International Journal of Engineering & Extended Technologies Research (IJEETR)

|ISSN: 2322-0163| www.ijeetr.com | A Bimonthly, Peer Reviewed, Scholarly Indexed Journal |

| Volume 8, Issue 2, March - April 2026 |

DOI:10.15662/IJEETR.2026.0802153

Smart Pollination Assistance Rover with Mobile Bluetooth Control System

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Publication History: Received: 25.02.2026; Revised: 20.03.2026; Accepted: 25.03. 2026; Published: 28.03.2026.

ABSTRACT: This paper presents the design and development of a Smart Pollination Assistant Rover using a Bluetooth-controlled system for improving agricultural productivity. Pollination is a critical process in crop yield, but natural pollinators are decreasing due to environmental changes and pesticide usage. To address this issue, the proposed system introduces an automated rover that assists in artificial pollination efficiently.

The rover is built using an ESP32 microcontroller, DC motors for movement, a motor driver, and a servo motor for controlled pollination action. The system is operated through a Bluetooth interface, allowing the user to control the rover remotely via a mobile device. The compact and cost-effective design makes it suitable for small and medium-scale farms.

The developed prototype demonstrates effective pollination with reduced human effort and time. It ensures uniform pollen distribution and improves crop productivity. This system provides a sustainable and technological solution for modern agriculture, reducing dependency on natural pollinators and supporting precision farming practices.

KEYWORDS: Smart Pollination System, IoT in Agriculture, ESP32 Microcontroller, Wireless Control, Robotic Farming, Automated Pollination, Embedded Systems

I. INTRODUCTION

The rapid advancement of agricultural technology has created new opportunities to improve crop productivity and sustainability. One of the major challenges faced in modern agriculture is the decline in natural pollinators, which directly affects crop yield and quality.

Traditional pollination methods are often labour-intensive, time-consuming, and inefficient in large-scale farming environments. This has led to the need for innovative and automated solutions to support the pollination process.

In recent years, robotics and Internet of Things (IoT) technologies have gained significant attention in precision agriculture. The integration of smart systems enables real-time monitoring, efficient resource utilization, and automation of critical farming activities.

The proposed Smart Pollination Assistant Rover is designed to assist in the pollination process using a mobile robotic platform controlled via Bluetooth communication. The system utilizes components such as sensors, microcontrollers, and actuators to navigate agricultural fields and perform targeted pollination.

This approach not only reduces human effort but also enhances accuracy and consistency in pollination. Furthermore, it contributes to increased crop yield and supports sustainable agricultural practices. The development of such intelligent systems represents a step toward the future of smart farming and automated agricultural solutions.

II. LITERATURE REVIEW

The application of advanced technologies in agriculture has significantly improved farming efficiency and productivity. Several studies have explored the use of robotics and automation for pollination and crop management. Early approaches focused on manual and semi-automated pollination techniques, which required significant human intervention and were often inefficient in large-scale agricultural fields.

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Recent research has emphasized the integration of robotic systems for precision agriculture. Mobile robots equipped with sensors and control systems have been developed to perform tasks such as crop monitoring, spraying, and pollination. These systems utilize microcontrollers, wireless communication technologies like Bluetooth and Wi-Fi, and various actuators to operate autonomously or semi-autonomously. Such innovations help reduce labor costs and improve operational accuracy.

Furthermore, the use of Internet of Things (IoT) in agriculture enables real-time data collection and monitoring of environmental conditions, enhancing decision-making processes. Some studies have also incorporated artificial intelligence techniques for better navigation and task optimization in agricultural robots.

Despite these advancements, challenges such as high implementation costs, limited adaptability, and power consumption still exist. Therefore, there is a need for cost-effective and efficient solutions like the Smart Pollination Assistant Rover to address these limitations and support sustainable agricultural practices.

III. RESEARCH METHODOLOGY

This study adopts a system design and experimental methodology to develop and evaluate the Smart Pollination Assistant Rover for agricultural applications. The research begins with problem identification, focusing on the inefficiencies in traditional pollination methods and the need for automation in modern farming. A comprehensive review of existing technologies in agricultural robotics and IoT-based systems is conducted to define system requirements and design objectives.

The proposed system is developed using a microcontroller-based platform integrated with Bluetooth communication for remote operation. Key hardware components such as DC motors, motor drivers, a servo motor, battery unit, and chassis are assembled to construct a mobile robotic rover. The control system is programmed to enable movement, navigation, and pollination actions based on user input through a mobile device.

