International Digital Organization for Scientific Research ISSN: 2579-079X
IDOSR JOURNAL OF SCIENCE AND TECHNOLOGY 7(1):67-76, 2022.

Design and Implementation of an Intelligent Voice Controlled Wheel Chair

Nambale Anthony, Kalyankolo Zainab and Kalyankolo Umar

Department of Electrical and Telecommunication Engineering School of Engineering and Applied Sciences Kampala International University Uganda.
Email: anthonynambale@gmail.com

ABSTRACT

This research describes Intelligent Voice Controlled Wheelchair which operates on user's voice commands. The disabled people cannot move from one place to another on their own. They continuously need someone to help them in getting the wheelchair moving. This voice controlled system make them more independent. Powered wheelchairs with the standard joystick interface are unable to be controlled by many people. A voice controlled wheelchair can provide easy access for a physical disabled person who cannot control their movements especially hands. Few patients such as quadriplegic, cerebral palsy and multiple sclerosis are dependent on other people to move from one place to another and due to this they don't have the freedom of mobility. This voice controlled wheelchair help them to drive the wheelchair without anyone's help. This system can be controlled by the simple voice commands given by the user. Depending upon the direction specified in the commands, the Arduino will drive the motors. The speech recognition is done by voice recognition module, connected with Arduino. The wheelchair would operate on real analogous voice signal of patient or user using the wheelchair.

Keywords: Voice control, quadriplegic, cerebral palsy, multiple sclerosis and arduino.

INTRODUCTION

The smart wheelchair project is to enhance an ordinary powered wheelchair using sensors to perceive the wheelchair's surroundings, a speech interface to interpret commands. Intelligent wheelchair will play an important role in the future welfare society. The use of intelligent wheelchair encourages the view of the machine as a partner rather than as a tool. The population of people with disabilities has risen markedly during the past century. As the data come from the National Health Interview Survey (NHIS), two distinct trends have contributed to the increasing overall prevalence of disability: a gradual rise, due largely to demographic shifts associated with an aging population, as well as a rapid increase that is due to health impairments and accidents. Many individuals have problems to use a conventional wheelchair [1]. A recent clinical survey indicated that 9%-10% of patients who received power wheelchair training found it extremely difficult or impossible to use it for their activities of daily living, and 40% of patients found the steering and maneuvering tasks difficult or impossible. These people, suffering from motor deficits, disorientation, amnesia, or cognitive deficits, are dependent upon others to push them, so often feel powerless and out of control. Intelligent wheelchair has the potential to provide these people with effective ways to alleviate the impact of their limitations, by compensating for their specific impairments. In particular, robotic wheelchairs may help in maneuvering a wheelchair and planning motion. Recently, research of assistant robots is also emerging field of robotic applications [2].

The rising population of disabled and elderly community and lack of caretakers to look after them have become a crisis in most countries. Voice controlled wheelchairs give its user a chance to interact with the wheelchair in a human manner. Due to the uncertainties of the voice commands and unreliability of using one

interaction modality, user safety is compromised. In natural wheelchair user and caretaker conversation a lot of distance related uncertain instructions like 'little' and 'far' will be used. With incorporating these uncertain terms, the interpretation of voice commands will be enhanced. In most existing systems, Joystick support is used as backup modality. Even though this is intended as a safety feature, accidental joystick operation can lead to unfortunate situations [3,4,5].

People with arms and hand impairment finds difficult to use a normal wheelchair as their hands are not capable of operating the normal wheelchair and cannot move it to any direction. Therefore, voice controlled wheel chair is built to overcome the problems faced by such people and enable them to operate the wheelchair. The wheelchair will be operated using the voice commands through the given input. The Arduino will take care about all the directions the user wants. The instruction for each and every direction is written in the form of program in the Arduino itself. The voice commands to the wheelchair will be given by the unilateral mic placed as per the user comfort. The voice recognition will be done by HM2007 voice recognition module. The output from this module is then received by Arduino [6].The already written programs in the Arduino helps Arduino to convert this voice commands into considerable output and the wheelchair will move accordingly. By having a wheelchair control system people will become more independent. The wheelchair control system employs a voice recognition system for triggering and controlling all its movements. By using the system, the users are able to operate the wheelchair by simply speaking to the wheelchair's microphone. The basic movement functions includes forward and reverse direction, left and right turns and stop. The spoken words are linked to the voice recognition processor via a flexible microphone which can be bent as per the user's need. Many physically disabled patients cannot move any of the limbs below the neck. Hence manual and even joystick operated wheelchair are out of question for these patients. So the development of voice operated wheelchair will solve the query about the mobility of quadraplegic patient and make them independent of mobility [6,7,8].

