2023-07

Enhanced safety and automated wheelchair for patients with mobility disability: a case study of mount Meru referral hospital, Arusha, Tnzania

Rwegoshora, Florian

NM-AIST

https://doi.org/10.58694/20.500.12479/2201

ENHANCED SAFETY AND AUTOMATED WHEELCHAIR FOR PATIENTS WITH MOBILITY DISABILITY: A CASE STUDY OF MOUNT MERU REFERRAL HOSPITAL, ARUSHA, TANZANIA

Florian Mwijage Rwegoshora

A Project Report Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Science in Embedded and Mobile Systems of the Nelson Mandela African Institution of Science and Technology

Arusha, Tanzania

July, 2023

ABSTRACT

Physical disability remains a challenging problem in Tanzania. The number of people with physical disabilities is increasing every day for a variety of reasons. A wheelchair is one of the devices that assists these people in their daily lives. Various wheelchair designs have been developed, but the prevailing issue is that the existing systems continue to fall short of meeting the needs of the users. There is a great need for a design that can meet some of these people's needs, with safety as a top priority. To address these issues, the study intends to develop an enhanced safety and automated wheelchair for patients with mobility disabilities. The proposed system was a solar-powered wheelchair with some unique safety features for wheelchair users. The wheelchair was built with a joystick for mobility, an MQ-2, a Global System of Mobile communication (GSM), a Global Positioning System (GPS), an Ultrasonic sensor, a buzzer, a pushbutton, a solar panel, a lead-acid battery, and an Atmega 328P processor. Based on some of the previously mentioned important components, the system was able to detect fire once by making a sound via the buzzer, and family members were able to obtain any message if the wheelchair user was in danger simply by pressing the push button. Furthermore, the system was capable of tracking location based on wheelchair user consent and detecting obstacles within a 10cm range. The newly built prototype has a quick response time while maneuvering around with the joystick, and solar power can last for less than 3 hours.

DECLARATION

I, Florian Mwijage Rwegoshora, declare to the Senate of the Nelson Mandela African Institution of Science and Technology that this project report is my original work and that it has neither been submitted nor concurrently submitted for a degree award in any other institution.

25-07-2023

Florian Mwijage Rwegoshora

Name of Candidate **Signature** **Date**

The above declaration is confirmed by:

04-07-2023

Prof. Shubi Kaijage

Name of Supervisor 1 **Signature** **Date**

Dr. Judith Leo 23-07-2023

Name of Supervisor 2 **Signature** **Date**

COPYRIGHT

CERTIFICATION

The undersigned certify that they have read and found the project report titled, ***Enhanced Safety and Automated Wheelchair for Patients with Mobility Disability*** qualify for acceptance by the Nelson Mandela African Institution of Science and Technology (NM-AIST) in Arusha, in partial fulfillment of the requirements for the degree of Master of Science in Embedded and Mobile Systems of the Nelson Mandela African Institution of Science and Technology.

Prof. Shubi Kaijage		04-07-2023
Name of Supervisor 1	**Signature**	**Date**

Dr. Judith Leo		23-07-2023
Name of Supervisor 2	**Signature**	**Date**

ACKNOWLEDGEMENTS

God the Almighty be praised for His blessings. Without His permission, I doubt I would be able to complete this final year project, including this project report, on time. I completed everything I set out to do according to the plan. I would like to take this opportunity to express my gratitude to CENIT@EA, as well as the mentorship from lecturers at Nelson Mandela African Institution of Science and Technology, for their ongoing assistance in completing this research project successfully.

Further to that, I would like to give special thanks to my supervisors, Prof. Shubi Kaijage and Dr. Judith Leo, for their enthusiasm and unending assistance with proposal preparation, design, final design development, and dissertation preparation.

I am extremely grateful to my industry host supervisor in the Department of Biomedical Engineering at Mount Meru referral Hospital in Arusha, Tanzania, for the insights and facilitation provided during my internship period while working on this project.

Last but not least, my gratitude goes to my family members, advisors, and friends who have directly and indirectly supported me morally and in other ways. I sincerely appreciate your generosity and time.

DEDICATION

I sincerely dedicate my project report to my superwoman and loving mother, Florida Petro Kyangenyenkya Rwegoshora, for her assistance and prayers in completing my Master's degree. In memory of my late father, Erasmus Rwegoshora, I am honored to be your son.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

AC	Alternating Current
ASD	Adaptive Software Development
AT	Assistive Technology
BCI	Brain Computer Interface
BLDC	Brushless Direct Current
CCBRT	Comprehensive Community Based Rehabilitation in Tanzania
CD	Compact Disk
CENIT@EA	Centre of Excellence for ICT in East Africa
CM	Centimeter
COVID-19	Coronavirus disease of 2019
CS	Coding schemes
DC	Direct Current
DCS	Digital Communication System
DSDM	Dynamic systems development method
EEG	Electroencephalography
EGSM	Extended Global System for Mobile Communications
EN	Enable
ESP	Espressif
FDD	Feature-Driven Development
GDP	Gross Domestic Product
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System of Mobile communication
IDE	Integrated Development Environment
IoT	Internet of Things

IR	Infrared
KB	Kilobyte
M2M	Machine to machine
MHz	Megahertz
NM-AIST	The Nelson Mandela African Institution of Science and Technology
PC	Port C
PCB	Printed Circuit Board
PCS	Personal Communications Service
PDA	Personal Digital Assistants
PPM	Parts per million
PV	Photovoltaic
PVC	Polyvinyl chloride
PWM	Pulse-width modulation
RC	Resistance-Capacitance
RF	Radio frequency
SIM	Subscriber Identity Module
SMS	Short Messaging Service
TCP/IP	Transmission Control Protocol/Internet Protocol
TDS	Tongue Drive System
UNCRPD	The United Nations convention on the Rights for people with Disabilities
USART	Universal synchronous and asynchronous receiver-transmitter
USB	Universal Serial Bus
WHO	World Health Organization
WIFI	Wireless Fidelity
Wp	Watt peak
XP	Extreme Programming

CHAPTER ONE

INTRODUCTION

1.1 Background of the Problem

Humans' standard of existence is being raised via smart technology. With the rapid advancement of science and technology, the globe is becoming smarter in this modern day. Houses, health, automobiles, applications, and other smart technologies make life easier and faster than it has been in decades (Vazurkar *et al.*, 2021). According to a report by the World Health Organization (WHO), approximately 15% of the world's population is disabled. Physical disabilities are on the rise as a result of ageing, accidents, and diseases such as quadriplegia and paralysis (Aktar *et al.*, 2019). It was discovered that 9.3% of the population aged seven and up had some form of functional impairment. Disability levels were greater on the Tanzanian mainland (9.3%) than on Zanzibar (7.3%). In addition, rural areas (9.9% of the population) have a larger number of people with impairments than urban areas (7.8%) (The Institute of Development Studies,2020).

Tanzania has 4.2 million people with disabilities. People with impairments are frequently among society's poorest and most marginalized. Health, employment, and education all suffer as a result of disability. Because of their health or activity constraints, more than half of disabled children do not attend school. For physically challenged persons, independence is important; they want to make their own decisions (Ahluwalia *et al.,* 2017). The United Nations Convention on the Rights for People with Disabilities (UNCRPD) article 20 states that it is the responsibility of State Parties to ensure personal mobility with the highest possible independence for people with disabilities including the time of their choice and at an affordable cost. As a result, the developed prototype will be beneficial to the community. Science and technology are always changing. A new item developed to improve the life of a disabled person is IoT-based automatic wheelchair-using solar power (Vazurkar *et al.,* 2021).

A wheelchair is a wheeled chair that assists people in moving around. Individuals with limitations that restrict their capacity to walk utilize it. The primary goal of a wheelchair is to make a physically impaired person self-sufficient in terms of locomotion (Sowmya & Education, 2021). Wheelchairs have been available to assist people with disabilities in moving around since the late 1700s. A big number of people become lame and unable to walk normally every year as a result of a road accident. The finest assistive device for the elderly and differently-abled who are unable to walk normally in a wheelchair (Noman *et al.*, 2018). Our main goal is to charge the wheelchair-using renewable energy resources rather than relying on electricity. In rural locations, there are frequent power outages, which can make it difficult for disabled people who rely on energy to charge their wheelchairs. A solar-powered wheelchair can aid in this case (Sowmya & Education, 2021). Following a test, it was discovered that as compared to a battery-powered option, the solar power supply can enhance the travel radius by 26% (Vlaicu *et al.*, 2021). According to reports, just a small percentage of persons in need of wheelchairs can afford the most expensive models. As a result, the solution to this problem lies in creating a prototype system that target consumers may access locally with ease. This is the concept underlying the design and building of a solar-powered microcontroller-based wheelchair for disabled people (Ogbonna *et al.*,2021).

The Mount Meru Regional Referral Hospital is a government government-owned health facility in Arusha Region. The hospital has various units such as Orthopedic, surgery, diabetic, and others that facilitate medical assistance to the patients. The demand for an advanced wheelchair is very huge since the available ones are just manually operated and have a lot of limitations. Most of the patients admitted to the hospital are due to cases that involve road accidents and especially motorbike users. But apart from that, we have people who have other disabilities that stop them from walking normally. It's essential to take advantage of solar energy while also ensuring the safety of wheelchair users in general.

Figure 1: Manual wheelchair at Mount Meru Referral Hospital

Therefore, based on the difficulties that disabled people are facing at mount Meru hospital by using the manually operated wheelchair shown in Fig. 1, and considering the number of victims who need a wheelchair is increasing and there is a need to have a new design of wheelchair. The wheelchair developed will be automatic and solar-powered, connected with the GPS, Ultrasonic sensor, Fire detection sensor, and capable of sending SMS using GSM.

1.2 Statement of the Problem

The wheelchair used to have a lot of demands that need to be improved on the design of the system. The existing systems of the wheelchair at Mount Meru hospital save a purpose for people with disabilities to walk. But the wheelchairs are manually operated of which requires the individual to use a lot of energy to operate them. Apart from that, some need assistance person for operating them.

The lack of an automatic wheelchair that can be powered with solar and allow individuals to give various alerts with SMS and also get the location of the wheelchair is still a problem.

Thus, to address the issue, the developed a solar-powered wheelchair that can track its location, detect fire, detect obstacles at a 10cm range, and send SMS alerts for such indicators.

1.3 Rationale of the Study

The disabled community faces a lot of problems. Even though the case study is conducted at Mount Meru Referral Hospital in Arusha but the design can be used all over the Nation. The wheelchair relieves them of their difficulties and allows them to move around freely. There is a huge need of changing from a manually operated wheelchair to an automatic wheelchair that is eco-friendly. Powering the wheelchair is based on the solar system mechanism of which the sun can be easily harnessed and is free. The project will enable the users to have self-will in driving the wheelchair, giving their location based on their consent once they face problems. Based on the use of GSM, the safety of disabled people will be huge since the family and hospital members can receive necessary information sent by the person. One of the negative impacts that a lot of people don’t see on the manual wheelchair is that once one wheelchair is operated by two people, one sitting and the other person pushing to assist, this can lead to low Gross Domestic Product (GDP).

1.4 Objectives of the Study

1.4.1 Main Objective

To develop enhanced safety and automated wheelchair for patients with mobility disability for Mount Meru Regional Referral Hospital.

1.4.2 Specific Objectives

The study aimed to achieve the following specific objectives:

(i) To identify the requirements for developing enhanced safety and automated wheelchair for patients with mobility disability for Mount Meru Regional Referral Hospital.

(ii) To develop enhanced safety and automated wheelchair for patients with mobility disability for the Mount Meru Regional Referral Hospital.

(iii) To validate the developed system at the Mount Meru Regional Referral Hospital.

1.5 Research Questions

The study intended to answer the following questions:

(i) How are the requirements going to be gathered?

(ii) What are the main parameters and tools for developing IoT-based smart solar-powered wheelchair systems?

(iii) How did the developed system accomplish the goals?

1.6 Significance of the Study

Physically disabled people are in desperate need of new wheelchair designs that can help them with their daily activities. As a result, to address these issues, the developed wheelchair system will include some key features that could improve the safety of wheelchair users. The features that will be included are a fire detection system, the ability to send SMS in an emergency, and the ability to provide location and detection of an obstacle within a certain range. The system is useful in the health sector because it allows for easy tracking of wheelchairs and wheelchair users. As a result, the findings of this study are critical for Tanzania and Africa as a whole.

1.7 Delineation of the Study

People with physical disabilities will undoubtedly benefit much from the proposed wheelchair prototype. The established method will benefit not just Mount Meru Referral Hospital, but also Tanzania and Africa as a whole. The system's numerous features will assist wheelchair users, family members, and medical professionals in strengthening the privacy and safety of wheelchair users.

CHAPTER TWO

LITERATURE REVIEW

2.1 Wheelchair

A device providing wheeled mobility and seating support for a person with difficulty in walking or moving around. A person who has difficulty in walking or moving around and uses a wheelchair for mobility is known as a wheelchair user.

2.2 Types of Wheelchairs

The following are different types of wheelchairs:

(i) Outdoor wheelchair

4Power4's P4 country wheelchair was the first wheelchair we looked at Gravel, Grass, Pebbles, and Cobblestones are some of the surfaces it's designed to work on. The wheelchair manufacturer provides the specifications for the wheelchair. The wheelchair has sufficient power to work on hard surfaces, but it would not work on sand because the surface is soft, the wheelchair is quite heavy, and the contact area of the tires with the surface is limited as shown in Fig. 2.

Figure 2: Example of an outdoor wheelchair

(ii) All-terrain wheelchair

An all-terrain wheelchair is a wheelchair that allows a person to easily drive on all terrains because the driving method is productive, flexible, and fast. It also expands disabled people's reach capabilities and social limitations (Agarwal & Gautam, 2015). Tank tracks were used by the majority of all-terrain wheelchairs. It can work on ice, snow, sand, gravel, and mud. Due to the massive tank tracks, it is quite expensive. This wheelchair's positive trait originates from its name, Tank-chair, which allows it to travel effortlessly on practically any surface as shown in Fig. 3.

Figure 3: Example of an all-terrain wheelchair

(iii) Manual / Push Beach Wheelchair

The beach access wheelchair is a simple wheelchair made of non-corrosive; long-lasting PVC pipes as shown in Fig. 4. Because this is a manual wheelchair, the building was straightforward. The construction was made of balloon tires and was extremely light (Julie, 2016).

The majority of reviewers indicated that propelling the wheelchair was simple and did not involve much effort. According to some bad evaluations, turning was a challenging effort because you had to raise a little and guide the wheelchair to the left or right.

