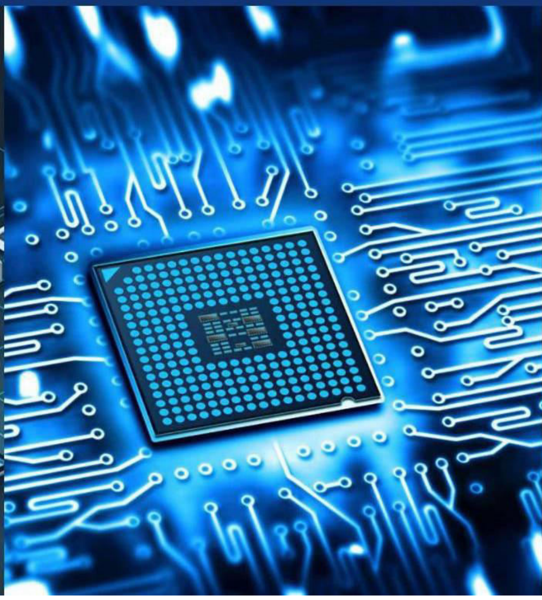
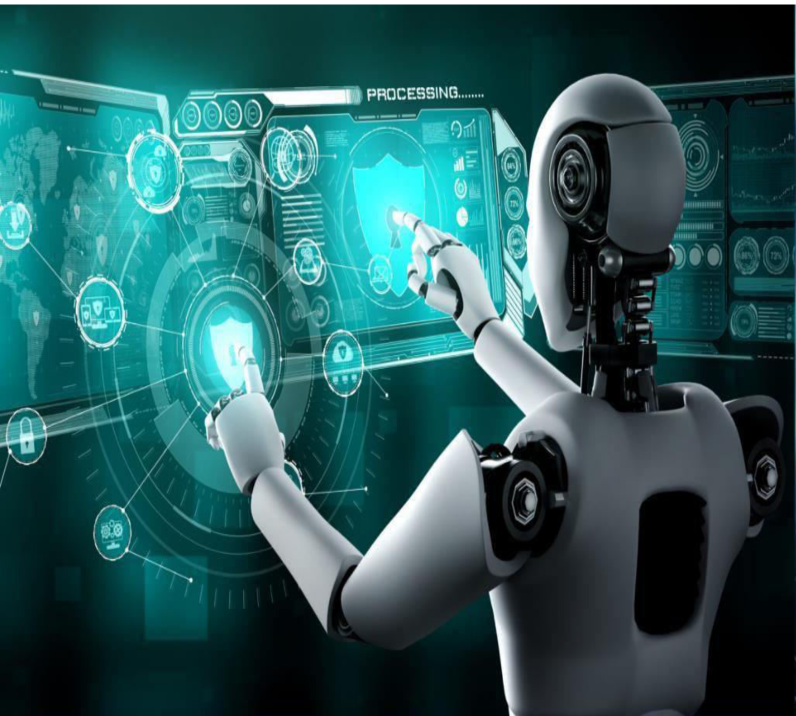
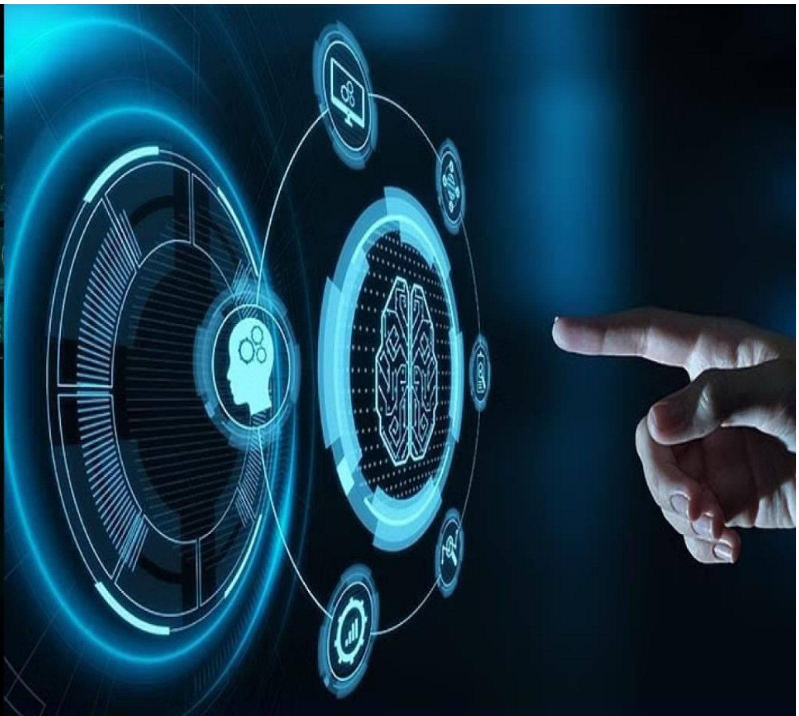
ISSN(O): 2320-9801
ISSN(P): 2320-9798