Objectives of the study

The aim of this project is to design and implement to cover the problems obtained by the manual wheelchairs. Making the total prototype as cost-effective and less expensive as possible.

METHODOLOGY

Project Description

The purpose of this project is to develop a wheelchair which will move as per the user's commands. This system works on voice commands given by the wheelchair user. The system is fully independent as the user do not need any other person to help him to move the wheelchair. There are basically five commands, which command is given by the user, accordingly the wheelchair will move. The voice commands of the user is recognized in the first step. Once it is recognized, the commands are converted into its equivalent instructions which drive the system. This system consists of two major modules namely Voice recognition module and motor driving module. The voice recognition is done through voice recognition module. The output of this module is directed to Arduino which uses a motor driver IC to drive the motors. The voice controlled wheelchair works using unilateral mic, voice recognition module, Arduino and motors. The input to the system is the unilateral mic. It's capable to take user's voice commands and not bother about other noises. The mic will be placed as per the user's comfort. The output is in the form of voice signals and is transferred to the voice recognition module which acts as an interface between mic and Arduino. The Arduino then receive the output from voice recognition module thus converting it into binary code. The system is unable to understand any language other than binary code. Thus, the generated voice command is converted into machine understandable form. This system uses

the Arduino uno R3. It is connected with motors to drive the wheelchair anywhere. Motors are responsible for the movement of wheelchair.

Hence, motors receives input from the Arduino and depending upon the instruction type, motors moves accordingly. This system uses two motors connected with motor driver. There are five different instructions that can be given to the motors, they are forward, backward, left, right and stop. The movement of wheelchair depends only upon these five commands. The wheelchair responds to the voice command from its user to perform any movement's functions. The basic movement functions include forward direction, left and right turns and stop. In order to recognize the spoken words, the voice recognition processor must be trained with the word spoken out by the user who is going to operate the wheelchair.