Figure 4: Example of manual/push beach wheelchair

(iv) Electric Beach Wheelchair

Beach Powered Mobility's Beach Cruiser is propelled by two dc motors. The balloon tires are also used on this wheelchair, and the frame is quite light as shown in Fig. 5. The batteries and motors, on the other hand, add the majority of the weight. When compared to manual beach wheelchairs, the major advantage of this wheelchair is that it does not require any help and goes remarkably fast in the sand.

Figure 5: Example of electric beach wheelchair

(v) Sports wheelchair

Being physically disabled doesn't mean that a life of sports and fun activities is not part of your lifestyle. The sports wheelchair is designed for combating the problem. Sports wheelchairs have shorter wheelbase rear wheels as shown in Fig. 6 for enhanced stability and are more geared toward self-propulsion by the wheelchair user. In general, there are two types of sports wheelchairs: racing wheelchairs and those used for other events such as court-based ball sports such as basketball, rugby, and tennis (Burton *et al.*, 2010).

Figure 6: Example of sports wheelchair

2.3 Types of Assistive Technologies

2.3.1 Tongue Drive System

Tongue Drive System (TDS) is an assistive technology that uses a wireless network to help persons with a variety of physical limitations to drive wheelchairs and manage different settings (Yousefi *et al.*, 2011). Patients who have lost function of their arms and legs, known as tetraplegia or quadriplegia, may benefit from the Tongue Drive System. The system is described as follows. A magnetic tracer is attached to the tongue, which generates a magnetic field, then there's a headset with an array of three-axis magnetic sensors to monitor changes in the tracer's magnetic field (Yousefi *et al.,* 2011). The magnetic tracer can be mounted to the tongue in two methods. The first is with tissue adhesives like PeriAcryl, which is routinely used in dentistry. However, because tracer tends to loosen after 1 to 2 hours, tongue piercing is an alternative approach (Kim *et al.,* 2012).

The changes are registered by sensors in the headset, which are then sent to a smartphone or computer, where they are converted into commands for the wheelchair motors. The wheelchair will shift direction as the patient moves his tongue. The tongue drive system has six commands, four of which are directional (UP, DOWN, LEFT, RIGHT) and two of which are selecting commands (single click and double click) (Yousefi *et al.,* 2011). However, it is difficult for persons with limited technological skills to use this system; for example, the process of selecting commands necessitates users to have sufficient technological expertise, which is still a challenge, especially in developing countries.

2.3.2 Eye Tracer

Measuring using the gaze points is a technique for converting the required movement (Plesnick *et al.,* 2014)**.** The user will need to calibrate his eye location using a predetermined calibration program when using an eye tracker that uses infrared technology to track the user's gaze location. Patients who have trouble using their limbs are restricted in their mobility. The equipment that can be used for eye tracking is called eye tribe (Meena *et al.,* 2016). Electrooculography and image processing are the two most common methods for determining eye gaze. The corneo-retinal standing potential, which exists between the front and back of the human eye, is measured via electrooculography.

The ideal method for determining the user's eye gaze in a wheelchair is to employ a non-contact method based on image processing. Only one individual will be used to determine the gazing points, but if a second user attempts to use the wheelchair, it will be rejected. Simple commands such as forward, backward, left rotation, right rotation, and stop movement are available to the user. On the screen, command labels are presented. The length of time spent at the gazing point is determined by the user’s needs (Cojocaru *et al.,* 2019).

Also, the same technological gap exists in this system because for users to be able to pick instructions, they must be knowledgeable about technology, which is an issue in developing nations with low literacy rates.

2.3.3 Sip and Puff

This technique is used by the majority of people who are unable to use their hands. Breath control is the most important approach in this type of technology, and commands are made by sipping and puffing (Feldt *et al.*, 2015). This design makes use of a Sip-and-Puff device as user input. Sip-and-Puff devices use air pressure from the person's mouth to generate signals that hardware and software can understand (Grewal *et al.*, 2018). A digital signal is generated by a series of sips and puffs, which are processed by a controller to safely propel the wheelchair down the chosen path (Mougharbel *et al.*, 2013).

The peripipe has an atmospheric pressure sensor that detects changes in air pressure. The pipe detects when the user takes a puff, double-puff, sip, double-sip, or long puff or long sip action based on these changes and wirelessly delivers instructions to facilitate wheelchair mobility (Feldt *et al.*, 2015). The peripipe is a pipe-shaped device that allows users to engage by controlling their breathing.

The technological gap is not very large, but the user must memorize the sip and puffs to issue commands, which can be written down or visualized on a computer screen.

2.3.4 Brain-Computer Interface

Based on the Brain-Computer interface system, brain neurons are controlled. The EEG "electroencephalography" is an electrophysiological procedure that records the electrical activity of the brain. The Brain-Computer Interface is a computer-based device that obtains brain signals that can be controlled using EEG "electroencephalography." The technique is particularly useful for individuals with Amyotrophic Lateral Sclerosis who need to maneuver their wheelchair in any direction (Ghorbel *et al.*, 2019). The brain signal must be processed and converted into specific commands before the output device can perform the needed tasks. With the assistance of a neurosky sensor that calculates the electrical activity of brain neurons. The electroencephalography (EEG) system is used by the sensor. The billions of cells in your cerebrum produce tiny electrical signals called brainwaves that structure non-straight instances (Sharma *et al.*, 2021).

Dealing with brain neurons is a massive undertaking that necessitates the user's understanding of the system, which is still a difficulty for individuals due to technology.

2.3.5 Voice Recognition

Speech is used to control the wheelchair. The voice is acquired by the system using the voice captured module and then compared with the voice recognition module using the predetermined voices stored in the system. One form of the voice recognition system is speaker-dependent, while the other is speaker-independent; one is dependent on a human, while the other requires only the training of words (Aktar *et al.*, 2019). The wheelchair's microphone is placed on it so that the wheelchair user can provide commands.

Forward movement, left and right turns, and a stop is among the basic movement functions. The speech recognition processor must be trained with the word uttered by the user who will operate the wheelchair to recognize spoken words (Priya *et al.*, 2018).

The technology isn't a problem because the words are chosen based on the user's preference for their original tongue.

2.3.6 Joystick

Using the joystick is when the command is started to be initiated and then send to the microcontroller to execute the command. After the execution, the command is sent by the controller in the form of a digital signal to the motor driver to control the movement of the two dc motors. Then due to the command of the joystick, the two-dc motor will rotate (Saharia *et al.*, 2017; Dicianno *et al.*, 2010)

2.4 The Existing System at the Mount Meru Hospital

The existing system as shown in Fig. 7, it’s a manual wheelchair that the wheelchair user is using at Mount Meru referral Hospital. Thus, the gap toward more advanced wheelchairs at the hospital is very huge and there is a high need for more innovations to maneuver the wheelchair users with various features. That’s why there is a need to develop a solar-powered wheelchair system integrated with the following features, tracking location, fire detection, capable of sending the message, and detecting obstacles at a certain range.

Figure 7: Existing wheelchair at Mount Meru Referral Hospital

2.5 Related Works

With a built-in programmable Arduino based on the ATmega32 microcontroller, a low-cost, readily controllable robotic wheelchair is produced in this work. Aside from controlling the wheelchair, some extra functions have been included, such as obstacle detecting sensors to stop the system in the event of an impending collision, and a surveillance camera (Noman *et al.,* 2018). However, the system doesn't use solar power.

The wheelchair is charged by solar, and it is controlled by an Android app and a joystick. It can also detect obstacles and has a horn feature. For wheelchair control, ESP8266 programming is done through a mobile application (Sowmya & Education, 2021). But the system can't track the location and doesn't give a response alert in case of dangerous cases like fire.

The system is an automated wheelchair controlled by a joystick and connected to the cloud. It's an automatic wheelchair that's configured using a temperature sensor, heartbeat sensor, obstacle detection sensor, GPS, and WIFI module. The processor is an ATmega 328. The ThingSpeak cloud is used to monitor and store data collected by sensors (Vazurkar *et al.,* 2021). But the system has no GSM mechanism for sending msg in offline and the wheelchair is not powered by solar.

The designed device was a solar-powered electric wheelchair that aids paraplegics and other impaired people in reducing their misery. The GPS was used to track the patient's movement (Ogbonna *et al.,* 2021). However, no mechanism is used for fire incidents and sending SMS.

This suggested system includes voice commands, GPS tracking of the patient's position, and data transmission via a smartphone app via Firebase. Obstacle detection is included, and the microcontroller is Arduino (Aktar *et al.*, 2019). But the system doesn't use solar power.

The design and deployment of a low-cost solar-powered wheelchair for physically challenged people are presented in this research. Using surface electromyography technology, the signals required to maneuver the wheelchair are obtained from various muscles of the hand. To categorize the patterns and features collected from the received signals, an artificial neural network-based classifier is built (Kaiser *et al.,* 2016). The system doesn't give tackle the tracking and alert problem in case of danger.

The goal of this concept is to develop a smart wheelchair. The Smart Wheelchair is a self-mobilizing gadget that is controlled by the user's order. The user will supply input commands to drive the wheelchair, which is interfaced through RF communication and voice command, to achieve the desired mobility. RF communication or voice command can be used depending on the user's preference. The major goal of this study is to gather additional information and build a wheelchair utilizing a Raspberry Pi and an RF controller to address the challenges that physically challenged people experience. The RF module, GSM and GPS module, servo motor, wheelchair, and device are all included. The wheelchair controls the entire module (Renuka *et al.,* 2021). The user will offer input commands to control the desired movement. The limitation found is that the system doesn't use solar power.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Materials

3.1.1 Case Study

The disability rate in poor and medium-income nations is anticipated to double by 2025, according to estimates. In Tanzania, even though the data is imprecise and inadequate, 8% of the population is disabled (Njelesani *et al.,* 2011). The study was carried out in Mount Meru referral hospital in Arusha as the fieldwork area for this project.

According to the findings of a survey conducted in Arusha and other parts of Tanzania, the majority of wheelchairs in use are manually operated. The use of this style of wheelchair has exposed wheelchair users to numerous safety and wheelchair-related issues. Furthermore, the usage of a manually operated wheelchair has required more than one person, with the majority of wheelchair users relying on the assistance of a close friend, resulting in a reduction in manpower in critical economic problems.

The Mount Meru Regional Referral Hospital provides a manual wheelchair for wheelchair users to utilize as shown in Fig. 7. There are numerous issues that users face when utilizing wheelchairs under current systems. As a result, it is critical for the development of new wheelchair models. Since beginning my internship at the hospital, I've focused all of my efforts on designing new types of wheelchairs that will benefit both the hospital and society as a whole.

3.1.2 Design of a Questionnaire

Because of the COVID-19 pandemic, the design of a questionnaire was the quickest and easiest way to collect a large number of responses. After writing down the necessary questions, I was given access to a Google Form after creating an account, where I could the questions with the appropriate groups. Wheelchair users, medical officers, and non-wheelchair users were the target groups.

3.2 Methods

3.2.1 Literature Review

It is the key method for this project to identify the gap in the existing systems by reviewing the current industry practices and academic research. The initial step is to identify essential limitations and classify them using a well-structured technique. A comparison of several aspects of these assistive technologies to the joystick assistive technology was done based on the following parameters: usability command, response time, information transfer rate, effects, fatigue, and costs. So that these factors have contributed to the current popularity of joystick assistive technology.

3.2.2 Data Collection

(i) Creating a Survey Questionnaire

The most common method of gathering quantitative primary data is through a questionnaire. A questionnaire enables the standardized gathering of quantitative data, resulting in data that is essentially systematic for analysis (Roopa & Rani, 2012). Questionnaires should always have a clear objective that relates to the research goals, and how the results will be used should be obvious from the start.

The main purpose of this study is to examine the effect, impact, and significance of wheeled mobility devices from the perspectives of customers, guardians, healthcare practitioners, policymakers, and funding organizations. It is very important to obtain the views from different groups concerning the wheelchair that exist and what are their opinion on the design that was constructed. Further to get their thought on new features they can suggest. The questionnaire will cover the following groups:

(a) Wheelchair users

(b) Hospital workers

(c) Non-wheelchair users

3.2.3 Development Model Used

Various kinds of methodology can be used to develop a system from design to implementation. In the case of the proposed system, I have selected the agile model as shown in Fig. 8 due to the following reasons:

(i) Changes in requirements are welcome, especially if they occur late in the development process.

(ii) There is no guesswork between the development team and the customer because there is a face-to-face connection and continuous input from the customer.

(iii) The agile technique requires a flexible team that can adjust to changing requirements.

Agile is defined as a software development process in which continuous testing and iterations occur throughout the development cycle (Srivastava *et al.*, 2017). Because the builds are sequential and incremental in terms of the functions required to build object-oriented software, Scrum is a hybrid of the Iterative and Incremental models. Scrum was created to speed up development, match individual and organizational mottos, create a performance-focused culture, support shareholder value generation, and foster good performance communication at all levels in order to improve individual progress and quality of life.

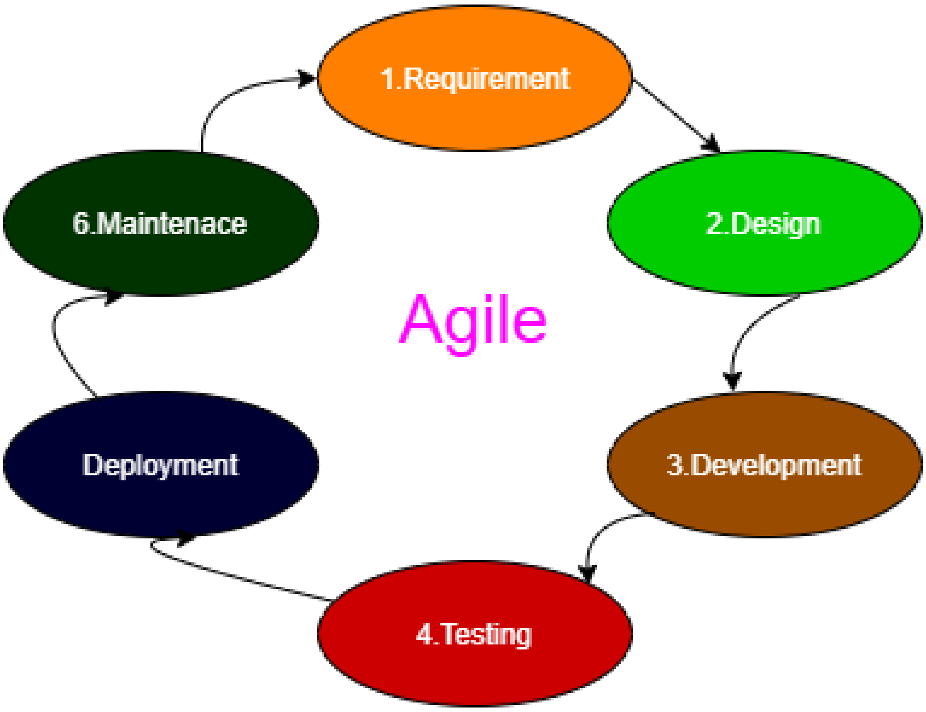


Figure 8: Development process of agile software

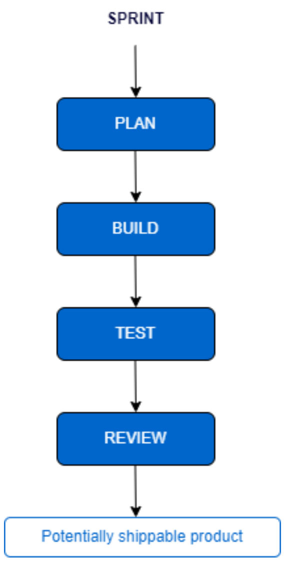


Figure 9: Scrum model basic diagram

Scrum is an agile method that defines the beginning phase and serves as an overview design stage in which the project's general objectives are specified and the software architecture is designed. The project is then wrapped up with a number of development iteration cycles (sprint cycles), each of which creates an increment of the system, and the project closure phase completes the necessary documentation.