The implementation phase involves prototyping and testing the rover under controlled conditions to evaluate its functionality, efficiency, and reliability. Performance metrics such as mobility, response time, and pollination accuracy are analysed. The results obtained are used to assess the effectiveness of the system and identify potential improvements. This methodology ensures a practical and scalable solution for smart agricultural applications.

IV. RESULTS AND DISCUSSION

The developed Smart Pollination Assistant Rover was successfully implemented and tested under controlled conditions to evaluate its performance and effectiveness in assisting pollination tasks. The system demonstrated reliable mobility and smooth navigation across different surfaces using the DC motor-driven chassis. The Bluetooth-controlled interface allowed real-time operation with minimal delay, ensuring accurate control of the rover's movement and pollination mechanism.

The servo motor-based pollination unit performed targeted actions efficiently, showing consistent operation during repeated trials. The system was able to reduce manual effort and time required for pollination compared to traditional methods. Additionally, the compact design and low power consumption made the rover suitable for small- and medium-scale agricultural fields.

However, certain limitations were observed during testing. The effectiveness of the rover is dependent on user control, which may affect precision in large or complex farm environments. Connectivity range of Bluetooth also limits long-distance operation. Environmental factors such as uneven terrain and obstacles can influence performance.

Overall, the results indicate that the proposed system is a cost-effective and efficient solution for assisting pollination, with potential for further enhancement through automation and advanced sensing technologies.

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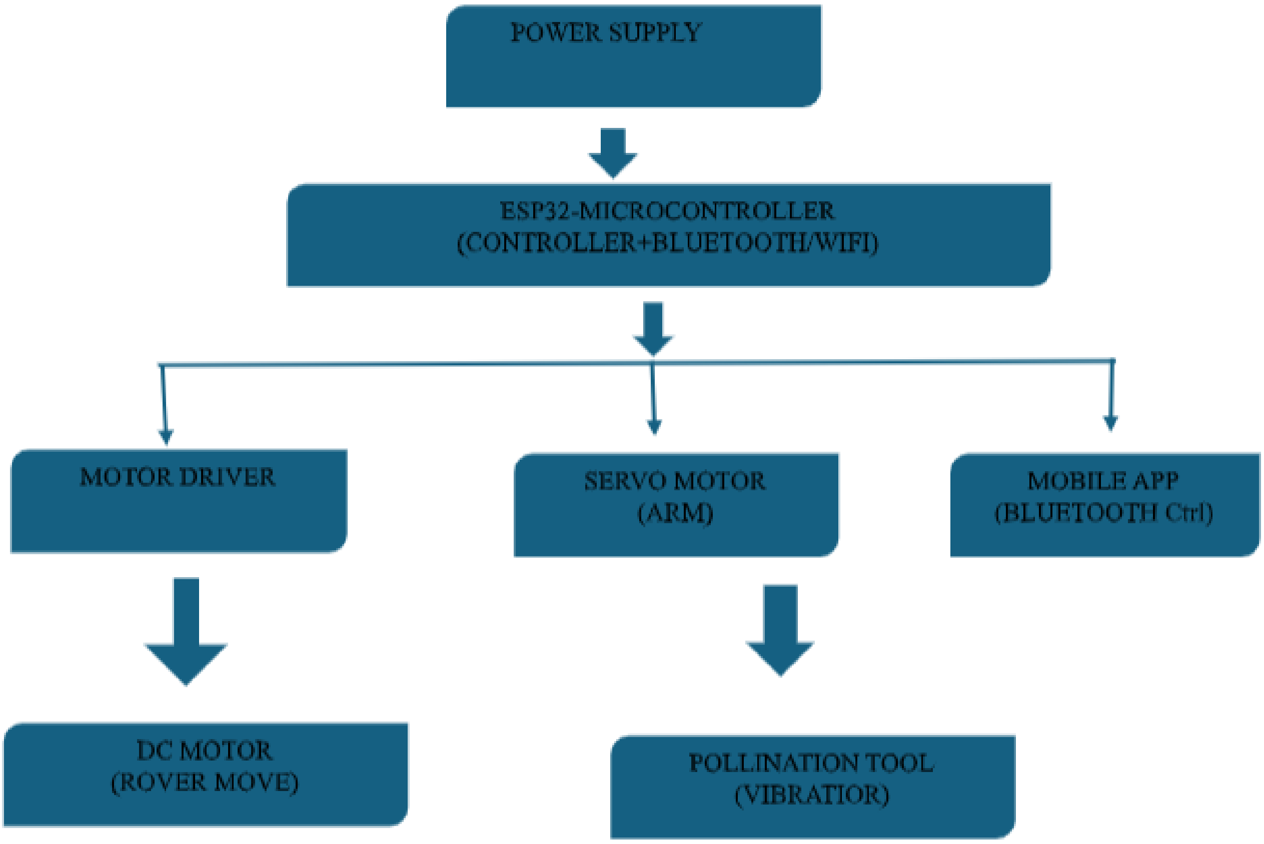

