Development of variable distance seed sowing machine using Arduino

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***Abstract*:** *Agriculture remains the backbone of many economies, particularly in developing countries where a large portion of the population relies on it for livelihood. Traditional seed sowing methods are labour-intensive, time-consuming, and often result in inconsistent seed spacing, leading to reduced crop yield and wastage. This project focuses on the design and development of a low-cost, semi-automated variable distance seed sowing machine integrated with Arduino-based control, which allows users to manage seed sowing efficiently using a mobile phone.*

The outcome of the project shows a significant improvement in seed sowing accuracy, reduced human labour, and enhanced efficiency. The system is modular, scalable, and suitable for small to medium-scale farmers. It contributes to the field of precision agriculture and opens doors for further automation using IoT and GPS-based control.

***Keywords*: Seed Sowing Machine, Arduino, Variable Spacing, Wiper Motor, Bluetooth Control.**

1. Introduction

In the modern agricultural landscape, precision and efficiency have become essential to ensure maximum yield and minimal resource wastage. Traditional methods of seed sowing, which are largely manual, are often labour-intensive, time-consuming, and inconsistent, leading to irregular spacing and seed wastage. These challenges have led to the development of automated solutions that enhance accuracy and productivity in the sowing process. This project, titled "Development of a Variable Distance Seed Sowing Machine Using Arduino Uno R3″, addresses these issues by proposing a cost-effective and efficient semi-automated sowing system tailored for small to medium-scale farmers.

The core of the proposed system is an Arduino Uno R3 microcontroller, which controls the seed metering mechanism based on input from various sensors. A motor-driven seed metering box ensures consistent dispensing of seeds, while distance variability is achieved by adjusting the timing of the seed release mechanism based on programmed logic. This allows for real-time control of seed spacing depending on crop requirements. The machine also features a user-friendly interface and can be adjusted to suit different field conditions and seed types.

This design not only reduces the need for manual labour but also improves the accuracy of seed placement, resulting in better germination rates and optimal plant population. Moreover, it provides a low-cost solution that can be adapted for various crops and field sizes, making it highly beneficial for farmers in developing regions. The integration of electronics with mechanical components in this project exemplifies the interdisciplinary approach needed for modern agricultural innovations. Through this project, we aim to contribute to the ongoing efforts to modernize farming practices and enhance food security through sustainable technology.

2. Literature Review

[1] Ratnesh Kumar et al. (2022) Design of automatic seed sowing Machine for agriculture sector. The design of an automatic seed sowing machine for the agriculture sector focuses on improving planting efficiency, reducing manual labour, and ensuring uniform seed placement. The literature survey examines various automation techniques, seed metering systems, and machine configurations. Research highlights the use of sensors, microcontrollers, and motors for accurate seed placement, addressing challenges such as varying soil conditions and seed types. The aim is to enhance productivity and precision in agricultural operations.

[2] Meena Chavan et al. (2017) In their Automated Seed Sowing Robot project we had made an automated robot which will be a helping hand to the farmers in field. Observing the current scenario this prototype robot can provide high efficiency in production and their cultivation. This robot can do multitasking which is lots of time consuming when done by manual-based method farming. It can sow seed, spray fertilizers and levelling of the surface. This project can be a better substitute for the human who performs the seeding and fertilizing.

[3] Chavan K V et al. (2024) The literature survey on the invention of the automatic seed sowing robot explores advancements in robotic systems for agriculture. It discusses the integration of sensors, actuators, and microcontrollers for precise seed placement, reducing human labour and enhancing efficiency. The review also highlights the challenges of varying soil conditions, seed types, and terrain. Various models and innovations in seed dispensing mechanisms, autonomous navigation, and cost-effective designs are examined to improve agricultural practices.

