Development of an Intelligent Voice-Controlled Solar Vehicle Using Mobile Application Interface

Mr. Maniratnam Tarapatla[1] Chikkam Madhav Sriram[2*] Gandham Naga Manikanta[2]
Rudra Naga Sai Pavan[2] Vanteddu Subramanyeswara Rao[2]
[1]Assistant Professor, Bonam Venkata Chalamayya Engineering College, Odalarevu, AP
[2]UG Student, Bonam Venkata Chalamayya Engineering College, Odalarevu, AP
Corresponding Mail ID: bunnyrudra619@gmail.com

How to Cite this Article:

Sriram, C. M., Manikanta, G. N., Pavan, R. N. S. & Rao, V. S. (2026). Development of an Intelligent Voice-Controlled Solar Vehicle Using Mobile Application Interface. International Journal of Creative and Open Research in Engineering and Management, <i>02</i>(04). https://doi.org/10.55041/ijcope.v2i4.187

https://doi.org/ 10.55041/ijcope.v2i4.187

Abstract: The increasing demand for sustainable energy solutions and smart automation has led to the development of innovative transportation systems. This project presents the design and implementation of a Voice Operated Solar Powered Vehicle using a Smartphone, which integrates renewable energy with advanced control technology. The system utilizes solar energy as its primary power source, reducing dependency on conventional fuels and minimizing environmental pollution. The vehicle is controlled through voice commands given via a smartphone application. These commands are transmitted wirelessly using Bluetooth technology to a microcontroller, which processes the input and controls the movement of the vehicle accordingly. The system enables basic directional controls such as forward, backward, left, right, and stop. A solar panel is used to charge the battery, ensuring energy efficiency and continuous operation. The integration of voice recognition technology enhances user convenience, making the system accessible and easy to operate without manual intervention. This project demonstrates the practical application of renewable energy and smart control systems in modern transportation. Overall, the proposed system is cost-effective, eco-friendly, and user-friendly, making it suitable for future advancements in intelligent and sustainable vehicle technologies.

Keywords: Solar Vehicle; Voice Control; Bluetooth; Microcontroller; Renewable Energy.

1. Introduction

The rapid development of renewable energy and smart communication technologies has led to innovative solutions in the field of automation and transportation. This project presents the design and implementation of a voice operated solar powered vehicle using a smartphone, which combines solar energy utilization with wireless control systems. The main objective of this project is to develop an eco-friendly vehicle that operates using solar power and can be controlled through voice commands via a smartphone. Solar energy, being a clean and renewable source, helps reduce dependence on conventional fuels and minimizes environmental pollution. In this system, the solar panel converts sunlight into electrical energy, which is used to power the vehicle. A smartphone application is used to send voice commands, which are transmitted through wireless communication (such as Bluetooth) to a microcontroller. The microcontroller processes these commands and controls the motors accordingly using a motor driver circuit. This project demonstrates the integration of renewable energy, embedded systems, and wireless communication technologies. It provides a cost-effective and efficient solution for modern transportation systems and highlights the importance of sustainable energy usage in future applications.

In today's world, increasing fuel consumption and environmental pollution have become major concerns. Conventional vehicles rely heavily on non-renewable energy sources such as petrol and diesel, which are limited and harmful to the environment. There is a growing need for eco-friendly and energy-efficient alternatives. At the same time, traditional vehicle control systems require manual operation, which may not be convenient or accessible for all users, especially in situations where hands free control is beneficial. This project addresses these issues by proposing a voice operated solar powered vehicle using a smartphone. The aim is to reduce dependence on fossil fuels by utilizing solar energy and to improve user convenience by enabling voice-based control through wireless communication. The challenge is to design a system that efficiently integrates solar power generation, wireless communication, and voice recognition to control a vehicle in a reliable and cost-effective manner.