International Journal of Innovative Research in Computer and Communication Engineering

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)





Impact Factor: 8.771

Volume 14, Issue 1, January 2026

www.ijircce.com ijircce@gmail.com +91-9940572462 +91 63819 07438

© 2026 IJIRCCE | Volume 14, Issue 1, January 2026| DOI:10.15680/IJIRCCE.2026.1401009

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Control Robotic Car by Mind Wave in IOT Network using Solar Energy Harvesting Method

Meenakshi H S, Ambika K B, Harshitha R, Hema Kumari D M, Kannika H S, Rahul Sagar T

Department of Computer Science and Engineering, Maharaja Institute of Technology Mysore Affiliated to Visvesvaraya University (VTU), Belagavi, Karnataka, India

ABSTRACT: This project presents a brain-controlled electric vehicle powered by solar energy, designed to make vehicle control more natural and accessible. Using Mind Wave EEG technology, the system captures brain signals and eye-blink movements through an EEG electrode and converts them into simple commands that control the movement of the vehicle. This hands-free approach is especially helpful for people with limited mobility, allowing them to operate the vehicle without physical efforts. The vehicle runs on solar energy, making it environmentally friendly and reducing dependence on conventional power sources. To ensure safe operation, features such as obstacle detection and collision avoidance are included, helping the vehicle move smoothly and avoid accidents. The system is built to provide quick response, stable navigation, and a comfortable user experience. In the future, this system can be improved by enhancing signal accuracy, reducing response delay, and adding more control commands. These advancements will help expand its use in real-world applications and provide better assistive mobility solutions.

KEYWORDS: Mind Wave EEG, Brain-Controlled Vehicle, Solar-Powered EV, Assistive Mobility, Obstacle Detection

I. INTRODUCTION

This project focuses on developing an electric vehicle (EV) control system using Brain–Computer Interface (BCI) technology, where vehicle commands are generated directly from EEG signals captured through non-invasive electrodes. BCI technology creates a direct communication link between the human brain and external devices, eliminating the need for physical controls. The main objective of this project is to demonstrate a reliable, low-cost, and user-friendly approach for controlling a vehicle using brain-generated electrical activity. In this system, EEG electrodes are placed on the forehead region to capture natural electrical signals produced by neural and physiological processes.

Since EEG signals are extremely weak and highly sensitive to noise, the system first performs signal conditioning, which includes amplification and filtering. The processed signals are then analyzed using a threshold-based detection method that identifies intentional signal variations generated by the user. This approach ensures that only deliberate actions are converted into control commands, thereby improving accuracy and system stability. Once the required signal patterns are detected, they are transmitted to a microcontroller, which translates them into vehicle movement commands such as forward, stop, left, and right. The EV is integrated with a motor driver and power system that responds instantly to these commands, enabling smooth and hands-free navigation.

