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An Intelligent Seed Sowing Robotic Design Control Using Smartphone

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Abstract

Agriculture is the backbone of many developing economies, and the adoption of automation technologies can significantly improve productivity and efficiency. This system presents the design and implementation of an intelligent seed-sowing robotic system controlled using a smartphone, aimed at reducing human effort and increasing precision in agricultural operations. The system is controlled through an Android smartphone application using Bluetooth or Wi-Fi communication, enabling the user to remotely navigate the robot and regulate seed sowing operations. Sensors are employed to monitor soil conditions and ensure uniform seed placement at appropriate depths and intervals. The robotic platform operates on rechargeable batteries, making it energy-efficient and suitable for field conditions.

Keywords: *Smartphone, DC/Gear Motors, Seed Sowing Mechanism, Arduino uno R3 – CH340 microcontroller, Bluetooth, Relay, Sensors, Power Supply, Mobile Application Software.*

1. Introduction

This system presents the design and development of an intelligent seed-sowing robotic system controlled using a smartphone. The proposed system utilizes a microcontroller-based robotic platform integrated with motors, sensors, and a seed dispensing mechanism. Agriculture plays a crucial role in the economic development of many countries, especially developing nations where a large portion of the population depends on farming for livelihood. One of the most critical and labor-intensive processes in agriculture is seed sowing, which directly influences crop growth and yield. Traditional manual sowing methods often result in non-uniform seed distribution, increased seed wastage, and high labor dependency. To address these challenges, researchers have explored mechanization and automation in agricultural practices. Early research focused on mechanized and automated seed sowing systems to reduce human effort and improve efficiency. Shinde and Patil (2015) introduced a Bluetooth-based agricultural robot for seed planting, demonstrating the feasibility of wireless control in farming applications [2]. Gayathri et al. (2016) proposed a microcontroller-based smart seed sowing machine that improved seed placement accuracy but lacked flexible user control [4]. Khan et al. (2016) highlighted the importance of robotics and wireless sensor networks in smart farming to enhance productivity and decision-making [5]. Karhe and Patil (2017) developed an automated seed sowing robot aimed at smart agriculture, emphasizing precision and reduced labor involvement [1]. Later, Jha and Gupta (2018) presented an Android-controlled agricultural robot, showcasing the advantages of smartphone-based control for agricultural operations [3]. The primary objective of this work is to design and develop an intelligent seed sowing robotic system controlled using a smartphone that reduces manual labor and improves sowing precision. The system aims to provide uniform seed placement, easy remote control through an Android application, and reliable operation under real field conditions [6].

1.1. Need for Automation in Agriculture

Manual seed-sowing is labor-intensive and time-consuming. It often leads to improper spacing and

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depth of seeds, which negatively affects germination. Automation helps reduce human effort, ensures consistency, and increases overall productivity. Robotic systems enable precise control of sowing operations while minimizing seed wastage.

1.2. Role of Robotics in Seed Sowing

Robotics plays a key role in improving agricultural efficiency. A seed-sowing robot can perform repetitive tasks with high accuracy and reliability. By using motors, sensors, and control units, the robot can move across the field and sow seeds uniformly. This approach reduces dependency on skilled labor and improves farming efficiency.

1.3. Smartphone-Based Control System

Smartphones provide a powerful and user-friendly interface for controlling robotic systems. In this project, a smartphone is used to control the robot through wireless communication such as Bluetooth or Wi-Fi. The mobile application allows users to control robot movement and seed-sowing operations easily, without the need for complex control hardware.

2. Method

The methodology of the intelligent seed-sowing robotic system involves the integration of hardware components, software control, and wireless communication to automate the seed-sowing process. The system is powered using a rechargeable battery, and a microcontroller acts as the central control unit. A smartphone application is used to send control commands to the robot through Bluetooth or Wi-Fi communication. These commands control the movement of the robot as well as the operation of the seed-sowing mechanism. DC motors, driven by a motor driver module, enable the robot to move in different directions across the field. A controlled seed dispensing unit releases seeds at uniform intervals and appropriate depth. Sensors such as obstacle detection and soil moisture sensors enhance safety and efficiency by monitoring field conditions. The robot performs real-time operations based on user input, ensuring accurate and efficient seed sowing with minimal human effort (Figure 1 and Table 1).

Wireless Communication: - The wireless module receives control signals from the smartphone. Commands are decoded and processed by the microcontroller in real time.

Robot Navigation and Movement: - DC motors controlled by a motor driver move the robot forward, backward, left, and right. Speed and direction are adjusted based on user input.

Seed Sowing Operation: -A seed hopper stores seeds for sowing. A servo or DC motor controls the seed dispensing mechanism. Seeds are released at uniform intervals and appropriate depth.

Sensor-Based Monitoring: -Obstacle detection sensors prevent collisions during movement. Soil moisture sensors ensure sowing is done under suitable conditions.

Real-Time Operation: -The robot responds instantly to smartphone commands. Continuous monitoring ensures smooth and accurate operation.

Safety and Power Management: -Emergency stop function is provided through the smartphone. Battery power is efficiently managed for longer field operation.

Seed Storage and Dispensing System: -Seeds are stored in a hopper and dispensed through a servo motor–controlled mechanism. This ensures uniform seed spacing and reduces seed wastage during operation.

Mobile App: -Processes user commands and sends control signals to the robot.