Table 1: Comparison of the scrum with other methods

SCRUM	OTHERS
More prescriptive, formalized arrangements, responsibilities, and iterations that are fully specified	Kanban Less restrictive, no formalized meetings, responsibilities, and iterations that are indefinite
Productivity is prioritized, resulting in increased customer satisfaction and greater flexibility	XP Less adaptable, and productivity isn't prioritized
Communication among team members is more effective, and there is less complication involved	FDD There is less communication, and the procedures are more complicated
Team members communicate more effectively	DSDM There is a lack of communication among team members
The procedures that are followed are both simple and sophisticated	ASD Complexity in procedural structure
User standards specify development and planning more precisely, allowing for improved traceability	Crystal User requirements aren't taken into account as much, and it's tough to track down the work that's been done.

3.2.4 Design and Specification of the System

Sensing, alerting, and processing are the three main modules developed in this design.

(i) Sensing Unit

This section of the unit contains the HC-SR 04 and MQ-2 sensors, which are used to determine distance and detect fire, respectively. The ultrasonic sensor close to the sensor determines the distance between the sensor and the object. The ultrasonic sensor was employed in this project to detect any obstruction encountered by the wheelchair at a distance of 10 cm. The smoke sensor is used to aid in the detection of fires to assist wheelchair users in escaping the situation. This sensor's working voltage is 5 V.

(ii) Unit for Processing and Monitoring

The open-source Arduino board microcontroller was utilized to build this unit. The voltage and clock speeds are 5V and 16 MHz, respectively. The data from the sensors is sent to the microcontroller for processing and analysis. The GSM module establishes good connectivity between the phone user and the cellular network. This was done to make it easier for the wheelchair user and close relatives to communicate for help. With the use of GPS, the wheelchair user's location was pinpointed.

(iii) Alerting Unit

A buzzer, MQ-2, and a GSM module made up the alerting equipment. Individuals whose phone numbers were synchronized in the system were notified via an alarm and SMS notification. The buzzer was utilized to provide an alarm that would alert the wheelchair user to a fire emergency. SMS notifications will be sent even in offline mode to the wheelchair user's close friends and family members using a GSM module. In addition, in the event of a fire, an SMS can be sent.

(iv) Functional and non-functional requirements

The fundamental functional and non-functional requirements are listed in Table 2.

Table 2: Functional and Non-functional requirements

S/N	Functional Requirements	Non-Functional Requirements
1.	The system shall detect the wheelchair encountering any obstacles.	Usability
2.	The system shall track the location of the wheelchair.	Localization
3.	The system shall detect the presence of fire by sending message.	Security
4.	The system shall use solar power for automation.	Performance
5.	The system shall use joystick for mobility.	
6.	The system shall send message in case of any emergence by pressing push button.	

3.2.5 The Designed System's Block Diagram

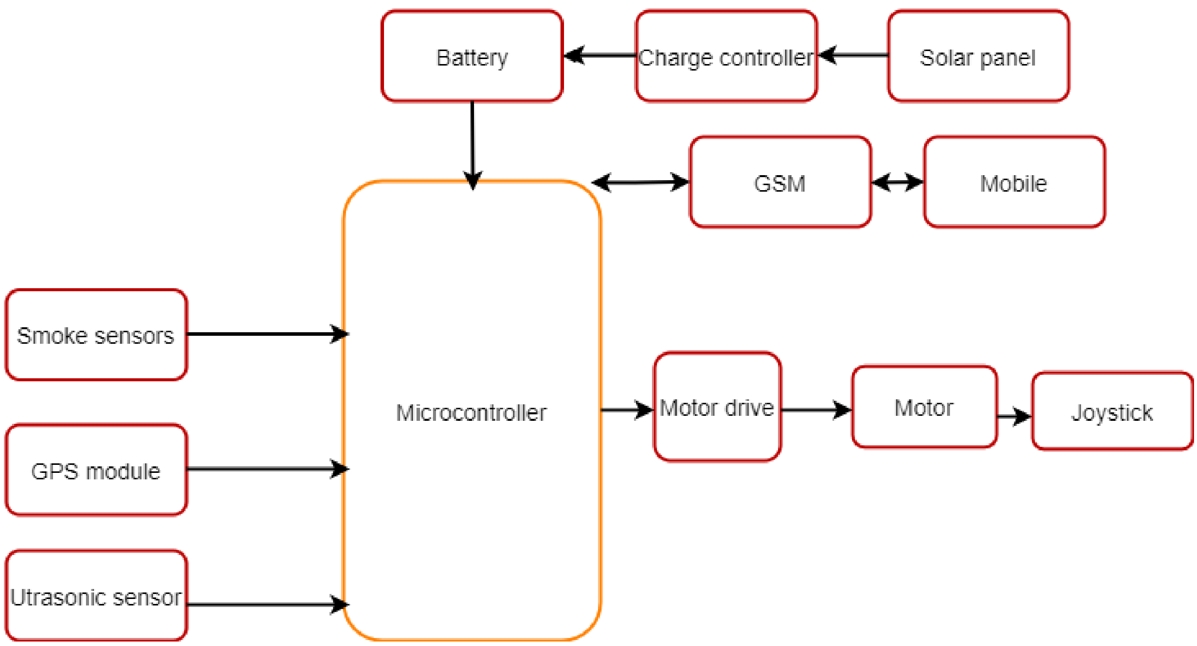


Figure 10: Representing a block diagram of a system that has been designed

The wheelchair user is expected to obtain various benefits from the designed system. The proposed system as shown in Fig. 10 is a solar-powered wheel operated by harnessing the sunlight from the solar panels. The possibly run time of the wheelchair is 3 hours based on the solar panel selected. The wheelchair user at his/her consent is capable of sending the location in case of any danger using GPS. Furthermore, in case the wheelchair user accounts for danger then via SMS using GSM the contacted individuals synchronized will receive the SMS. Once the wheelchair user encounters an obstacle in arrange of 10cm then the wheelchair is capable of avoiding the obstacle using the ultrasonic sensor. The system is capable of alerting the wheelchair user in case of fire problems using the smoke sensor.

3.2.6 Description of Electronic Devices

(i) Microcontroller

The Arduino IDE was built up such that a standalone Atmega 328 could be programmed, hence the Arduino UNO was utilized.

The open-source platform Arduino shown in Fig. 11 is well known for its use in the design and programming of electronic components. It is possible to control many electronic devices as well as send and receive information using the internet (Badamasi, 2014). The Arduino Uno board runs on 5 V and has a clock speed of 16 MHz.

Figure 11: Arduino Uno

The ATmega 328P shown in Fig. 12 is the most popular choice for anyone who wishes to construct an interactive design. It has a DC 5 V input voltage and an operating frequency of 40 Hz. It's a microcontroller on a single chip (Yeole *et al.*, 2015). This 8-bit microcontroller has a 32 kB read-write flash memory. There are 32 decent working registers and three configurable timer counters on this device. It also has serial programmable USART and internal-external interrupts. It features a total of 28 pins, with only 18 being used at any given time (Gunturi & Technology, 2013).

Figure 12: ATmega 328P

(ii) GSM Module

The SIM800 as shown in Fig. 13 could be a quad-band GSM/GPRS module with frequencies of GSM 850 MHz, EGSM 900 MHz, DCS 1800 MHz, and PCS 1900 MHz, designed for the global market (Balamurugan *et al.,* 2017). SIM800 supports the GPRS coding schemes CS-1, CS-2, CS-3, and CS-4 and has GPRS multi-slot class 12/ class 10 (optional). The SIM800 can accommodate practically all space requirements in M2M, smartphones, PDA, and other mobile device applications. In sleep mode, the current consumption of the SIM800 is as low as 1.2 mA, thanks to its power-saving design. TCP/IP protocol and expanded TCP/IP AT commands are integrated into SIM800, making it ideal for data transmission applications. SIM800 supports quad-band 850/900/1800/1900 MHz, allowing it to send voice, SMS, and data with little power usage. Its small size of 24*24*3mm allows it to fit into sleek and compact customer design requirements. It offers total cost reductions and a quick time-to-market for customer applications thanks to Bluetooth and Embedded AT (Trivedi *et al.,* 2018).

Because it functions as a mobile phone and accepts any SIM card with a unique number, the wheelchair user's close friends and family, as well as hospital medical personnel, will be able to receive messages if the wheelchair user requires assistance. This is simply accomplished by pressing the wheelchair's push button.

Figure 13: The SIM800 GSM Module

(iii) Global Positioning System (GPS) Module

The application of GPS technology is well-known in numerous fields, including navigation, positioning, and road engineering. The GY-NEO6MV2 shown in Fig. 14 module receives GPS signals and transmits them via the nRf905 wireless module, allowing the portable terminal to show geographic data such as longitude, latitude, and time independently, and then display it on Google Maps. The system employs a navigation receiver, the GY-NEO6MV2, whose baseband processing module is based on the u-blox NEO-6 module. This module is mostly used for vehicle navigation, and it can output the position and velocity of moving vehicles in real-time. In most cases, the positioning accuracy is less than 25 meters (Liu *et al.*, 2014).

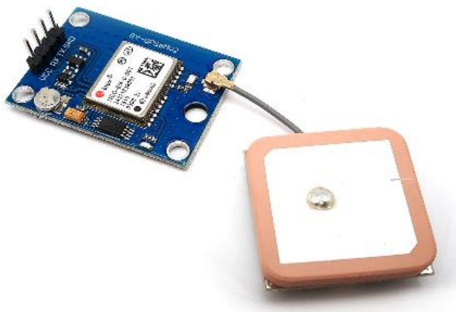


Figure 14: The GY-NEO6MV2 GPS Module

(iv) Smoke Sensor

Smoke sensor MQ-2 is a metal-semiconductor sensor made of silica, and the principle is that the tested gas causes the conductivity to change (Fig. 15). The measured gas's conductivity is inversely related to MQ-2 conductivity. The greater the resistance of MQ-2, the lower the concentration of the detected gas. The rated maximum temperature of the MQ-2 sensor is usually 300 to 400°C, the system can detect concentrations varying from 300 to 10 000 ppm, liquefied gases such as its sensitivity is pretty high, it is possible to detect other harmful gases and smoke in addition to natural gas so that the sensor is to be used in individual households and industrial gas leak tracking and portable gas detection (Yin, 2016).

Once a fire has erupted, smoke detectors are used to detect it. Our system transmits a powerful fire alarm through the buzzer if the smoke detection method returns a positive result; otherwise, it sends a moderate fire alert because there is no smoke or gas in the air created by fire combustion.

Figure 15: MQ-2 Sensor

(v) Warning Device

A buzzer is a buzzing sound-producing active gadget that can be passive or active. The component as shown in Fig. 16 is most likely to work at a resonance frequency of 2300 Hz and an operational voltage of 4 V to 8 V. In the event of a fire, the buzzer will be coupled to the microcontroller's output pin to obtain an alarm. The passive piezoelectric buzzer was utilized in this project to alert the wheelchair user if a fire broke out nearby. This will certainly assist wheelchair users in making a quick evacuation and saving their lives in the event of an emergency.

Figure 16: Buzzer

(vi) Ultrasonic Sensor

The purpose of the ultrasonic sensor HC-SR04 as shown in Fig. 17 was to determine the distance between an object and the sensor in its vicinity (Alselectro, 2013). The sensor is made up of four pins, as shown in the diagram. It has an ultrasonic transmitter that sends out the created sound waves, and when those waves hit an object, the echo waves, or reflected waves, are rebounded back to the ultrasonic receiver. Even though it is relatively simple to maintain and direct an ultrasonic beam as a result of the diffraction of its small waves due to their short wavelength (Kaur *et al.,* 2015)

The calculated distance (about 343m/s after reflection from an object) and the time that the reflected waves have taken to return to the sensor using the sound speed. The wheelchair will be able to detect the existence of any barrier or object at a distance of less than 10 cm from the side where the ultrasonic sensor is inserted, according to the concept of the produced prototype. The module is attached to the microprocessor, which processes and analyzes the obtained data before sending it to the wheelchair for the next action to take. If an obstruction is discovered, the wheelchair will halt, but if no obstacle is found, the wheelchair will continue to proceed.

Figure 17: Ultrasonic Sensor

(vii) Rubber Wheel + DC TT Motor

These motors shown in Fig. 18 can be powered from 3 VDC to 6 VDC, with the higher voltages causing them to travel a little faster. With a gear ratio of 1:48, these studies (yet economical) plastic gearbox motors (also known as 'TT' motors) are a quick and low-cost method to get your projects moving.

Figure 18: A combination of rubber wheel + DC TT Motor

(viii) Motor Driver

As seen in Fig. 19, the L298N standard packaging has 15 pins. The internal system of the L298N chip has a four-channel logical drive circuit with a maximum output voltage of 35 V, a working current of 2 A, and a rated power of 25 W, allowing it to drive two direct currents motors (Yin *et al.*, 2016).

The L298N module is easy to control in our project; it can not only adjust the DC motor's positive and reversal rotation, but it can also speed by modulating the PWM wave that the control board outputs; the driver module has an overcurrent protection function, which protects the entire circuit and the DC motor when the motor becomes stuck.

