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Oxygen-Supported Wheelchair For Enhanced Copd Mobility

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Abstract: Chronic Obstructive Pulmonary Disease (COPD) patients often face significant mobility challenges while managing their need for constant oxygen therapy. The movement of a person from one place to another during his/her unhealthy conditions becomes a tedious task. This paper proposes the development of a wheelchair designed to provide both mobility and safety for COPD patients. The wheelchair is equipped with an Arduino Uno microcontroller, allowing the user to navigate using a joystick for directional control (left, right, forward, and backward). Four 200 RPM DC gear motors, controlled by an L298N motor driver circuit, power the wheelchair. Additionally, the system integrates a Pressure Sensor to monitor the air pressure within the attached B-type oxygen cylinder, ensuring continuous oxygen supply. In the event of low pressure, an automatic buzzer is triggered to alert the user, ensuring timely intervention and enhancing overall patient safety. This innovative solution addresses the dual challenge of mobility and health management for COPD patients, improving their quality of life.

Keywords- Embedded Technology, Joystick Control, Oxygen Pressure Monitoring.

I. INTRODUCTION

COPD, a chronic respiratory illness, severely restricts breathing and daily routines. Globally, approximately 65 million people experience moderate to severe COPD, as documented by “World Health Organization.” This condition alone was responsible for more than 3 million deaths in 2005, which is 5% of overall deaths worldwide. By the year 2030, it is projected that chronic obstructive pulmonary disease (COPD) will claim the lives of more people than tobacco, becoming the third most common cause of mortality. Of the ailments that caused death in India in 2005, COPD alongside chronic respiratory diseases accounted for 53% of them, and for 44% of the disability-adjusted life years lost to chronic diseases. It is estimated that India has around 30 million COPD patients, and the country reports one of the highest COPD mortality rates worldwide, exceeding 64.7 deaths per 100,000 people.

Individuals with severe COPD frequently require supplemental oxygen and wheelchair assistance for mobility, often necessitating the assistance of two caregivers—one for oxygen regulation and another for wheelchair operation. This research focuses on creating a specialized wheelchair for COPD patients, designed to accommodate a B-type oxygen cylinder. An Arduino Uno microcontroller is the system's core, enabling joystick-controlled movement of the wheelchair in forward, reverse, and lateral directions, driven by four 200 RPM DC gear motors managed by an L298N motor driver circuit. To maintain a consistent oxygen supply, a pressure sensor is employed to monitor the cylinder's air pressure. In the event of a pressure drop below a safe limit, an integrated buzzer sounds, alerting the user to take immediate action. The objective of this novel approach is to improve both mobility and safety for COPD patients who depend on continuous oxygen therapy.

II. LITERATURE REVIEW

Sugnyadevi et al [1]

In this study, it aims to fulfil an important goal for people with COPD: to live independently. The solution that is proposed, is to create a smart wheelchair with two cylinders on the right and left of the armrest, allowing balance between the two, as well as allowing residents to easily switch from one side if the cylinder is running out. This wheelchair is designed to transform into a bed using a linkage mechanism, serving dual purposes. It runs on a lead-acid battery and can be controlled automatically through a joystick. It also features a ring-shaped sound alarm to inform others, since patients wearing an oxygen mask might not be able to speak. It includes a removable toilet receptacle to help ensure the user does not have to leave the wheelchair. The wheelchair has the following five features, Automatic movement, and conversion of seating from bed to wheelchair, **removable toilet container, and alarm and oxygen cylinder tin.**

Jabde et al [2]

In this paper, author explained that the majority of disabled people depend on others to take care of their daily need, particularly while moving from one place to other places. The people in need can use a wheelchair control system to increase their level of independence. Voice recognition technology is used by the wheelchair's control system to begin and control every movement. To operate the wheelchair, it combines a motor control interface board, a microcontroller, and voice recognition with Google Assistant. With the device, users can voice orders into Google Assistant to operate the wheelchair. The basic operational technique includes turning left and right, moving ahead and backward, and other basic working processes and come to an end. The system encourages self-reliance, gives caretakers comfort, and lets users take an active role in their everyday lives.

P.K. Priyanka et al [3]

It mentions that a wheelchair can move according to the gesture given by the person who is using the wheelchair. Some improvisation and betterment can be done such that the wheelchair can be more accessible to those who are not completely paralyzed and it can be a boon for those people.