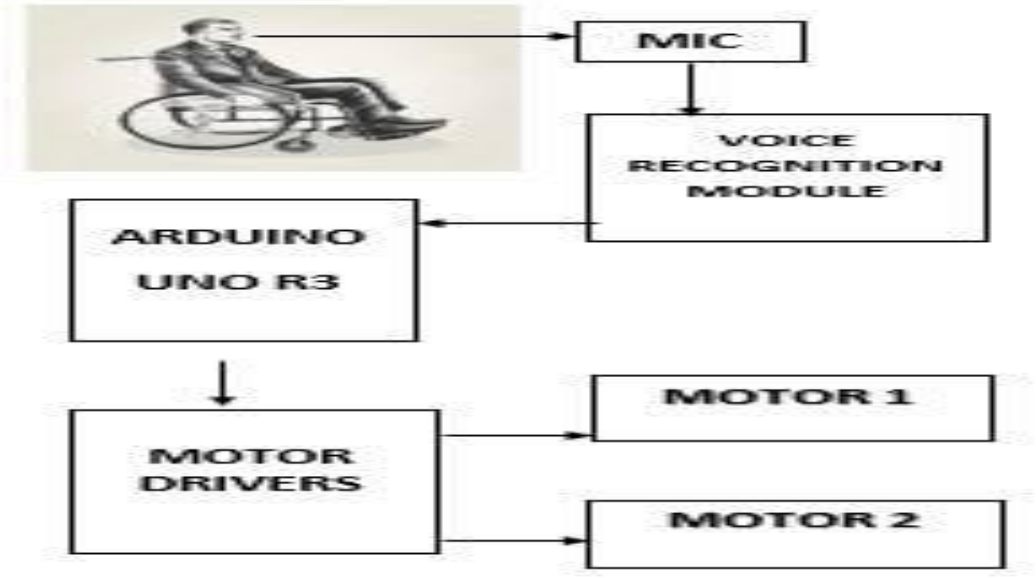

Figure 1: Showing the System Architecture

The system would recognize the commands given to it and hence would work or rather respond according to the given command. Below is the flowchart of the acceptance of the commands given to the system. Once the command is given through the mic it hardly takes time for the system to respond accordingly.

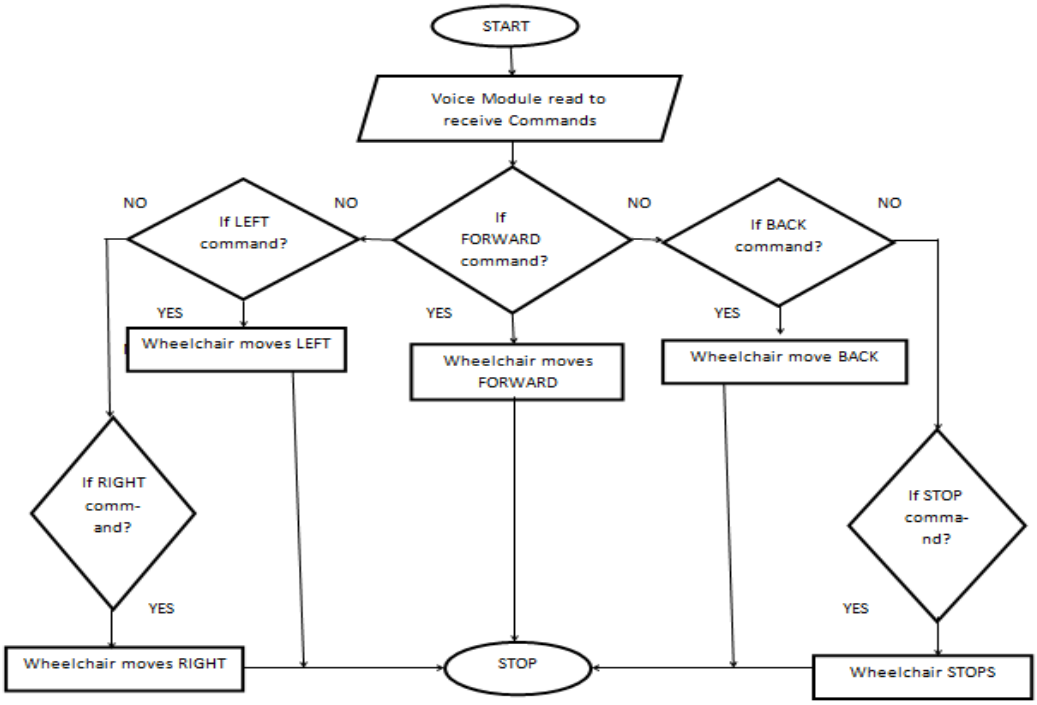

Figure 2: Showing the flowchart of the commands

Hardware Description

The system uses four major hardware, they are mic, voice recognition module, Arduino and motors.

1. Mic

This voice controlled wheelchair uses unilateral mic. The unilateral mic is capable of ignoring noises apart from the actual voice commands. The mic receives the voice commands from the user and send it to the voice recognition module.

2. Voice Recognition Module.

Figure 3: Showing the Voice recognition module

The voice recognition mo dule ie v3.1 is used to recognize the voice commands given by the user and it can be trained by the user. It's a 48-pin single chip CMOS voice recognition LSI circuit with on-chip analog front end. In this system, the voice recognition module is trained and it takes the input from mic available in the system. The wheelchair uses the voice recognition module interfaced with the Arduino Uno R3 to convert the voice commands into motor understandable instructions to move the wheelchair as commanded by the user.