Several research works have been carried out in the fields of solar-powered vehicles and voice-controlled systems. These studies focus on improving energy efficiency, reducing environmental impact, and enhancing user convenience. Many researchers have developed solar-powered vehicle models that utilize photovoltaic panels to convert sunlight into electrical energy. These systems help reduce dependency on fossil fuels and promote the use of renewable energy sources. However, some designs face challenges related to energy storage and efficiency. In the area of automation, voice-controlled systems have gained popularity due to their ease of use. Researchers have implemented voice recognition techniques using smartphones and microcontrollers, enabling hands-free control of devices. These systems are especially useful for assisting physically challenged individuals. Additionally, Bluetooth-based wireless communication has been widely used for short-range control applications. It provides a reliable and low-cost method for transmitting commands from smartphones to embedded systems. Motor driver circuits like L293D are commonly used in such projects to control DC motors effectively. They allow bidirectional movement and proper speed control of vehicles. This project combines all these existing technologies—solar energy, voice control, Bluetooth communication, and microcontroller systems—to develop an efficient, eco-friendly, and user-friendly vehicle [1-10].

Depends on sunlight availability, so performance is reduced in cloudy or night conditions. Limited power output from the solar panel affects speed and load capacity. Bluetooth range is limited, so the vehicle can only be controlled within a short distance. Voice commands may be affected by noise or unclear speech. Requires a smartphone for operation. Efficiency depends on proper alignment of the solar panel. Not suitable for heavy-duty or long-distance applications. Battery storage (if used) may have charging and lifespan limitations [11-20].

To design and develop a solar-powered vehicle using renewable energy, reducing dependence on fossil fuels, and promoting eco-friendly technology. To implement voice-controlled operation using a smartphone with Bluetooth communication, enabling wireless and user-friendly control of the vehicle. To integrate microcontroller, motor driver, and solar power system for efficient control of vehicle movements (forward, backward, left, right) in a cost-effective system. The work "Voice Operated Solar Powered Vehicle using Smartphone" is designed to develop an eco-friendly and smart vehicle system. It uses a solar panel to convert sunlight into electrical energy, which powers the vehicle. A smartphone application is used to give voice commands such as forward, backward, left, and right. These commands are transmitted through Bluetooth communication to a microcontroller. The microcontroller processes the received signals and controls the motors using a motor driver (L293D). Based on the command, the vehicle moves in the desired direction. The system integrates renewable energy with wireless communication and embedded technology, making it efficient, user-friendly, and suitable for modern applications

2. Proposed System

The proposed system is a voice operated solar powered vehicle using a smartphone, designed to provide an eco-friendly and user-friendly transportation solution. This system integrates solar energy, wireless communication, and embedded control technology. The system mainly consists of a solar panel, battery (optional), microcontroller, Bluetooth module, motor driver (L293D), and DC motors. The solar panel converts sunlight into electrical energy, which is used to power the system and charge the battery if included. A smartphone application is used to give voice commands. These commands are converted into digital signals and transmitted through the Bluetooth module to the microcontroller. The microcontroller receives and processes these signals. Based on the received command, the microcontroller sends control signals to the motor driver (L293D), which drives the DC motors. This enables the vehicle to move in different directio such as forward, backward, left, and right. The proposed system offers an efficient combination of renewable energy utilization and smart control, making it cost-effective, environmentally friendly, and easy to operate. It can be further enhanced with advanced features like obstacle detection, GPS tracking, or IOT integration.

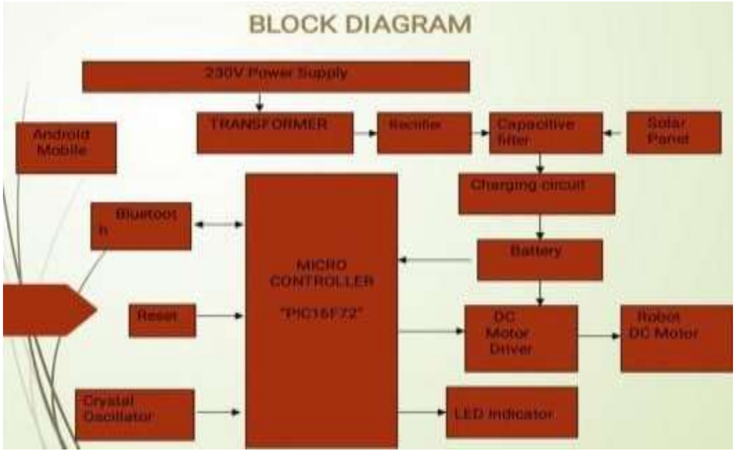

Fig.1: Block Diagram

The system works by combining solar energy generation with voice-based wireless control.

