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Automated Wheelchair for Physically Challenged with AIoT Modules

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Automated Wheelchair for Physically Challenged with AIoT modules

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***Abstract* — The possible Smart Wheel Chair and its components are discussed in this chapter, as well as the ways in which it incorporates the microcontroller device that enables widespread electric wheelchair manipulation using head movements. Digital and mechanical components are housed in the device. The Automated Wheel Chair (AWC) is a resource and assistance device for paraplegics. Humans with a higher degree of impairment, such as quadriplegics, may benefit greatly from the intended chair. Quadriplegics are men and women who, due to age or infection, are unable to move any of the body's organs save the head. The accelerometer records processing unit is used to create a revolutionary head motion popularity technique. This article also includes information about the Bluetooth device that is mounted on the wheel chair, as well as the accelerometer that powers the motors and controls the chair's actions inside the domestic environment. Our wheelchair focuses not only on the tool's movement but also on the health of the person who uses it. The method is entirely dependent on the Internet of Things, and sensors are used to detect the cardiac rate and blood oxygen levels. The ultrasonic sensors aid in the detection of impediments, allowing the chair to move in a more exact path. Other objectives of this chapter include elucidating the use of the Smart Wheel Chair (SWC) to protect disabled people from catastrophic pandemics like COVID-19 or to assist them in their treatment of any pandemic-causing sickness.**
The current project's purpose is to expand an automatic sensing wheelchair by including sensors into its components. Such features in chairs increase a challenged individual's independence while also allowing them to be monitored by their loved ones.

***Keywords*— PIR, Thermometer, Alexa, Internet of Things, Ultrasonic sensor.**

I. Introduction

A condition defined as a considerable impairment of an individual's regular functions is known as disability. Individuals with disabilities are those whose body functions are compromised due to a variety of limitations. Over 1 billion people are considered to be disabled in some way. This equates to around 15% of the global population, with up to 190 million (3.8%) people aged 15 and older experiencing considerable difficulties in functioning as illustrated in the figure , necessitating the use of healthcare services. The number of persons living with disabilities is rising, owing to the ageing of the population and the rise in chronic health issues. Disabilities come in a wide range of forms. Some disability-related health issues result in poor health and severe healthcare needs, whereas others do not. People with disabilities, on the other hand, have the same general healthcare needs as everyone else and, as a result, require access to mainstream healthcare services. Article 25 of the UN Convention on the Rights of Persons with Disabilities (CRPD) affirms that people with disabilities have the right to receive the best possible healthcare, free of discrimination. However, few countries provide adequate, high-quality assistance for people with disabilities. In the health sector, only a few countries gather data that allows for disaggregation by handicap. This was especially evident during the COVID-19 pandemic, when countries failed to systematically consider disability in their pandemic response. People with disabilities are now at three times higher risk of getting COVID-19, experiencing severe symptoms from COVID-19, or dying from the disease, as well as having poorer health during and after the pandemic, whether or not they are infected with COVID-19.

II. Impact of pandemics

A. Impact of COVID-19 on Disables

COVID-19 is a new disease, and we're constantly learning more about it, including who's more likely to get sick. Most people with impairments aren't at an increased risk of contracting COVID-19 or developing serious sickness

from it. Because of underlying medical issues, crowded living circumstances, or systemic health and social disparities, some people with disabilities may be more likely to become infected or suffer severe disease. COVID-19 appears to be more likely to make people sick who have substantial underlying chronic medical disorders such chronic lung illness, a bad cardiac ailment, or a weakened immune system. Around 2.5 percent of India's population is disabled, according to official estimates[1]. However, this figure is likely understated, as the World Health Organization estimates that roughly 15% of the world's population is disabled, with about 80% of those living in middle and low-income nations. People with impairments, like everyone else, require standard healthcare. Furthermore, certain disabilities are associated with underlying health issues that can exacerbate symptoms if patients get COVID-19. However, due to variables such as inaccessible facilities, financial constraints, a lack of accessible transportation, and previous unfavourable experiences with the healthcare system, people with disabilities are more likely to have unmet health requirements[1]. Furthermore, due to their need for personal physical contact for support and the inaccessibility of essential public health information, methods to slow the spread of the virus, such as social distance, are difficult to execute for people with disabilities.

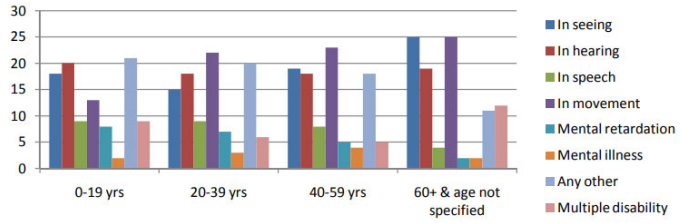

Fig. 1 Distribution of Disabled among different disabilities. (Courtesy of Social Statistics profile 2016; Ministry of Statistics and Programme Implementation, Government of India)

B. *Obstacles faced during the pandemic to facilitate Disables*

During the lockdown, reports have highlighted difficulty in obtaining food, needed products, and life-saving medical operations, as well as the inaccessibility of information and helplines. Moreover, there have been divergent and adamant efforts by the bodies that maintain the response during these health crises.