Figure 19: L298N

(ix) Voltage Regulator

The voltage regulator provides a constant DC voltage of 5 V. It acts as a voltage stabilizer for circuit components that are powered by DC voltage. Due to its proclivity for overheating, the L7805 requires a heat sink. The maximum current draw of the regulator is 1 A. The L7805 as seen in Fig. 20 can handle 15 volts. The microcontroller is fed a 5 V gain generated by the L7805. A link between two diodes feeds this regulator, preventing current flow back and providing alternate voltage (Srivastava *et al.*, 2021).

Figure 20: Voltage regulator

(x) Crystal Oscillator

A crystal oscillator with a frequency of 16 MHz shown in Fig. 21 was employed. A Crystal Oscillator provides a far more stable and exact reference clock signal than its RC and ring equivalents, allowing it to be used in a wide range of applications, including wireless transceivers (Lei *et al.*, 2017).

Figure 21: Crystal oscillator

(xi) Copper Clad Board

Copper Clad Boards can be used to make your circuit boards, breakout boards, DIY boards, and other industry boards and applications. This board shown in Fig. 22 is 6x6 inches and is composed of high-quality phenolic laminate.

Figure 22: Copper Clad Board

(xii) Ferric chloride

Iron (III) Chloride (FeCl3), commonly known as Ferric Chloride (Iron trichloride) as shown in Fig. 23, is an inorganic chemical. It's a common iron combined with a +3-oxidation state. With a melting point of 307.6^{o}C, the anhydrous chemical is a crystalline solid. The color of the crystals varies depending on the viewing angle: reflected light appears dark green, while transmitted light appears purple-red (Obe *et al.*, 2020).

Figure 23: Ferric chloride

(xiii) Solar Panel

The global energy demand is increasing every day. Solar energy must be used to meet essential needs. Photovoltaic technology is used to harness the sun's energy (Sathyanarayana *et al.*, 2015). A photovoltaic (PV) system is made up of a series of solar panels that convert sunlight into electricity. Each solar panel is made up of PV cells (photovoltaic cells) composed of semiconductor materials. Knowing the cell efficiency and fill factor can be used to estimate the capacity of a PV cell.

For demonstration purposes, a polycrystalline solar panel shown in Fig. 24 with a capacity of 2.5 Wp was employed in our developed prototype.

Figure 24: Polycrystalline solar panel

(xiv) Charge Controller

Because the sun's rays aren't consistent on the solar panel, the amount of electricity generated fluctuates, lowering the battery's effectiveness (Hans *et al.*, 2018). In this instance, a charger controller is required to ensure a consistent DC output.

The charge controller that will be used in the prototype is rated at 24 volts and 10 amps as shown in Fig. 25.

Figure 25: Charger controller

(xv) 12V Lead-acid Battery

Lead's natural properties include mass, malleability, low melting point, corrosion resistance, electrical properties, and long-term resistance. When positive and negative plates are placed in an electrolyte, they react and produce power. The approximate voltage of a standard lead-acid battery is shown in Fig. 26 is 2 V/cell; so, the total voltage on a battery is 12 V for all 6 cells (Diniş *et al.*, 2015). The battery's primary function is to store electrical energy for future use.

Figure 26: Lead-Acid Battery

3.2.7 Process of Designing Printed Circuit Boards

Following the design of the PCB layout in Proteus Design Suite, as shown in Fig. 27, it will be printed on glossy paper. The circuit is next to be ironed using gloss paper on top of the clad board until it appears nicely on the board. Mix 25 grams of ferrous chloride with 50 ml of water (H20). Wait 5-10 minutes after dropping the copper PCB board into the liquid. The PCB should then be washed in water and cleaned with thinner. The PCB circuit will then be ready to be tested for continuity and short circuit. Following testing, the final procedure will be to attach the components in the holes created by the drill bit hole maker, followed by soldering the components.

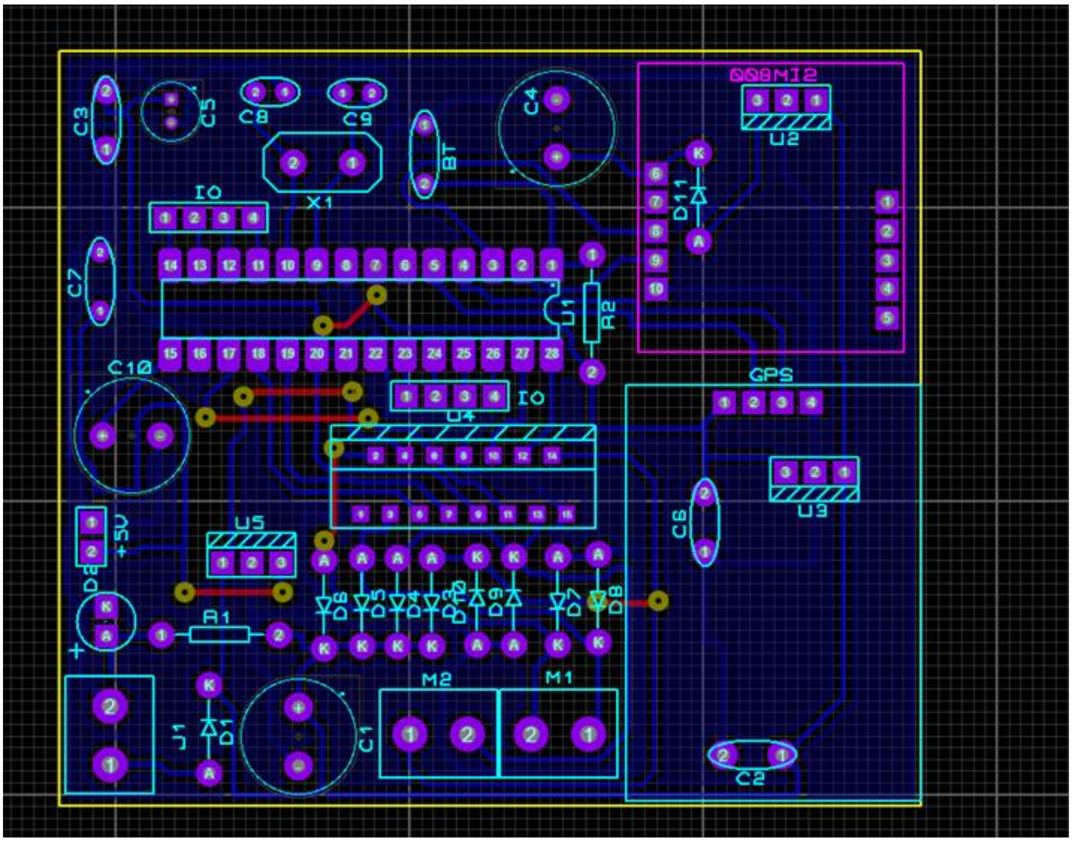


Figure 27: PCB Design etched with conductive pathways

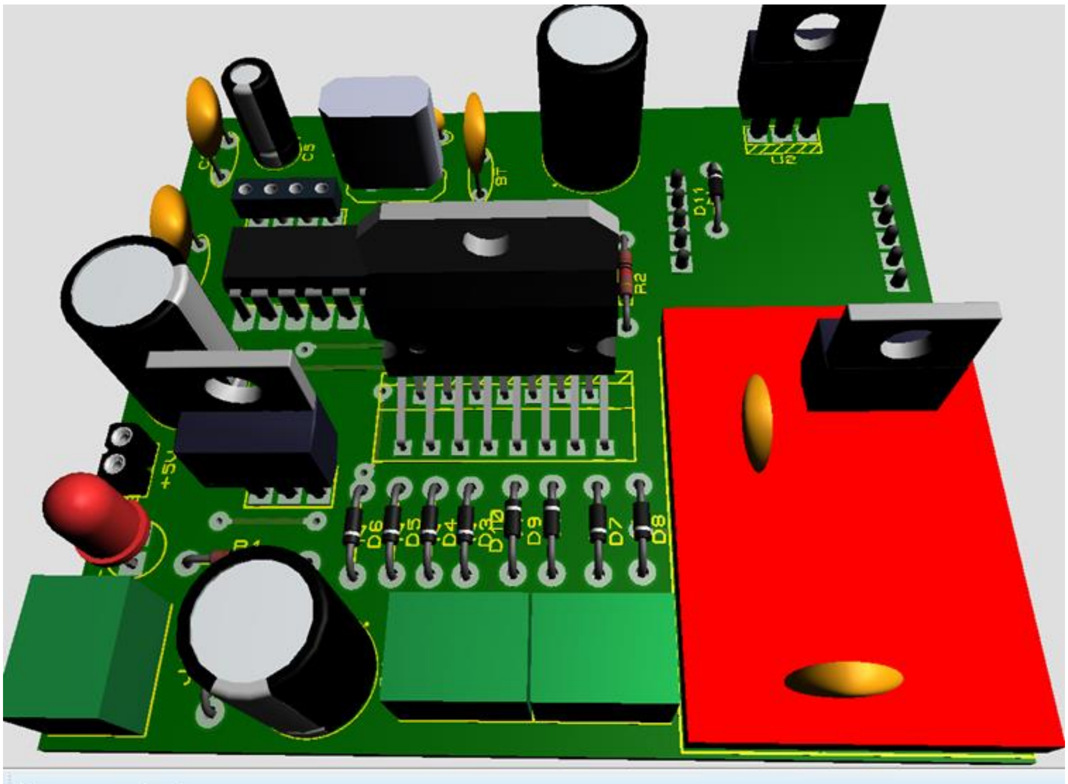


Figure 28: The 3D view on PCB layout

3.2.8 System Implementation

(i) System Components Configuration and Integration

It is critical to utilize a graphical representation known as a circuit diagram to demonstrate how the components are electrically connected. It also depicts a decent component road map as well as the circuit's relationship.

The circuit's relationship to their general interactions is well represented in the circuit as shown in Fig. 29. The ATmega328P has a total of 28 pins. There are 6 analog pins and 14 digital pins. The GPS module's transmitter (Tx) and receiver (Rx) pins, with a clock frequency of 16MHz, were connected to pins 4 and 5 of the ATmega328P, respectively. The ultrasonics' echo and trigger pins are connected to the microcontroller's pins 14 and 15, respectively. The GSM module's transmitter (Tx) and receiver (Rx) pins were connected to the Atmega328P's pins 2 and 3, respectively. The MQ-2 analog output pin is connected to pin 11 of the Atmega328P, and the sensor value is converted to PPM (Parts per million) using this connection. The joystick pins were connected to pins 24 and 25, respectively. Motors can be controlled in either a clockwise or anticlockwise direction. H bridge is a 16-pin integrated circuit with two motors connected to pins out1, out2, out3, and out4. PWM pins EN1 and

EN2 are used, while IN1, IN2, IN3, and IN4 are used to send signals to the motors. Connect the L293 IN1, IN2, IN3, and IN4 pins to the ATmega32 PC0, PC1, PC2, and PC3 pins. L293 pins EN1 and EN2 are connected to 5 V. Connect the VCC and GND pins of the L293 to 12 V and ground, respectively. Set the crystal and ATmega32 frequencies to 16 MHz. The buzzer has two pins, one connected to ATmega328 pin 13 and the other grounded. The connection of the solar power to the charge controller to the 12V lead-acid battery ensures that the deep cycle batteries are not overcharged through the day and that energy somehow doesn't run back to the solar panels overnight, draining the batteries.

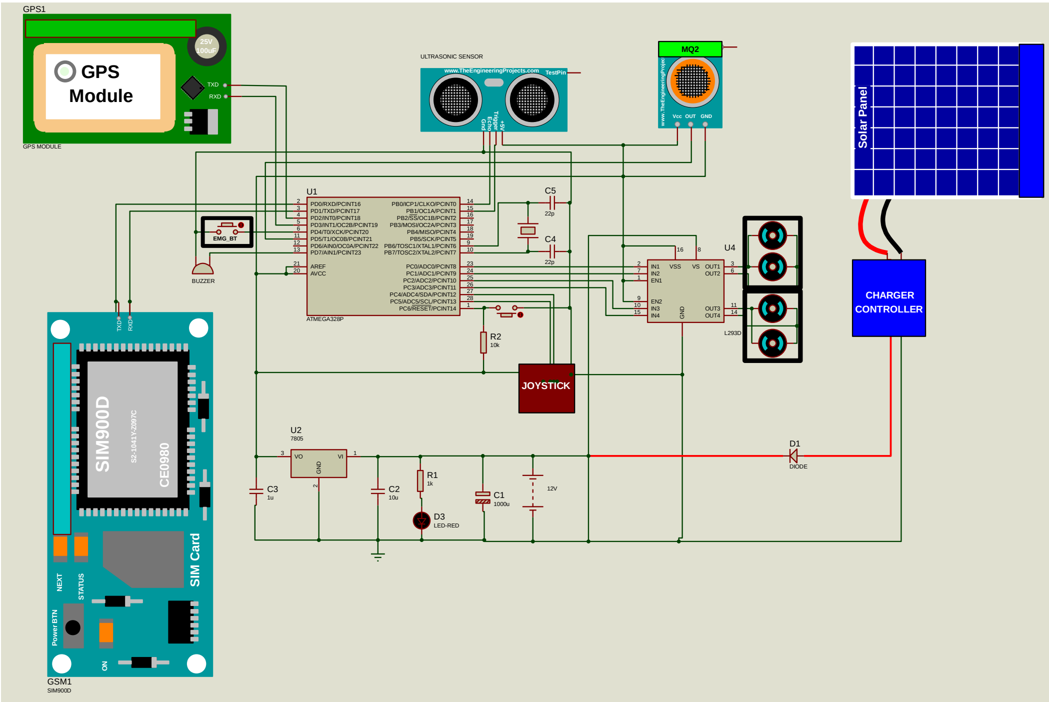


Figure 29: System components configuration

(ii) Programming Languages and Software Used

We drew our circuit with Proteus Design Suite as shown in Fig. 29. Proteus is a type of software created by the Labcenter firm in the United Kingdom. The design process of hardware circuits can be greatly reduced using Proteus' robust simulation capabilities and huge resource libraries (Liu & Li, 2010). The Proteus simulation program can first be used for hardware circuit design, simulation, and debugging.

The Arduino Integrated Development Language (IDE), a general-purpose, functional, and high-level programming language, was used to construct this system. The Arduino IDE is a free and open-source software package that includes a text editor with C++ and C programming language functions. Because the software provides free access to the module that you have, you can easily use it in the program. The program code was written using the Arduino IDE's text editor.

Coding was required for the sensors to work to their maximum potential. As a result, a significant portion of the circuit's development is dedicated to performing the essential coding.

