

Intelligent Wheelchair Design for Individuals with Disabilities: An IoT Approach Grounded in AI-ML Technologies

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Abstract— Intelligent Wheel Chairs are mechanical devices that let the person move around on their own. As a result, the wheelchair user needs to exert less energy and effort to turn the wheels. Furthermore, it enables visually or physically challenged individuals to go from one location to another. The wheel-chair also contains a system for recognising obstacles, which reduces the risk of mishaps when moving. In recent years, smart wheelchairs have piqued people's interest. These devices are particularly beneficial for getting from one location to another. The gadgets can also be utilised in nursing homes for elderly people who have trouble moving about. For people who have lost their mobility, the devices are a godsend. There have been several types of intelligent wheelchairs developed in the past, however, new wheelchair generations are being produced and put to use that have artificial intelligence and provide the user a few options. People with certain lifelong disabilities brought on by accident, paralyses, or old aged, sometimes rely on other people for assistance. Their independence is increased by giving them access to remote health care via a health monitoring system, since the doctor continuously keeps track of their health without making any effort. By going there the services online, they can only speak with their doctors directly in the event of an emergency. Intelligent healthcare systems assist impaired individuals because they cannot afford to go acquire entry to the medical systems. There are a lot of disabled people in the world today who have trouble moving around or going about their daily lives. These people are primarily reliant on other people for support. But they can become self-independent and accomplish some everyday activities on their own with the support of assistive gadgets. Wheelchairs are the assistive technology that is most commonly utilised. A wheelchair is essentially a chair with wheels that can assist those who are unable to walk due to disease, a disability, or an injury in getting around. However, many people with disabilities who have weakened joints and limbs are unable to manoeuvre the wheelchair. So they and the rest of society can greatly benefit from smart wheelchairs. Smart wheelchairs are electric-powered wheelchairs

with numerous additional features, including computers and cameras. By developing a health monitoring system based on a smart wheelchair that can accommodate more users and doesn't need as much upkeep as wearable technology does, it may be possible to track their health status. Smart wheelchairs prioritise both the user's and the patient's health monitoring in addition to the wheelchair's mobility. The current work's goal is to create a smart sensing by adding sensors to the wheelchair's frame. The project also intends to create a similar wheel chair that is intelligent and so assists the user in their movement.

Index Terms—Wheelchair, Sensors, Self-independent, Intelligent healthcare system, DC motors, Battery, Raspberry pi, etc...

I. INTRODUCTION

In this section, a brief introduction to People with impairments are unable to move, smart gadgets provide them with access to healthcare systems. A conceivable method of keeping track of the patient's health by creating a health-monitoring system, you can improve your situation. The current project's goal is to create a low-cost by incorporating a microcontroller-based smart wheel chair to detect health problems, attach a health monitoring device to a normal wheel chair. Using heart rate and breath to detect any cardiovascular abnormalities By sending the alert, you can rate and alert certain cell phone users over the cellular network, a signal is sent. Persons with impairments cannot afford for travelling, intelligent devices allow them to obtain healthcare services. One method of monitoring the patient's health is by creating a monitoring system. By fusing a regular wheelchair with a microcontroller-dependent health monitoring system, the objective of this research is to produce a low-cost smart wheelchair [1][2].

Physically challenged people with various physical disabilities encounter numerous challenges in their day-to-day lives when it comes to commuting from one location to another, and they may even have to rely on others to get from one location to another. Over the last few years, there have been numerous substantial initiatives to construct smart wheelchair platforms that would allow a person to operate it with simplicity and without ambiguity [1]. A Smart Wheelchair is a Power Wheelchair that has numerous sensors, assistive technologies, and computers to help a user with a disability, such as an impairment, a physical disability, or a permanent injury, with the mobility needed to go freely and safely. Traditional wheelchairs are rapidly being replaced by these sorts of wheelchairs; nevertheless, their high costs preclude a huge number of disabled individuals from owning one. Only 5 to 10% of the world's 100 million disabled individuals have access to wheelchairs, according to the World Health Organization (WHO) [3].