- Solar Energy Conversion: The solar panel absorbs sunlight and converts it into electrical energy. This energy is used to power the vehicle (and charge a battery if present).
- Power Supply to Circuit: The generated power is regulated and supplied to the microcontroller, Bluetooth module, and motor driver circuit.
- Voice Command Input: The user gives commands (like forward, backward, left, right) through a smartphone application using voice.
- Wireless Communication: The smartphone converts voice into signals and sends them via Bluetooth to the receiver module connected to the microcontroller.
- Signal Processing: The microcontroller receives the signals and interprets the command.
- Motor Control: Based on the command, the microcontroller sends signals to the motor driver (L293D), which drives the motors.
- Vehicle Movement: The motors rotate accordingly, and the vehicle moves in the desired direction

The main blocks of these projects are design aspect of independent modules are considered. block diagram is shown in fig. 2

Fig. 2*:* Overall System Layout

Fig: 3. Android Mobile

Fig: 4. Motor Driver

3. Prototype Development

The prototype development of the voice operated solar powered vehicle using a smartphone involves the design and integration of various hardware and software components to achieve a functional working model. The system is built on a compact chassis with two DC motors attached to the wheels, enabling movement in different directions. A solar panel is mounted on the vehicle to capture sunlight and convert it into electrical energy, which is stored in a rechargeable battery through a charging circuit. This stored energy acts as the main power source for the entire system. The control unit of the prototype is the PIC16F72 microcontroller, which is programmed using Embedded C. A Bluetooth module (HC-05) is connected to the microcontroller to establish wireless communication with an Android smartphone. A voice control application installed on the smartphone is used to convert spoken commands into digital signals. These signals are transmitted via Bluetooth to the microcontroller. Upon receiving the commands, the microcontroller processes them and sends appropriate control signals to the motor driver IC (L293D). The motor driver amplifies these signals and drives the two DC motors accordingly. Depending on the command received, the vehicle can move forward, backward, turn left, turn right, or stop. Additional components such as a crystal oscillator and reset circuit are included to ensure proper functioning of the microcontroller.

The prototype is designed to be compact, efficient, and eco-friendly, demonstrating the practical application of renewable energy and wireless control systems. This model successfully integrates solar power, embedded systems, and voice recognition technology, making it a useful solution for modern smart vehicle applications.

Fig. 5: Prototype overall circuit

4. Hardware components

The hardware components used in the voice operated solar powered vehicle using a smartphone include several essential units that work together to achieve the desired operation of the system. The primary component is the solar panel, which converts sunlight into electrical energy and serves as the main power source. This energy is stored in a rechargeable battery through a charging circuit, ensuring continuous power supply even when sunlight is not available. A voltage regulator is used to provide a stable voltage to sensitive components like the microcontroller and Bluetooth module.

The central control unit of the system is the PIC16F72 microcontroller, which processes all incoming commands and controls the overall operation of the vehicle. A Bluetooth module (HC-05) is used to establish wireless communication between the smartphone and the microcontroller. The smartphone acts as the input device, where voice commands are given using a mobile application, and these commands are transmitted via Bluetooth. To drive the motors, a motor driver IC (L293D) is used, which acts as an interface between the microcontroller and the DC motors. It amplifies the control signals and allows bidirectional movement of the motors. The DC motors are responsible for the movement of the vehicle and are connected to the wheels. A crystal oscillator is connected to the microcontroller to provide accurate timing signals, and a reset circuit is used to restart the system when necessary. Additionally, an LED indicator is included to display the power status of the system. All these components are interconnected on a PCB or breadboard to form a complete working system. Together, they enable the vehicle to operate using solar energy and respond to voice commands from the smartphone efficiently.

The testing of the voice operated solar powered vehicle using a smartphone is carried out under controlled conditions to ensure proper functioning of all components and overall system performance. Initially, the solar panel is exposed to sufficient sunlight to generate electrical energy and charge the battery through the charging circuit. The battery voltage is checked to ensure that it provides a stable power supply to the microcontroller, Bluetooth module, and motor driver. The Bluetooth module (HC-05) is paired with the Android smartphone, and a voice control application is used to send commands. The system is tested in a noise-free environment to ensure accurate recognition of voice commands such as forward, backward, left, right, and stop. Each command is given multiple times to verify the response of the microcontroller and the corresponding movement of the vehicle.