Yet, the Government of India tackled some of the following circumstances:

- Ensure information accessibility; exempt caregivers from lockout limitations; and exempt employees with specific disabilities from work linked to essential services.
- Provide vital services to disabled people in quarantine. Giving disabled people first priority in treatment and,
- To vaccinate the people of Village and Rural areas has been one of the most daunting challenges that the government has been trying to cope with.
- Teach emergency service personnel on the requirements of disabled people, among other things.

However, because these recommendations are discretionary, their implementation has been limited. The pandemic has brought to light the importance of social protection(s) in achieving resilience and recovery. According to The National Social Assistance Programme, NSAP in India provides a monthly pension to people living below the poverty level who have severe and numerous disabilities. In response to the COVID-19 issue, the government stated that three months' worth of pension will be paid in advance. However, there are variations in pension amounts between states, and the payment of pensions has been delayed in numerous states. The COVID-19 pandemic provides an opportunity to reform and heal the fissures in our social institutions, as well as to include communities who have previously been marginalised. People with disabilities, for example, have long attempted to find flexible and work-from-home options, with little or no success. Within a few days of the epidemic, both public and private sector organisations made major expenditures in video-conferencing technology and software tools to make similar arrangements for their non-disabled personnel. It is critical to recognise the significance of workplace accommodations in order to build more inclusive environments for everybody.

C. *Elucidation on Barriers faced by People with Disabilities*

Persons with disabilities are perceived as being limited in their daily activities due to a complex set of interrelated circumstances, some of which are related to the person and others which are related to the person's environment and social/political structures[2]. The social concept of disability proposes that society has created physical or mental barriers that affect people with impairments[3]. When people with disabilities try to get healthcare, they face a variety of obstacles, including the following:

1) Exorbitant Expenditures: Two major reasons why people with disabilities in low-income nations do not receive much-needed healthcare are the cost of health services and transportation. In comparison to around a third of persons without disabilities, just over half of those with disabilities cannot afford healthcare.

2) Physical Impediments: Barriers to healthcare facilities include uneven access to buildings (hospitals, health centres), inaccessible medical equipment, insufficient signage, narrow doorways, internal steps, inadequate bathroom facilities, and inconvenient parking places. Because

examination tables are not height-adjustable and mammography equipment only accommodates women who can stand, women with mobility issues are frequently unable to obtain breast and cervical cancer screening.

3) *Limited Service Availability:* There is a scarcity of adequate services for disabled persons. Many studies show that people with disabilities have significant unmet healthcare needs due to a lack of resources, particularly in rural and remote locations.

4) Health workers' skills and expertise are insufficient: People with disabilities were nearly three times more likely to claim that healthcare providers' skills were insufficient to fulfil their needs, were four times more likely to be treated badly, and were nearly twice as likely to be denied care.

The situations in which people are born, live, learn, and work, as well as factors that influence their health and affect their functionality, are referred to as social obstacles. The following are some examples of social barriers: When compared to children without disabilities, children with disabilities are four times more likely to be victims of violence[4][5]. In the United States, 22.3 percent of people with disabilities have an income of less than $15,000, compared to 7.3 percent of people without disabilities[4][5][6]. More information about these statistics is illustrated in Figure 2. People with disabilities makeup 10.1 percent of high school graduates, compared to 22.3 percent of students without impairments.

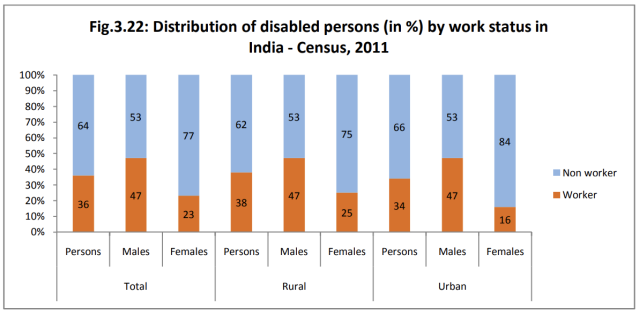

Fig. 2 Working and Non-working Disabled Percentage (Source: CDC)

People with disabilities have worse health, less education, fewer economic possibilities, and higher poverty rates than people without impairments. This is owing to the numerous challenges they confront in their daily lives, as well as the lack of assistance available to them.[8]

Disabilities are now recognised as a human rights concern. People are disabled not only physically, but also by society. If governments, non-governmental organisations, professionals, and persons with disabilities and their families work together, these barriers can be addressed[8].

D. Impact of these barriers especially in Pandemics' situation

COVID-19 and other pandemics provide significant obstacles for persons with disabilities, such as increasing hurdles to healthcare, information and much-needed support systems for people with disabilities. People with disabilities face a particular set of stressors and obstacles that could exacerbate their mental health. Researchers have shown that persons with disabilities have a tougher time accessing crucial medical supplies, which can become even more difficult when resources are limited (Campbell, Gilyard, Sinclair, Sternberg, & Kailes, 2009). Disability-related social isolation has been found to be higher among some people than among their non-disabled peers (O'Sullivan & Bourgin, 2010). Due to the physical separation, they may feel more lonely. According to the National Academies of Science, Engineering, and Medicine, social isolation and loneliness have been linked to an increase in heart disease, dementia, and other health concerns. It is also more difficult for persons with disabilities, who may be at increased risk of disability-related consequences if they contract the virus, to practise social distance and take preventive measures. In addition to heightened health issues, higher security concerns, and social marginalisation, people with disabilities living in conflict zones suffer a host of other challenges that negatively affect practically every aspect of their lives.