[4] Sandesh N G et al. (2020) "An Automated Sowing Seed using AG-ROBOT" explores the development of robotic systems for precision agriculture. It highlights the use of automation to improve seed sowing efficiency, reduce labour, and ensure consistent seed placement. Key technologies such as microcontrollers, GPS, and sensors for soil condition analysis and seed monitoring are discussed. The study emphasizes the importance of cost-effective designs and adaptability to different agricultural environments for optimized performance.

[5] Senthilnathan N et al. (2018) The literature survey on "Fabrication and Automation of Seed Sowing Machine Using IoT" focuses on integrating Internet of Things (IoT) technology into seed sowing systems. It reviews innovations in automated seed placement using sensors, GPS, and IoT-based monitoring for real-time data analysis. The study highlights improvements in precision, efficiency, and reduced labour through automation. Additionally, it examines challenges such as connectivity issues and adapting to diverse agricultural environments for optimal results.

[6] Narendra Chaurasia et al. (2023) A literature survey on Automatic Seed Sowing and Spraying Agriculture Robots explores advancements in precision farming, automation, and robotics in agriculture. Research highlights the integration of sensors, GPS, and IoT to enhance accuracy and efficiency in seed sowing and pesticide spraying. Various studies discuss autonomous robots designed with AI and computer vision for real-time field monitoring. The use of actuators and robotic arms for precise seed placement and uniform spraying has been extensively analyzed. Additionally, researchers emphasize sustainability benefits, including reduced labour costs, optimized resource utilization, and minimized environmental impact. Challenges such as cost, power consumption, and adaptability remain key areas of focus.

[7] Adedeji Kasali et al. (2023) A literature survey on Design, Fabrication, and Development of an Automated Seed-Sowing Machine. The study states that the automated seed-sowing machine effectively addresses common agricultural challenges by improving

planting accuracy and reducing labour. The authors suggest that future enhancements could include integrating Internet of Things (IoT) technologies for remote monitoring and control, as well as adapting the design for various crop types and field conditions.

[8] Throat swapnil et al. (2017) A literature survey on Design and Fabrication of Seed Sowing Machine. The seed sowing machine offers a practical and economical solution to the challenges faced by small-scale farmers in seed planting. Its manual operation, versatility, and ease of use make it a valuable tool for improving agricultural productivity in regions with limited resources.

[9] Venkatesh et al. (2020) A literature survey on Development of Farmer assisting IoT based Seed Deployer. The developed IoT-based seed deployer successfully automates the seed sowing process, offering precision, efficiency, and ease of use. By enabling remote operation and accommodating various seed types, the system presents a practical solution for modernizing agricultural practices, particularly beneficial for small to medium-scale farmers.

[10] Arpita Mukherji et al. (2024) Precision Farming with Automatic Seed Sowing Machines. This paper emphasizes that automatic seed sowing machines play a crucial role in transforming traditional farming practices into more efficient, sustainable, and precise operations, helping farmers maximize productivity while reducing the environmental footprint. The integration of such technology in farming represents a step toward modern, data-driven agriculture, offering solutions to pressing challenges in the sector.

Recent advancements in the field of agricultural automation emphasize the need for efficient and precise seed sowing mechanisms. Ratnesh Kumar et al. (2022) highlight the development of automatic seed sowing machines that integrate microcontrollers and sensors for accurate seed placement, reducing manual labour and ensuring uniformity. Meena Chavan et al. (2022) designed a multifunctional robot capable of seed sowing, fertilizer spraying, and surface levelling to enhance field productivity. S. Sundaram et al. focused on robotic systems that utilize actuators and sensors for efficient operation in varying soil conditions. Similarly, Sandesh N G et al. (2020) emphasized robotic automation using GPS and soil monitoring sensors for consistent seed sowing. Senthilnathan N et al. (2018) introduced IoT-based automation for real-time monitoring and precision in seed placement, despite challenges related to connectivity and field conditions. Narendra Chaurasia et al. (2023) explored the integration of AI, GPS, and IoT in agriculture robots, enhancing precision in both seed sowing and spraying activities. The studies collectively underline the importance of cost-effective, adaptable, and sustainable solutions to modernize farming practices while addressing key challenges such as terrain variability, resource management, and environmental concerns

The proposed work aims to design and develop a variable distance seed sowing machine integrated with an Arduino microcontroller for precise seed dispensing in agricultural fields. The machine will address the problems of manual sowing by ensuring consistent spacing, reducing seed wastage, and minimizing human effort.