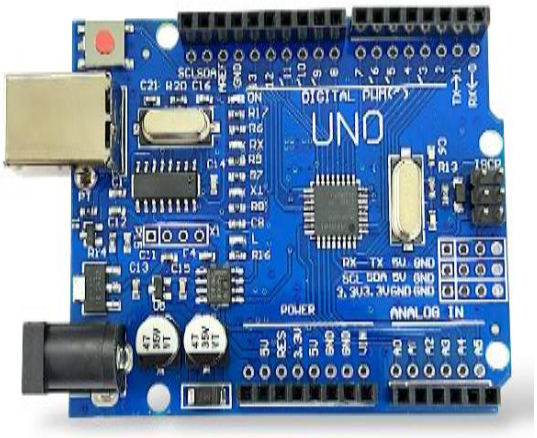

Figure 1 Arduino UNO

The intelligent seed sowing robot is controlled using a smartphone through an Android application with Bluetooth or Wi-Fi communication. A microcontroller processes the control commands and operates DC motors for robot movement and a servo motor for seed dispensing. Soil moisture and

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ultrasonic sensors are used to monitor soil condition and detect obstacles. The system is powered by a rechargeable battery, making it suitable for efficient field operation (Figure 2).

Table 1 Experimental Input Component, Range and Purpose

Component	Range / Specification	Purpose
Smartphone (Android)	Bluetooth/Wi-Fi enabled	Acts as user interface for robot control
Bluetooth Module	10–15 m range	Wireless communication between smartphone and robot
Wi-Fi Module	30–50 m range	Long-range wireless control and monitoring
DC Gear Motor	60–150 RPM	Provides movement to the robot
Motor Driver	Up to 2 A per channel	Controls speed and direction of motors
Servo Motor	0°–180° rotation	Controls seed dispensing mechanism
Seed Hopper	Capacity: 0.5–1 kg	Stores seeds for sowing
Ultrasonic Sensor	2–150 cm detection range	Detects obstacles and avoids collision
Battery	7.4–12 V	Powers the entire robotic system
Voltage Regulator	5 V / 3.3 V output	Regulates voltage for components
Robot Chassis & Wheels	Field-suitable size	Supports and moves the robot

3. Results and Discussion

3.1. Results

The intelligent seed-sowing robotic system controlled using a smartphone was successfully designed and tested. The robot established a stable wireless connection with the smartphone application through Bluetooth/Wi-Fi, enabling smooth and reliable control. All basic movements such as forward, backward, left, and right were executed accurately in response to user commands (Figure 3).

Figure 3 Final Output Observation

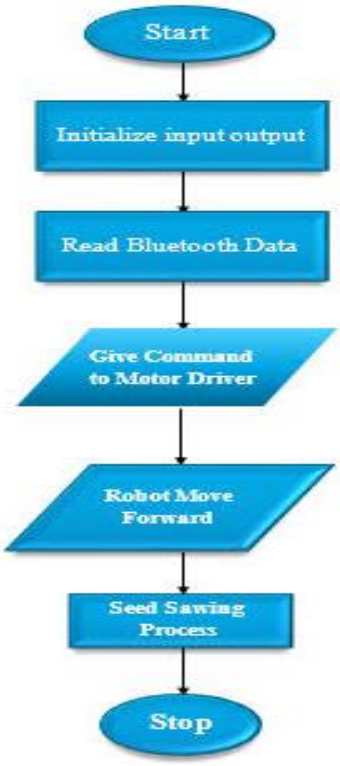

Figure 2 Flowchart

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3.2. Discussion

The results indicate that the proposed robotic system significantly reduces manual labor and time required for seed-sowing operations. The use of smartphone-based control proved to be simple, flexible, and user-friendly, making the system accessible even to farmers with limited technical experience. Uniform seed placement achieved by the robotic system is expected to improve germination rates and crop yield. Wireless communication ensured real-time response, although communication range may limit usage in very large fields. The system's performance depends on proper calibration of sensors and motor speed control. Overall, the discussion confirms that the proposed intelligent seed sowing robot is a feasible and efficient solution for small- and medium-scale farming applications. With further improvements, the system has strong potential to contribute to precision agriculture and sustainable farming practices (Figure 4 and Table 2).

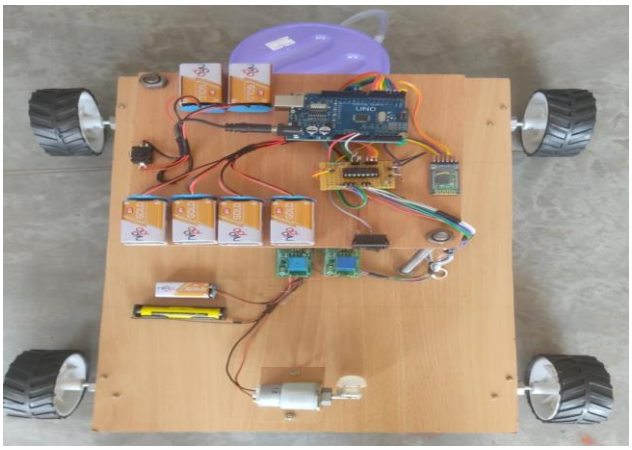

Figure 4 Hardware Setup

Table 2 Parameter and Output Observation

Parameter	Output Observation
Control method	Smartphone-based wireless control
Response Time	Less than 1 s
Navigation Accuracy	High
Seed Dispensing Accuracy	Uniform and consistent
Power Requirement	Low

Conclusion

The intelligent seed-sowing robotic system controlled using a smartphone has been successfully designed and implemented to automate the seed sowing process. The system effectively reduces manual labor while ensuring uniform seed placement and minimizing seed wastage. Smartphone-based wireless control provides a simple, flexible, and user-friendly interface for operating the robot.

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