As a result of the widespread assumption that people with disabilities must be cared for and kept in restrictive environments for their "protection," people with disabilities are denied basic dignity and the opportunity to explore and realise who they are. However, if the pandemic and its attendant social restrictions spread, persons with disabilities in these fragile contexts are at risk of being pushed even further away from their communities. A range of cultural assumptions regarding their capacity to reliably meet professional requirements, their reported greater likelihood of health-related absences, and other misconceptions have stopped people with physical disabilities from being able to achieve economic security and independence. The pandemic's economic impact on the global and local economies might be devastating for their collective advancement, precisely as people with disabilities are beginning to dispel these myths by entering the workforce in greater numbers.

III. Role of Technology in bolstering disabled individuals

A. Aarogya Setu

The Arogya Setu app is a tech-marvel developed by the Government of India. The app (logo displayed in figure 3) assists the Indian government in identifying hotspots and thus preventing the spread of the disease. The more users who use the programme, the more effective it will be at spreading the virus.

Fig. 3 Aarogya Setu application logo. (Source: Google Play Store)

Aarogya Setu improves the safety of those around you by detecting and preventing potential infection risks in you and others[12]. It acts as a shield of protection for all your loved ones.

B. *Working of Aarogya Setu*

As you go about your daily activities, Aarogya Setu uses contact tracing to keep track of all the people you come into contact with. The figure 4 illustrates the working of Aarogya Setu App. If any of them tests positive for COVID-19 at a later date, you will be notified immediately and preemptive medical intervention will be organised for you. If you come into contact with a COVID-19 positive person in the first or second degree, Aarogya Setu will notify you and get you medical help as soon as possible. You can also use the self-assessment test to identify infection risks.

Fig 4 Working of Aarogya Setu application logo. (Source: MavenCluster)

C. *Why Aarogya Setu is not of value to disables?*

Unfortunately, Aarogya Setu is inaccessible to those with visual and hearing impairments, and crucial COVID-19 updates were not available in accessible versions. This can lead us to conclude unequivocally that people with disabilities have been disproportionately affected by the extraordinary public health emergency and accompanying lockdown and recovery efforts as they are one of the groups most vulnerable to mistreatment and isolation during times of unrest and crisis

D. *Utility of Assistive Technology - Robotic help to the disabled during the pandemic.*

Technology has progressed to the point where it can now solve issues that were previously unthinkable. The powered exoskeleton is an externally worn robotic system that uses assistive technology and artificial intelligence to help people with locomotor disabilities such as those caused by spinal injuries or strokes regain their independence. The exoskeleton makes use of innovation and technology to allow people with disabilities to take advantage of every opportunity that comes their way.

This externally worn robotic support system displayed in Figure 5 is being developed by GenElek Technologies, A start-up based in New Delhi to help people with neurological conditions such as paralysis, stroke, and spinal cord injury (SCI) walk or move better. They're trying to come up with a way for people to expand their capabilities. The device primarily improves the wearer's mobility and aids in the natural recovery of the person's gait pattern, as well as assisting them in the rehabilitation process. The device is small and easy to use, with a long battery life and quick response time.

IV. Artificial Intelligence Of Things in general Healthcare

The Artificial Intelligence of Things (AIoT) is a concept that encompasses anyone, anything, at any time, in any location, using any service, on any network. It is a megatrend in next-generation technologies that has the potential to impact the entire business and other spectrum. It can be defined as the interconnection of uniquely identifiable smart objects and devices within today's internet infrastructure, with additional benefits as displayed in Figure 6. The advanced connectivity of these devices, systems, and services, which

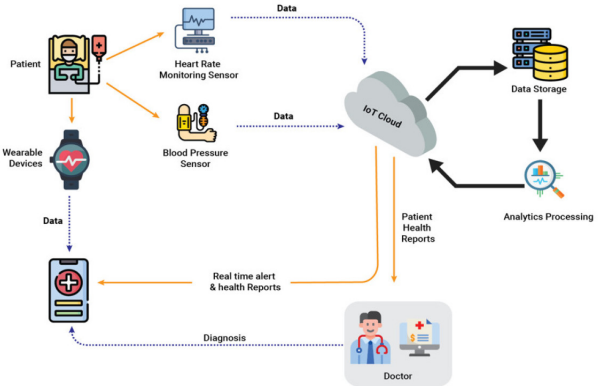

Fig. 6 AIoT has a large influence on the general healthcare sector (Source: Embedded Computing Design)

goes beyond machine-to-machine (M2M) scenarios, and is typically one of the benefits. As a result, automation can be implemented in almost any field[13]. Smart cities, traffic congestion, waste management, structural health, security, emergency services, logistics, retail, industrial control, and health care are just a few of the applications where the Internet of Things can help.