The movement of the vehicle is tested on a flat and smooth surface to observe proper motor operation and directional control. The response time between the command given and the action performed by the vehicle is also evaluated. Additionally, the system is tested under different lighting conditions to check the efficiency of the solar panel and the battery backup. All connections are checked for stability, and components are monitored for overheating or malfunction during operation. The overall testing ensures that the system performs reliably, responds accurately to voice commands, and operates efficiently using solar energy.

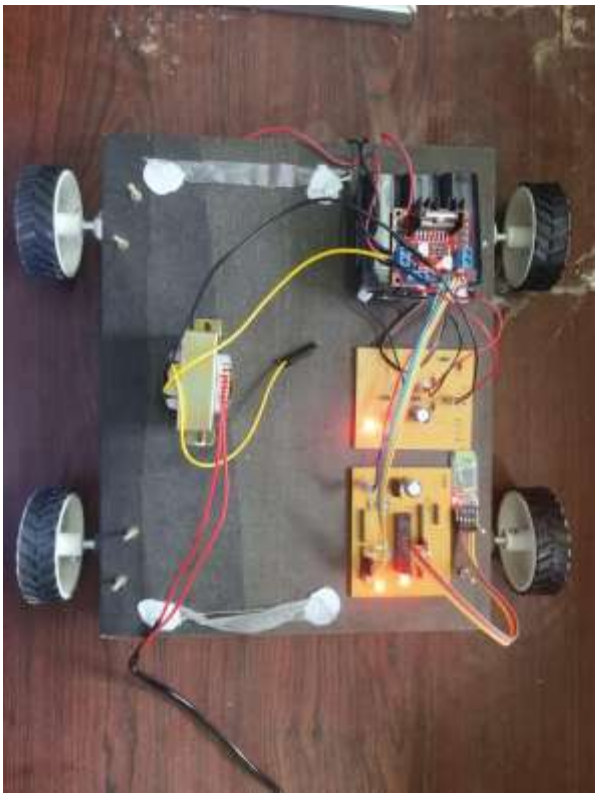

Fig:6. Testing Condition of Transformer

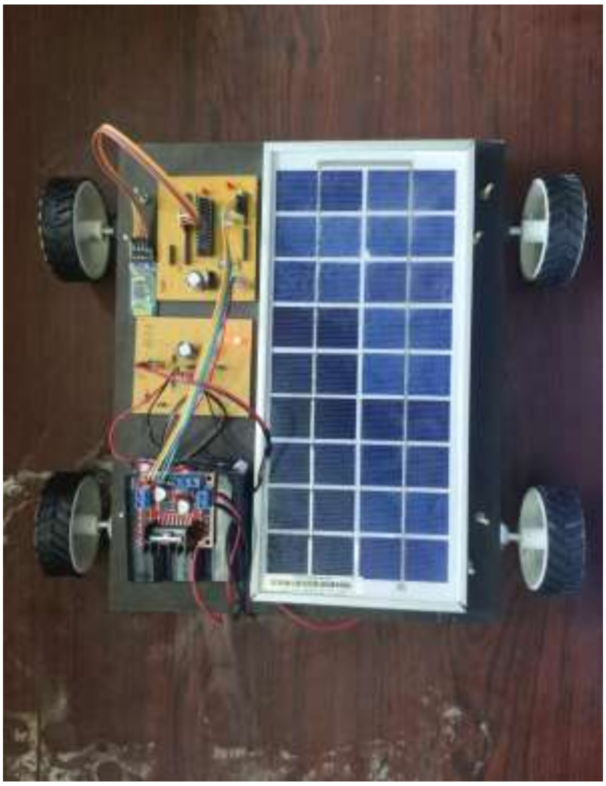

Fig:7. Testing Condition of Solar

Fig:8. Overall Testing Circuit

The testing of the system under solar-powered conditions is carried out to evaluate the performance of the vehicle when it operates solely using energy generated from the solar panel, without relying on external charging sources. In this testing, the solar panel is placed under direct sunlight to ensure maximum energy generation. The output voltage and current of the solar panel are measured to confirm that it is producing sufficient power to charge the battery and support system operation. The charging circuit is observed to ensure that the energy from the solar panel is properly transferred to the battery without any loss or overcharging. The battery level is monitored continuously to verify that it stores adequate energy and supplies a stable voltage to the microcontroller, Bluetooth module, and motor driver. The system is powered ON using only the solar-charged battery, and no external power supply is used during this test.

