IJITCE

ISSN 2347- 3657

International Journal of Information Technology & Computer Engineering

Email : ijitce.editor@gmail.com or editor@ijitce.com

International Journal of Information Technology & Computer Engineering
ISSN 2347–3657
Volume 13, Issue 2, 2025

An Infrared- and Gesture-Controlled Wheelchair Robot

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ABSTRACT:

New developments in sensor integration and automation have led to significant improvements in mobility solutions for those with physical limitations. Many people with little dexterity in their hands may find that traditional wheelchairs, which employ joystick controls, are too difficult to use. The development of gesture-controlled wheelchairs, which enable users to direct the wheelchair's motions by body gestures, is a solution to this problem. An accessible and efficient mobility solution is the subject of this project, which involves a home automation system and a gesture-controlled wheelchair that incorporates infrared sensors, an L293D motor driver, a buzzer, and MEMS (Micro-Electro-Mechanical Systems) sensors. Wheelchair navigation instructions are translated into motion by the MEMS sensor, which recognizes hand or head motions. The L293D motor driver receives these instructions from a microprocessor and uses them to move the wheelchair in various directions, including forward, backward, left, and right. One use of the infrared sensor is home automation, which allows customers to remotely operate various electrical equipment. This improves freedom by letting people with mobility issues use common home appliances without touching them. An additional safety feature is a built-in buzzer that notifies users or caretakers of impending danger, malfunction, or other issues.
The easy, hands-free manner of operation provided by the gesture-controlled wheelchair empowers users. Users may effortlessly maneuver the wheelchair using this method, as opposed to relying on conventional joysticks or button-based controls. Home automation elements that may be controlled by an infrared remote further increase convenience, allowing physically challenged folks better access to their surroundings.
The low cost and simplicity of integration with preexisting mobility devices are two of the system's main features. Lightweight and without requiring complicated calibration, the MEMS sensor technology used for gesture detection is perfect for practical uses. With the infrared sensor for home automation, users may easily turn on and off lights, fans, and other appliances. As a crucial safety element, the buzzer alarm system notifies users in the event of problems or obstructions in the wheelchair's route.
People with severe mobility disabilities will be able to reclaim their freedom and control of their environment thanks to this project's substantial contribution to the evolution of assistive technology. This offers a complete and functional solution with its integration of MEMS-based gesture control, automation of infrared sensors, and motorized wheelchair mobility with L293D motor drivers. More improvements, such Internet of Things (IoT) connection and voice control integration, might make the system even more accessible and allow for remote operation. The ultimate goal of the home automation system and gesture-controlled wheelchair is to provide physically disabled people with a more intelligent, efficient, and user-friendly means of transportation, hence improving their quality of life.

EMBEDDED SYSTEMS

A computer system that is purpose-built to carry out a single or limited set of tasks, often under the restrictions of real-time computing, is known as an embedded system. As with other physical and mechanical components, it is often integrated into a whole device. A personal computer or other general-purpose computer, on the other hand, may be programmed to do a wide variety of functions. These days, many of the everyday items we use rely on embedded systems to function. Design engineers may improve the embedded system to decrease product size and cost while boosting reliability and performance since it is devoted to certain functions. Because of their mass production, certain embedded systems are able to take advantage of cost savings.
From small, handheld gadgets like digital watches and MP3 players to massive, permanently installed systems like those managing nuclear power plants, traffic lights, and industrial controls are all examples of physically embedded systems. From simple systems using a single microcontroller chip to complex systems housing several modules, peripherals, and networks in a massive chassis or enclosure, complexity may range greatly.
The phrase "embedded system" lacks a precise definition because the majority of systems have programmability in some form. While they share some components with embedded systems, such operating systems and microprocessors, handheld computers are not technically embedded systems as

International Journal of Information Technology & Computer Engineering

ISSN 2347–3657

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they enable the loading of multiple programs and the connection of peripherals. Computer hardware and software, either fixed in capability or programmable, particularly intended for a certain sort of application device—this is what's called an embedded system. Embedded systems may be found in a wide variety of objects, including but not limited to: vehicles, medical devices, cameras, home appliances, aircraft, vending machines, toys, and, of course, cellular phones and personal digital assistants. A programming interface is given to programmable embedded devices, and programming for embedded systems is a niche field in and of itself. Embedded Java and Windows XP Embedded are two examples of embedded-specific operating systems and language platforms. On the other hand, certain budget consumer goods include integrated application and operating system components, employ very cheap microprocessors, and have limited storage space. Instead of being loaded into RAM (random access memory), as applications on personal computers are, in this situation the program is written permanently into the system's memory.