V. Revolutionizing the healthcare using AIoT:

One of the most appealing application areas for the IoT is medical and health care. Many medical applications, such as remote health monitoring, fitness programmes, chronic diseases, and elderly care, could be enabled by the Internet of Things. Another important potential application is compliance with treatment and medication at home and by healthcare providers[14]. As a result, medical devices, sensors, and diagnostic and imaging devices can all be considered smart devices or objects that are integral to the IoT. Healthcare services based on the Internet of Things are expected to lower costs, improve quality of life, and enhance the user experience. The Internet of Things has the potential to reduce device downtime for healthcare providers by allowing for remote provisioning. In addition, the Internet of Things can correctly identify the best times to replenish supplies for various devices to ensure that they run smoothly and continuously[14]. In recent years, researchers have focused their efforts on addressing the IoT's potential in the healthcare field while taking into account a variety of practical challenges including the ones faced by Disables. As a result, there are now a plethora of applications, services, and prototypes available in the field. Network architectures and platforms, new services and applications, interoperability, and security are among the research trends in IoT-based health care. In addition, many countries and organisations around the world have developed policies and guidelines for deploying IoT technology in the medical field[15]. In the healthcare field, however, the Internet of Things is still in its infancy. At this point, various stakeholders interested in further research should have a thorough understanding of current research on IoT in the healthcare context.

VI. Dichotomy of IoT and Embedded Systems:

As lucidly displayed in the Figure 7, The IoT is not to be confused with Embedded systems. One might be flustered by the first look of both the domains but on rigorous elucidation, both turn out to be entirely different.

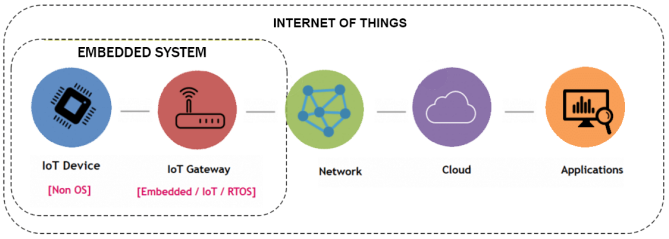

Fig. 7 Relationship between IoT and Embedded Systems (Source: SR University)

A. *Embedded Systems*

Embedded Systems is a controller having a particular role within a broader mechanical or electrical system, sometimes with real-time processing restrictions. It's commonly found as part of a larger gadget that includes physical and mechanical components and includes both software and hardware implementation as shown in Figure 8. Many modern devices are controlled by embedded systems. Embedded systems account for 98% of all microprocessors produced. Microcontrollers (microprocessors with integrated memory and peripheral interfaces) are prevalent in modern embedded systems, but regular microprocessors (using external chips for memory and peripheral interface circuits) are also widespread, especially in more complicated systems[16].

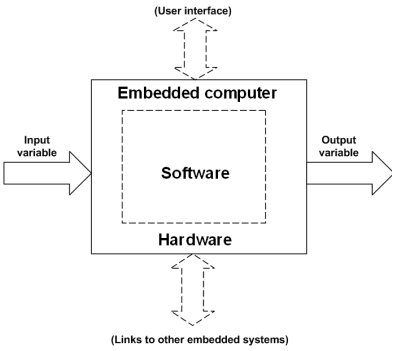

Fig. 8 The whitebox view of Embedded Systems[17]

B. *Internet of Things*

Because of the convergence of different technologies, real-time analytics, machine learning, commodity sensors, and embedded systems, the meaning of the Internet of Things has expanded. The Internet of Things is enabled by traditional domains like embedded systems, wireless sensor networks, control systems, automation (including home and building automation), and others. The Internet of Things, or IoT, refers to the billions of physical devices connected to the internet and collecting and exchanging data around the world. Connecting all of these diverse objects and attaching sensors to them gives devices that would otherwise be dumb a level of digital intelligence, allowing them to converse using real-time data without needing a person. The Internet of Things is bringing the digital and

physical worlds together to make the world around us smarter and more responsive as showcased by the diagram in Figure 9.

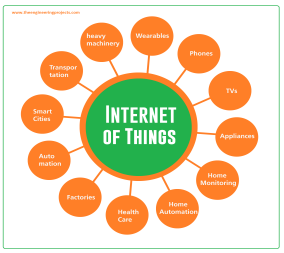

Fig. 9 Domain coverage of the Internet of Things
(Source: theengineeringprojects.com)

IoT is a combination of Embedded Technology (ET), Network Technology (NT) and Information Technology (IT). To transform your Embedded system into an IoT system, all we have to do is install NT & IT infrastructure.

ES – Embedded System: Your Smart Air Conditioner will include an inbuilt system that collects temperature data from a sensor and sends it to the cloud (internet) via a wifi module. This is the Embedded system for you.

NT – Network Technology: Your Network Technology is made up of the Wifi network and the Cloud.

IT : An APP will be installed on your phone that will receive the data. The app will turn on the air conditioning based on the data it receives and your GPS coordinates. The foundation for mobile apps is a straightforward IT system.