The Bluetooth module is paired with the smartphone, and voice commands are given to operate the vehicle. The response of the system is checked to ensure that the microcontroller processes commands correctly even when powered only by solar energy. The movement of the vehicle is tested on a flat surface, and its performance is observed in terms of speed, response time, and smooth operation. The system is also tested under varying sunlight conditions such as full sunlight, partial sunlight, and low light to analyze the efficiency of the solar panel. In reduced sunlight conditions, the effect on battery charging and vehicle performance is observed. The duration for which the vehicle can operate using stored solar energy is also measure. Overall, this testing ensures that the vehicle can operate efficiently using only solar power, confirms the reliability of the charging system, and demonstrates the feasibility of using renewable energy for real-time applications.

The testing of the system using a transformer-based power supply is carried out to evaluate the performance of the vehicle when it operates using an AC mains source instead of solar energy. In this condition, a step-down transformer is used to convert the high voltage 230V AC from the mains supply into a low voltage 12V AC, which is suitable for the system. This 12V AC is then passed through a rectifier circuit to convert it into DC voltage, followed by a capacitive filter to remove ripples and produce a smooth DC output. A voltage regulator is used to provide a stable voltage required for the microcontroller, Bluetooth module, and other electronic components. During testing, all connections are carefully checked to ensure proper insulation and safety while handling the AC supply. The output voltage of the transformer and the rectified DC voltage are measured using a multimeter to confirm that they are within the required range. The system is powered ON using this regulated supply, and the proper functioning of all components is verified.

The Bluetooth module is paired with the smartphone, and voice commands are given to control the vehicle. The response of the microcontroller is observed to ensure that it correctly receives and processes commands under transformer-powered conditions. The motor driver (L293D) is checked for proper operation, and the DC motors are observed for smooth movement in all directions such as forward, backward, left, and right. The performance of the system is evaluated in terms of response time, stability, and continuous operation. Since the transformer provides a constant power supply, the system is expected to show consistent performance without fluctuations. The temperature of components such as the transformer, regulator, and motor driver is monitored to ensure safe operation.

5. Result and Discussions

a. Performance of voice operated solar powered vehicle using smart phone:

The performance of the voice operated solar powered vehicle using smartphone was evaluated based on parameters such as response time, accuracy of command execution, power efficiency, and overall system stability. The system showed satisfactory performance during testing under both solar-powered and transformer-based conditions. The Bluetooth communication between the smartphone and the HC-05 module was found to be reliable within a range of approximately 8–10 meters. The voice commands given through the smartphone application were accurately recognized and transmitted to the microcontroller. The PIC16F72 microcontroller processed these commands efficiently, resulting in quick and correct responses from the vehicle. The delay between command input and vehicle movement was minimal, indicating effective communication and processing.

The motor driver (L293D) performed efficiently by controlling the two DC motors with proper direction and speed. The vehicle demonstrated smooth movement in all directions such as forward, backward, left, and right. The performance of the motors was stable when operated on a flat surface, ensuring proper control and balance of the vehicle. In terms of power performance, the solar panel was able to generate sufficient energy under direct sunlight to operate the system and charge the battery. The battery provided a stable power supply, allowing the system to function even when sunlight was not available. However, under low sunlight conditions, the performance slightly decreased due to reduced power generation. When powered through the transformer-based supply, the system exhibited consistent and uninterrupted performance. Overall, the system demonstrated efficient operation, reliable communication, and effective utilization of solar energy. The project proved to be a successful implementation of a smart and eco-friendly vehicle controlled through voice commands.

b. Response time analysis

Response time analysis refers to the time taken by the system to react after receiving a voice command from the smartphone. It is an important performance parameter that determines how quickly and efficiently the system responds to user inputs. In this project, the response time includes several stages such as voice input given through the smartphone, conversion of voice into a digital signal, transmission through the Bluetooth module (HC-05), reception by the PIC16F72 microcontroller, processing of the command, sending control signals to the motor driver (L293D), and finally the movement of the DC motors. The total delay of the system is the sum of all these stages.

During testing, it was observed that the system responds quickly to voice commands with very minimal delay. The Bluetooth communication and microcontroller processing were found to be efficient, resulting in fast execution of commands. The average response time of the system was approximately 0.5 to 1 second, and no major lag was observed under normal operating conditions. However, a slight delay may occur due to factors such as background noise during voice input, weak Bluetooth signal strength, or low battery power. The analysis of the system shows that the response time remains nearly constant for repeated commands, indicating stable and reliable performance. The delay is very small and acceptable for real-time applications. Overall, the system is capable of processing commands efficiently without significant latency, ensuring smooth and responsive operation of the vehicle.