As a result, we must supply a cost-effective Smart that not only reduces costs but also has a variety of features that utilise the most up-to-date components and technology. Many pleasant attempts had been made in the current scenarios to achieve this goal. They've used artificial intelligence in the construction of an autonomous wheelchair that navigates using machine learning concepts, and some have also used Internet of Things technology to control the wheelchair using a voice recognition system [4].

II. INTERNET OF THINGS - IOT

The definition of the Internet of Things is the extension of Internet connectivity into physical objects and everyday objects as a result of the advancement of many technologies. The Internet of Things is enabled by technologies such as embedded systems, wireless sensor networks, control systems, and automation, including building and home automation. The IOT ecosystem is made up of web based intelligent components equipped with high technology based sensing devices, CPUs & the h/w that gathers, share, and act on data collected from their surroundings. Although these gadgets can be interacted with, the majority of them operate without human intervention [3][4]. A smart wheelchair is a power wheelchair (PWC) that records the driver's actions and interactions with their surroundings. This is accomplished by placing sensors and/or cameras in strategic locations to provide feedback on a driver's ability to control the gadget and safely traverse their surroundings [5][6].

III. EMBEDDED SYSTEMS

A computing system that is programmed and controlled by a real-time operating system to carry out a function in an embedded context is known as an embedded system. An embedded system's design is tailored to the needs and specifications of the user. A computer board is included, which is linked to an input/output. The application programme can use the functionalities provided by the embedded operating system to offer the desired

functionality. Hardware, application software, and the real-time operating system, which gives the processor the means to carry out the operation, are the three key elements of an embedded system.

The RTOS establishes a group of rule based approaches for the application program's execution. As a result, an embedded system is a microcontroller system controlled by a real-time control system and driven by trustworthy software. The key benefit of employing embedded systems is that they provide improved performance at a reasonable value having power consumptions very very low which could be adjusted very easily using variable devices. Embedded system/s, on the other hand, take a longer time to establish themselves in the market & a significant amount of developmenta; efforts.

Embedded systems had been widely accepted in the medical industry, and doctors employ them in a variety of ways. They can be utilized as a preventative medicine tool by allowing patients to self-treatments. Embedded systems had also improved prosthetics by delivering innovations to prosthetic technician. Doctors can keep track of their patients by remotely monitoring them using the IoT's and an expanded inter-network. Users have been more proactive about their personal health as a result of smart technology-based embedded medical devices.

Clinicians have expressed a significant need for the service that a intelligent wheel-chair may provide, according to a recent poll. The following are some of the most important survey findings: According to clinical estimates, 10–20% of patients who receive power wheelchair training find it extremely difficult or impossible to use the wheelchair for daily activities. When patients were particularly questioned about steering and manoeuvring tasks, the percentage of patients who responded that they were challenging or impossible rose to 50%.

80 % of the doctors who responded said they saw a number of patients every year who are unable to utilize a power wheelchair due to a lack of motor based skillsets, strengths, or visual acuities. 32 percent of these doctors (27 percent of all respondents) said they saw at least as many patients who are unable to utilize a power wheelchair. According to the professionals who treat them, over half of the patients who are unable to manoeuvre a powered wheel-chair using traditional ways might benefit from an automated navigation system.

IV. LITERATURE SURVEY

The majority of the studies under review include driving and steering aspects of smart wheelchair control. The topic of controlling a wheelchair with a variety of methods—including brain waves, tongue-driven systems, face movement control, hand gesture control, etc.—is covered. A Health Monitoring System that may be fitted into a wheelchair and uses a range of sensors was only briefly discussed in a few articles. There is a research opportunity due to the accessibility of inexpensive sensors and the paucity of thorough research on health-monitoring smart wheelchairs. The choice of a wheelchair is difficult and reliant on a variety of elements, such as the disease, morphology, rate of evolution, and environment of the user (at home, in the office, etc.). As a result, there is no such thing as a “model” wheelchair. As a result, the wheelchair is chosen based on both financial and technological considerations. Where one force sensor is positioned in each pressure zone, the position of every force sensor could be found out. Temperature sensors are connected in the same way as force sensors are connected, with a temperature sensor placed directly in front of each pressure sensor. Many studies have shown that a smart wheelchair can provide the most help to its user.