IoT = ET + NT + IT

For instance, Let's imagine you have an internet-connected "Smart air conditioning device" in your home. (This is an internet-connected "thing") Now imagine it's a hot summer day, and you've arrived home from work. You want your house to be cool enough when you walk in the door. As a result, when you leave your office, you can use your mobile device to turn on the air conditioning unit in your home (another "Thing" connected to the internet). Technically, you can manage your air conditioning system from anywhere in the globe if both the AC and your cell phone are connected to the "Internet."

Furthermore, Your phone will notify your home air conditioner that you are leaving the office. It is possible since It can detect your GPS coordinates and determine that you are moving and, depending on the temperature, your phone will turn on the air conditioning, and the phone will simply alert you that it is on.

VII. Smart Wheel Chair based on AIoT is Future of Industry 4.0 : Adoption of AIoT in Smart Wheelchair – SWC

The goal of developing an inexpensive smart wheel chair is integrating a microcontroller-based health monitoring system to a regular wheelchair, taking all necessary COVID 19 precautions and detections, including cardiovascular abnormality using heart rate and breath rate (to measure oxygen saturation level), and sending the alert signal through a wireless mobile network. IoT is concerned with devices communicating through the internet, while AI is concerned with devices learning from their data and experience. “The Internet of Things connects “dumb” devices to the internet, while artificial intelligence provides them with a “brain.”

The two technologies work together to build intelligent, linked systems, with AI serving as the "brain" to the Internet of Things' "body." IoT systems benefit from AI's machine-learning and decision-making capabilities, which improve data management and analysis while delivering enormous productivity increases.

A. Major segments of AIoT:

1) that collects temperature data from a sensor and sends it to the cloud (in

B. Coinage of the term “Smart Wheelchair”

The study of “Smart Wheel Chair” is the product of the Department of Scientific and Industrial Research (DSIR), Government of India, sanctioned project " Automated Wheel Chair (AWC) for Physically Challenged". On March 27, The ministry of social justice and empowerment had issued guidelines to prevent disable persons in the light of COVID-19 pandemic. In spite of that disabled persons suffered hard during lockdown. Some important examples of disabled persons suffered during lockdown are :

“*I need 24x7 medical attention. But when I asked my caregivers to come to my home, they said they can’t because the police will not allow them. There is no clear vision, how will they get passed.*”

~ Lt. Col Ramesh Chandra Sarna
Lt. Col Ramesh Chandra Sarna is bedridden after a stroke.

“*It is hard to find a job with my disability. Now I don’t know when the factory will reopen and when it does, I don’t know if I will still have my job.*”

~ Shahnawaz, disability in right leg.

Examples like the ones mentioned above and others from many disabled individuals during the lock-down that was put in place in lieu of COVID-19 inspired the advent of the concept of Smart Wheel Chair. It is specifically designed keeping disabled individuals in notice, and to bolster them in their fight against COVID-19. This project has been an extension of an already sanctioned project under

Department of Scientific and Industrial Research, Govt. of India under PRISM scheme DSIR/PRISM/119/2016-17. While AWC (Automated Wheel Chair) is designed for general-purpose usage by the disabled individuals, SWC (Smart Wheel Chair) focuses on providing aid and care to disabled individuals suffering from COVID-19 or any pandemic in general. The sanctioned project caters the in-dependency to the quadriplegics. Quadriplegics refer to the people who are unable to use their four limbs.

VIII. Common Modules between Automated Wheel Chair and Smart Wheel Chair:

The rudimentary principle on which Smart Wheel Chair is based is "Automated WheelChair – (AWC)". The modules that SWC is based upon are born out of AWC. An electric AWC is shown in Figure 11.

Fig. 11 An automated wheelchair with a self driving module readily available in the market[19].

Certain common modules include:

1. Bluetooth and GPS (Global Positioning System)
2. Real time Positioning by the used of GPS
3. Wiper Motor
4. Accelerometer
5. Head Motion Recognition Module
6. Obstacle Detection Module
7. Module based on sensors

A) Ultrasonic Sensor: HC-SR04, HRUSB – MaxSonar EZ2 MB1423. PING Ultrasonic Sensor.

B) Distance Measurement Module: Module of measuring distance when obstacle is stationary, Module of measuring distance when obstacle is moving.

C) Pulse Rate Detection Module.

The above mentioned modules are common in both AWC (Automated Wheel Chair) and SWC (Smart Wheel Chair). Additionally, some modules related to AIoT are surmounted on the SWC to consolidate the smart features that can enable its utilization in facilitating disabled.

IX. Modules of Smart Wheel Chair (SWC):

It is important to note that the aim of Smart Wheel Chair (SWC) is to protect disables especially, quadriplegics from COVID-19 by embodying three extra modules in Automated Wheel Chair (AWC) :

These modules include Module for maintaining Social Distancing, Robotic Arm Module incorporated with EEG Handsets, and Alexa Assistant Module.

A. Module for Maintaining Social Distancing

The built-in module is critical for pandemics, as social distancing is one of the most significant components in keeping a person safe during a pandemic.