K. Senthil Kumar et al [4]

In this paper, the authors present the implementation of IoT devices alongside fully automated operational gadgets. These tools are beneficial for hospitals, public areas, and tourist attractions. They also monitor oxygen levels and ensure continuous flow through IoT technology. It includes programming that alerts caregivers when oxygen levels drop or if there are issues with the oxygen flow. A safety strap and decelerator mechanism (brake) are utilized to ensure patient safety. Sensors are employed to oversee the condition of the oxygen cylinder and wheelchair. An arrangement has been designed to securely attach the oxygen cylinder vertically to the wheelchair for better weight distribution.

Kedar Sukerkar et al [5]

In this paper author uses IOT devices and automatic operation gadgets. It is Utilitarian for Hospitals and public areas and also Tourist areas. Also Monitor Oxygen level and Oxygen flow at all times by any IoT device. If programming for heedful to the Attender when Oxygen level goes low or any issues in Oxygen flow. Separation of patient Safety using a Safety Strap and Decelerate (Brake) mechanism. Control the sensors by monitoring the Oxygen cylinder and Wheelchair. Delineation to place the Oxygen barrel upright with a wheelchair for Weight Adjusting.

Tani et al [6]

In this paper, the author outlined mechanisms designed for a mobile robotic platform that features active wheels capable of maximizing negotiable step height while reserving ample interior space for an oxygen tank. The control algorithm based on the tether was improved and demonstrated effectiveness during outdoor following experiments. To this point, emphasis has been placed on boosting hardware capabilities; however, the true usability of this solution should be judged through objective assessments involving HOT patients themselves. Specifications may require adjustment according to their feedback regarding certain attributes like size, weight, and battery life. Additional safety sensors and fail-safe mechanisms are equally crucial before practical deployment. We plan to conduct usability testing directly with HOT patients to help ensure this robotic system can genuinely improve their quality of life. Though progress has been made, more work remains to fully realize this assistive technology's potential to meaningfully aid those with limited mobility.

Wesmiller et al [7]

In this paper, the reason for this to think about was to survey the viability of an assistive gadget in making strides to work out resistance among patients with extremely incessant obstructive pneumonic illness (COPD) and to distinguish characteristics that upgrade the benefits of its utilization.

Shay et al [8]

This study conducted by Shay et al. (2020) investigated The association between mobility and functional ability in individuals hospitalized with COPD. This study identifies the important problem of functional decline during hospitalization, a common occurrence in this patient group. The research highlights that patients with COPD tend to have decreased mobility and functional status, even at admission, and such limitations worsen during exacerbation. The authors demonstrated that healthcare professionals should evaluate both the mobility and functional status of those suffering from COPD during their hospital stay. The use of targeted interventions, including early mobilization protocols and pulmonary rehabilitation, can optimize patient outcomes and minimize the burden of COPD-related disability.

Thorpe et al [9]

In this paper provides an in-depth examination of barriers reported in previous literature and highlights that allowing physical exercise and pulmonary rehabilitation for COPD patients, can help to alleviate symptoms of the disease. In examining relevant supportive research, the author emphasizes the importance of assessing mobility and functional ability for those with COPD who find themselves in the hospital. On this basis, physical activity and lung rehabilitation pose large barriers that inhibit the ability of patients with COPD. These include illness, individual and social issues in relation to overcoming the barriers and building healthy commitment towards physical activity and pulmonic rehabilitation. Aside from several outcomes that are in use to correct some of the disorders, it is not doubtful that members of the health occupations must positively find and rectify barriers to pulmonary rehabilitation and physical activity among patients with severe COPD. Without this direct consideration and action, patients with COPD can create these disorders and most certainly will fail to use physical exercise and lung rehabilitation, even when urgently indicated.

Arnold et al [10]

In this paper**,** Base theory tries to build a theory regarding the researched area. The theory that emerged from this study suggests that COPD patients who understand that AOS does not impact their systems negatively experience adverse effects on the physical, mental, or social aspects of the disease. Patients under NHS Standard-AO system can't utilize prescribed drugs if they arrive in the AO system itself. H. Primarily, the fame of the precision of measuring instruments and the system's weight. There is also a significant amount of embarrassment that comes out in public areas in the ANAO system. This is to highlight the challenges required for patients to incorporate medical technology into their lives without referring to later end users, and take risks concerning the dignity of technology. New learning in this research was the absence of special information clauses within specified AOs, the anxiety that oxygen would evaporate (unreliable measures), and the crucial role of patients in the treatment and care for AO devices. This is a serious controversy regarding the effect of AO use. But they can all be managed with patient feedback. This is an optimally designed intervention. All of these conditions can be treated to optimize AO bond compliance and improve the physical and social benefits of mobility in this group of patients.