CHARACTERISTIC OF EMBEDDED SYSTEM

- Speed (bytes/sec): Should be high speed
- Power (watts): Low power dissipation
- Size and weight: As far as possible small in size and low weight
- Accuracy (%error): Must be very accurate
- Adaptability: High adaptability and accessibility
- Reliability: Must be reliable over a long period of time

APPLICATIONS OF EMBEDDED SYSTEMS

Here, in the Embedded World, we are living. The smooth operation of the various embedded goods that surround you is crucial to your day-to-day existence. In your living room, you have a TV, radio, and CD player; in your kitchen, you have a washing machine or microwave oven; and at your office, you have card readers, access controllers, and palm devices that let you do a lot. In addition to all of this, your automobile has a plethora of built-in controls that handle functions between the bumpers, most of which you probably don't give a second thought to.

- **Robotics:** industrial robots, machine tools, Robocop soccer robots
- **Automotive:** cars, trucks, trains
- **Aviation:** airplanes, helicopters
- Home and Building Automation
- **Aerospace:** rockets, satellites
- **Energy systems:** windmills, nuclear plants
- **Medical systems:** prostheses, revalidation machine.

MICROCONTROLLER VERSUS MICROPROCESSOR

When comparing microprocessors and microcontrollers, what are the key differences? Any general-purpose microprocessor, such an 8086, 80286, 80386, 80486, or a Pentium from Intel, or a 680X0 from Motorola, etc., is considered a microprocessor. In addition to lacking on-chip I/O ports, these microprocessors also lack random-access memory (RAM). Because of this, they are often called general-purpose microprocessors. Designing a working system around a general-purpose CPU like the 68040 or Pentium requires the addition of extra components like as RAM, ROM, I/O ports, and timers. Though these systems are more costly and cumbersome due to the inclusion of external RAM, ROM, and I/O ports, they provide the benefit of being versatile in that the designer may choose the quantity of RAM, ROM, and I/O ports required for the work at hand. Microcontrollers are an exception to this rule. On a single chip, you'll find a microprocessor, random access memory (RAM), read/write (ROM), input/output (I/O) ports, and a timer in a microcontroller. So, since the CPU, random access memory (RAM), read/write memory (ROM), input/output (I/O) ports, and timer are all integrated into a single chip, the designer is unable to include any more memory, I/O ports, or timer into the product. Because of its set quantity of on-chip ROM, RAM, and number of I/O ports, microcontrollers are perfect for many applications where space and cost are important considerations. It is not necessary to have a 486 or even an 8086 CPU for many applications; for instance, a TV remote control. Typically, these programs will need some kind of input/output function in order to read signals and toggle bits.

INTRODUCTION

Redefining mobility for those with limited upper-body movement, gesture-controlled wheelchairs provide a novel alternative to traditional button-operated devices. They are a groundbreaking advance in assistive technology. This innovative method takes use of sensor integration by recording and deciphering minute hand or head movements with the help of cutting-edge devices like gyroscopes and accelerometers. Users are granted remarkable autonomy and command since they are not obligated to physically touch the wheelchair. The primary mechanism by which gesture-controlled wheelchairs operate is by the integration of sensor data into a sophisticated computer system. The user's hand motions are being painstakingly tracked by accelerometers, which are incorporated in a tiny transmitting device. In order to recognize certain motions, the system analyzes this real-time data using complex algorithms. After these movements are translated into precise commands, the wheelchair's direction and speed are decided. The significance of this technology extends well beyond its technical aspects. People with mobility-limiting disorders or spinal cord injuries, for example, can experience a dramatic improvement in their quality of life as a result of this. Research and technological advancements are the defining features of gesture-controlled wheelchair development. Challenges such as improving accuracy, decreasing costs, and enhancing usability are still top concerns. The necessity for creating affordable, high-tech wheelchair solutions is magnified in India, where about 20% of the population suffers from a movement-related handicap. Giving those with movement impairments access to affordable mobility solutions is the bigger aim, and the project's purpose, which is centered upon technology innovation, aligns with that. When it comes to assistive technology, gesture-controlled wheelchairs are shaping up to be game-changers. In addition to practical solutions to mobility problems, these innovations mark a sea change in how society perceives and addresses the needs of persons with disabilities. With each technological breakthrough, gesture-controlled wheelchairs get nearer to becoming a ubiquitous and indispensable tool that will enable individuals to traverse the globe with unparalleled autonomy and respect.