- Develop a variable seed spacing machine that can be adjusted based on speed using an Arduino microcontroller.
- Minimize resource wastage by ensuring accurate seed placement and reducing the need for manual labour.

3. Methodology

Working Principle: The following diagram (Fig.1) represents the working of a variable distance seed sowing machine using Arduino based on an Atmega 328 microcontroller (which is used in Arduino Uno).

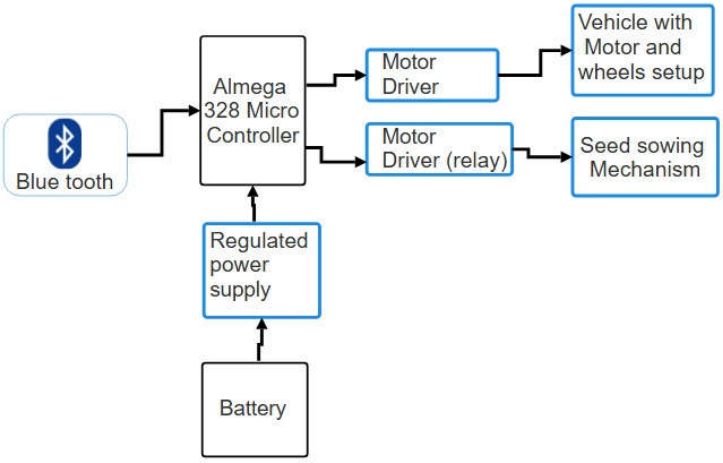

Figure 1. Block diagram of Seed Sowing Machine

3.1 Components Used – Brief Description

a. **Chassis**: The chassis acts as the main structural framework of the machine. It provides a sturdy base to mount all other components, ensuring mechanical stability during movement across the field.
b. **Wheels**: The wheels enable the movement of the machine and provide traction on uneven field surfaces. They are driven by the motor and are essential for maintaining consistent sowing intervals.
c. **Bevel Gear**: Bevel gears are used to transfer rotational motion from the motor to the pinion shaft at a 90° angle. This enables the direction of motion to change, which is crucial for driving both the seed roller and the wheels efficiently.
d. **Hopper**: The hopper stores seeds and regulates their flow to the seed roller. It ensures a consistent supply of seeds and helps maintain uniform spacing during sowing.
e. **Ball Bearings**: Ball bearings are used in rotating parts to reduce friction and mechanical wear. They enhance smooth movement and increase the durability of the system.
f. **Battery**: A rechargeable battery powers the motor and the Arduino microcontroller. It ensures portable and uninterrupted operation in the field.
g. **Microcontroller (Arduino Uno R3)**: The Arduino receives user commands via Bluetooth and controls the relay to turn the motor ON or OFF based on programmed sowing intervals. It is the brain of the machine.
h. **Relay Module**: The relay acts as a switch, turning the motor on or off based on Arduino signals. It ensures accurate control of the seed dispensing mechanism.
i. **Bluetooth Module**: The Bluetooth module allows wireless communication between a smartphone and the Arduino. Users can control machine operations such as start/stop, speed, and seed spacing.
j. **Wiper Motor**: The wiper motor provides the mechanical power to rotate the gear system, which drives both the seed roller and the wheels, ensuring synchronized motion for accurate sowing.

3.2 Fabrication and Assembly Process

Various components of the working model are shown Figure 2, 3 4 and 5 shows the Chassis, Motors and wheel, Bevel gear and Hopper and Arduino, Relay & Bluetooth module respectively.

