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Automatic Seed Sowing

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Abstract

Agriculture is one of the industries that has been growing rapidly due to advanced technology. Plant cultivation has been one of the most essential undertakings for ages. Tools that reduce time and effort in agriculture have been developed to increase efficiency of cultivating plants. The most common agricultural machinery used is tractor. However, it is not sustainable due to air pollutants caused by combustion of fuel. Furthermore, the use of tractor is not suitable for small scale farming and most of them manually sow by hand. The Automatic Seed Sowing project offers a cost-efficient and eco-friendly solution for small-scale farmers by utilizing electricity for continuous, effective, and low-impact seed sowing. This approach reduces dependence on human labor and fossil fuels. The main goal is to ensure that seeds are accurately placed in the designated holes during the sowing process. This study involves the development of an electric-powered seed sowing machine tailored for small farming plots of 5 m × 5 m. The machine is specifically designed for sowing spinach in soft organic soil and operates solely on a 12 V battery. The methodology covers various aspects including the creation of a flowchart, testing methods, a Gantt chart, drilling methods, and engineering analysis. Regular maintenance, such as battery replacement and repairs or replacement of damaged parts, is required for the machine. This machine's ability to precisely place seeds in pre-marked holes while eliminating the need for fossil fuels and human labor makes it both cost-effective and environmentally friendly. The study suggests that this technique can boost sustainability and increase agricultural productivity.

1. Introduction

With the advancement of technologies in the field of agriculture, modern farming has brought solutions to old problems. One of these innovations is the Automatic Seed Sowing RC Car, a project whose aim is to increase precision and efficiency in the process of sowing seeds to help in the improvement of sowing seeds operations. Some of the challenges with small holder farmers that this project seeks to solve include labor intensiveness, irregular seed distributions and the environmental effects occasioned by fuel-powered implements.

Elements of the Automatic Seed Sowing RC Car include several components that enhance the planting mechanism. In its essence, the car contains a robotic system operated by a remote control and supported by rechargeable batteries, which negates the usage of fuel and consequently the emission of hazardous chemicals into the atmosphere. It has a seed container which is placed in a way that seeds can easily fall at desired intervals as the car is moving [1]. The front part of the car is fitted with a triangular hoe that forms trenches in the soil allowing for controlled planting of the seeds. Next, a scraper traverses over the sown seeds and ensures that the seeds are covered evenly by the soil which increases the germination rate, and the crop yield due to the standard seed coverage. One of the main goals of this work is to design an effective solution to accelerate the process of sowing seeds. Some of the traditional methods of planting hands require a lot of time and manpower, meaning that a farmer can plant a given area only within a certain span of time. The RC car has greatly minimized the time taken to sow seeds because the process is automated thus enabling farmers to cover larger acreage with little energy. This innovation not only saves time but also helps to overcome the problem of labor shortage among small farmers, thus increasing productivity and business activity in farming.

Another benefit of the Automatic Seed Sowing RC Car is environmental sustainability. The fact that this seeding process is done using a battery-powered system makes it friendly to the environment since the impacts of carbon are relatively lower than those of fuel-powered machines. This aspect of the project is in line with the international strategies of minimizing emission of greenhouse gases and encouraging sustainable agriculture. Also, the soil is not likely to be disturbed by the car, thereby preserving the soil structures as well as preventing erosion.

To make sure that the project fulfills agricultural requirements, matters like field dimension, seed category, sowing depth as well as spacing were considered during the development stage. They decided to perform simulations on the interactions between the hopper, metering mechanism, seed delivery system and the planting elements of the car. These simulations enabled the design by increasing its effectiveness and durability. Material selection was also a serious factor, and therefore high-grade aluminum or stainless steel was used for strength, durability and corrosion resistance optimizing the long-term efficiency and cost of the machine.

In short, Automatic Seed Sowing RC car can be considered as a greater development in agriculture technology providing a practical approach to the problems encountered during the conventional seed plantation. In its objectiveness, this invention can serve as a platform that will make small scale farming more effective and less damaging to the environment.

2. Literature Review

A review of the literature outlines the research that will be done utilizing trustworthy data and understanding of the connections between the topics under investigation. It provides an overview of prior, ongoing, and related investigations in addition to an introduction to the study topic, pertinent ideas, and concepts. Finally, it goes beyond just summarizing the work of previous academics by providing a summary and identifying pertinent titles in the field. A review of the literature outlines the research that will be done utilizing trustworthy data and understanding of the connections between the topics under investigation. It provides an overview of previous, ongoing, and related investigations in addition to an introduction to the study topic, pertinent ideas, and concepts.