This project successfully demonstrates a working prototype of a BCI-controlled electric vehicle, making it suitable for assistive mobility, rehabilitation systems, and future human–machine interaction applications. By using simple EEG hardware and efficient signal processing techniques, the system avoids the complexity of advanced machine-learning models while still delivering stable and reliable performance. Overall, the project highlights the potential of EEG-based control systems in developing accessible, innovative, and intelligent mobility solutions for individuals with physical limitations and emerging smart-control technologies.

II. RELATED WORK

Brain–Computer Interface (BCI) technology has been increasingly used to control assistive systems such as robotic cars, wheelchairs, and robotic arms by converting EEG signals into movement commands. Many existing studies use non-invasive EEG devices like MindWave, OpenBCI, and Emotiv to enable hands-free control through attention levels,

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

eye blinks, and facial movements. These approaches show promising results but often depend on complex machine-learning models, which increase system cost, processing requirements, and user training time. Some researchers have explored simpler threshold-based EEG control methods to reduce complexity and improve real-time performance. However, many current systems still lack important features such as reliable safety mechanisms, IoT-based monitoring, and sustainable power support. As a result, their practical use in real-world environments remains limited. To address these challenges, the proposed work focuses on a low-cost EEG electrode-based robotic vehicle that uses simple signal processing, real-time obstacle detection, IoT connectivity, and solar energy harvesting. This approach aims to provide a more practical, safe, and user-friendly solution for assistive mobility and future smart control applications.

III. PROPOSED ALGORITHM

Design Considerations

- The system uses non-invasive EEG electrodes to safely capture brain signals.
- A simple threshold-based method is used to ensure quick and reliable response.
- Signal quality and battery level are continuously monitored during operation.
- Vehicle movement commands are predefined and previously executed commands are tracked.
- Obstacle detection is given priority to maintain safe navigation.
- Solar energy with battery backup is used for efficient and sustainable power supply.
- IoT communication enables smooth operation with minimal delay.
- The system lifetime is defined by the availability of sufficient power to execute commands.

A. Description of the Proposed Algorithm

The proposed algorithm aims to ensure **accurate, safe, and energy-efficient control** of the EEG-based brain-controlled robotic vehicle. It focuses on reliable command generation, collision avoidance, and efficient power usage. The algorithm operates in three main steps.

Step 1: EEG Signal Processing

EEG and eye-blink signals are acquired using non-invasive electrodes and filtered to remove noise. Key features such as attention level and blink strength are extracted and compared with predefined thresholds. Only valid signals are converted into movement commands, reducing false actions.

Step 2: Command Validation and Safety Check

The generated command is transmitted to the vehicle via IoT communication. Obstacle sensors continuously monitor the surroundings, and if an obstacle is detected, the vehicle is stopped immediately. Only safe commands are executed, ensuring reliable navigation.

Step 3: Energy Management

After command execution, battery status and solar energy availability are monitored. When solar power is available, the battery is charged to support continuous and sustainable operation. System status is updated through the IoT dashboard. Overall , the algorithm provides stable performance, safe movement, and efficient energy utilization for assistive mobility applications.

IV. PSEUDO CODE

Step 1: Start the system by initializing all required components such as the EEG electrodes, microcontroller, IoT module, motor driver, obstacle sensors, and solar power unit.
Step 2: Continuously collect brainwave signals and eye-blink information from the EEG electrodes.
Step 3: Clean the collected signals by filtering and amplifying them to remove noise and unwanted disturbances.
Step 4: Analyze the processed signals to extract meaningful features like attention level, blink strength, and eye movement direction.
Step 5: Compare the extracted features with predefined threshold values to identify the user's intended command. If the signal meets the threshold, generate a valid movement command; otherwise, ignore the signal.
Step 6: Send the identified command wirelessly to the robotic vehicle using the IoT communication module.
Step 7: Before executing the command, check for nearby obstacles using the safety sensors. If an obstacle is detected, immediately stop the vehicle; otherwise, allow the vehicle to move as commanded.
Step 8: Control the motors through the motor driver to perform actions such as moving forward, turning left or right, or stopping.