III. METHODOLOGY

The proposed system involves the integration of several key components to create a wheelchair tailored for COPD patients Arduino Uno microcontroller, is responsible for all controls. Left, right, forward, and backward movement of the wheelchair are regulated by the user through a joystick that communicates with the Arduino. These signals are processed and relayed to the L298N motor driver circuit, which drives the four 200 RPM DC gear motors attached to the wheelchair's wheels, enabling smooth and precise navigation. A B-type oxygen cylinder is securely attached to the wheelchair, with a Pressure Sensor continuously monitoring the air pressure within the cylinder. This real-time data is fed back to the Arduino, which evaluates whether the pressure remains within a safe range. If the pressure drops below a critical threshold, the system automatically activates a buzzer, alerting the user to the low oxygen levels. This integrated approach ensures that the patient can move independently while continuously monitoring their oxygen supply, addressing both mobility and health needs seamlessly and efficiently.

3.1.BLOCK DIAGRAM

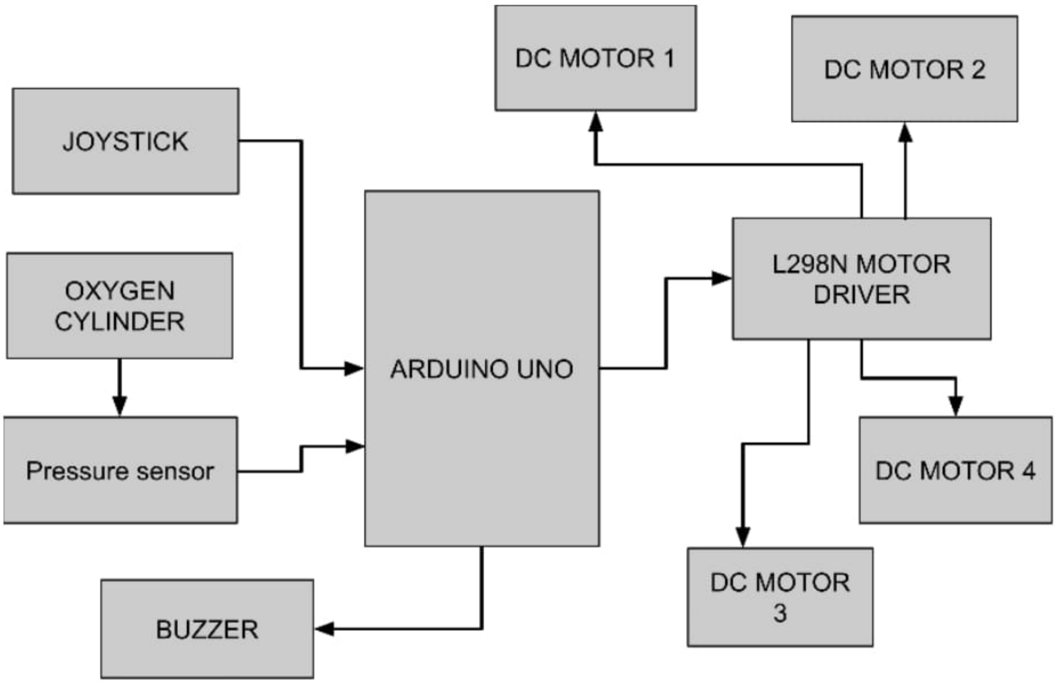


Fig. 1 Systematic representation of wheelchair

3.2.FLOW CHART

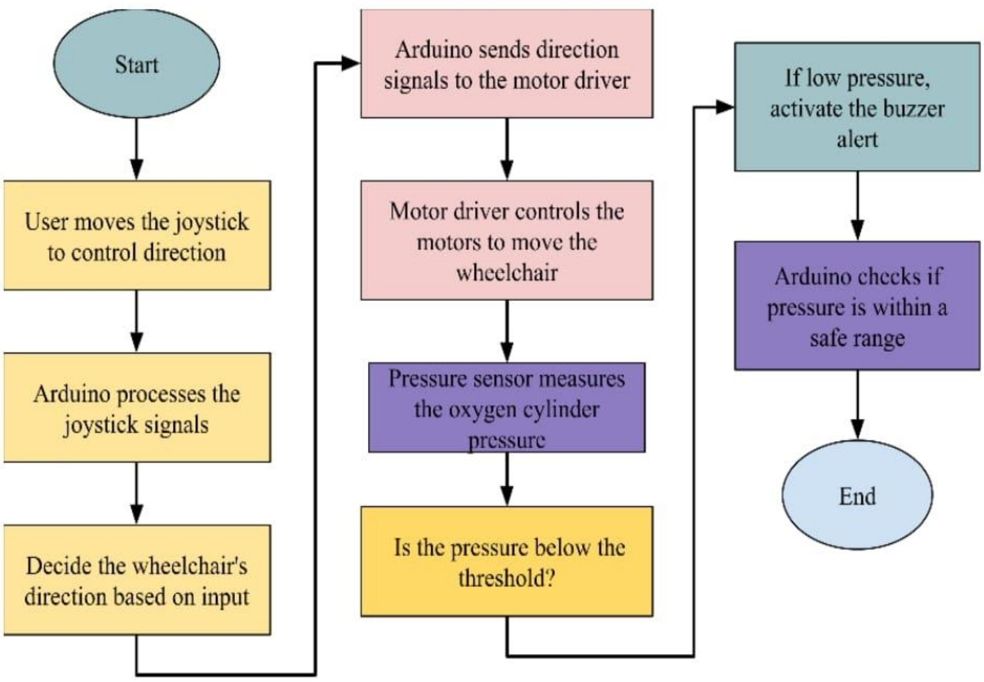


Fig 2. Process Map

3.3. Working

As per fig. 1, we have used the Arduino Uno as a microcontroller. The pressure sensor and joystick serve as the primary input mechanisms, facilitating navigation and commands: four 200 RPM DC gear motors powered the wheelchair, smoothly controlling its movements via an L298N motor driver circuit connected to an Arduino Uno microcontroller rechargeable power supply fed electricity to the microcontroller and other components, ensuring seamless operation. Through a joystick allowing left, right, forward, and backward movement in four directions, the user piloted the wheelchair, sending input signals processed by the Arduino. It then regulates the motor driver to shift the wheelchair as commanded by the joystick's adaptations. Meanwhile, an integrated pressure sensor ceaselessly tracked the air pressure within the B-type