V. OVERVIEW

In recent years, smart wheelchairs have received a lot more attention in comparison to power wheelchairs. Traditional/manual wheelchairs that are powered by a battery or electricity are known as power wheelchairs. They are largely deficient in terms of functionality and safety features. Smart wheelchairs, on the other hand, have functionality and safety features. Typically, a smart wheelchair contains an electrically propelled wheel-chair with a computer and numerous sensors. The advancement of artificial intelligence, computing, and robotics has resulted in the growth of smart wheelchairs [4].

A smart wheelchair is made up of a computer that controls the movement of the wheelchairs using inputs from sensors. Sensors acquire data from the environment, which is then processed by a computer and the necessary procedures are conducted. The user can also control the smart wheelchair manually. Smart wheelchairs are currently available on the market, but they are out of reach for most people. Because they are driven by high-capacity batteries and high-torque motors, the price of the product rises accordingly [5].

A person who is 90–95 percent handicapped cannot drive the wheelchair because the motion is given by a Joystick and Toggle switch. As a result, these individuals require the presence of a companion or a caregiver. The most common type of wheelchair used by laypeople is the manual or traditional wheelchair. Because a middle-class individual cannot buy a power wheelchair, they must rely on the manual wheelchair. These chairs will be manually

operated, which will make it difficult for the disabled to move from one location to another without assistance [6]. As a result, smart wheelchair upraises must be used to replace power and regular wheelchair upraises in order to provide more maneuverable motion to the wheelchair. Smart wheelchairs have been developed to assist users with navigation in a variety of ways, including ensuring collision-free riding, assisting with specific tasks (e.g., passing through doorways), and autonomously transferring the user between sites [7].

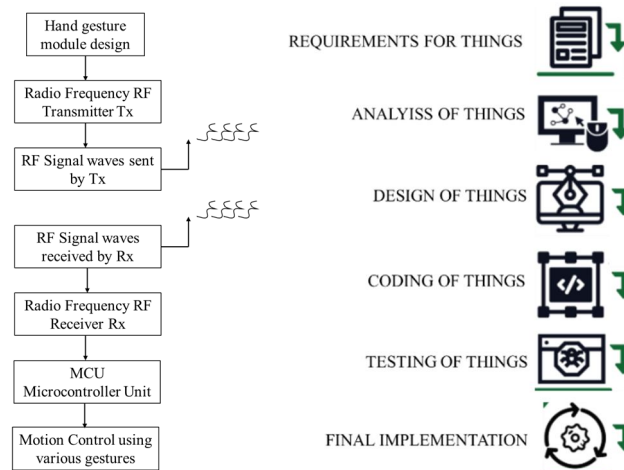


Fig. 1 : Pictorial representation of the proposed module & Flow chart (DFD) of the assistance & navigation system

VI. RESEARCH OBJECTIVES

This paper address the 5 important research objectives' which are listed one after the other as follows [8].

- Gesture controlled wheel chair
- wheelchair control through eye blinking
- voice controlled smart wheel chair
- wheelchair guidance and assistance system
- wheelchair fall detection

VII. BACKGROUND REVIEW

The results of previous studies under review include driving and steering aspects of smart wheelchair control. The topic of controlling a wheelchair using a variety of methods—including brain waves, tongue-driven systems, face movement control, and hand gesture control—is covered. A Health Monitoring System that may be fitted into a wheelchair and uses a range of sensors was only briefly discussed in a few articles. There is a research potential due to the accessibility of inexpensive sensors and the paucity of in-depth research on health-monitoring smart wheel-chairs.

The selection of a wheelchair is challenging and dependent on a number of factors, including the user's pathology, morphology, rate of evolution, and surroundings (at home, in the office, etc.). As a result, there is no such thing as a "model" wheelchair. As a result, the wheelchair is chosen based on both financial and technological considerations. Where one force sensor is positioned for every zonal pressure area, then the force sensor (each one) in the module could be identified [9][8].