EXISTING SYSTEM

Users with significant motor impairments are unable to use traditional wheelchairs due to the joystick-based controls' reliance on manual dexterity. There are still issues with accessibility and usability with certain high-tech wheelchairs, even when they include voice commands or joystick-based control systems. People with severe mobility impairments sometimes find it challenging to use traditional systems due to the absence of gesture control features. On top of that, current wheelchair designs don't have home automation capabilities, so people still need help from others to use their appliances. Traditional wheelchairs also lack safety features like obstacle recognition and emergency notifications, which makes them more prone to accidents. An sophisticated wheelchair with gesture control, home automation, and safety features is necessary since these solutions do not have real-time remote accessibility or automation capabilities.

PROPOSED MODEL

The proposed system integrates home automation with motion control using an L293D motor driver, movement control using MEMS-based gesture recognition, safety warnings through a buzzer, and movement control through infrared sensors. When a user moves their hand or head, the MEMS sensor picks it up and uses it to send directions to the wheelchair. To regulate the wheelchair's forward, backward, left, or right movement, a microprocessor processes these instructions and then communicates with the L293D motor driver. Users have more freedom in their day-to-day lives because to the IR sensor's ability to remotely manage household equipment. The system incorporates a buzzer to provide instant notifications in the event of obstructions, system malfunctions, or emergencies. People with poor dexterity in their hands will find this gesture-controlled system very accessible as it does away with the need for physical input devices like joysticks. Users may easily control lights, fans, and other appliances using the home automation function that uses infrared sensors. By sounding an alarm in the event of operational problems or obstructions, the buzzer provides an additional degree of security for both users and caretakers. People with disabilities will be able to move about more freely and engage with their environment more meaningfully because to this device, which is practical, inexpensive, and straightforward to install.

BLOCK DIAGRAM

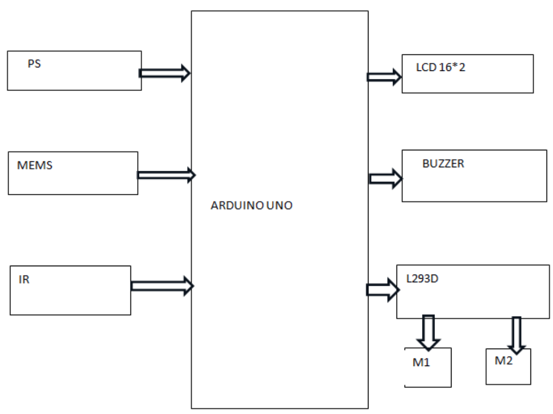

Figure 1: Block Diagram

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ISSN 2347–3657
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Microcontroller:

A tiny controller, or microcontroller, as the name implies. Often used as a processing or controlling unit, they are similar to single-chip computers. For instance, microcontrollers that do decoding and other regulating operations are likely integrated into the control you are using. They find further use in vehicles, home appliances, microwaves, toys, and any other area requiring automation.

Arduino Uno Microcontroller:

One such microcontroller board is the Arduino Uno, which uses the Atmega328 (datasheet). It has a 16 MHz crystal oscillator, 6 analogue inputs, 14 digital input/output pins (6 of which may be used as PWM outputs), a power connector, an ICSP header, a reset button, and a USB connection. All you need is a USB cable, an AC-to-DC converter, or a battery to get it going; it comes with everything you need to support the microcontroller.
A key difference between the Uno and all previous boards is the absence of the FTDI USB-to-serial driver chip. Rather of that, it has an Atmega8U2 that has been configured to convert USB to serial. To celebrate the impending release of Arduino 1.0, the name "Uno"—which means "One" in Italian—has been chosen. The Uno and Arduino version 1.0 will serve as the foundational versions for future Arduino releases. For a comparison with prior generations, see the index of Arduino boards. The Uno is the newest in a series of USB Arduino boards and the standard model for the Arduino platform.