oxygen cylinder, transmitting readings to the Arduino Uno for real-time analysis. When the oxygen pressure is lower than a predefined threshold, a buzzer alarm will be activated by the Arduino so that the user will hear it. It helps in early intervention and avoids oxygen saturation drop which improves patient safety wheelchair supports moving across surfaces and going beyond to move without any external help for indoor and outdoor movement. Attached to the wheelchair and not only it stabilizes the oxygen cylinder but also provides a way to access the oxygen cylinder without any danger or risk of falling down or losing the grip of the wheelchair.

IV. SYSTEM DESIGN

Sr. No	Component	Function
1	Arduino Uno	Acts as the central microcontroller that processes inputs and controls the wheelchair's movement and oxygen monitoring system.
2	Joystick	Provides user input for controlling the movement of the wheelchair.
3	L298N Motor Driver	Regulates the speed and direction of the motors by supplying them with the proper current and voltage.
4	200 RPM Gear Motor	Provides mechanical movement to the wheelchair.
5	Oxygen cylinder	Holds and secures the oxygen cylinder.
6	Pressure Sensor	Monitors the pressure of the oxygen cylinder to ensure a continuous oxygen supply.
7	Buzzer	Provides an audible alert when oxygen levels are low.

Table 1. Components of Wheelchair

4.1. Arduino Uno

- **Function:** As the central controlling unit, the microcontroller processes various inputs to maneuver the wheelchair and monitor oxygen levels.
- **Role in Project**: It receives signals from the joystick and pressure sensor, comprehending the data to direct the motor driver and buzzer accordingly for navigation and alerts.
- **Specifications:**
  - Microcontroller: ATmega328P
  - Digital I/O pins: 14 (6 PWM output)
  - Analog inputs: 6
  - Clock speed: 16 MHz
  - Operating voltage: 5V.

Fig. Arduino Uno (Microcontroller)

4.2. Joystick Module

- **Function:** Provides user input for controlling the movement of the wheelchair.
- **Role in Project:**

serves as the primary navigation **interface so that** the user **can** move the wheelchair in **various** directio ns.