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

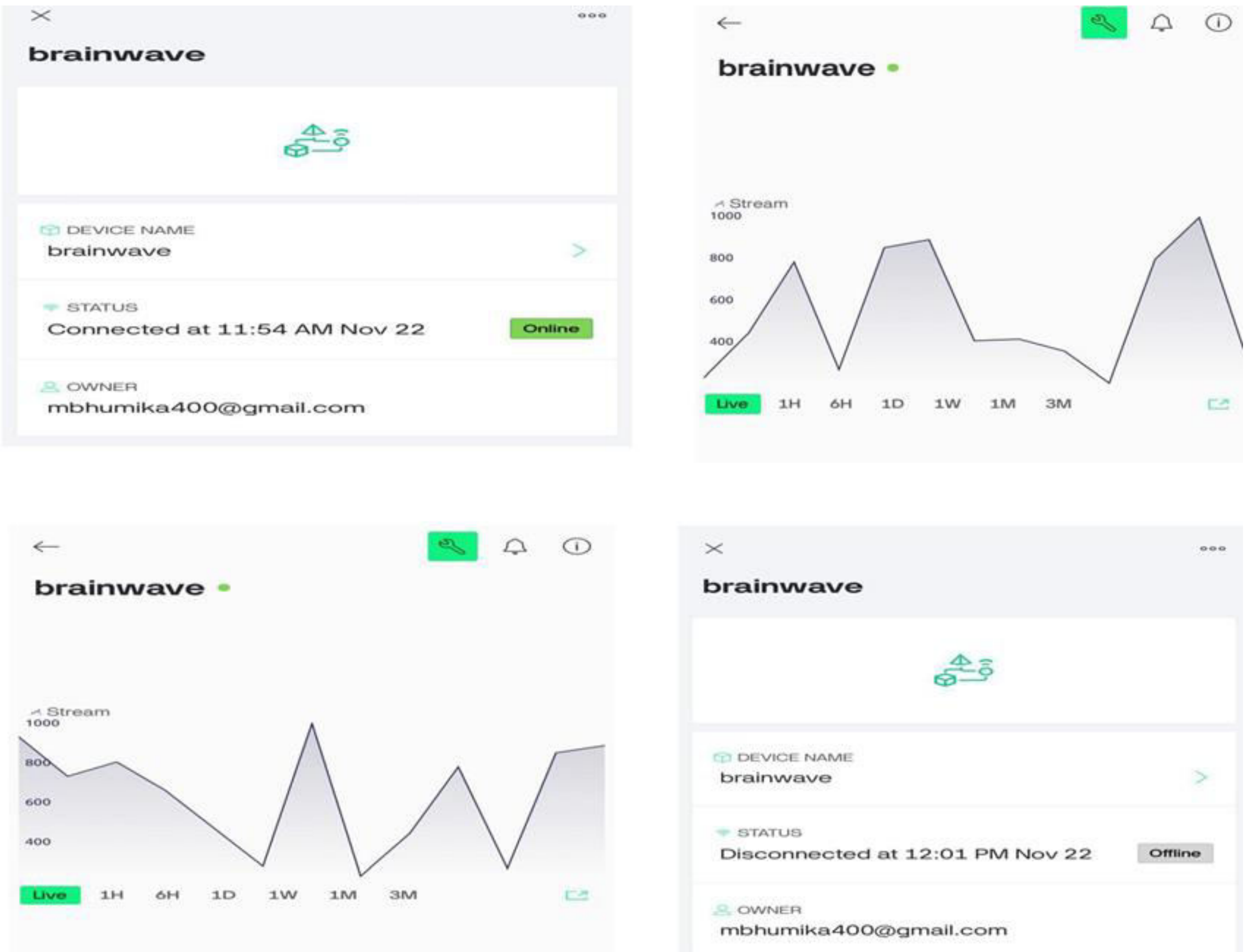
International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Step 9: Monitor the battery status and solar power availability. If the battery level is low and solar energy is available, charge the battery using the solar panel.
Step 10: Update the system status, including movement commands, obstacle alerts, and power levels, on the IoT monitoring dashboard.
Step 11: Repeat the above steps continuously until the system is switched off.
Step 12: End the process.