3. Arduino Uno R3

Figure 4: Showing the Arduino Uno R3

The Arduino Uno R3 acts as an intermediate agent between the voice recognition module and the motors to drive the wheelchair. It is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller. It receives the input given to the voice recognition module and converts into the format accepted by the motors and thus the motors works according to the command given. The Arduino needs to be interfaced to the motors as well as the voice control module.

4. D.C Motor

Figure 5: Showing D.C motor

The Arduino is coupled with motors to drive the system as per the user's demand. The proposed system consists of four, DC magnetized, 100 rpm motors (Johnson motors) to equalize the weight distribution and stall torque. The motors will be attached to all the four wheels and two motor drivers will be connected to each side.

This system will be a Real-Time Voice controlled Wheelchair for the physically disabled person. This system will be designed to operate the wheelchair based on the voice of the user and control the movement according to the command given by the operating person. The voice would be given through a unilateral mic and would be converted into binary format by voice recognition kit. Thus this binary format would be checked with the binary code fed to the microcontroller, if true the command will be performed. More specifically, this system is designed to allow an admin and users to give the voice command to the wheelchair. These command would be performed within seconds. On the whole it's basic operation would be left, right, stop, go, back. Basically it's a wheelchair controlled by voice.

Advantages

1. The patients like quadriplegic and cerebral palsy, lack of force, can easily handle this voice controlled system.

2. The use of Arduino make the programming of the system easy and thus, reduced the software and hardware interfacing problems.
3. The system can be operated by giving synthetic voice commands.
4. The system is fully automated because of the use of Arduino and motor drivers.

Block Diagram

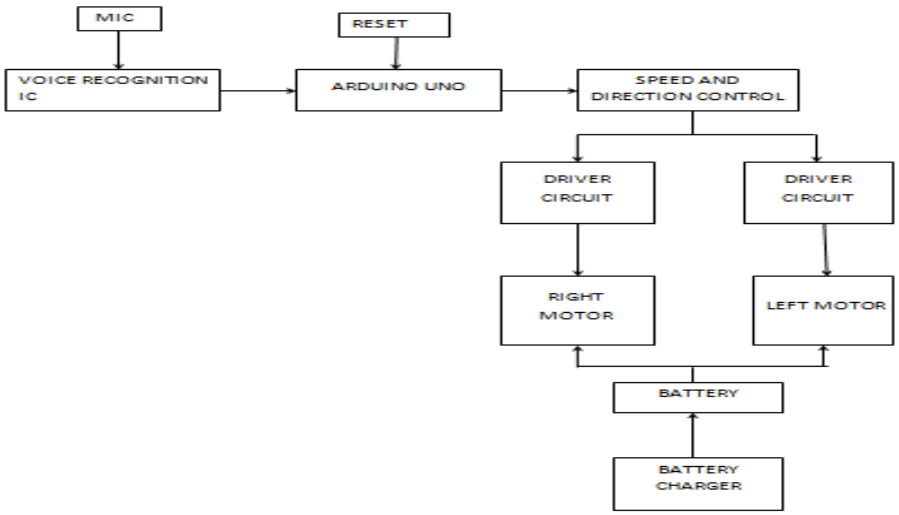

Figure 6: Showing the Block diagram of the system

Above diagram shows the system block diagram showing the interconnections between each block or module of the system. All the modules are mounted onboard as to ease the wheelchair movement. This includes a microphone which is located nearest to the user so as to make it handy and easy to use. Generally, the input voice level of the user affects the recognition accuracy of the command given result. Principally, the system is triggered by the voice command word produced by the user through the use of this microphone. The voice of the user using the system is already trained and stored in the module. So when the user gives the command, the module matches it with the existing command and gives the output if the voice and the command matches.

Certain people cannot even speak words properly. For them rather than using words as a command, vals can be used. These are just a normal sound which can be formed by any person. It makes the command giving process easy and the cerebral palsy affected people can also use the system. In this system some advanced voice commands are designed so that the highly disabled person can use it. The working of the wheel chair is based on the voice recognition unit which is the heart of the system. There are five types of motions considered, moving forward, moving in reverse direction, moving to the left and moving to the right and stop. The system starts by applying the supply voltage to the speech recognition circuit.