- **Specifications:**
  - Two-axis analog joystick (X & Y)
  - Operating Voltage: 5V
  - Push-button function for addition

Fig. Joystick

4.3. L298N Motor Driver

- **Function:** Governing direction and velocity by administering required current and voltage to power the motors.
- **Role in Project:** Acts as the liaison between the Arduino and the DC motors, allowing for smooth and seamless mobility.
- **Specifications:**
  - Operational Voltage Range: 5V to 35V

- Maximum Output Current: 2A per channel
- Control
- Dual H-Bridge motor controller

Fig. L298N motor driver

4.4. 200 RPM DC Gear Motors (×4)

- **Function:** Provides mechanical movement to the wheelchair.
- **Role in Project:** Propels the wheelchair with sufficient grunt and speed to permit comfortable and hassle-free movement around obstacles**.**
- **Specifications:**
  - Speed: 200 RPM
  - Voltage: 12V DC
  - Torque: ~3-5 kg.cm
  - Gear Ratio: 1:30

Fig. Gear motor

4.5. Oxygen Cylinder Tin

- **Function:** Holds and secures the oxygen cylinder.
- **Role in Project:** Ensures that the oxygen supply remains stable and securely attached to the wheelchair.
- **Specifications:**
  - Material: Stainless steel or aluminum
  - Compatible with standard medical oxygen cylinders

Fig. Oxygen Cylinder Tin

4.6. Pressure Sensor

- **Function:** Monitors the pressure of the oxygen cylinder to ensure a continuous oxygen supply.
- **Role in Project:** Senses low oxygen levels and triggers the signal to the Arduino that activates the buzzer alert.
- **Specifications:**
  A. Operating Voltage: 5V
  B. Pressure Range: 0–250 psi
  C. Output: Analog signal

Fig. Pressure Sensor

4.7. Buzzer

- **Function:** Provides an audible alert when oxygen levels are low.

- **Role in Project:** Warns the user or caregiver to replace the oxygen cylinder when pressure drops below a critical level.
- **Specifications:**
  - Operating Voltage: 3V–12V
  - Sound Level: 85 dB+

Fig. Buzzer

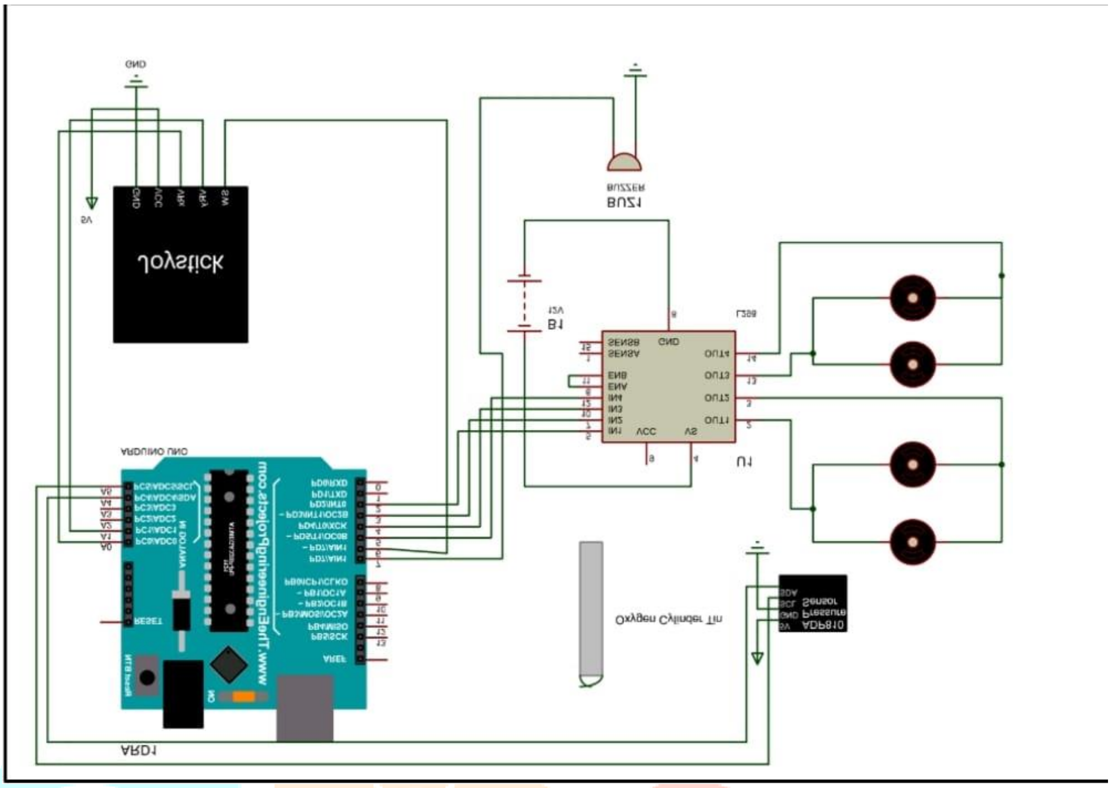
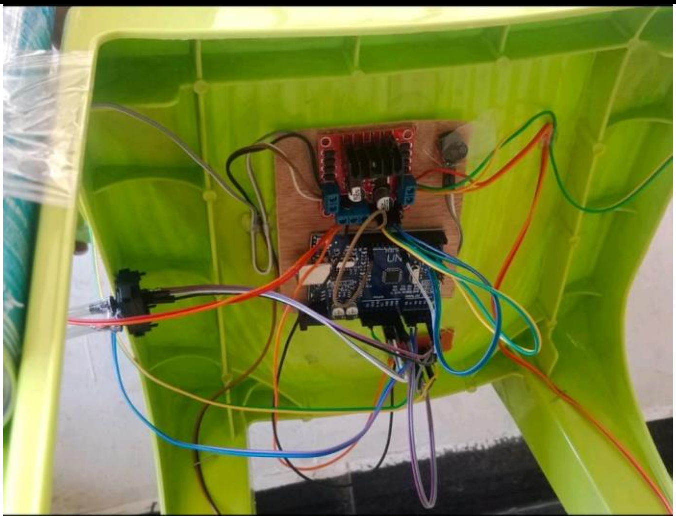