V. SIMULATION RESULTS

The proposed EEG-based brain-controlled robotic vehicle was simulated to evaluate command accuracy, response time, safety, and energy efficiency. EEG signals representing attention and eye-blink patterns were correctly processed using a threshold-based method, enabling reliable generation of movement commands such as forward, left, right, and stop with near real-time response. Obstacle detection was effectively simulated, where the system immediately stopped the vehicle upon detecting obstacles within a safe distance, ensuring collision avoidance. The IoT module successfully provided real-time updates of system status, including commands and power levels. Solar energy simulation demonstrated efficient battery charging and reduced power consumption, supporting sustainable operation. Overall, the simulation results confirm that the system delivers accurate control, fast response, safe navigation, and energy-efficient performance, making it suitable for assistive mobility applications.



© 2026 IJIRCCE | Volume 14, Issue 1, January 2026| DOI:10.15680/IJIRCCE.2026.1401009

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

VI. CONCLUSION AND FUTURE WORK

This work presents an **EEG-based brain-controlled robotic vehicle** with **IoT monitoring and solar power**, enabling hands-free and energy-efficient mobility. A simple threshold-based approach converts brain and eye-blink signals into reliable movement commands, while obstacle detection ensures safe navigation. Real-time monitoring and sustainable power operation make the system suitable for assistive mobility applications. Future work includes improving signal accuracy, adding intelligent learning-based control, expanding command options, and validating the system through real-world .

REFERENCES

[1] Tanaka, K., Matsunaga, K., and Wang, H. O., "Electroencephalogram-based control of an electric wheelchair," *IEEE Transactions on Robotics*, vol. 21, no. 4, pp. 762–766, 2005.

[2] Winod, A. P., and Cheng, K. W. E., "Towards a Brain-Computer Interface based control for next generation electric wheelchairs," in *Proceedings of the 3rd International Conference on Power Electronics Systems and Applications (PESA)*, IEEE, 2009, pp. 1–5.

[3] Hekmatmanesh, A., Nardelli, P. H. J., and Handroos, H., "Review of the state-of-the-art of brain-controlled vehicles," *IEEE Access*, vol. 9, pp. 110173–110193, 2021.

[4] Liu, K., Yu, Y., Liu, Y., Tang, J., Liang, X., Chu, X., and Zhou, Z., "A novel brain- controlled wheelchair combined with computer vision and augmented reality," *Biomedical Engineering Online*, vol. 21, no. 1, pp. 1–18, 2022.

[5] Rabhi, Y., Mrabet, M., and Fnaiech, F., "A facial expression controlled wheelchair for people with disabilities," *Computer Methods and Programs in Biomedicine*, vol. 165, p. 89–105, 2018.

[6] Al-Nuimi, A. M., and Mohammed, G. J., "Face direction estimation based on MediaPipe l landmarks," in *Proceedings of the 7th International Conference on Contemporary Information Technology and Mathematics (ICCITM)*, IEEE, 2021, pp. 185–190.

[7] Zhao, H., Yuen, P. C., and Kwok, J. T., "A novel incremental principal component analysis and its application for face recognition," *IEEE Transactions on Systems, Man, and Cybernetics – Part B*, vol. 36, no. 4, pp. 873–886, 2006.

[8] Amareswar, E., Naik, M. R., Prasad, S. V. S., Chandra, N. V., and Karthik, R., "Design of Brain Controlled Robotic Car using Raspberry Pi," in *Proceedings of the 5th International Conference on Trends in Electronics and Informatics (ICOEI)*, IEEE, 2021, pp. 185–189.

[9] Kapur, G., Semwal, G., and Kushwaha, P., "Wireless portable bot car controlled by brain signals," in Proceedings of the 5th International Conference on Electronics and Sustainable Communication Systems (ICESC), IEEE, 2024, pp. 265–270

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

9940 572 462 6381 907 438 ijircce@gmail.com

Scan to save the contact details

www.ijircce.com