- **Cutting the raw material as per the design and shape**: Mild steel square tubes are cut to build the 450×450 mm chassis frame.
- **Building the frame using cutters and arc welding**: The chassis is assembled and welded with precise 90° joints for strength and accuracy.

Figure 2. Chassis

- **Fixing the battery and motors**: The wiper motor, DC motors, and 12V battery are securely installed along with control electronics.
- **Fixing the wheel to the frame**: Wheels are mounted using axles with ball bearings and connected to motors for traction and smooth field movement.

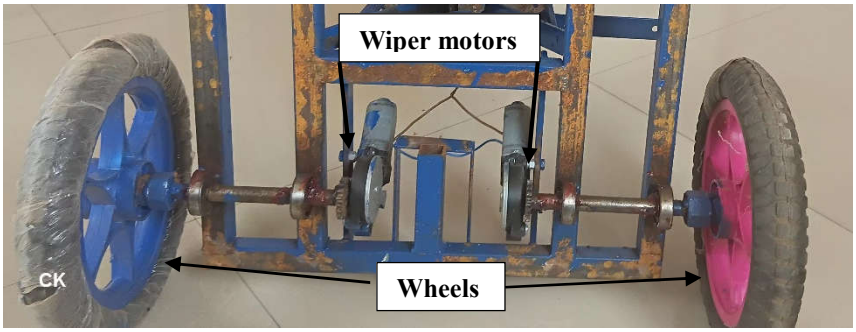

Figure 3. Motors & Wheels

- **Mounting the bevel gear and hopper**: The bevel gear system is installed for seed roller drive, and the metal hopper is mounted for controlled seed metering.

Figure 4. Bevel gear & Hopper

- **Installing Arduino and wiring electronics**: Arduino Uno, relays, and Bluetooth module are wired and fixed onto the chassis.

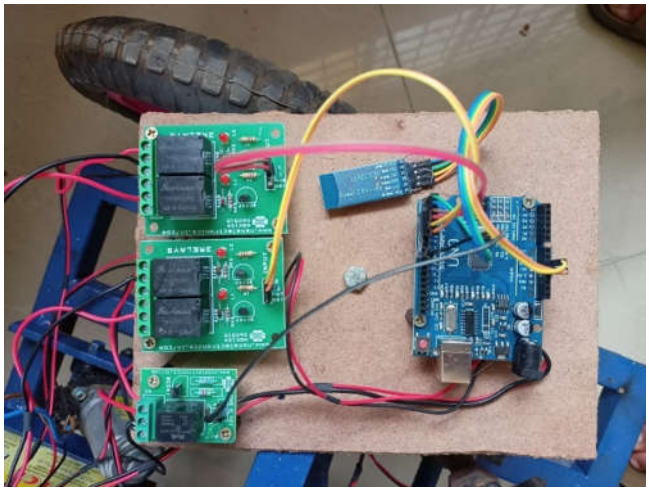

Figure 5. Arduino, Relay & Bluetooth module

- **Uploading code and testing system**: Arduino is programmed to control seed spacing and motion; system is tested for accuracy and performance.

3.3 Working

The Variable Distance Seed Sowing Machine is designed to automate and precisely control the process of seed sowing in agricultural fields. It functions through the integration of mechanical and electronic components, centrally controlled by an Arduino Uno (ATmega328 microcontroller). The entire assembly is built on a **chassis**, which provides the structural support to mount all essential components such as the wheels, hopper, gear system, motor, and electronic modules.

The machine is powered by a **battery**, which supplies electricity through a **regulated power supply** to ensure the proper functioning of sensitive components like the Arduino board and the motor drivers. A **Bluetooth module** facilitates wireless communication between the user and the microcontroller. Using a smartphone, the user can send commands such as start, stop, seed spacing adjustments, and speed control to the Arduino.