(iii) The Developed System's Functionality

(a) Flow chart

The flow chart of the developed system is shown in the diagram below. The flow chart is a visual representation of an algorithm that provides information about the system's activity and connectivity. The boxes of various kinds and rows, correspondingly, represent the general interconnectedness of the activities. In the flow chart below, the operation illustrating the flow from beginning to end is displayed. The sensors employed in this study are clearly defined in terms of their functionality in the flow chart.

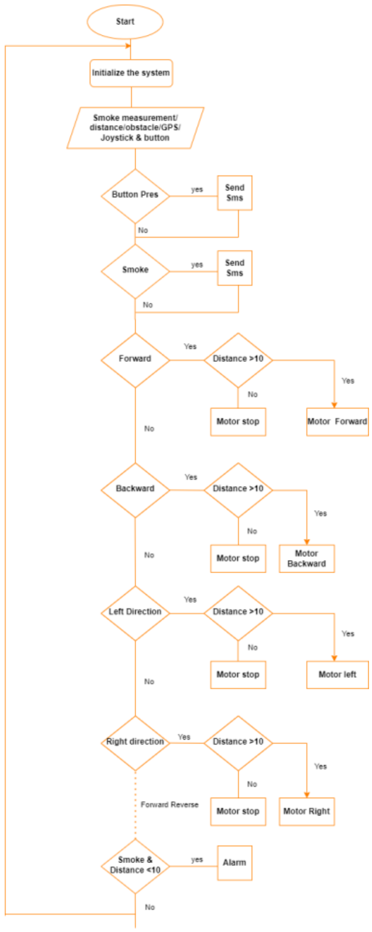


Figure 30: Representing the flow chart of the system

As shown in Fig. 30, the system was turned on so that parameter initialization could begin and components could function. The joystick is used to control the wheelchair's mobility. The joystick controls the wheelchair's movement to the right, left, backward, and forward. Any movement initiated by the joystick generates a command that is sent to the motors to drive the wheels. The good news is that the data is delivered directly to the microcontroller and can be altered at any time. In this experiment, an ultrasonic sensor was utilized to stop the wheelchair from traveling at a distance of 10 cm if the wheelchair user encountered any obstacles. The system uses alternatively two power supply sources the battery or the solar power for powering the wheelchair. If the wheelchair user comes into contact with fire, the MQ-sensor will detect it and the buzzer will sound a warning, as well as send an SMS to nearby people whose numbers are synchronized. Under the authorization of the wheelchair user, the location of the wheelchair might be easily tracked using GPS.

3.2.9 System Testing

System testing is the process of testing an integrated system as a whole. Before testing the full system, it was necessary to start with the unit and integration testing to ensure that all of the required functionalities were met.

(i) Lab Testing Approach

The testing was carried out using the lab testing method. The mechanical frame construction and PCB circuit design were well done using this testing approach. The Arduino Integrated Development Environment (IDE) is an open-source software tool for creating code that includes a text editor. Because the platform includes C++ and C functions, users can create their modules and include them in their projects. The program code was written using an Arduino-provided text editor. Following the creation of the wheelchair's mechanical frame, the wheels implanted with motors were tested to verify if the terminals were functioning properly. For obstacle detection, an ultrasonic sensor was installed at the front of the wheelchair. The MQ-2 sensor was then mounted to the front section in case a fire was detected. On the PCB, GSM and GPS were installed. The system was powered on once the USB Arduino was connected to the computer and the initialization of the other components began. The program code was uploaded to the Arduino and compiled to convert it to binary, which allowed the instructions to be executed. The output from essential SMS indications might be viewed in mobile phones and others with the naked eye. All critical parameters were thoroughly tested and yielded positive results.

Figure 31: Prototype testing in the lab

(ii) Field Testing Approach

For well testing of the developed prototype and evaluating its operation then the system was taken to the normal surface for testing. In this case, since the movement of the wheelchair is done by a person not sitting considering it's a small prototype then consideration of the weight of a normal human being is highly neglected. However, throughout the entire process, the system operation was observed. The purpose of this field test is to ensure that the prototype produces the functionality that is required.

The field test approach utilized the same system components. The wheelchair's whole movement was begun by the joystick, which sent a clear signal to the motors that drive the wheelchair's wheels, allowing mobility in the desired direction. After then, if the wheelchair contacts an obstacle at a distance of less than 10cm, the ultrasonic sensor identifies it and allows the wheelchair to stop. The variable resistor linked to the wheelchair allowed for easy regulation of its speed. To match the user's demands, the detection distance for an obstacle can be changed in the code. When a fire breaks out during the moving process, the MQ-sensor detects the fire and sends an SMS, as well as sounding an alarm with the buzzer. With the user's permission, the user's location can be easily determined via GPS. The wheelchair has a battery, and the electricity is turned on, but if the battery runs out of charge, the solar panel will charge it.

During the research for the design of this wheelchair system, it was discovered that creating a wheelchair for a human being to sit in would have little impact on some important parameters such as fire detection, human position localization, and obstacle detection. Much of the difference would be due to the consideration of motors that would be able to drive the wheels while taking into account the weight position at the time.

Figure 32: Prototype testing in the field

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Result of Validation of System Parameters

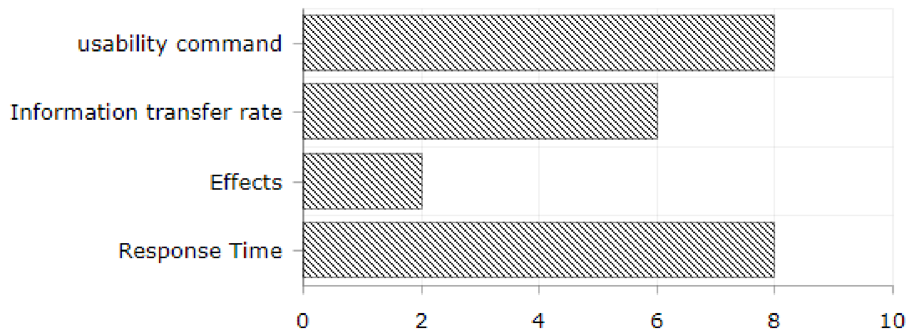


Figure 33: Validation of the system parameters

4.2 Results of the System Design

4.2.1 Results of the Direction Commands

The above results were obtained as per the test that was conducted based on the use of the joystick to see how is the system responding towards the commands in the favorite direction. The number of trials done to be satisfied with the way that the joystick respond was 10 times. It was found that the response was less than one second as shown in Table 3.

Table 3: The amount of time it takes the joystick to respond

Joystick control	Time of response	Number of trials
Forward	Less than 1 second	10
Backward	Less than 1 second	10
Right	Less than 1 second	10
Left	Less than 1 second	10
Stop	Less than 1 second	10

4.2.2 The Result of the Fire Detection

During the moment that the fire has started and the MQ2 sensor has captured the data, the buzzer will sound and a message will be sent to the synchronized number as shown in Fig. 34.

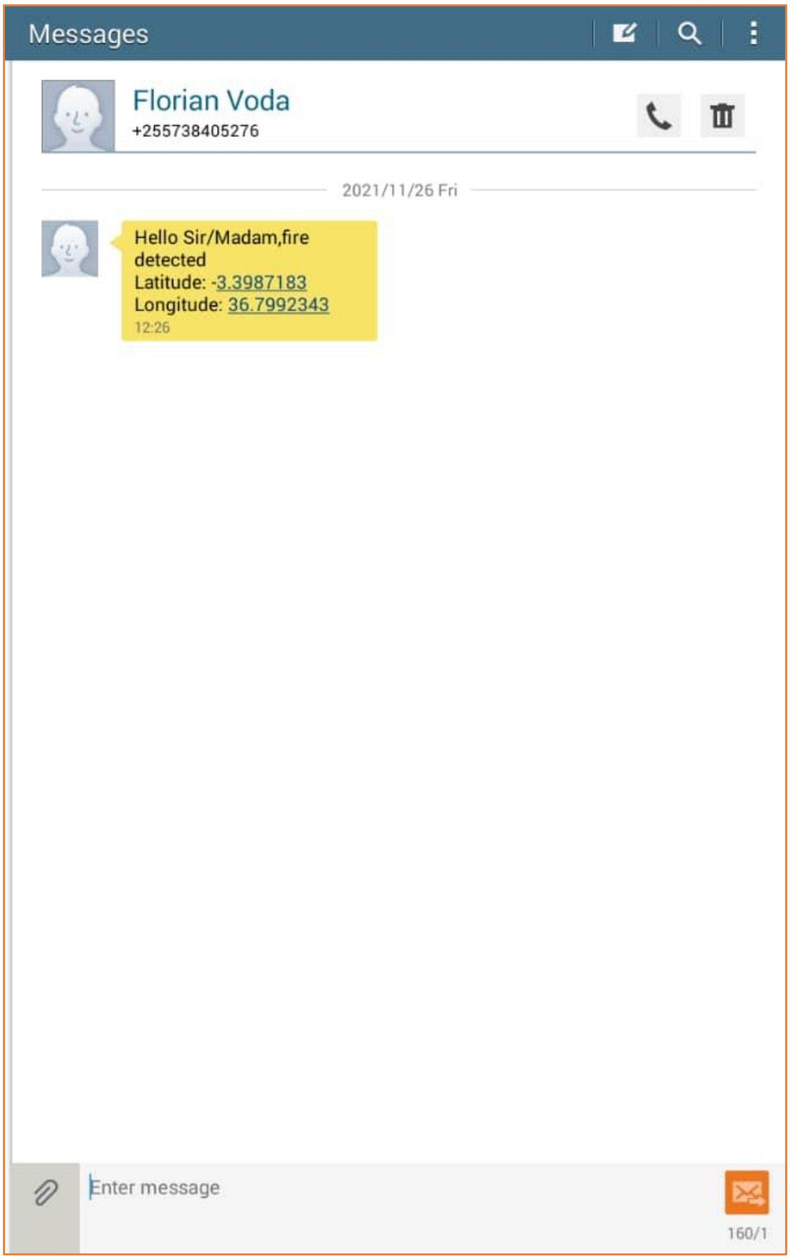


Figure 34: Short messaging service notification of fire breakout

4.2.3 Short Messaging Service Notification via GSM

According to the SIM800L GSM's functioning mechanism, when the push button near the top of the wheelchair was pressed, the message for asking assistance was obtained, as shown in

Fig. 35. The process for sending messages is done in offline mode. The latitude and longitude coordinates are sent in parallel with the message.

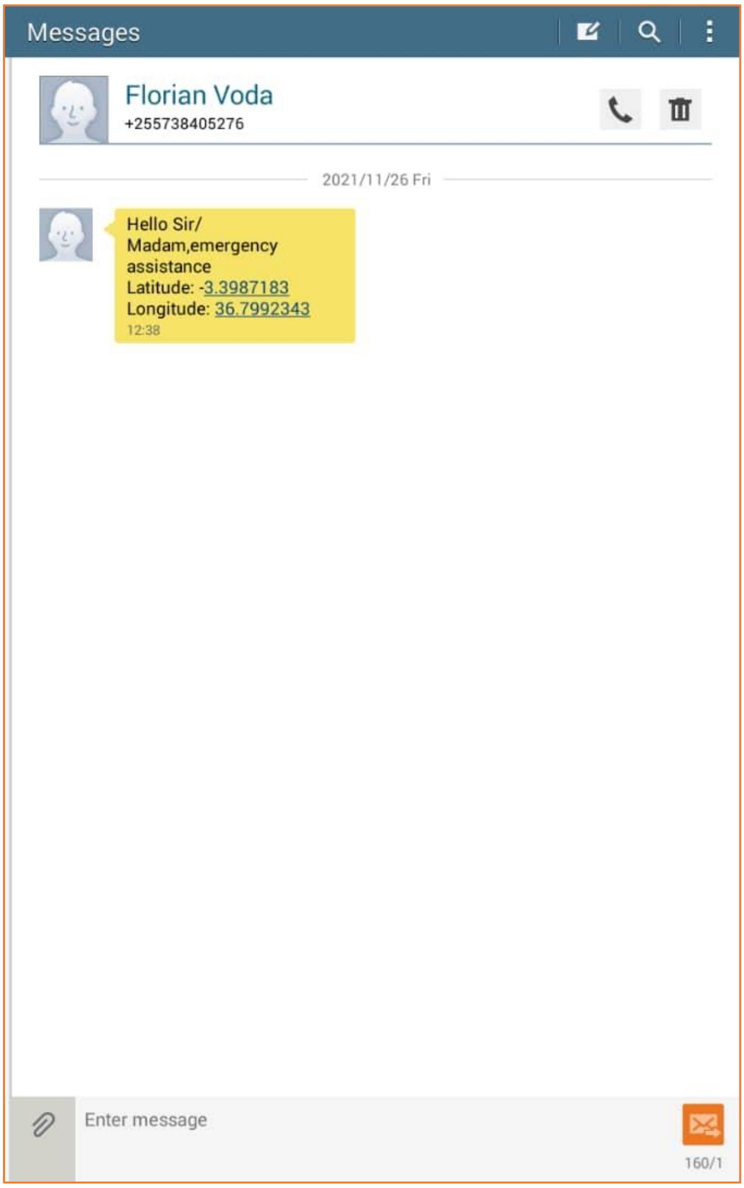


Figure 35: Short messaging service notification of emergency alert

4.2.4 Result Based on Location Tracking

The message is sent to the proper number after pressing the push button, and the latitude and longitude values are acquired from it. If the green signal begins to blink, the GSM is active. The values are obtained from the GSM by the microcontroller, and the latitude and longitude numbers are entered into Google Maps to obtain an exact position, as illustrated in Fig. 36.