ARDUINO UNO BOARD:

One board that uses the Atmega328 microprocessor is the Arduino Uno. A 16 MHz ceramic resonator, 6 analog inputs, 14 digital I/O pins (including 6 PWM outputs), 1 USB port, 1 power connector, 1 ICSP header, and 1 reset button are all part of it. All you need is a USB cable, an AC-to-DC converter, or a battery to get it going; it comes with everything you need to support the microcontroller.

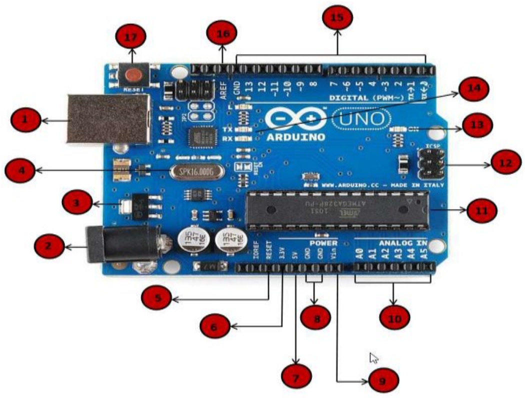

Figure 2: Arduino uno board

In contrast to all of its predecessors, the Uno does not have the FTDI USB-to-serial driver chip. As an alternative, it makes use of USB-to-serial converters coded into the Atmega16U2 (Atmega8U2 up to version R2).

HARDWARE COMPONENTS

POWER SUPPLY UNIT

The power supply for this system is shown below.

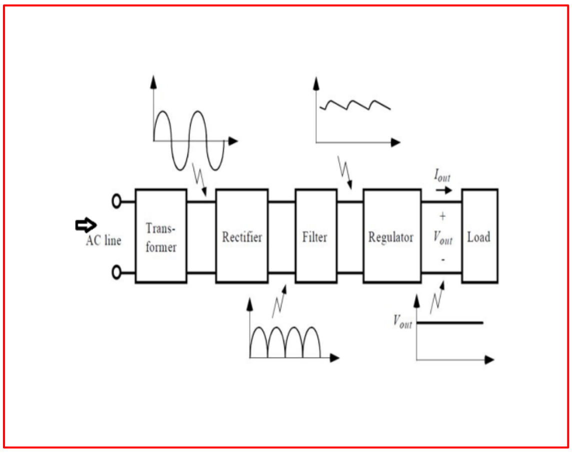

Figure 3: power supply

Diodes:

Only one path of electrical current may pass through a diode. Current may flow in either direction, as shown by the arrow in the circuit symbol. Originally termed valves, diodes are essentially an electrically enhanced version of the mechanical component.

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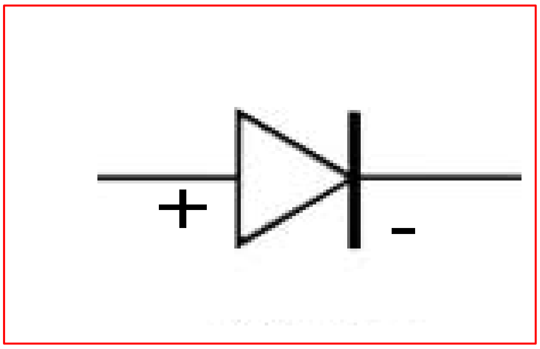

Figure 4: Diode Symbol

One kind of electrical component that restricts current flow is the diode. A voltage loss of around 0.7V will be the sole influence on the signal when the diode is "forward-biased" in this way. No current will flow through a diode that is "reverse-biased" when the current is applied in the other direction.

Rectifier

A rectifier's job is to change the phase of an alternating current (AC) waveform so that it appears as a direct current (DC) waveform. Both "half-wave" and "full-wave" rectifiers are used for rectification. Diodes are used in both devices to convert AC current into DC current. The Half-Wave Resettable The graphic shows that the half-wave rectifier is the simplest rectifier type since it only employs one diode.