Fig 3. Architecture of Wheelchair

V. EXPERIMENTAL SETUP AND RESULT

5.1. Experimental setup

(a)



(b)

5.2. RESULT

The project "Oxygen-Supported Wheelchair for Enhanced COPD Mobility" successfully developed a smart, motorized wheelchair that enhances both mobility and safety for individuals requiring continuous oxygen therapy. Powered by four 200 RPM DC gear motors controlled via an L298N motor driver circuit, the wheelchair allows seamless navigation through an Arduino Uno-based joystick system An important advancement is the addition of a pressure sensor which monitors the oxygen cylinder's air pressure to guarantee continuous oxygen supply. If low pressure is detected, an automatic buzzer alert system warns the user to take action. This intelligent design greatly improves life autonomy of COPD patients by ensuring safety, effectiveness, and ease of mobility and health management.

VI. LIMITATION AND BENEFITS

6.1. Limitations

- The wheelchair relies on battery power, requiring frequent recharging for continuous operation.
- The wheelchair is optimized for smooth and indoor surfaces but may struggle on rough or uneven terrain.
- The motors and structural design support a specific weight limit, making it unsuitable for heavier users.
- Users or caregivers must manually replace the oxygen cylinder, which may not be convenient in emergencies.

6.2. Benefits

- This motorized system gives a patient with COPD the freedom to move around unaided by any external force.
- It also ensures they will have an uninterrupted supply of oxygen, reducing the number of medical emergencies associated with such conditions.
- The ease of operating the wheelchair will go a long way to enhance better way of living by minimizing their dependence on care.

VII. CONCLUSION

The integrated oxygen cylinder wheelchair represented a breakthrough for COPD patients' mobility and care. Its joystick navigation and oxygen pressure monitoring synergized to boost movement freedom while maintaining uninterrupted, safe oxygen therapy crucial for COPD. When oxygen levels diminished, an automatic alert swiftly notified occupants, allowing instant action and decreasing the risks of perilous circumstances. This article thoroughly answered the twofold trials confronted by COPD patients. It proposed a dependable, easy-to-use remedy enhancing autonomy as well as general well-being through a balancing of portability with life-sustaining gas delivery.

VIII. FUTURE SCOPE

The project's substantial potential for future enhancements could significantly improve the mobility assistance and healthcare support received by those suffering from COPD. One vital revision involves integrating an Internet of Things-based oxygen monitoring system, permitting real-time tracking of oxygen levels and self-activated alerts through a mobile application. Additionally, incorporating GPS navigation and obstacle detection sensors could enhance safety while navigating and allow caregivers to monitor the wheelchair from afar. To further increase accessibility, voice and gesture control implementation may empower patients with limited hand function to more easily operate the wheelchair. A promising prospective upgrade includes solar charging support, which would prolong battery life and provide a more sustainable energy source. Another innovation worth exploring is a remote assistance feature to provide medical guidance or summon help when needed. A future improvement could involve an automated system that changes cylinders, which would make the process smoother and hence encourage users to undertake the activity with more convenience. All these future enhancements will make the wheelchair a bright, intelligent, and very efficient solution to COPD patient mobility.

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