Looking for tools and materials apart from soil and seeds helps to avoid inefficiencies in planning, creativity, budgetarily, managing risks, compliance with laws, environmental conservation and document each process to produce a successful project in engineering or technical disciplines.

The first tools which require manual energy like the dibbler and transplanting trowels are effective for small-scale farming [2]. The dibbler, made from mild steel or leaf spring, has a sharpened edge for easy soil penetration, while the transplanting trowels, crafted from mild steel or aluminum, assist with soil manipulation. Seeds can also be broadcast manually or with mechanical seeders, covering the soil uniformly, which is ideal for crops that don't require precise spacing. Existing products such as seed drills ensure precise seed placement and uniform germination. For instance, the manual corn seed planter allows accurate maize seed planting with built-in row markers, and the manual oilseed drill, equipped with a fluted roller, is used for sowing crops like rapeseed and mustard [3][4][5].

In addition to equipment, soil is also an important resource to be used as a medium to make this project a success. Determining the type of soil that is used is one of the most important factors when it comes to growth. Organic soil is desired due to its high nutrient content and holds water while draining well [6]. Organic soil must be used to allow farms to practice sustainable agriculture by positively impacting the health of the soil and improving the microorganisms present within it. This type of soil is of great significance to the growth of spinach seeds, which are the subject of the current project.

The seed also plays an important role in determining whether the project is successful or otherwise. This project focuses on planting spinach seeds as an example in **Fig. 1**, a popular leafy vegetable in Malaysia. Spinach can grow as compact plants (10 - 20 cm) or larger, upright plants (up to 1.5 m) if given enough space. It thrives with 4 - 8 hours of direct sunlight or over 6 hours of indirect light, in loamy soil at least 10 cm deep. Proper

drainage and organic matter are crucial to prevent root rot. Spinach is drought-tolerant and benefits from heavy nitrogen fertilizers, promoting rapid growth and more leaves. Fertilizing every two weeks after transplanting enhances yield. Seeds are classified as fine (1-5 mm) or coarse (6 mm and above). Plant seeds 0.5 to 1.0 cm deep to avoid drowning or drying out [7].

Fig. 1 *Spinach seed*

Arduino Uno is the most popular microcontroller board, and it is one of the main items used in projects that are plug and play, and affordable. This program is from Interaction Design Institute Ivrea, Italy, where it was started in 2005 as the Arduino project, and it was designed for educating learners and for furthering the process of hardware connection. The board utilizes the ATmega328P microcontroller and operates at a clock frequency of 16 MHz. The ATmega328P microcontroller offers 32 KB of flash memory, 2 KB of SRAM, and 1 KB of EEPROM. This version comes with 14 digital I/O pins and 6 analog inputs, as well as a USB connection, a power jack, an ICSP header, and a reset button which allows the board to be powered through USB or an external power supply [8].

3. Methodology

The Automatic Seed Sowing project's methodological strategy is described in this chapter's methodology section. It has a flowchart that highlights both group and individual contributions and shows the sequential processes from the original project idea to the finished mechanical build. A Gantt chart that spans one through fourteen weeks further helps to visualize the project's timetable, major tasks, accomplishments, and coordinated efforts. When combined, these charts offer visible and understandable insights into the project's well-organized progress.

This stage of the Automatic Seed Sowing project entails a thorough analysis of technological concepts and literature. Important regions consist of:

- Examining scholarly articles, case studies, and developments in precision seeding technology is the literature review.
- Technical Principles: Researching automatic agriculture technologies now in use, precision seeding mechanics, and electric energy conversion.
- Environmental Impact: Evaluating reductions in carbon footprints and benefits to ecological sustainability and soil health as compared to conventional techniques. Investigating appropriate electric circuits, energy storage options, and overall energy balance for the seed sowing apparatus is part of the renewable energy integration process.
- Technological Challenges: Determining and suggesting fixes for equipment upkeep, adaptability to various agricultural environments, and dependability.
- Regulatory and Safety Considerations: A summary of the laws, guidelines, approvals, and certifications that are required.
- Comparative analysis: To find areas for improvement and facilitate well-informed decision-making, traditional and automated seed sowing techniques are compared.