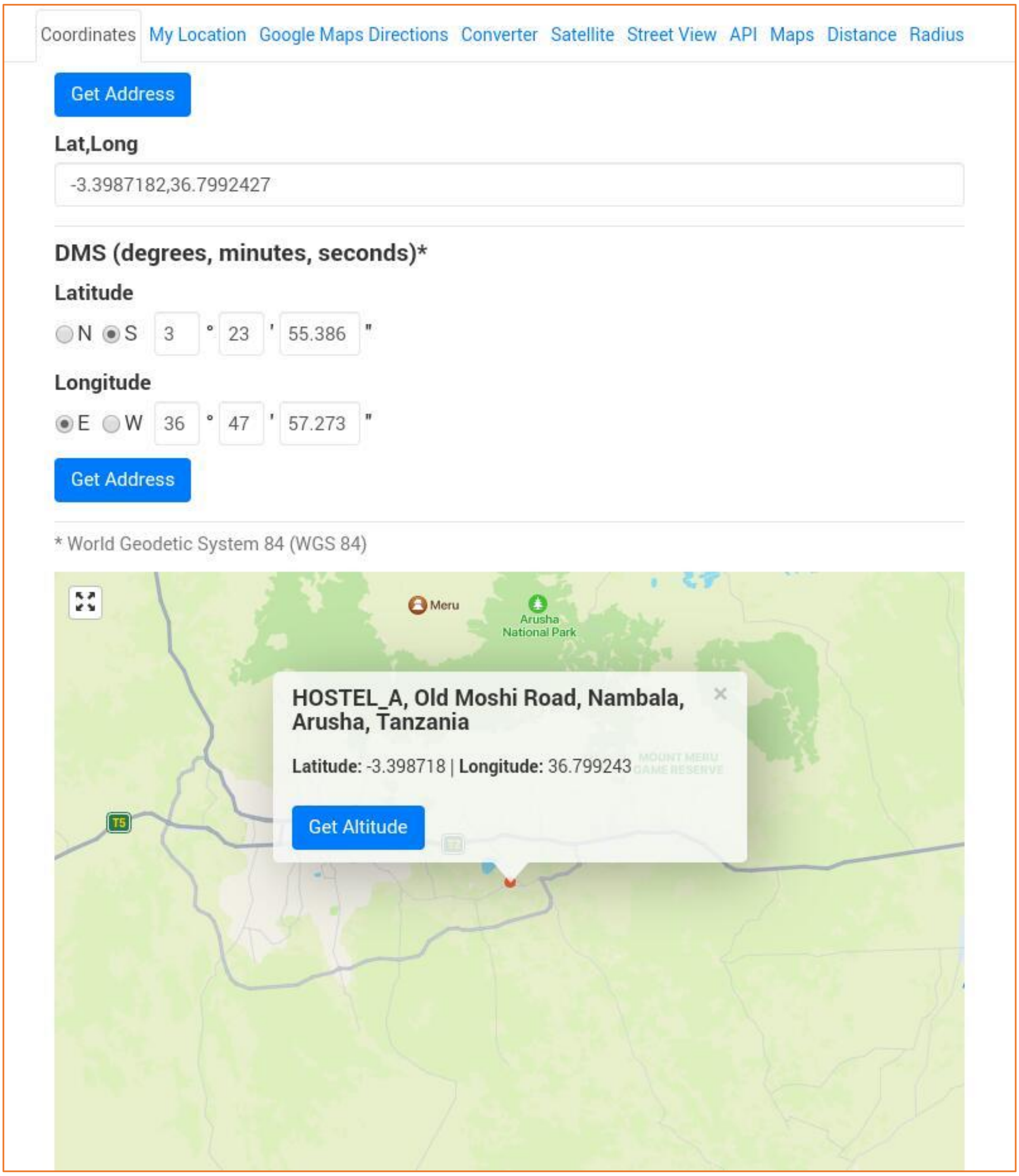


Figure 36: Shows the wheelchair's location

4.2.5 Obstacle Detection Result

The ultrasonic sensor has been mounted to the front part of the wheelchair, as illustrated in Fig. 37. The wheelchair came to a halt after encountering the object at a distance of <10 cm. This reduced the chances of the wheelchair user meeting problems in difficult situations.

Figure 37: Displaying the use of an ultrasonic sensor to detect an obstacle

4.3 Results from Data Collection

4.3.1 The Results of the Survey on Assistive Technologies

According to Fig. 38, 58.1 % of wheelchair users prefer using a joystick as assistive technology, followed by 21% who prefer speech recognition, 4.2% who prefer Brain Computer Interface, 8.1% Tongue Drive system, 4.3% who prefer Eye tracer, and 4.3% who prefer none. This is why, in this project, joystick assistive technology was used for the mobility of the developed wheelchair.

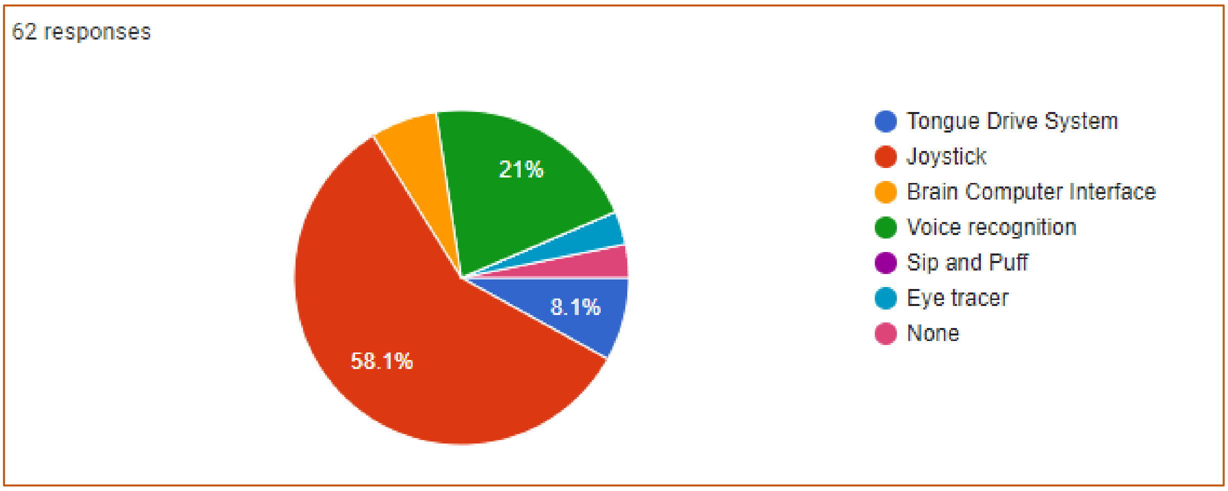


Figure 38: Representation of assistive technologies results in the survey

4.3.2 Results of Demographic Research

According to Fig. 39, 53.2% of the respondents were wheelchair users, 30.6% were medical officers, and 16.1% were non-wheelchair users. For the prototype design, it was critical to acquire the necessary information from all parties. Figure 40 shows that 54.8% of male participants, 40.3 % of female participants, and 4.8% of participants did not specify their gender. Figs. 41 and 42 show that 38.7% of people with physical disabilities are between the ages of 30 and 40, 30.6% are between the ages of 20 and 30, 14.5% are between the ages of 40 and 50, 8.1% are between the ages of 10 and 20, 6.5% are between the ages of 50 and above, and 1.6% are between the ages of 0 and 10.51.6 % had a hand disability, 30.6 % had a leg disability, 9.7% had paralysis, and 8.1 % had an age issue. As a result of the above responses, the focus of the prototyping design was on the usage of the joystick as modern assistive technology.

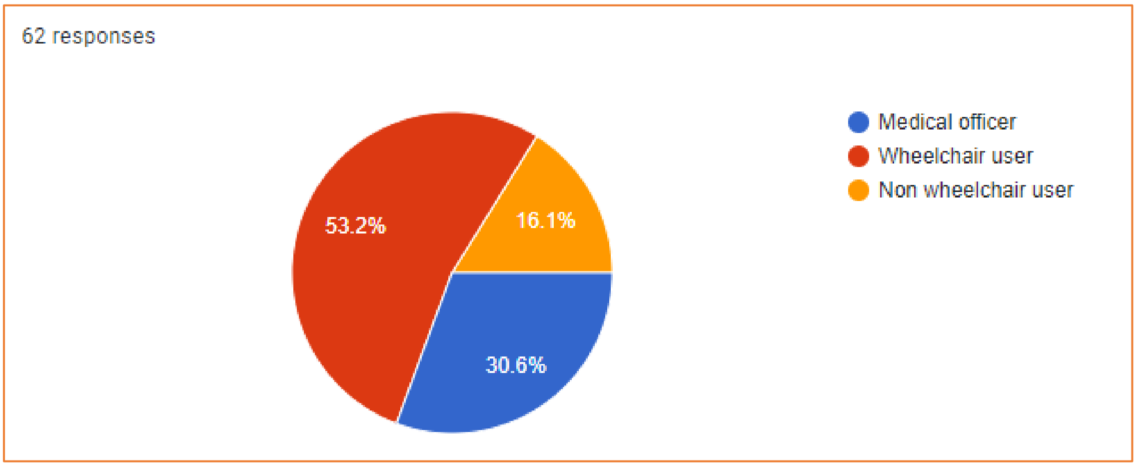


Figure 39: Representation of targeted groups results in the survey

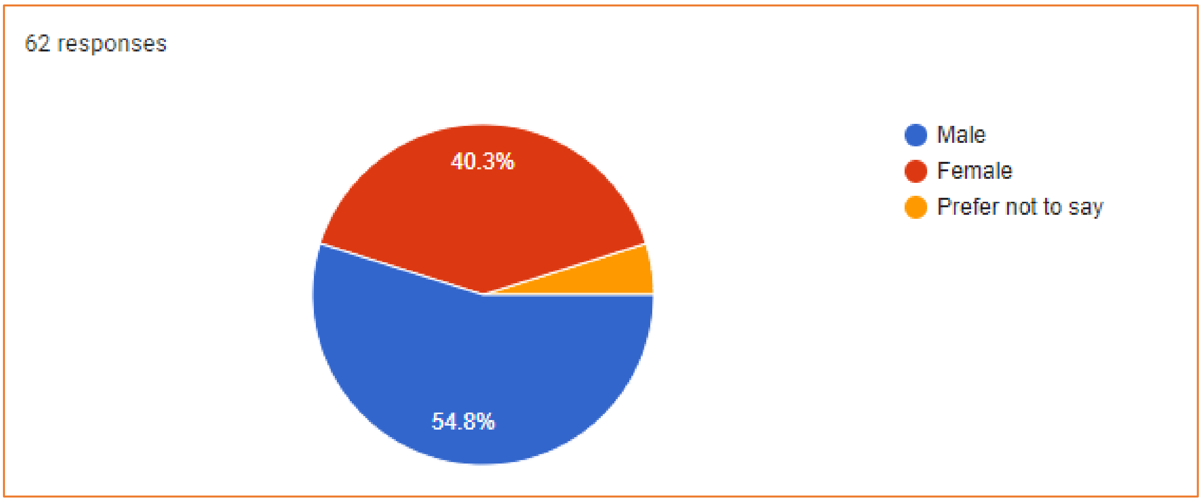


Figure 40: Results for gender-targeted groupings based on the survey

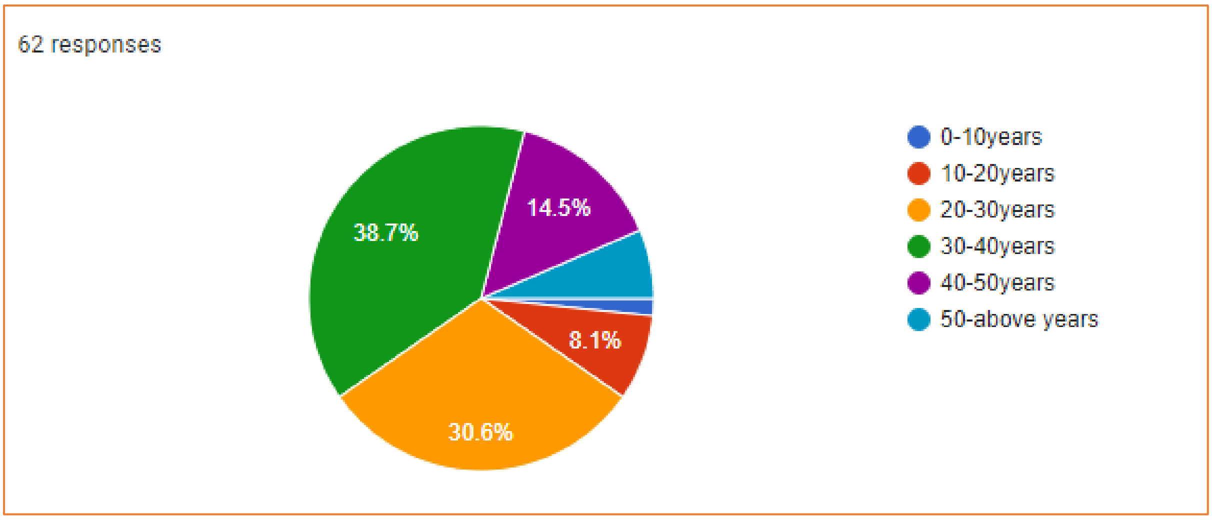


Figure 41: Results for the age of targeted groups based on the survey

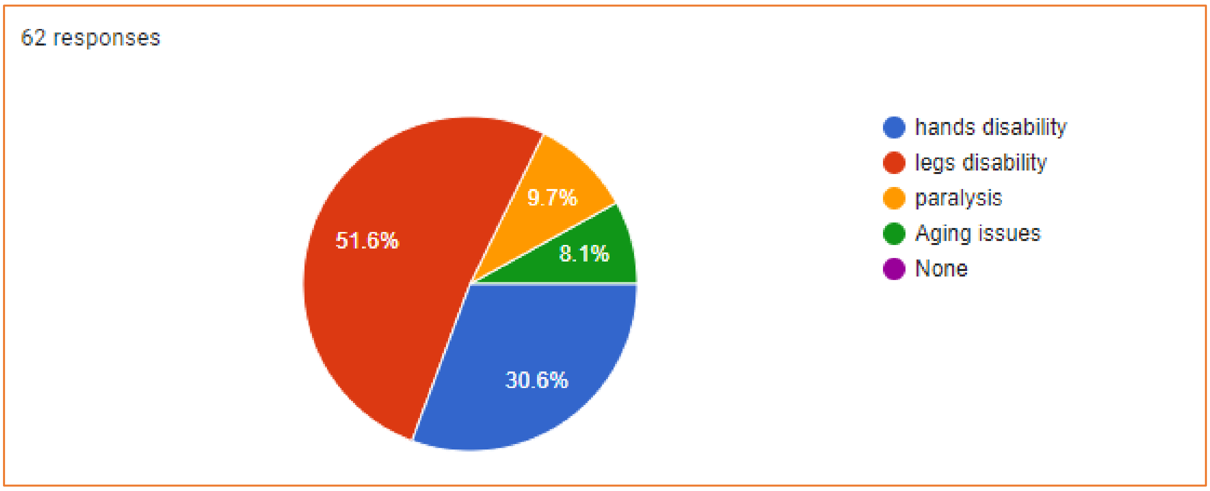


Figure 42: Results for the type of disability based on the survey

4.3.3 Results Based on the User's Experience

Wheelchair users face a variety of safety concerns, and their responses were as follows: 46.8% have accident difficulties, 77.4% have fire incidents, 56.5 % have speed limit issues, and 45.2 % have monitoring issues as shown in Fig. 43. Then, based on their previous experiences, they were asked to choose some of the finest improvements for their wheelchair. 50 % chose obstacle detection mechanism, 66% preferred Monitoring location of the wheelchair, 66% preferred Fire detection, 85.5 % would want an Automatic wheelchair 59.7 % and 54.8 % recommended new mobility assistance technology to be attached as shown in Fig 44. Based on the responses, it was critical to incorporate features such as a fire detection system, obstacle detection, location monitoring, and smart wheelchair technology.