According to the World Health Organization, establishing a set distance between one person and another is the recommended technique for minimising physical contact with possible COVID-19 carriers[20]. SARS-CoV-2 and influenza virus transmission are analogous to that of common respiratory viruses. It is thought that separating oneself from others has some effect on the spread of common respiratory illnesses. Even without antiviral drugs or vaccines, the findings of this study show how large social isolation can help prevent the transmission of a variety of respiratory infections. As a result, extensive social isolation could be one of the most effective ways to battle a pandemic of respiratory viruses connected to it [21]. PIR (Pyroelectric Infrared Sensors) are built specifically for motion detection and have a wide range of applications.

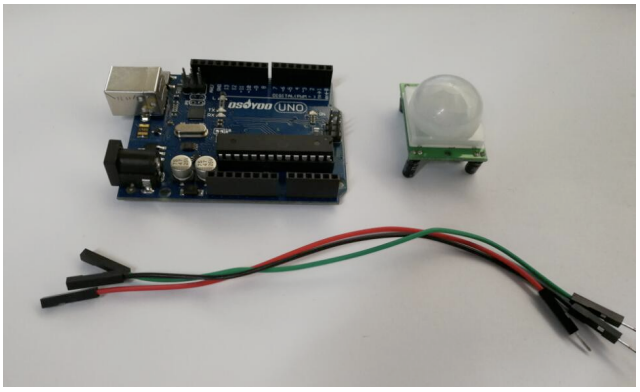

Fig. 12 A PIR sensor with OSOYOO UNO board and connecting wires

(Source: osoyoo.com)

The PIR proposed in this study is the OCTIOT PIR sensor, which is highly efficient, simple to use, and can be controlled remotely[22]. A typical OCTIOT PIT sensor is shown in Figure 12. OCTIOT sensor systems use OCTi-Sense Technology, which provides accurate motion detection while also being energy efficient in the installation area[22].

There are certain characteristics of OCTIOT sensors that support the use of this technology in the suggested wheelchair. The OCTIOT sensor is composed of high-quality materials, indicating its safety as well as our long-term commitment to product service and value. This increases the device's toughness when it comes to heavy use and handling[22]. Installation is simple; the sensor is lightweight and tiny in size, the property of easy installation of OCTIOT sensors comes in very helpful, as illustrated in Fig 1. This states that the wheelchair's mobility and smooth movement are preserved[22].

The range of this OCTIOT PIR (Poly-Infrared Sensor) is another strong feature. The range of a typical IoT sensor is between 5-8 meters[22]. This is more than enough to keep a social distance while in a crowded situation. The OCTIOT sensor's power consumption is typically set between 0.4 and 0.7 W. When the sensor is put on the wheelchair, the overall system efficiency is maintained[22].

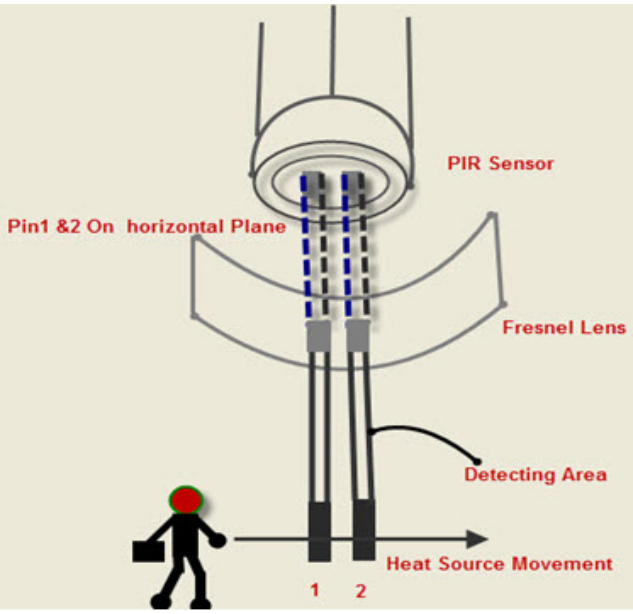

Fig. 13 PIR motion working principle and its usage in social distancing (Courtesy of ELPROCUS)

This module is mounted to keep a check over the Social Distance module. OCTIOT PIR (Passive Infrared) sensor maintains social distance between impaired and somebody standing close to him. In a specified range, PIR may detect human movement as illustrated in Figure 13 It operates by determining the specifications specified in the sensor.

The majority of PIRs are used to detect the presence of humans, animals, and other objects, and generate findings using a binary - Yes/No technique, as shown in Figure 2. Essentially, we may use PIR to identify the presence of any human in the neighbourhood of the wheelchair, as well as to estimate the distance between individuals present in the proximity of the wheelchair. The PIR proposed in this study is the OCTIOT PIR sensor, which is highly efficient, simple to use, and can be controlled remotely[22]. A typical OCTIOT PIT sensor is shown in Figure 1.

The sensor does not emit any energy but passively receives it from the environment by sensing infrared light. When infrared radiation from a human body or a particle with a high temperature concentrates on the optical system, the pyroelectric device generates a sudden electrical signal, causing an alarm to sound. The OCTIOT Microwave(MW) sensor can be used in this case. To maintain social distance, this sensor can detect human presence in a confined environment (room). One of the primary areas where the PIR system can be found is security. PIRs use body heat radiation to identify the presence of humans and animals. This might be used to perform tasks like unlocking doors, recording video, and so on. PIRs are commonly used because of their low power consumption. Hence, all the features of OCTIOT sensor makes it a very viable and robust choice for incorporating it into the Smart wheelchair.