Conclusion:

Voice operated solar powered vehicle using smartphone has been successfully designed, developed, and tested, demonstrating the effective integration of renewable energy and modern communication technologies. The system utilizes solar energy as a clean and sustainable power source, reducing dependency on conventional fuels and minimizing environmental impact. The use of a rechargeable battery ensures continuous operation even when sunlight is not available. The implementation of voice control through a smartphone provides a user friendly and convenient method of operation. The Bluetooth module enables reliable wireless communication between the smartphone and the microcontroller. The PIC16F72 microcontroller efficiently processes the received commands and controls the motor driver. (L293D), which in turn drives the DC motors to achieve the desired movement of the vehicle. The system was tested under both solar-powered and transformer-powered conditions, and it was observed that the vehicle performs efficiently with minimal response time. While the solar-powered mode is eco-friendly and cost-effective, the transformer-based supply provides stable and continuous performance. The overall system showed reliable operation, accurate command execution, and satisfactory performance. This project highlights the potential of combining solar energy with embedded systems and wireless communication for developing smart and sustainable applications. It serves as a practical solution for energy-efficient and user-friendly vehicle control systems and can be further enhanced for real-time and advanced applications.

References:

[1]. Haque, A. B., Shurid, S., Juha, A. T., Sadique, M. S., & Asaduzzaman, A. S. M. (2020, February). A novel design of gesture and voice controlled solar-powered smart wheel chair with obstacle detection. In 2020 IEEE International Conference on Informatics, IoT, and Enabling Technologies (ICIoT) (pp. 23-28). IEEE. https://doi.org/10.1109/ICIoT48696.2020.9089652

[2]. Pathik, B. B., Ahmed, A. A., Alamgir, L., & Nayeem, A. (2014, April). Development of a cell phone-based vehicle remote control system. In 2014 International Conference on Intelligent Green Building and Smart Grid (IGBSG) (pp. 1-6). IEEE. https://doi.org/10.1109/IGBSG.2014.6835161

[3]. Mohanraj, S., Ganesh, B. S., Parthiban, K., & Praveenkanth, K. (2024, April). Solar Powered Voice Controlled Autonomous Assistive Robot. In 2024 International Conference on Communication, Computing and Internet of Things (IC3IoT) (pp. 1-5). IEEE. https://doi.org/10.1109/IC3IoT60841.2024.10550332

[4]. Premchandran, V., Karthikkumar, M., Thamizharasan, V., & Sathish, E. (2021). Solar Powered Autonomous Robotic Car Using for Surveillance. In Intelligent Manufacturing and Energy Sustainability: Proceedings of ICIMES 2021 (pp. 249-256). Singapore: springer Singapore. https://doi.org/10.1109/IC3IoT60841.2018.1055762

[5]. Pande, N. A., Chikhalkar, J., Jadhav, V., Guha, S., & Waghmare, R. (2023, April). Voicecontrolled elevator with solar backup and SOS messaging. In International Conference on Soft Computing for Security Applications (pp. 469-483). Singapore: Springer Nature Singapore. https://doi.org/10.1109/ICIoT48696.2190.9053462

[6]. Amaresh, K., Hussain, A., Nazzal, H. R. A. A., AAlyas, M. A., Kumar, K. N., Krishna, A. A., & Vidyasagar, K. (2024, December). Solar Based Android Operated Wheel Chair. In 2024 International Conference on Augmented Reality, Intelligent Systems, and Industrial Automation (ARIIA) (pp. 1-7). IEEE. https://doi.org/10.1109/ARIIA63345.2024.11051608

[7]. Tabassum, M., Ramamoorthy, A. K., Sasikala, K. J., Kashem, S. B. A., & Karuppasamy, K. A Prototype design for controlling a Solar powered car with a GSM remote control. https://doi.org/10.1109/ICESC51422.2021.9532712

[8]. Athipatla, S., Kandati, B., Kanipaku, S., & Kalluri, D. (2023, February). Solar powered bluetooth controlled grass cutting robot. In 2023 Third International Conference on Artificial Intelligence and Smart Energy (ICAIS) (pp. 1-7). IEEE. https://doi.org/10.1109/ICAIS56108.2023.10073789