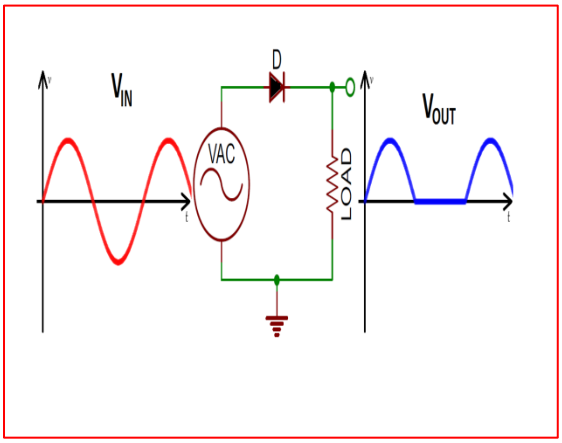

Figure 5: Half Wave Rectifier

LIQUID CRYSTAL DISPLAY

An array of color or monochrome pixels arranged in front of a light source or reflector makes up a liquid crystal display (LCD), a thin, flat display device. Two polarizing filters, with their polarity axes perpendicular to one other, and a column of liquid crystal molecules hanging between two transparent electrodes make up each pixel. Light would not be able to travel through them if the liquid crystals weren't interposed. To make light flow through two filters, the liquid crystal changes the polarization of the light entering the first filter.

A program's ability to communicate with the outside world depends on its input and output devices, which in turn rely on human communication. An LCD display is a typical accessory for controllers. 16X1, 16x2, and 20x2 LCDs are among the most popular types of displays that are often linked to the controllers. Which works out to sixteen characters on a single line. The first set has 16 characters on each line while the second set has 20 characters on each line. The use of "smart LCD" displays allows for the visual output of information by many microcontroller devices. Affordable, user-friendly, and capable of producing a readout utilizing the display's 5X7 dots plus cursor, LCD displays built on the LCD NT-C1611 module are a great choice. They use mathematical symbols and the usual ASCII set of characters. The display needs a +5V power and 10 I/O lines (RS, RW, D7, D6, D5, D4, D3, D2, D1, D0) for an 8-bit data bus. The only additional lines needed for a 4-bit data bus are the supply lines and six more (RS, RW, D7, D6, D5, D4). The data lines are tri-state and do not affect the microcontroller's function when the LCD display is disabled.

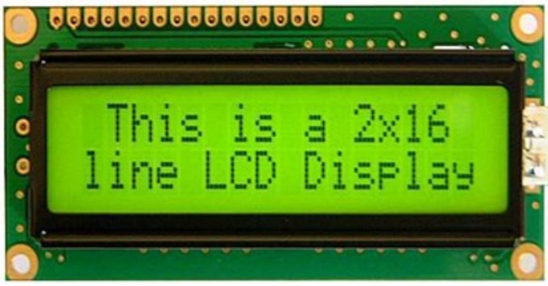

Figure 6: 2x16 LCD Display

BUZZER

In a magnetic transducer, the circuitry includes an iron core, a yoke plate, a wound coil, a permanent magnet, and a vibrating diaphragm that can be moved. The magnet's field gently draws the diaphragm up nearer the core's surface. A positive alternating current (AC) signal causes the diaphragm to move up and down, which in turn vibrates the air. This is achieved by the current passing through the excitation coil, which forms a fluctuating magnetic field. A resonator, which is composed of a cavity and one or more sound holes, may amplify vibrations in order to generate a loud sound.

ISSN 2347–3657

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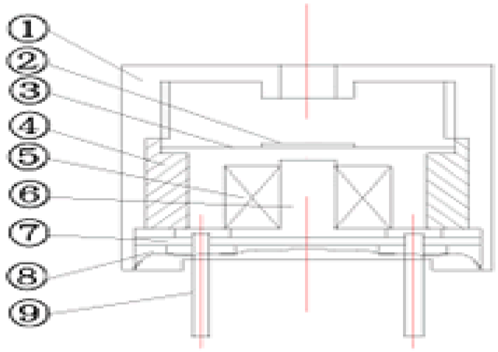

ESP8266 Wi-Fi Module

This project revolves on this. Because the project relies on WIFI control of appliances, the module is a crucial part of it.
One remarkable feature of this tiny board is the integrated MCU (Micro Controller Unit), which allows for the control of I/O digital pins via a simple programming language that is almost pseudo-code like. Another benefit is that the ESP8266 Arduino compatible module is a low-cost Wi-Fi chip with full TCP/IP capability. The Chinese company Es press if Systems is situated in Shanghai and makes this gadget.
In August 2014, this chip made its debut in the ESP-01 version module manufactured by the third-party company AIThinker. The MCU can establish basic TCP/IP connections and connect to WiFi networks with the help of this little module. He was His tiny size and cheap pricing (1.7–3.5$) enticed a lot of hackers and geeks to look into it and utilize it for all sorts of projects. Because of its enormous success, Espressif now offers a wide variety of models with varying size and technological specs. Its replacement includes ESP32.