Figure 7: Showing the chair mounted with motors

For the forward command the wheelchair moves in forward direction. For the reverse direction the opposite movement of wheel rotation will occur. The left command is dependent on the mechanism of the wheel ie. right wheel moves forward and left wheel moves backward and right command makes left wheel moves forward and right wheel rotate backward. However all these commands are to be fed into the voice recognition kit via a PC/Laptop. The wheelchair system will go back to the stand by condition or end the whole system by turning off the power supply of the speech recognition board.

Hardware Components

1. Arduino Uno R3
2. Motor drivers
3. DC magnetized motor(Johnson motors)-4
4. Battery and battery charger
5. Voice recognition module v3.1
6. Mic (Unilateral)
7. laptop/PC (for storing the voice commands)
8. Capacitors

Above is the image of the chair built manually out of iron. For the proper functioning of the wheels four motors are installed in the middle of the wheels on all the four sides. For the proper convenience of sitting on the chair a plastic chair can also be used instead of a metal chair.

In this system many capacitors would be used in order to remove the noise which is produced during the command giving and interpreting the commands. Too much noise is made during the movement of the system, hence to remove it the capacitors are used.

TESTING AND RESULTS

Circuit Breakers

In the field we also looked at different circuit breakers used in metering and different sizes. A circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Its basic function is to detect a fault condition and interrupt current flow. Unlike a fuse which operates once and then must be reset to resume normal operation. Circuit breakers are made of different sizes from small devices that protect an individual household up to large switchgear designed to protect high voltage circuits feeding the entire city.

Advantage of circuit breakers over fuses

A Circuit breaker can trip in case of an overload to protect the meter or the transformer unlike a fuse that gets burnt till the transformer is finally damaged.

Report on Faults and Substation Faults

A fault is any abnormal electric current that occurs within the power line.

In the simplest form faults are said to occur on a power system if abnormally high currents or short circuit flows or if abnormally low current flows/no current flows at all i.e. open circuit.

The major causes of short circuit are;

- ✓ Insulation breakdown/failure i.e. due to over voltage application or heating effects of currents.
- ✓ Mechanical injury leading to conductor/insulation breaking then different phases coming into contact.
- ✓ Tensions/ badly sagging conductors. Moving objects knocking down supports and conductors joining up.
- ✓ Moving objects coming into contact with the lines themselves.

Some of the effects of power system faults are as follows

- Equipment can get damaged due to high currents/short circuit.
- Equipment operating at non protective levels.
- Equipment not operating at all i.e. when the feeder is not in.
- It also causes the equipment to stall particularly motors.

Categories of Power Line Fault

Transient faults: these are fault that occurs in line for short period of time. These commonly in overhead power line, transient faults may be cause due to

- Momentary tree contact; to address this problem, line clearance is encouraged
- Lightning strike: this is the main cause of transient fault in overhead lines, this is common during rainy conditions
- Birds or other animal gets in contact with line
- Conductors clashing each other: this may be due to poor sagging and tensioning of conductors or due vibrating forces from the ground. To overcome this problem resonance damper can be used to reduce the effect of vibrating forces

Asymmetric faults: these cause different effect in phases example of such faults are

- Line to line fault due short circuit
- Two lines to the ground faults: to lines gets in contact with the ground

Symmetric fault: these cause similar effect in different lines or phases

Examples of Common Faults in Line

Broken neutral conductor

This led to some consumer experiencing high voltages and others getting a stable voltage and others will get dim lights. Consumers having effective earthling experienced a stable voltage since earthling was there to stabiles the voltage. The consumers with poor earthling system experienced high voltage due to broken return [neutral conductor] and ineffective earth system.

Short circuit

This a situation whereby the phase get into contact with another phase and thus leading to high value of current damaging the equipment and making the feeder to open. Another situation here is to find an HV line falling in the LV line, this results into electrical shock and producing arcs on the line

Broken jumpers on the line.