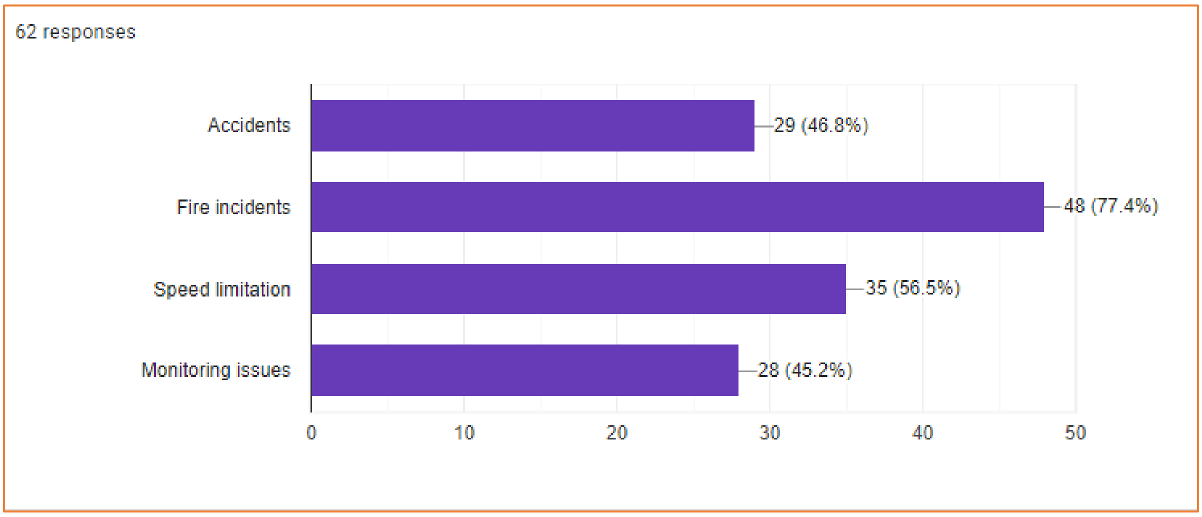


Figure 43: Representation of wheelchair user's experience results

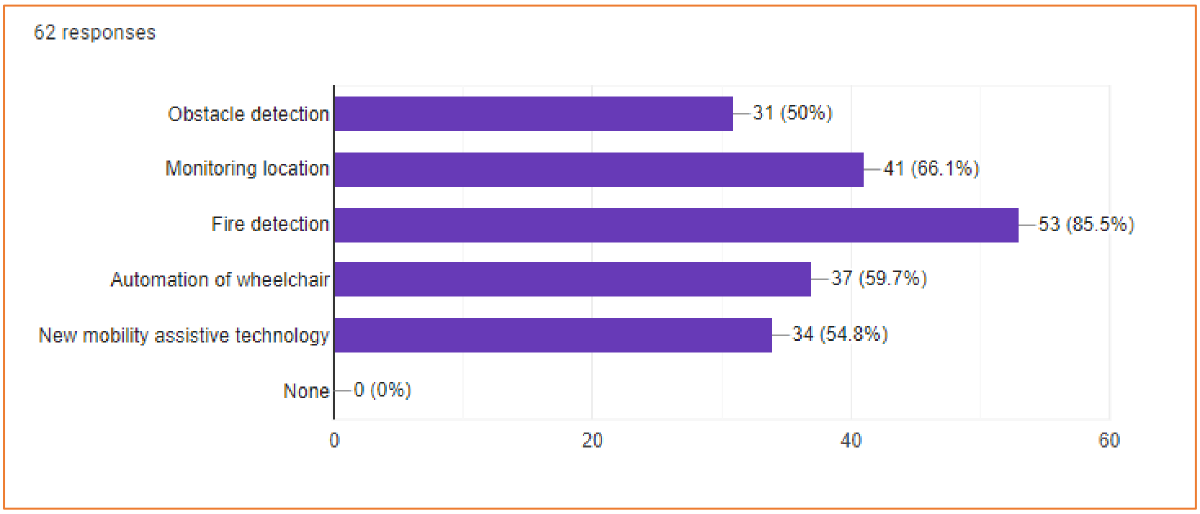


Figure 44: Representation of wheelchair user's design requirement result survey

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Physical disability is a problem in our country, thus improvements to wheelchairs are urgently needed. The final goal of this project was to develop a prototype of a convenient solar-powered wheelchair. Solar energy is both free and available in the environment. Solar energy has no negative impact on the environment. Even though manual wheelchairs are useful for disabled individuals, users have indicated that they are in critical need of more advanced wheelchairs. At Mount Meru Referral Hospital for the Disabled, a newly engineered solar-powered wheelchair prototype was put into use. In the case that the user is in danger, members of the user's family and the hospital will now receive vital information such as the user's position and message. This proposed method aids people with various disabilities and the elderly in becoming self-sufficient.

The following issues were addressed in this project as a result of the gaps in existing systems:

(i) In a fire emergency, the wheelchair could be alerted via the buzzer, and the person whose phone number was synchronized with the system could be notified via SMS using the GSM module.

(ii) The wheelchair user's consent was acquired for the wheelchair's location.

(iii) The technology was capable of avoiding obstacles at a distance of 10cm and delivering SMS by pushbutton in the event of an emergency.

(iv) Solar power as an alternate source of power and environmentally friendly source of power was utilized.

5.2 Recommendations

The new method will significantly improve the present wheelchairs that wheelchair users use. The following are the recommendations to the interested stakeholders in the health sector:

(i) To use the deployed technology to help people with physical disabilities at Mount Meru referral hospital and around the country.

(ii) Funding must be supplied through the Ministry of Health and Social Welfare to stimulate more design and to distribute some of the most advanced wheelchairs as aids to individuals who cannot afford to buy them.

The phrase "physical disability" has such a broad definition that a single design cannot be appropriate for all users because their needs may change. The following recommendations should be considered for future work:

(i) a design needs to be able to fit any person with any form of physical disability. As a result, in the future, an integrated wheelchair system with all types of assistive technology and machine learning capabilities would be quite beneficial.

REFERENCES

Agarwal, S., & Gautam, S. (2015). *Analysis and optimization of all terrain wheelchair* (No. 2015-01-1368). SAE Technical Paper.

Ahluwalia, S. M., Varghese, T. N., Patil, N. S., Sarbhukan, M. R., Pathan, S. K. U., Jaiswal, A. S., & Khatik, T. Y. (2017). Design and fabrication of sensors assisted solar powered wheelchair. *International Journal of Engineering Trends and Technology*, *46*(2), 71-74.

Aktar, N., Jaharr, I., & Lala, B. (2019). Voice Recognition based intelligent Wheelchair and GPS Tracking System. *2nd International Conference on Electrical, Computer and Communication Engineering, 2019*(2), 1–6.

Badamasi, Y. A. (2014). The working principle of an Arduino. *Proceedings of the 11th International Conference on Electronics, Computer and Computation, 2014*(11), 1–6. https://doi.org/10.1109/ICECCO.2014.6997578.

Balamurugan, K., Elangovan, S., Mahalakshmi, R., & Pavithra, R. (2018). Automatic check-post and fast track toll system using RFID and gsm module with security system. *Proceedings of IEEE International Conference on Advances in Electrical Technology for Green Energy, 2018*(2022), 83–86.

Burton, M., Fuss, F. K., & Subic, A. (2010). Sports wheelchair technologies. *Sports Technology*, *3*(3), 154-167.

Cojocaru, D., Manta, L. F., Vladu, I. C., Dragomir, A., & Mariniuc, A. M. (2019, October). Using an eye gaze new combined approach to control a wheelchair movement. *2019 23rd International Conference on System Theory, Control and Computing*, 626-631.

Dicianno, B. E., Cooper, R. A., & Coltellaro, J. (2010). Joystick control for powered mobility: Current state of technology and future directions. *Physical Medicine and Rehabilitation Clinics*, *21*(1), 79-86.

Diniş, C. M., Popa, G. N., & Iagər, A. (2015). Study on sources of charging lead acid batteries. *IOP Conference Series: Materials Science and Engineering*, *85*(1), 1–8. https://doi.org/10.1088/1757-899X/85/1/012011.

Feldt, T., Freilich, S., Mendonsa, S., Molin, D., & Rau, A. (2015). The Peripipe: A Sip-And-Puff Remote Control for Music Playback. *Proceedings of the International Conference on New Interfaces for Musical Expression*, *2015*(5), 34–35.

Ghorbel, A., Amor, N. B., & Jallouli, M. (2019). A survey on different human-machine interactions used for controlling an electric wheelchair. *Procedia Computer Science, 159*(23), 398–407. https://doi.org/10.1016/j.procs.2019.09.194.

Grewal, H. S., Matthews, A., Tea, R., Contractor, V., & George, K. (2018). Sip-and-puff autonomous wheelchair for individuals with severe disabilities. *2018 9th IEEE Annual Ubiquitous Computing, Electronics & Mobile Communication Conference,* 705-710.

Gunturi, V. N. R. (2013). Micro controller based automatic plant irrigation system. *International Journal of Advancements in Research & Technology*, *2*(4), 194-198.

Hans, M. R., Sandeep, K. K., & Badgujar, V. R. (2018). Performance Analysis of Battery for Solar based Wheelchair. *2018 International Conference on Information, Communication, Engineering and Technology*, 1-6.

Hsg, S., Pranjala, S. D., & Bhagyashree, C. A. P. (2019). Voice Controlled Wheelchair for Physically. *International Journal for Research in Applied Science & Engineering Technology*, *6*(V), 2375–2380. https://www.researchgate.net/publication/330037097.

Kaiser, M. S., Chowdhury, Z. I., Mamun, S. A., Hussain, A., & Mahmud, M. (2016). A neuro-fuzzy control system based on feature extraction of surface electromyogram signal for solar-powered wheelchair. *Cognitive Computation*, *8*, 946-954.

Kaur, M., & Pal, J. (2015). Distance measurement of object by ultrasonic sensor HC-SR04. *International Journal for Scientific Research & Development*, *3*(05).

Kim, J., Huo, X., Minocha, J., Holbrook, J., Laumann, A., & Ghovanloo, M. (2012). Evaluation of a smartphone platform as a wireless interface between tongue drive system and electric-powered wheelchairs. *IEEE Transactions on Biomedical Engineering*, *59*(6), 1787-1796.

Lei, K. M., Mak, P. I., & Martins, R. P. (2017). A 0.4 V 4.8 μW 16MHz CMOS crystal oscillator achieving 74-fold startup-time reduction using momentary detuning. *2017 IEEE International Symposium on Circuits and Systems*, 1-4.

Liu, L. J., & Li, Z. Q. (2010). Design and simulation of LED clock circuit based on Proteus. *2010 International Conference on Computer, Mechatronics, Control and Electronic Engineering*, 315-316.

Liu, X., Feng, Z., Zhang, Y. Y., & Liu, S. Q. (2014). GPS Positioning System Design Based on Micro Control Unit. *Advanced Materials Research*, *915*, 1171-1174.

Meena, Y. K., Chowdhury, A., Cecotti, H., Wong-Lin, K., Nishad, S. S., Dutta, A., & Prasad, G. (2016). Emohex: An eye tracker based mobility and hand exoskeleton device for assisting disabled people. *2016 IEEE International Conference on Systems, Man, and Cybernetics*, 002122-002127.

Mougharbel, I., El-Hajj, R., Ghamlouch, H., & Monacelli, E. (2013). Comparative study on different adaptation approaches concerning a sip and puff controller for a powered wheelchair. *2013 Science and Information Conference*, 597-603.

Njelesani, J., Couto, S., & Cameron, D. (2011). Disability and rehabilitation in Tanzania: A review of the literature. *Disability and Rehabilitation*, *33*(22-23), 2196-2207.

Noman, A. T., Khan, M. S., Islam, M. E., & Rashid, H. (2018). A New Design Approach for Gesture Controlled Smart Wheelchair Utilizing Microcontroller. *2018 International Conference on Innovations in Science, Engineering and Technology*, 64-68.

Obe, C. T., Oti, S. E., Eya, C. U., Nnadi, D. B. N., & Nnadi, O. E. (2020). A low-cost printed circuit board design technique and processes using ferric chloride solution. *Nigerian Journal of Technology*, *39*(4), 1223-1231.

Ogbonna, O. C. (2021). Development of Solar Powered Electric Wheelchair for Physically Challenged Persons. *International Journal of Innovative Science and Research Technology*, *6*(3), 385–391.

Plesnick, S., Repice, D., & Loughnane, P. (2014). Eye-controlled wheelchair. *2014 IEEE Canada International Humanitarian Technology Conference, 2014*(1), 1–4.

Priya, C. A., Pranjala, S. D., & Supreeth, H. S. G. (2018). Voice Controlled Wheelchair for Physically Disabled People. *International Journal for Research in Applied Science & Engineering Technology*, *6*, 2375-2380.

Renuka, K., Harini, R., Balaji, V., & Ashok, N. (2021). Raspberry Pi based Multi-optional Wireless Wheelchair Control and Gesture Recognized Home Assist System. *IOP Conference Series: Materials Science and Engineering*, *1084*(1), 012071. https://doi.org/10.1088/1757-899x/1084/1/012071.

Roopa, S., & Rani, M. S. (2012). Questionnaire designing for a survey. *Journal of Indian Orthodontic Society*, *46*(4), 273-277.

Saharia, T., & Bauri, J. (2017). Joystick controlled wheelchair. *International Research Journal of Engineering and Technology*, *4*(7), 235–237. https://irjet.net/archives/V4/i7/IRJET-V4I740.pdf.

Sathyanarayana, P., Ballal, R., Sagar, P. L., & Kumar, G. (2015). Effect of shading on the performance of solar PV panel. *Energy and Power*, *5*(1A), 1-4.

Sharma, H., Mahajan, R., Sakthivel, G., Saravanakumar, D., & Raghukiran, N. (2021). Brain Computer Interface Controlled Wheel Chair. *Journal of Physics: Conference Series, 1969*(1), 1-6. https://doi.org/10.1088/1742-6596/1969/1/012065.