[9]. Shete, S. H., Kamble, S. R., Patil, A. V., Gurav, S. R., Patil, S. P., & Desai, S. S. (2017, March). Solar powered touch screen wheelchair. In 2017 International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS) (pp. 1-4). IEEE. https://doi.org/10.1109/ICIIECS.2017.8276133

[10].Bharani, S. B., Sujith, K. V., Tanushree, S., & Tambe, Y. (2021). Arduino based voice controlled robotic arm and wheels. Turkish Journal of Computer and Mathematics Education, 12(12), 2452-2457. https://doi.org/10.1109/ICESC51422.2018.5854712

[11].Kurundkar, S., Lakhote, S., Kadam, M., Rupani, J., Kothawade, A., & Gawande, A. (2023, November). Arduino Based Smart Vacuum Cleaner Robot. In 2023 2nd International Conference on Futuristic Technologies (INCOFT) (pp. 1-6). IEEE. https://doi.org/10.1109/INCOFT60753.2023.10425131

[12].Maheswari, R., Azath, H., Sharmila, P., & Gnanamalar, S. S. R. (2019, May). Smart village: Solar based smart agriculture with IoT enabled for climatic change and fertilization of soil. In 2019 IEEE 5th International Conference on Mechatronics System and Robots (ICMSR) (pp. 102-105). IEEE. https://doi.org/10.1109/ICMSR.2019.8835454

[13].Nirmala, A. P., Asha, V., Chandra, P., Priya, H., & Raj, S. (2022, February). IoT based secure smart home automation system. In 2022 IEEE Delhi Section Conference (DELCON) (pp. 1-7). IEEE. https://doi.org/10.1109/DELCON54057.2022.9753086

[14].Shaowei, N., Minling, Z., Zhiwei, Z., Xia, L., Zifei, L., & Yuhui, K. (2023, January). Design and implementation of smart curtains. In 2023 IEEE 3rd International Conference on Power, Electronics and Computer Applications (ICPECA) (pp. 718-722). IEEE. https://doi.org/10.1109/ICPECA56706.2023.10076146

[15].Rathore, V., Vishwakarma, A., Trivedi, N., Bais, S. S., & Ahuja, K. (2024, December). Digital Guardians: A Wrist-Worn Autonomous Drone Pilot for Live Safety Surveillance. In 2024 IEEE 4th International Conference on ICT in Business Industry & Government (ICTBIG) (pp. 1-6). IEEE. https://doi.org/10.1109/ICTBIG64922.2024.10911771

[16].Srivastava, D., Sahu, P., & Geetha, G. (2022, July). Autonomous Vehicle for Physically Impaired People. In 2022 International Conference on Innovative Computing, Intelligent Communication and Smart Electrical Systems (ICSES) (pp. 1-7). IEEE. https://doi.org/10.1109/ICSES55317.2022.9914262

[17].Kalpana, S., Rajagopalan, S., Ranjith, R., & Gomathi, R. (2020, July). Voice recognition based multi robot for blind people using lidar sensor. In 2020 International Conference on System, Computation, Automation and Networking (ICSCAN) (pp. 1-6). IEEE. https://doi.org/10.1109/ICSCAN49426.2020.9262365

[18].Islam, M. H., Fariya, K. Y., Talukder, T. I., Khandoker, A. A., & Chisty, N. A. (2021, August). IoT based smart self-power generating street light and road safety system design: a review. In 2021 IEEE Region 10 Symposium (TENSYMP) (pp. 1-5). IEEE. https://doi.org/10.1109/TENSYMP52854.2021.9550937

[19].Li, H., Zheng, M., & Eggleston, M. S. (2022, October). The Gecko Sensor: An Ultra-Compact, Low-Cost, Solar-Powered Environment Monitoring Device. In 2022 IEEE Sensors (pp. 1-4). IEEE. https://doi.org/10.1109/SENSORS52175.2022.9967187

[20].Raj, D., Kumar, V., Singh, B., Ram, S. C., Moray, A., & Bahuguna, A. (2024, November). An overview on sustainability approaches towards automotive industry for a better future. In 2024 International Conference on Advances in Computing, Communication and Materials (ICACCM) (pp. 1-10). IEEE. https://doi.org/10.1109/ICACCM61117.2024.11059173