A overview of the various types of smart wheel chairs is accessible in Sibai & Manap's research work. They also talk about joy-stick steering's, head / chin / tongue movements, and gaze / face direction on the HMI. Sip and Puff Technology, EEG (Brain Signals), Voice Input, Hand Gesture Control, Navigation Methods & Devices, and Future Work on Health Monitoring are all discussed in the study. For those with severe disabilities, Kim et al. discuss a Smart Wheel Chair with a Tongue Driven System (TDS). Purnomo et

VIII. RESULTS & DISCUSSIONS

After all of the components are combined, we have a working skeleton model for the wheelchair. According to the hand movements, the wheelchair model works properly. Fig. 3 gvies the prototype of the wheel chair (Similar one will be designed & built by us) [10].



Fig. 2 : Prototype of the wheel chair (Similar one will be designed & built by us) & Eye blink sensor design (Similar one will be designed & built by us)

The Eye Blink sensor-controlled wheelchair has been successfully designed. The design shown enables for wheelchair control using a variety of hardware and software components, resulting in an efficient system. The Fig. 4 gives the eye blink sensor design. The wheelchair that is operated by voice commands has been designed successfully. The design provided allows for wheelchair control using a variety of hardware and software components, resulting in a functional system. The process of control & navigational guidance is shown in the Fig. 5 [11].



Fig. 3 : Control & Navigational Guidance (Similar one will be designed & built by us) & How to stay independent with the help of the wheel chair (Similar one will be designed & built by us)

Helps disabled people in locating wheelchair accessible or handicapped-accessible facilities in their area. The Fig. 6 gives an idea of how to stay independent with the help of the wheel chair. When the system detects a fall, the warning system is activated. The buzzer will sound, and the collected data will be analysed before being transferred to the IoT platform. The blink mobile application was used to achieve the second and third objectives. The wheelchair's location was determined using a Google map. The Fig. 7 gives us an idea of how to develop a fall detection system [12][13].

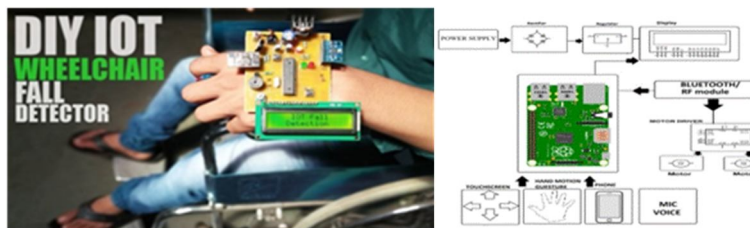
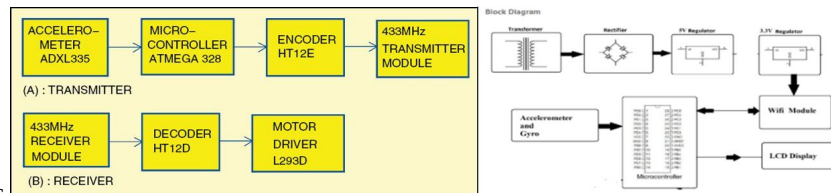


Fig. 3 : Fall detection system development (Similar one will be designed & built by us) & Block diagram of the smart wheel chair for the disabled persons



IX. RESULTS

Fig. 5 : Block diagram of the hand gesture controller

The working of wheelchair is controlled by hand gesture As we hold the transmitter in our hands, the wheelchair moves in accordance with our hand motions. When we tilt our hands forward, we begin to move ahead and keep

going until the next command is delivered. When we move our hands in a reverse direction, they change state and begin to move backwards until another command is issued.

X. CONCLUSIONS

This project shows a wheelchair model that can be operated by hand gestures, eye blinking, vocal commands, fall detection, and navigation help. The sensor is utilised to control the wheelchair, making it more intelligent and user-friendly by decreasing human activity and physical strain while also providing spontaneous output. We've employed numerous facial actions, such as sipping and puffing, to control the wheelchair. Other devices, such as Bluetooth and ZigBee, could be used to communicate with various devices. Research activities have begun to investigate various mechanical replies in order to improve human administrations process of action in a way that complements existing organizations by utilising the IoT's potential. The proposed structure lays out clear research techniques for how the Internet of Things may help with pediatric and senior care, continuous disease monitoring, private prosperity, and health management. To gain a better understanding of IoT social protection security, we looked at a variety of security requirements and proposed a model that can help mitigate security risks. Overall, the survey's findings are expected to be beneficial to researchers, engineers, prosperity experts, and politicians working in the field of IoT and social protection advancements.

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