The desired specifications and needs of the product to be created, together with other relevant information, are provided in the Product Design Specification (PDS). The recognized design issue is that traditional sowing techniques frequently fail because they depend too heavily on manual labor, which causes irregularities and inefficiencies in the procedure. The goal of the design is to create an enhanced sowing system that uses electric energy to accurately plant seeds in rows at a given depth to address this problem. By increasing the sowing process's overall accuracy and efficiency, this invention seeks to lessen the need for human labor while raising production.

Multidisciplinary Applied Research and Innovation Vol. 6 No. 1 (2025) p. 190-196

Table 1 *Product Design Specifications*

Aspect	Explanation
Functional performance	Include overload safety measures to lower the chance of accidents and avoid damage to the equipment. Precision: planting seeds precisely, uniformly spaced, and in equal amounts to increase plant productivity.
Safety	The material used to reduce the chance of sharp edges or debris falling off, use materials for the front scraper that are strong and unlikely to bend or break while in use.
User-friendly	Easy to use and capable of being controlled using a remote control.
Maintenance, repair and retirement	The remote control's battery must be changed, and any broken parts should be replaced or fixed.
Appearance	Simple and have similarity with car remote control.
Sustainability	To guarantee the structural integrity of the product, statistical analysis will be used to examine potential stresses and strains in the componentry. Eliminating unrealistic or unsustainable design alternatives requires this step.

Product Design Specification in **Table 1** provides detailed information on a specific product that is to be designed as well as the specifications that it will adhere to. The design problem that has been discovered is traditional methods of sowing may be ineffective due to the utilization of human labor. Because of that, we came up with a design purpose which is to develop the sowing process to place the seed in rows at depth using electric energy. Other than that, the features in this design contain an integrated electric circuit for renewable power, accurate, energy- efficient seeding process, and rechargeable battery.

3.1 Method

This project was followed in a structured way to make the prototype of this Automatic Seed Sowing RC car functional. The project started with formulating the problem of slow and laborious methods of sowing seeds traditionally. This created the need to seek other available tools and technologies to enhance this process. Following the collection of pertinent information, the team proceeded to the next step: design, where first impressions and concepts were drawn as shown in **Fig. 2**. These sketches were beneficial in envisioning the proposed solution and thus fine-tuning the design more. Subsequently technical drawings of the different parts to be used in constructions of the prototype were developed. The team then constructed and experimented with multiple components to enhance the design over time based on the outcome and feedback received. This process went on until the team was ready to complete the mechanical structure.

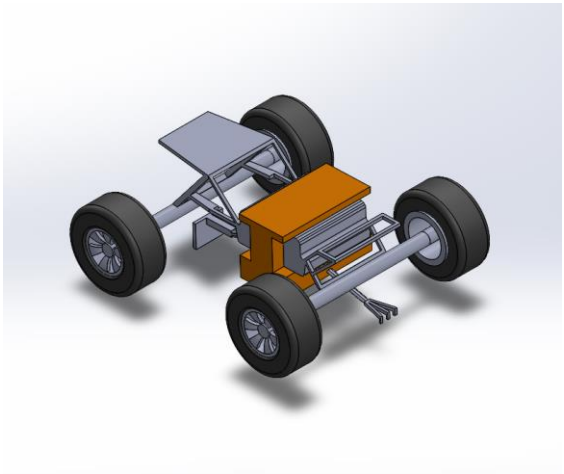

Fig. 2 *The assembly drawing of an Automatic Seed Sowing RC car*

For the design of this RC car, there are modifications to the structure where the original chassis has been cut to place the seed container. Then, 4 wooden blocks of different sizes that have thickness 1 cm, 2 cm, 2 cm and 3.5 cm were cut using a jigsaw machine to obtain 2 sizes (11 cm x 9 cm) and (5 cm x 3 cm). After that, the block with the largest size is drilled using a drill machine at a 45° with a depth of 2 cm. The hole was punched in the front sight to be used as a front scraper on an RC car. Using universal brackets and screws, these two are applied

to the wooden surface and tied together with 4 wooden blocks to form a box with a space in the middle. Next, the shaft of the three-pronged hoe is sharpened using a belt sander machine to maximize tightness when the shaft goes into the hole that has been drilled earlier. Ensuing, the wooden block that forms the box is applied to the RC car in the middle of its body, then a three-pronged hoe is inserted into the drilled hole. The shaft of the three-pronged hoe is shortened if the point is too deep into the soil causing difficulty for the RC car to move. Hereafter, the Arduino set is used to apply to the motor to allow the motor to rotate clockwise and counterclockwise in one complete revolution at low speed. The motor is attached to the bottle cap and the body has a hole punched to allow the seeds to fall when the motor rotates. All these steps have been shown as in **Fig. 3**. After everything is ready, then this RC car can work perfectly.