B. Robotic Arm Module incorporated with EERG Handsets

A brain-controlled wheelchair is much of a necessity for people who are unable to utilise a motorised wheelchair owing to motor, sensory, perceptual, or cognitive problems to move around. Robotics, sensor technology, and artificial intelligence advancements present a lot of potential for constructing an upgraded wheelchair. Brain computer interface (BCI) systems translate diverse patterns of brain activity into commands in real time, allowing them to communicate with physical objects and to control external devices.. Traditional EEG sensors are prohibitively expensive and are exclusively used in hospitals and laboratories. In order to interpret signals, the electrodes of EEG sensors require conductive gel on the skin for recording the precise readings.

Fig. 14 NeuroSky EEG headset and NeuroPlace mobile app[23].

The technique of electroencephalography (EEG) is one example of detecting brain activity. EEG is a method of recording electrical activity produced by the firing of neurons in the brain along the scalp. EEG stands for electroencephalography, which is the recording of the brain's spontaneous electrical activity over a brief period of time using several electrodes on the scalp. This can also be stored on the cloud and can be viewed by the application[23]. The application along with the modern, and portable EEG is displayed in Figure 14. Neurons cause EEG to be generated. Neurotransmitters are formed when the potential created by neurons travels down the nerve fibres. This neurotransmitter activates dendritic receptors. An electric signal is generated by combining receptors and neurotransmitters, which can be measured on the scalp. This voltage varies from 1 to 100 microvolts.

The advantage of adopting a portable EEG brainwave headset is that it reads brain electric activity using dry active sensor technology. Traditional gel-based EEGs can take up to 30 minutes to begin collecting data, whereas the Neurosky headsets can start collecting data in seconds. As a result, headsets based on Neurosky technology are both affordable and simple to use.

Electroencephalogram (EEG): The physical signs of cerebral activity are EEG signals. EEG signals are private and difficult to imitate since they are a depiction of individual-dependent inner mental activity. It has a number of advantages, including confidentiality because it corresponds to a mental task, (ii) difficulty to mimic, and (iii) near-impossibility to steal because brain activity is sensitive to a person's stress and mood, and an aggressor cannot force the person to reproduce his or her mental pass[25].

The amount of electrical signals emitted by our brains is represented by the electroencephalogram (EEG) signal. Scalp electrodes are used to measure it non-invasively. When neurons function as part of the nervous system, they are the source of those electrical processes. It makes use of deep learning to distinguish four different movements from an EEG signal: left, right, forward, and stop[26]. These four signals can be fetched by the electroencephalogram (EEG) which then performs signal processing.

Fig. 15 Robotic Arm mounted on Smart Wheelchair (SWC) with Electroencephalogram[24] (Source : Learning motion primitives from demonstration. Advances in Mechanical Engineering)

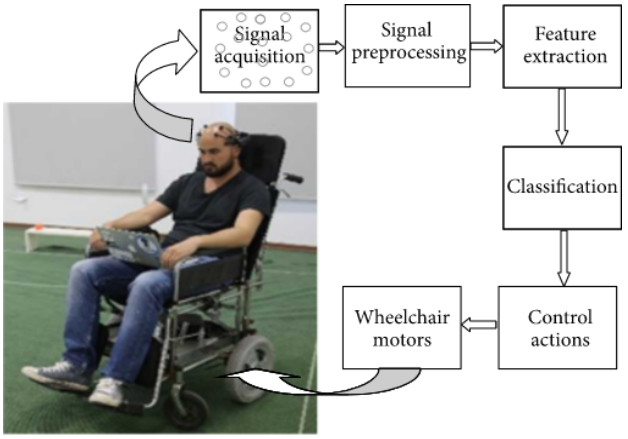

Fig. 16 working of portable EEG mounted on the chair[27].

Using BCI (Brain-Computer Interface), after signal

acquisition, signal processing is performed to extract features from BCI to classify the movement direction. Once direction is established, the control actions are called in action, and sends the signal to the robotic arm to move in four directions — right, left, up, down which will enable the robotic arm to get hold of physical objects. This can provide major assistance to the disabled individual in picking up the object and returning it to the person sitting on the wheelchair.

C. *Alexa Assistant Module:*

The Internet of Things, sensors, smart phones, smart appliances, cloud computing, and digital assistants like Amazon Alexa, Google Home, Google Assistant, Apple Siri, and Microsoft Cortana are all contributing to providing the assistance in facilitating the disabled. Smart homes and appliances were designed from the start to improve the quality of life for non-disabled people. Residents of smart homes have reported enjoying the benefits of security, energy savings, and the ability to operate their lighting, HVAC (heating, ventilation, and air conditioning), door locks, and coffee makers while in their personal space, such as in bed or on a couch[28].