RELAYS:

Industrial controls, automotive systems, and home appliances all make extensive use of electrically controlled switches called relays.
By using a relay, two independent voltage sources may be isolated from one another; in other words, a little quantity of voltage or current on one side can manage a big amount of current or voltage on the other side, and vice versa.

Inductor

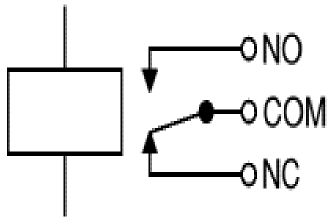

Fig7 : Circuit symbol of a relay

DRIVING A RELAY:

Two of the SPDT relay's five pins are used by the magnetic coil, one serves as the common terminal, and the other two are typically closed and normally connected. The coil is activated when a current passes across it. At the beginning, when the coil is deenergized, the usually closed pin and common terminal will be connected. A new connection will be formed between the common terminal and usually open pin when the coil is activated, breaking this connection. Therefore, the relay will be activated whenever the microcontroller sends an input signal to it. You may drive the loads connected between the common terminal and typically open pin while the relay is on. Consequently, the high-current loads are driven by the relay, which receives 5V from the microcontroller. This means the relay may be used as a means of isolation.
The microcontroller and digital systems do not have enough current to operate the relay. In contrast to the 10 milliamps required to activate the relay's coil, the microcontroller's pin can only provide 1 or 2 milliamps. This is why the microcontroller and the relay are separated by a driver, like ULN2003, or a power transistor. By connecting ULN2003 to the relay and microcontroller, it is possible to activate many relays simultaneously.

SOFTWARES

The Arduino platform is an open-source, user-friendly hardware and software environment for prototyping. It is comprised of a programmable circuit board (also called a microcontroller) and an Integrated Development Environment (IDE) called Arduino that is pre-made for writing and uploading code to the physical board.
The main characteristics are:
• Many sensors can send signals in digital or analog formats to Arduino boards, which may then be used to activate motors, control LEDs, establish connections to the cloud, and much more.
• The Arduino IDE (also called "uploading software") allows you to command your board's operations by communicating with the microcontroller on the board.

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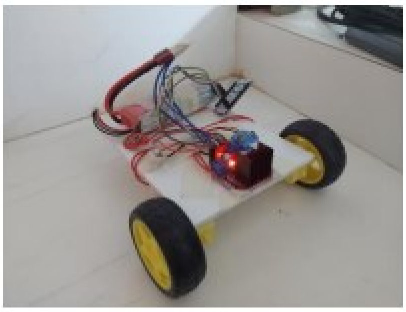
• A separate device, known as a programmer, is not required to load fresh code into an Arduino board, in contrast to most prior programmable circuit boards. The usage of a USB connection is all that is required. • The Arduino IDE employs a streamlined version of C++, which facilitates programming learning. Last but not least, Arduino offers a standardized form factor that simplifies the microcontroller's tasks.
Now that we know what the Arduino UNO board is and how it works, we can go on to setting up the Arduino IDE. As soon as we figure this out, we can upload our software to the Arduino board.

RESULTS

Hand gesture



Model

CONCLUSION

The creation of a wheelchair that can be controlled by gestures and has home automation features would greatly help people with physical disabilities to move about and be independent. This all-inclusive assistance device has MEMS sensors for gesture control, infrared sensors for automating appliances, L293D motor drivers for wheelchair mobility, and a buzzer for safety alarms. Individuals with severe motor impairments will find this system very useful since it offers hands-free operation, remote home control, and an emergency alarm system—features that are not found in conventional wheelchairs.

The system is affordable and suitable for real-world deployment since it uses microcontrollers and sensors that are inexpensive. Further enhancements to accessibility might be made in the future with capabilities like voice control, AI-based gesture detection, and Internet of Things integration. In the end, the home automation-enabled gesture-controlled wheelchair is a huge leap forward in accessible mobility solutions, giving people with disabilities much-needed freedom and independence.

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