V. CONCLUSION

The Smart Pollination Assistant Rover presents an effective and practical solution for improving pollination in greenhouse agriculture. The system successfully combines a Bluetooth-controlled mobile platform with a non-contact vibration-based pollination mechanism to assist in the pollination process. By utilizing an ESP32 microcontroller and simple hardware components, the rover offers a low-cost and user-friendly alternative to conventional manual methods and expensive automated systems.

The developed system reduces labor effort, improves consistency in pollination, and enhances overall efficiency in greenhouse operations. The integration of a camera module allows precise positioning, while the vibration mechanism ensures safe pollen transfer without damaging flowers.

The experimental results demonstrate that the rover performs reliably under controlled conditions and can cover multiple plants in less time compared to manual pollination.

Overall, this project highlights the potential of combining basic automation with human control to achieve effective results in smart agriculture. The proposed system is especially suitable for small and medium-scale farmers, contributing to increased productivity and sustainable farming practices.

VI. FUTURE WORK

The proposed Smart Pollination Assistant Rover demonstrates an effective approach for assisting pollination in agricultural fields. However, several enhancements can be implemented to improve its efficiency, scalability, and real-time applicability. In the future, the system can be upgraded from a Bluetooth-controlled model to an IoT-based or GPS-enabled autonomous navigation system, allowing the rover to operate without human intervention and cover larger areas efficiently.

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Integration of advanced sensors such as vision cameras and AI-based object detection can help in identifying flowers that require pollination, thereby improving accuracy. The use of machine learning algorithms can further optimize pollination timing based on environmental conditions like temperature, humidity, and crop type.

Additionally, incorporating solar power can make the system more energy-efficient and suitable for long-duration field operations. Multi-crop adaptability and swarm robotics (multiple rovers working together) can also be explored to increase productivity. Future developments may also include mobile app integration for remote monitoring and control, making the system more user-friendly for farmers.