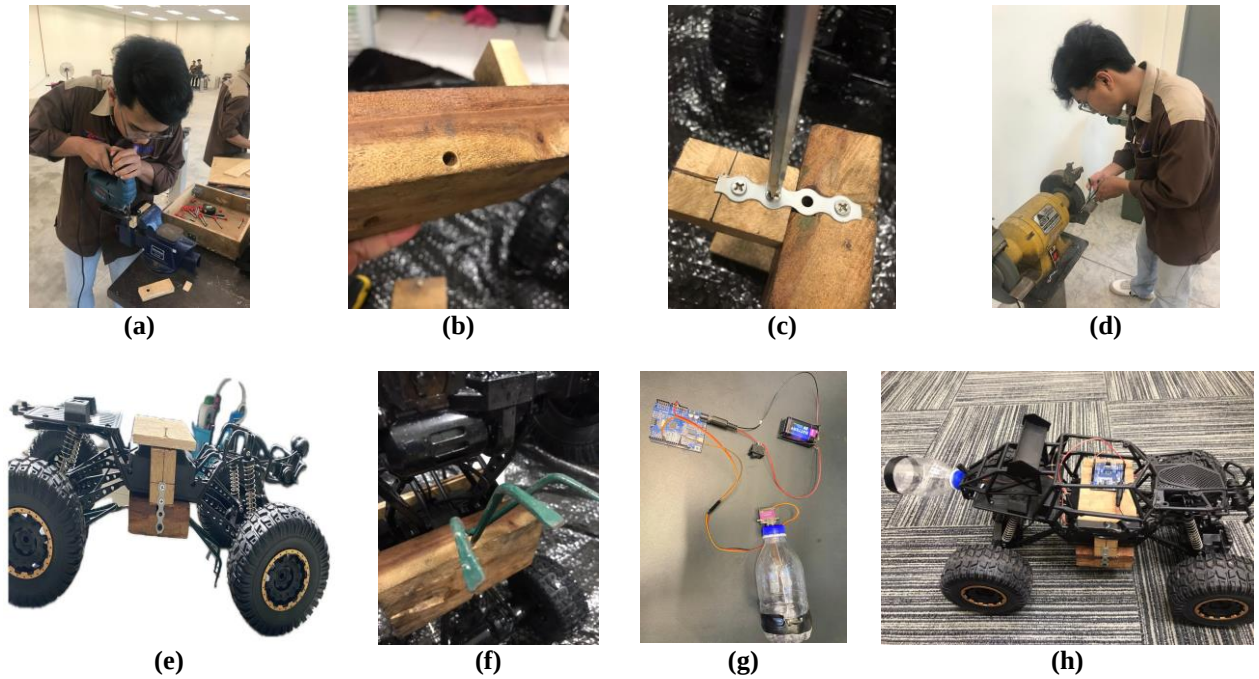

Fig. 3 *Step to develop the Automatic Seed Sowing (a) Saw a block of wood; (b) Drill a hole; (c) Tie using a universal bracket and screw it; (d) Sharpened three-pronged hoe; (e) Apply wooden block to RC car body; (f) Insert three-pronged hoe to the hole; (g) Arduino UNO circuit setup design; (h) Complete Automatic Seed Sowing*

3.2 Materials

Any engineering project includes several materials to be used, and the choice of materials is a very important step especially in the process of the Automatic Seed Sowing RC car construction. This is determined by the type of material used, cost of materials used, durability, and overall effectiveness of the final product or outcome. In this part, the criteria for choosing materials, the considered solutions and the reason for choosing the final materials are presented.

To begin with, criteria for choosing the material were determined according to the specific characteristics of the project. Such requirements included tensile strength, density, resistance to corrosion, the price, and weldability. The selected materials had to offer the necessary load bearing capacity while at the same time ensure that the RC car remained lightweight and easily maneuverable. Also due to usage in agricultural applications the materials were expected to have high resistance to soil, moisture and varying climatic conditions.