Broken jumper of 11kv feeder of transformer: this results in 3 phase transformer being fed by two lines and as result low voltages were encountered on side of customer the low voltage was due voltage sharing in the winding of a 3phase transformer.

Falling of rotten poles due to bad weather

Here during rainy seasons many of the rotten poles that were strong in sunny days were found down because of the wind and bad weather.

Permanent faults in power line

This is a fault that makes the feeder to trip out whenever racked in .The feeder can only be racked in when fault is completely corrected. Such a problem can be on a transformer which is burnt within the line or any other persistent cause. This problem is difficult to discover in absence of fault location protection system. It can be addressed by patrolling the feeder till problem discovered. If the feeder has many T-offs, one by one t-off is disconnected while feeder is racked in. this is done until when T-off with a fault is got and patrolled again until the fault is disconnected from the feeder or line. Permanent fault in addition can also be due entangled conductors that can make feeder permanently refuse to be racked in. Can also be burnt vulture within the line contact and leading to high currents and tripping the feeders out.

Air Break Switches

Air Break Switches are special switches designed to isolate a circuit. There are usually employed in outdoor installations. Special Arcing Horns are provided to quench the arc which occurs when the current is interrupted. Air Break Switches should not be used to interrupt load currents. They are isolating devices. They can, however, be used to interrupt small currents such as the exciting current of a transformer or the capacitive charging current of a long transmission line. A variation of the Air Break Switches is the Load Switch which can interrupt current on load.

Activity Duration

	NUMBER OF WEEKS							
ACTIVITIES	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8
DATA COLLECTION	X	X						
DATA PROCESSING			X					
DATA ANALYSIS				X				
PURCHASING OF COMPONENTS					X			
CIRCUIT CONNECTION						X		
MICROCONTRLLER CHECKING							X	
CIRCUIT ALLIGNMENT								X
REPORTING AND DISSEMINATION								X

CONCLUSION

The project has been done successfully despite the fact that a few challenges have been met during the research period. This project has enlightened a great exposure and findings in the field of engineering from experienced staff including supervisors and other field engineers who give advice in the practical part of my carrier and general knowledge on various practical field attachments. Harsh weather conditions like strong wind, heavy rainfall and report writing process were the most challenging of all the sections.

RECOMMENDATION

The faculty or school of engineering and applied sciences should continue providing more structured programs and enough time allocations in concern to internship practices to the engineering students, research to be carried out hence gaining more skills to favorably compete in the job market. A training schedule should also be made in order to optimize the training period for the continuing students to understand the actual period internship starts and ends.

REFERENCES

1. Chhabria, S. A. and Dharaskar, R. V. (2011). Multimodal Interface forDisabledPersons',international Journal of Computer Science and Communication
2. [2] Simpson, R. C. (2005). Smart Wheelchairs: A Literature Review', J. Rehabil. Res. Develop., 42, pp. 423-436.
3. Yi, J. Z., Tan, Y. K., Ang, Z. R. (2012). Microcontroller Based Voice-Activated Powered Wheelchair Control' ACM 2007 ISBN: 978-1-59593-852-7.
4. Fehr, L., Edwin, W. and Skaar, S. B. (2010). Adequacy of Power Wheelchair Control Interfaces for Persons with Severe Disabilities:

A Clinical Survey', J. Rehabil. Res. Develop, 37 (3), pp. 353-360.

5. Yasunari Obuchi, Multiple-Microphone Robust Speech Recognition Using Decoder-Based Channel Selection, Advanced Research Laboratory, Japan, 2004.
6. Masisani William Mufana and Adabara Ibrahim (2022). Overview of Smart Grid: A Review. *IDOSR Journal Of Computer and Applied Sciences* 7(1):33-44.
7. Masisani William Mufana and Adabara Ibrahim (2022). Monitoring with Communication Technologies of the Smart Grid. *IDOSR Journal Of Applied Sciences* 7(1) 102-112.
8. Masisani William Mufana and Adabara Ibrahim (2022). Implementation of Smart Grid Decision Support Systems. IDOSR Journal of Scientific Research 7(1) 50-57.