Fig. 17 An Amazon Echo with Alexa firmware installed (Source: Open accessed from Unsplash.com)

The integration of Alexa assistant into the smart wheelchair will provide a feature to fasten the process of movement. Smart Wheelchairs will be controlled by the patient using basic verbal commands that will be processed by Amazon Alexa's built-in speech recognition system, which is a smart home automation strategy. For directions, these users' commands are identified[29].

The module can be installed using either a design of embedded systems or an AIoT (Artificial Intelligence of Things). The latest Amazon Echo Dot Generation is a fantastic smart speaker. It's a two-way loudspeaker from Amazon's Echo device lineup, and it's been on the market since late 2018[30]. It combines the features of the IPA Alexa, allowing for voice control and identification. The use is based on a steady power source and a WIFI connection to the Alexa Voice Service (AVS). As a result, the Echo dot functions as a form of voice command gateway to the AVS cloud.

Fig. 18 An Amazon Alexa device is portable and easy to be carried around (Source: Alexa For Seniors).

As per amazon, Echo Dot's sleek and compact appearance makes it a useful addition to any space. This fulfills our need to add it to our current existing wheelchair. Dot may be placed in the hand rest of the chassis of the wheelchair or on the periphery of the wheelchair and used as a smart alarm clock that can also turn out your lights because of the ability of built-in speakers.

Fig. 19 Amazon Alexa boon for Quadriplegics (Source: Alexa For Seniors).

Alternatively, you may shop or order online using it's voice feature. To add voice control to your home stereo system in the living room or den, Echo Dot can connect directly to speakers using a 3.5 mm stereo connection, Bluetooth, or Wi-Fi for compatible wireless speakers. Alexa can also be mounted-off the wheelchair in case of visiting doctors or places where the entire wheelchair cannot be focused. The customized 'create intent' feature of Alexa can help us connect the Alexa module with GPS to enable the tracking and locating the wheelchair at all times. Alexa can also help in keeping track of temperature readings and trigger warnings when the temperature and vitals exceeds the threshold readings.

It is highly efficient both in carrying, and power

consumption. It can have both wired and wireless modes (only in Echo Tap model), with charging lasting upto 2 or 2.5 hours, which can again be plugged back into the smart wheelchair and can be charged using an outlet.

X. Conclusion

The final wheelchair, as designed and realised, is a cost-effective response to society's demand for modern smart assistive technology in both specific situations like pandemics and in general. Infrared sensors were used to implement obstacle avoidance and social distancing procedures during the pandemic emergency. The temperature and heart rate of the wheelchair user are monitored, and if the data exceed a specified normal level, a warning message is sent to the individuals selected by the user. These features are possible with the least amount of latency thanks to AIoT. Smart wheelchair technology is now available for use in interior spaces that have been changed to prevent access to drop-offs. The first commercially successful smart wheelchair is planned to be sold as a device that can be operated autonomously indoors but requires assistance outside or in unaltered interior environments. As sensor technology improves, the range of locations in which smart wheelchairs can safely operate will grow. As a result, it's a good idea to think about cost-effectiveness, mobility, and user-friendliness as crucial components for future improvements in the field of smart wheelchairs. AIoT has alleviated a slew of problems, and new AIoT inventions are projected to reinforce improvements in smart wheelchair technology to aid disabled people in emergency situations such as pandemics.

XI. Limitations

It's probable that one would need help getting around to learn about the modules in the initial term of using the SWC and to obtain sound familiarity of the features of the Smart Wheelchair. Because of all the modules that add weight and are usually much heavier than manual wheelchairs, you'll need considerable strength to use them. As a result, mobility is reduced, making it difficult to move and possibly necessitating the use of a special vehicle. They have the potential to induce repetitive strain injuries, especially in the shoulders. Long journeys or steep ascents are not advised. The Alexa module lacks functionality without bespoke intents via Alexa skill set. It is possible that they will be unreasonably pricey. You'll have to be careful with how much power you consume, and SWC will need to go through a variety of maintenance processes.

XII. Future Works

The planned chair modules are extremely valuable, and they are supposed to help the disabled during pandemics and other situations. There are certain extrapolations that can be followed in the suggested system to improve certain characteristics and the smart wheelchair's overall efficiency. The smart wheelchair may be coupled with Amazon's Alexa or Google's Home devices to improve accessibility and responsiveness, making it a smart home component rather than a stand-alone system. The most promising future scopes include controlling AC temperature, digital locks throughout the house, and turning on/off lights throughout the house, among others through customized Alexa/Google Home programs. Carbon-Fibre frames are highly durable and do help in decreasing the overall weight, and correspondingly increasing the mobility, but it is highly expensive[31]. As a result, future scope necessitates the development of an alternative to the traditional heavy plastic or iron-based structure. Aluminum has the potential to be an excellent substitute, but further research is needed before concluding on this option. Another long term goal in the pipeline is to figure out how to adapt the wheelchair to surmount an oxygen support system for the patients with moderate/severe breathing problems, or Asthma and at the same time make it fire-resistant. Because of their lack of movement, disabled people are especially vulnerable to fire-related disasters. Because liquid oxygen is a highly flammable fluid/gas, mounting an oxygen cylinder on a wheelchair increases the chance of an explosion. As a result, making chairs fire-resistant or fire-proof is critical, and it must be done quickly.

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