Upon receiving commands, the **Arduino** processes them and activates the appropriate **motor driver circuits**. Two motor drivers are connected to the **vehicle's wheels**, while another—controlled via a **relay**—regulates the **seed sowing mechanism**. A **wiper motor** drives a **bevel gear** system, which transmits rotary motion at a 90° angle to both move the vehicle and rotate the **seed roller** within the **hopper**. The **hopper** releases seeds at intervals determined by the programmed seed spacing logic in the Arduino.

Ball bearings support the rotating shafts, reducing friction and enhancing smooth operation. The synchronized control between the vehicle movement and the seed roller ensures seeds are sown at variable yet accurate distances as specified by the user. This smart mechanism reduces manual labour, improves seed placement precision, and increases agricultural efficiency, especially for small to medium-scale farmers.

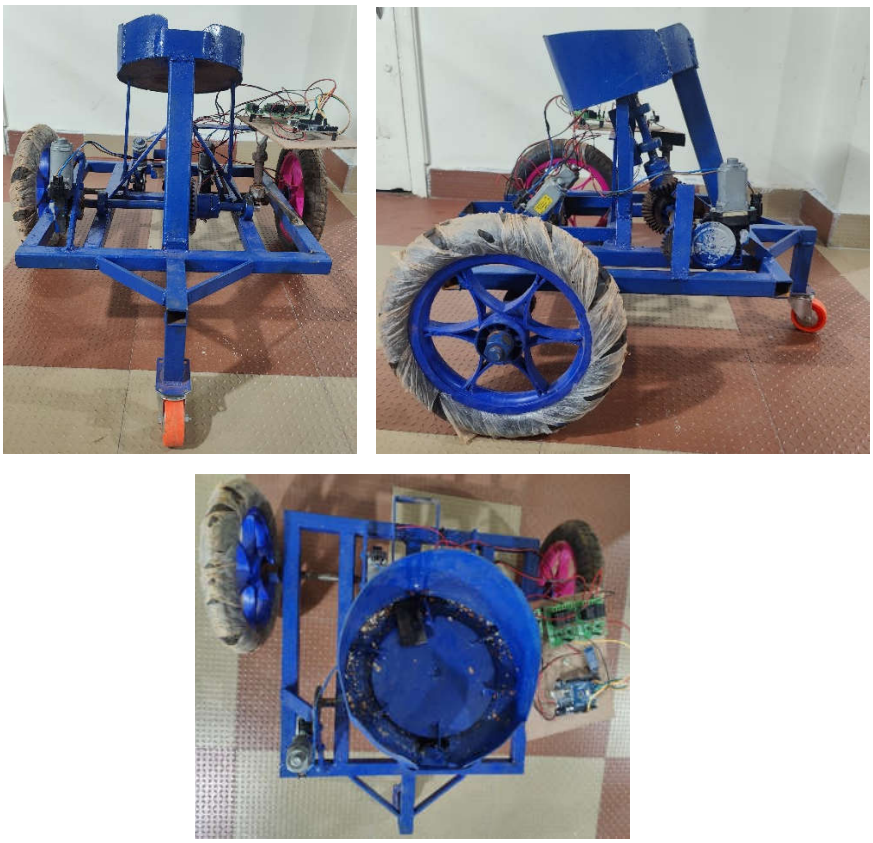

Figure 7. Variable distance seed sowing machine using Arduino

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4. Conclusion

This seed plantation machine has great potential for increasing the productivity of the planting. Till now tractor was the main traction unit for nourishment in farming. With the adaptation of this seed planting machine its purpose will be done. Hence there is need to promote this technology and made available to even small-scale farmers with affordable prices. This machine can be made by raw materials also which saves the cost of whole project and is easily manufactured in available workshops. The only cost is of metering device and sensors. Hence by using this machine we can achieve flexibility of distance and control depth variation for different seeds, hence usable to all seeds.

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