Sowmya, C. H. (2021). Smart Solar Wheelchair Controlled Using Android App and Joystick. *Turkish Journal of Computer and Mathematics Education*, *12*(12), 2403-2407.

Srivastava, A., Bhardwaj, S., & Saraswat, S. (2017). SCRUM model for agile methodology. *2017 International Conference on Computing, Communication and Automation*, 864-869.

Srivastava, K., Kushwaha, V., Kumar, V., Narayan, Y., & Singh, V. (2021). Auto Power Control System from Four Different Sources. *Proceedings of the 3rd International Conference on Communication & Information Processing*, 1-9.

Trivedi, T., Narad, A., Verma, S., Purohit, N., & Shrivastava, D. D. (2018). Audio system using GSM module for announcement. *International Research Journal of Engineering and Technology*, *5*(5), 2816-2818.

Vazurkar, A., Danke, A., Sayyed, R., & Salunke, G. D. (2021). Wheelchair Management System Using IoT. *International Journal of Advance Scientific Research & Engineering Trends*, *5*(12), 154–156.

Vlaicu, L. I., & Repanovici, A. (2021). A Wheelchair Solution with Solar Panels. *Acta Technica Napocensis-Series: Applied Mathematics, Mechanics, and Engineering*, *64*(1-S1), 69-74.

Yeole, A. R., Bramhankar, S. M., Wani, M. D., & Mahajan, M. P. (2015). Smart phone-controlled robot using ATMEGA328 microcontroller. *International Journal of Innovative Research in Computer and Communication Engineering*, *3*(1), 352-356.

Yin, H. (2016). Smart home smoke detection and relay contract based on STM32. *2016 5th International Conference on Environment, Materials, Chemistry and Power Electronics*, 475-478.

Yin, L., Wang, F., Han, S., Li, Y., Sun, H., Lu, Q., Yang, C., & Wang, Q. (2016). Application of drive circuit based on L298N in direct current motor speed control system. In *Advanced laser manufacturing technology*, *10153*, 163-169.

Yousefi, B., Huo, X., & Ghovanloo, M. (2011). Preliminary assessment of Tongue Drive System in medium term usage for computer access and wheelchair control. *Proceedings of the Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, *03*(04), 5766–5769. https://doi.org/10.1109/IEMBS.2011.6091427.

APPENDICES

Appendix 1: Questionnaire Samples

what is your role?

Mark only one oval.

a) medical officer

b) Wheelchair user

c) Non wheelchair user

Medical officer

1. Is physical disability a challenge in Tanzania?
   Mark only one oval.
   a) True
   b) False
   c) None

2. Do you think it's important to design smart wheelchair for wheelchair users?
   Mark only one oval.
   a) Very important
   b) Less important
   c) None

3. is it necessary to monitor wheelchair users' location?
   Mark only one oval.
   a) Yes
   b) No
   c) May be

4. is it important to improve wheelchair from manual to electric wheelchair?
   Mark only one oval.
   a) Yes
   b) No
   c) May be

Wheelchair user

5. What gender are you?
   Mark only one oval.
   a) Male
   b) Female
   c) Prefer not to say
   d) Others

6. What is your age?
   Mark only one oval.
   a) 0-10 years
   b) 10-20 years
   c) 20-30 years
   d) 30-40 years
   e) 40-50 years
   f) 50- above years

7. Can you describe your disability?
   Mark only one oval.
   a) hands disability
   b) legs disability
   c) paralysis
   d) Aging Issues
   e) None

8. Have you been using the wheelchair for a long time?
   Mark only one oval.
   a) 0-5 years
   b) 5-10 years
   c) 10-20years
   d) 20-above years

9. How do you make use of your wheelchair?
   Mark only one oval.
   a) Indoors
   b) Outdoors
   c) Spots
   d) None

10. Do you use a personal assistant on a regular basis?
    Mark only one oval.
    a) Frequently
    b) Sometimes
    c) Never

11. what is the driving mechanism of your current wheelchair?
    Mark only one oval.
    a) Joystick
    b) Tongue
    c) Manually push
    d) Brain
    e) Sip and puff
    f) Voice recognition

12. Are you ready to try out new wheelchair assisting technologies?
    Mark only one oval.
    a) Yes
    b) No
    c) May be

13. Which assistive technology you find more flexible?
    Mark only one oval.
    a) Joystick
    b) Tongue dive system
    c) Eye tracer
    d) Brain Computer interface
    e) Sip and puff
    f) Voice recognition
    g) None

14. When pushing the wheelchair, oneself, would you say you travel slowly or quickly?
    Mark only one oval.
    a) Slowly
    b) Fast
    c) Average

15. What are the most significant challenges you have as a result of using a wheelchair in your daily life?
    Mark only one oval.
    a) Fatigue
    b) Accidents
    c) Theft
    d) Others

16. are there any safety issues that you face on your current wheelchair?
    Check all that apply.
    a) Accidents
    b) Fire incidents
    c) Speed limitations
    d) Monitoring issues

17. What features would you like to be attached to your wheelchair?
    Check all that apply.
    a) Obstacle detection
    b) Monitoring location
    c) Fire detection
    d) Automation of wheelchair
    e) new mobility assistive technology
    f) None

18. Is it tough for you to ask for aid in order to conquer a challenge?
Mark only one oval.
a) Yes
b) No
c) May be

19. What is the comfort level of your existing chair?
Mark only one oval.
a) Normal
b) Best
c) Excellent
d) I don't know

20. are there times that you can go out without mobility aids?
Mark only one oval.
a) Frequently
b) Sometimes
c) Never

Non-wheelchair user

21. Do you have a close person with physical disability??
Mark only one oval.
a) Yes
b) No
c) May be

22. is that person active wheelchair user?
Mark only one oval.
a) Yes
b) No
c) May be

23. Which type of wheelchair are they using?
Mark only one oval.
a) Manual wheelchair
b) Electric wheelchair
c) Smart wheelchair
d) None

24. Would you support them in buying smart wheelchair once designed regardless of the cost?
Mark only one oval.
a) Yes
b) No
c) May be

Appendix 2: Code

```
#include <SoftwareSerial.h>
#include <TinyGPS++.h>

#define motor1A A5
#define motor1B A4
#define motor2A 12
#define motor2B 13
#define Button 6
#define Buzzer 9
#define Echo 5
#define Trig 8

#define MQ A3
#define speedControl A2

#define motorSpeed 11
#define joystick_x A0
#define joystick_y A1

int Distance,xValue = 0,yValue = 0,spdMotor=0,Alarm=0;
double duration;
char Rx='0';
bool systemOn=false;
String Latitude="6.78",Longitude="34.54";
bool sms,Smoke;

TinyGPSPlus Gps;
SoftwareSerial gps(3, 2);
```

```
void setup(){
//Pin configuration
  pinMode(motor1A, OUTPUT);
  pinMode(motor1B, OUTPUT);
  pinMode(motor2A, OUTPUT);
  pinMode(motor2B, OUTPUT);
  pinMode(motor2B, OUTPUT);
  pinMode(motorSpeed, OUTPUT);
  pinMode(Buzzer, OUTPUT);
  pinMode(Button, INPUT_PULLUP);
  pinMode(Trig, OUTPUT);
  pinMode(Echo,INPUT);
  pinMode(MQ,INPUT);
  pinMode(speedControl,INPUT);
  pinMode(joystick_x, INPUT);
  pinMode(joystick_y, INPUT);
  Serial.begin(9600);
  gps.begin(9600);

//Register configuration
  motorStop();


}


void loop(){
//Joystick Readings
  GPSData();
  xValue = analogRead(joystick_x);
  yValue = analogRead(joystick_y);
  spdMotor=map(analogRead(speedControl),0,1023,0,255);
```

```
   //digitalWrite(motorSpeed,spdMotor);
   analogWrite(motorSpeed,spdMotor);
   Smoke=digitalRead(MQ);
   Smoke=!Smoke;

//Ultrasonic reading
   digitalWrite(motorSpeed,HIGH);
   digitalWrite(Trig,HIGH);
   delayMicroseconds(10);
   digitalWrite(Trig,LOW);
   duration=pulseIn(Echo,HIGH);
   Distance=0.017*duration;
   duration=0;
   if(Distance>=50)   Distance=40;
   if(Distance<=0)    Distance=0;

//Motor controll
   if (xValue<=10 && yValue>=400){
     if(Distance<10){
       motorStop();
       Alarm=1;
     }else{
       motorForward();
       if(Alarm==0)   Alarm=0;
     }
   }else if (xValue>=800 && yValue>=400)
     motorBack();
   else if (xValue>=400 && yValue>=800){
     if(Distance<10){
       motorStop();
```

```
      Alarm=1;
    }else{
      motorLeft();
      if(Alarm==0)   Alarm=0;
    }
  }else if (xValue>=400 && yValue<=10){
    if(Distance<10){
      motorStop();
      Alarm=1;
    }else{
      motorRight();
      if(Alarm==0)   Alarm=0;
    }
  }else
    motorStop(); //Motor controll

//SMS
  digitalWrite(Buzzer,Alarm);
  if(digitalRead(Button)==LOW)
    SendSms("Hello:Emergence situation");
  if(Smoke){
    if(sms)   SendSms("SMOKE detected,Fire posibility");
    sms=false;
    Alarm=1;
  }else{
    sms=true;
    if(Alarm==0)   Alarm=0;
  }   //SMS
}
```

```
//Motor forward
void motorBack(){
  digitalWrite(motor1A,LOW);
  digitalWrite(motor1B,HIGH);
  digitalWrite(motor2A,HIGH);
  digitalWrite(motor2B,LOW);
}

void motorForward(){
  digitalWrite(motor1A,HIGH);
  digitalWrite(motor1B,LOW);
  digitalWrite(motor2A,LOW);
  digitalWrite(motor2B,HIGH);
}

//Motor stop
void motorStop(){
  digitalWrite(motor1A,LOW);
  digitalWrite(motor1B,LOW);
  digitalWrite(motor2A,LOW);
  digitalWrite(motor2B,LOW);
}

//Motor manuver
void motorLeft(){
  digitalWrite(motor1A,HIGH);
  digitalWrite(motor1B,LOW);
  digitalWrite(motor2A,LOW);
  digitalWrite(motor2B,LOW);
}
```

```
void motorRight(){
  digitalWrite(motor1A,LOW);
  digitalWrite(motor1B,LOW);
  digitalWrite(motor2A,LOW);
  digitalWrite(motor2B,HIGH);
}


void SendSms(String message){
  Serial.println("AT+CMGF=1");    //To send SMS in Text Mode
  delay(100);
  Serial.println("AT+CMGS=\"+255713349458\"\r");
  delay(100);
  Serial.print("Dear Sir/Madam!");
  Serial.println(message);
  Serial.print("Latitude:");
  Serial.print(Latitude);
  Serial.print("Longitude:");
  Serial.print(Longitude);
  delay(300);
  Serial.println((char)26);//the stopping character
  delay(300);
}//SMS
void GPSData(){
  while(gps.available() > 0)
    if (Gps.encode(gps.read()))
  Latitude=(Gps.location.lat(), 6);
  Longitude=(Gps.location.lng(),6);
}
```

RESEARCH OUTPUTS

(i) Research Paper

Rwegoshora, F. M., Leo, J., & Kaijage, S. (2022). A Comparative Study of Assistive Technologies for Physically challenged peoples for usability of Powered Wheelchair Mobility Aid. *International Journal of Advances in Scientific Research and Engineering*, *8*(1), 44-51. https://doi.org/10.31695/IJASRE.2022.8.1.6.

(ii) Poster Presentation

Appendix 3: Poster Presentation

ENHANCED SAFETY AND AUTOMATED WHEELCHAIR FOR PATIENTS WITH MOBILITY DISABILITY: A CASE STUDY OF MOUNT MERU REFERRAL HOSPITAL, ARUSHA, TANZANIA

1. Florian Mwijage Rwegoshora, 2. Dr. Judith Leo, and

3. Prof. Shubi Kaijage

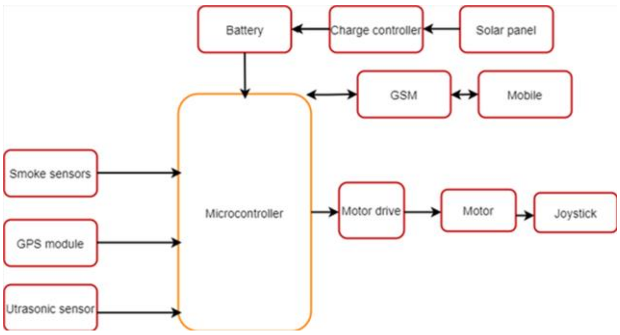
Introduction

A wheelchair is a wheeled chair that assists people in moving around. Individuals with limitations that restrict their capacity to walk utilize it. The primary goal of a wheelchair is to make a physically impaired person self-sufficient in terms of locomotion.

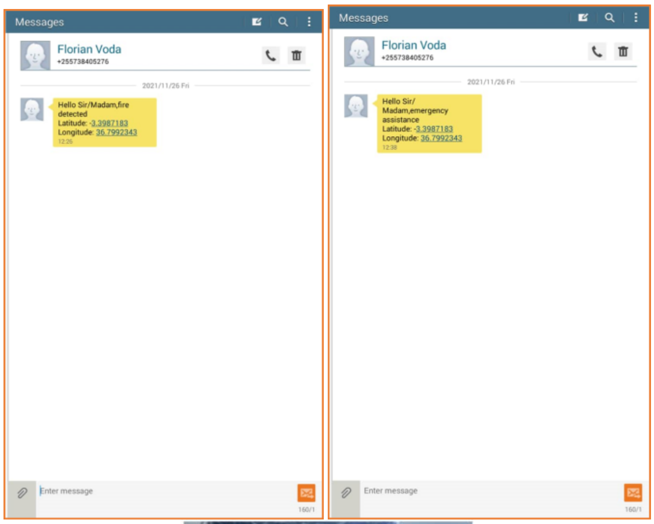
Problem Statement

The lack of an automatic wheelchair that can be powered with solar and allow individuals to give various alerts with SMS and also get the location of the wheelchair is still a problem. Thus, to address the issue, the developed a solar-powered wheelchair that can track its location, detect fire, detect obstacles at a 10cm range, and send SMS alerts for such indicators.

Methods



Results



Conclusion

The following issues were addressed in this project as a result of the gaps in existing systems: In a fire emergency, the wheelchair could be alerted via the buzzer, and the person whose phone number was synchronized with the system could be notified via SMS using the GSM module and location could be obtained. The technology was capable of avoiding obstacles at a distance of 10cm and delivering SMS by pushbutton in the event of an emergency. Solar power was utilized.