REFERENCES

1. S. Pota mitis, I. Rigakis, A. Tatlas, K. Petrakis, Design of electronic pollination systems using robotic insects, Artificial Intelligence Review, Vol. 58, Issue 2, 2025, pp. 1–20.
2. A. Kumar, S. Verma, Smart self-pollination system using artificial intelligence and robotic vehicles, International Journal of Intelligent Systems and Applications in Engineering, Vol. 11, Issue 3, 2023, pp. 245–252.
3. J. Zhang, Y. Wang, L. Chen, Development of autonomous robotic pollination system for greenhouse crops, Journal of Agricultural Engineering Research, Vol. 189, 2024, pp. 112–120.
4. M. Shalal, T. Low, C. McCarthy, Review of unmanned aerial vehicles for crop pollination and monitoring, Biosystems Engineering, Vol. 242, 2025, pp. 45–60.
5. R. Patel, K. Singh, Automated pollination robot for precision agriculture, International Journal of Scientific Research in Engineering and Technology, Vol. 10, Issue 6, 2022, pp. 98–104.
6. P. Sharma, R. Gupta, Bluetooth controlled agricultural robot for smart farming applications, International Engineering Research Journal (IERJ), Vol. 3, Issue 2, 2021, pp. 567–570.
7. S. N. Rao, V. Reddy, Design and implementation of Arduino-based agricultural rover using wireless communication, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 9, Issue 4, 2020, pp. 2100–2106.
8. C.Nagarajan and M.Madheswaran - ‘Stability Analysis of Series Parallel Resonant Converter with Fuzzy Logic Controller Using State Space Techniques’- Taylor &Francis, Electric Power Components and Systems, Vol.39 (8), pp.780-793, May 2011. DOI: 10.1080/15325008.2010.541746
9. C.Nagarajan and M.Madheswaran - ‘Experimental verification and stability state space analysis of CLL-T Series Parallel Resonant Converter’ - Journal of Electrical Engineering, Vol.63 (6), pp.365-372, Dec.2012. DOI: 10.2478/v10187-012-0054-2
10. C.Nagarajan and M.Madheswaran - ‘Performance Analysis of LCL-T Resonant Converter with Fuzzy/PID Using State Space Analysis’- Springer, Electrical Engineering, Vol.93 (3), pp.167-178, September 2011. DOI 10.1007/s00202-011-0203-9
11. S.Tamilselvi, R.Prakash, C.Nagarajan,“Solar System Integrated Smart Grid Utilizing Hybrid Coot-Genetic Algorithm Optimized ANN Controller” Iranian Journal Of Science And Technology-Transactions Of Electrical Engineering, DOI10.1007/s40998-025-00917-z,2025
12. S.Tamilselvi, R.Prakash, C.Nagarajan,“ Adaptive sliding mode control of multilevel grid-connected inverters using reinforcement learning for enhanced LVRT performance” Electric Power Systems Research 253 (2026) 112428, doi.org/10.1016/j.epsr.2025.112428
13. S.Thirunavukkarasu, C. Nagarajan, 2024, “Performance Investigation on OCF and SCF study in BLDC machine using FTANN Controller," Journal of Electrical Engineering And Technology, Volume 20, pages 2675–2688, (2025), doi.org/10.1007/s42835-024-02126-w
14. C. Nagarajan, M.Madheswaran and D.Ramasubramanian- ‘Development of DSP based Robust Control Method for General Resonant Converter Topologies using Transfer Function Model’- Acta Electrotechnica et Informatica Journal , Vol.13 (2), pp.18-31,April-June.2013, DOI: 10.2478/aeei-2013-0025.
15. C.Nagarajan and M.Madheswaran - ‘DSP Based Fuzzy Controller for Series Parallel Resonant converter’- Springer, Frontiers of Electrical and Electronic Engineering, Vol. 7(4), pp. 438-446, Dec.12. DOI 10.1007/s11460-012-0212-0.
16. C.Nagarajan and M.Madheswaran - ‘Experimental Study and steady state stability analysis of CLL-T Series Parallel Resonant Converter with Fuzzy controller using State Space Analysis’- Iranian Journal of Electrical & Electronic Engineering, Vol.8 (3), pp.259-267, September 2012.
17. C.Nagarajan and M.Madheswaran, “Analysis and Simulation of LCL Series Resonant Full Bridge Converter Using PWM Technique with Load Independent Operation” has been presented in ICTES’08, a IEEE / IET International Conference organized by M.G.R.University, Chennai.Vol.no.1, pp.190-195, Dec.2007

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18. Suganthi Mullainathan, Ramesh Natarajan, "An SPSS and CNN modelling based quality assessment using ceramic materials and membrane filtration techniques", Revista Materia (Rio J.) Vol. 30, 2025, DOI: https://doi.org/10.1590/1517-7076-RMAT-2024-0721
19. M Suganthi, N Ramesh, "Treatment of water using natural zeolite as membrane filter", Journal of Environmental Protection and Ecology, Volume 23, Issue 2, pp: 520-530,2022
20. K. Lakshmi, M. Prasad, IoT-based smart agriculture system with robotic assistance, International Journal of Innovative Technology and Exploring Engineering (IJITEE), Vol. 8, Issue 9, 2019, pp. 120–125.
21. Sugumar, R. (2025). Federated AI in Offline-First Mobile Health Architectures for Privacy-Preserving Clinical Intelligence. *International Journal of Science, Research and Technology, 8(4), 14589-14600.*
22. Gopinathan, V. R. (2024). Real-Time Financial Risk Intelligence Using Secure-by-Design AI in SAP-Enabled Cloud Digital Banking. *International Journal of Computer Technology and Electronics Communication, 7(6), 9837-9845.*
23. Olukayode, F., Habeeb, M., Parupelli, S. K., Mathew, A., Manpreet, K., Amir, R., ... & Salil, D. (2025). Review of Recent Advances in Lithium-Ion Batteries: Sources, Extraction Methods, and Industrial Uses. *Batteries, 11(12), 433.*