fault may occur in the manufacturing of the motors e.g. in our case the rpm of one motor i.e. motor 1 were 4058 and the rpm of other motor i.e. motor 2 were 3524. It means that the motor with less rpm will have less speed and the wheel chair will not move in a straight line. To eliminate this fault we used encoder module for both the motors separately. a disc is attached to the motors with 4 slits. The encoders are placed in such a way that the slits move in between the sensor on the encoder. Encoder reads the data and calculates the rpm of both motors, and sends them to Arduino. The encoder module have sensor on it. Which gives a high pulse when the slits comes and give 0V when the slit is gone. The more the no. of slits the more accurate will be the result of the encoder and more will be the speed balanced.

Fig. 5. Complete Final Wheelchair with all features.

VII. Conclusion

Concisely, the paper clearly indicates that this wheelchair makes the user independent and secure through its working. The use of Saber tooth drive not only enhances the movement and control of the wheelchair but also avoids it from being damaged along with other features that are highly beneficial to the users in regards to independence and information.

As we know, wheelchair was invented in 18th century, since then many new technologies has been implemented to improve the structure of wheelchair and to provide ease to the patient. Although we have tried our best to make this project as successful as we can but still there are many things which could be included, but due to short time of period and many other reasons it was not possible. But in the below description we have suggested some of the important technologies which should be added in future to improve the working of this project.

Mind control: Controlling wheelchair by electric signal coming from brain. When we think something neuron emits 0 to 50 HZ electric signal.

Power Source: Another source of power can be solar panel roof which will be an alternative power source.

Artificial intelligence and image processing: It can also be used in Artificial intelligence and image processing in future.

Gearbox System: PWM modulation can also increase the speed.

REFERENCES

[1] Amin, Ishtiaque, and Philip Beard. "Relay replacement for brushed DC motor drive in automotive applications." 2016.

[2] Muhammad Nasir Khan, Syed K. Hasnain, Mohsin Jamil, Sameeh Ullah, "Electronic Signals and Systems Analysis, Design and Applications International Edition," in Electronic Signals and Systems Analysis, Design and Applications: International Edition , River Publishers, 2020

[3] Khan, Muhammad Nasir, Hasnain Kashif, and Abdul Rafay. "Performance and optimization of hybrid FSO/RF communication system in varying weather." Photonic Network Communications vol. 41, no. 1, pp. 47- 56, 2021.

[4] Jamil, Mohsin, Muhammad Nasir Khan, Saqib Jamshed Rind, Qasim Awais, and Muhammad Uzair. "Neural network predictive control of vibrations in tall structure: An experimental controlled vision." Computers & Electrical Engineering, vol. 89, pp. 106940, 2021.

[5] Khan, Muhammad Nasir, Mohsin Jamil, Syed Omer Gilani, Ishtiaq Ahmad, Muhammad Uzair, and H. Omer. "Photo detector-based indoor positioning systems variants: A new look." Computers & Electrical Engineering, vol. 83, pp. 106607, 2020.

[6] Kashif, Hasnain, Muhammad Nasir Khan, and Ali Altalbe. "Hybrid optical-radio transmission system link quality: link budget analysis." IEEE Access, vol. 8, pp. 65983-65992, 2020.

[7] Khan, Muhammad Nasir, and Fawad Naseer. "IoT based university garbage monitoring system for healthy environment for students." In 2020 IEEE 14th International Conference on Semantic Computing (ICSC), pp. 354-358. IEEE, 2020.

[8] Van Der Slikke, R.M., De Witte, A.M., Berger, M.A., Bregman, D.J. and Veeger, D.J.H., 2018. Wheelchair mobility performance enhancement by changing wheelchair properties: What is the effect of grip, seat height, and mass?. International Journal of Sports Physiology and Performance, 13(8), pp.1050-1058.

[9] Devigne, L., Aggravi, M., Bivaud, M., Balix, N., Teodorescu, C.S., Carlson, T., Spreters, T., Pacchierotti, C. and Babel, M., 2020. Power wheelchair navigation assistance using wearable vibrotactile haptics. IEEE transactions on haptics, 13(1), pp.52-58.

[10] Ding, D. and Cooper, R.A., Electric powered wheelchairs. IEEE Control Systems Magazine, 25, 2, 22-34, 2005.

[11] Attali, Xavier, and Francois Pelisse. "Looking back on the evolution of electric wheelchairs." Medical engineering & physics 23, no. 10, 735-743, 2001.