Primarily, the plastic-made RC car used in this project has numerous veins on its design that makes it considerably strong and can support a 20-year-old male teenager. This strength vs lightweight has been achieved by using this option that is necessary for easy movement and the optimum use of resources. It is resistant to corrosion and cost-effective. The electronic as well as mechanical parts were constructed from normal materials like copper, silicon and some polymers to ensure good performance and reliability at large. For the seed container, it's made from high-density polyethylene (HDPE) because of its long life, non-toxic nature, resistance to moisture and chemicals, making sure that seeds handling is safe, durable under agricultural conditions and long lived. Next, the stainless-steel three-pronged hoe because of its high strength, resistance to corrosion and durability. In harsh agricultural conditions, this substance allows efficient penetration of the soil and its long-term use is guaranteed. In addition, it is universally acknowledged that a heavy hardwood block provides a perfect blend of durability, strength and resistance to wearing out. Necessary, it serves as a firm and

steady bottom to which other parts can then be bound so that they remain functional over long periods regardless of varied surroundings.

4. Result and Discussion

The testing is done to make sure this Automatic Seed Sowing able to sow the seed and the amount of seed is consistently sowed.

Table 2 *Data collection of seeds deposited for 1 revolution of servo motor*

No. of testing	Seed deposited
1	50
2	63
3	55
4	61
5	59

The product testing phase, which focused on data collection for automated seed sowing, was aimed at finding out the number of seeds deposited into the hole during one complete revolution of the servo motor as shown in **Table 2**. To improve the idea of an autonomous seed-sowing remote-control car and construct it more effectively, various problems must be resolved prior to the project's launch.

- Seeds placement:
  Precision and Consistency: It has the feature of placing seeds in rows at the appropriate depth and spacing between seeds. The front part of the car shaped in a three-pronged hoe makes a furrow in the soil as the car operates; this leads to a controlled environment in which the seeds drop into the furrows made. On top of this RC car, there is a seed container with a hole at a favorable position to let seeds drop at intervals. The scraper at the back of the car sees to it that the seeds are well decorated by levelling the soil on them and compacting it. This assists in placing the seeds in equal measures thus increasing the chances of germination besides the yields.
- Environment
  Reduction in Pollution: In this project, the use of the rechargeable battery-powered RC car has no fuel hence negating air pollution and, in turn, minimizing the contamination of the environment. Seeding fertilization involves the use of clean energy in the form of rechargeable batteries, meaning that the entire process is more environmentally friendly and has minimal impact on ecosystems. The smaller release of carbon dioxide or other greenhouse gases is beneficial in environmental conservation.
- Time:
  Efficiency and Speed: It will be observed that the use of the automatic seed sowing RC car greatly shrinks the time taken to plant seeds compared with the hand planting method. As for the seed placement and soil covering this method also has a benefit of not requiring a person to constantly maintain and operate the equipment. This reduces time consumption, but also relieves the labour bottleneck for small farmers, extending the area coverage per amount of time. This results in improved rates and productivity and therefore leads to enhanced efficiency in farming.

5. Conclusion

The automated seed sowing initiative achieved its goals after a thorough analysis and testing process. Farmers using 5 m x 5 m plots can improve sowing time with the use of electric-powered seed sowing equipment. Accurate and dependable seed dispersal was confirmed by simulation testing on a functional prototype with automated operations. The machine's potential to improve agricultural automation by raising productivity and decreasing labor is demonstrated by the findings. The prototype will be improved in the future, and field testing will be done to make sure it works well and is durable under actual farming circumstances.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Muhammad Danish Aizam Ismayudin, Nor Najmi Hakimi Nor Azman, Nur Amirah Sabrina Azman, Mohd Hadri Mohamed Nor;* ***data collection:*** *Muhammad Danish Aizam Ismayudin, Nor Najmi Hakimi Nor Azman, Nur Amirah Sabrina Azman;* ***analysis and interpretation of results:*** *Muhammad Danish Aizam Ismayudin, Nor Najmi Hakimi Nor Azman, Nur Amirah Sabrina Azman;* ***draft manuscript preparation:*** *Muhammad Danish Aizam Ismayudin, Nor Najmi Hakimi Nor Azman, Nur Amirah Sabrina Azman, Mohd Hadri Mohamed Nor. All authors reviewed the results and approved the final version of the manuscript.*

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