Solar Powered Seed Sprayer Machine

Ammar A.M. Al-Talib¹, Yap Chee Xian², Ain Atiqa³, Nor Fazila Abdullah⁴

Department of Mechanical and Mechatronics, Faculty of Engineering, Technology and Built Environment, UCSI University, 56000 Kuala Lumpur, Malaysia

E-mail: ammart@ucsiuniversity.edu.my, 1001954697@student.ucsiuniversity.edu.my, ainatiqa@ucsiuniversity.edu.my, norfa@ucsiuniversity.edu.my

Abstract

The main objective of this project is to fabricate a complete functional seed sprayer machine which is fully powered by solar energy. The solar seed sprayer machine should be able to spray different types of vegetable seeds. Further analysis about the performance has been conducted through the seed amount sprayed over time and area covered by the machine. Solar energy is used as the power supply for the machine. Wireless communication is used to remotely control the machine, and the 3D printing technology is used to assist in the fabrication of required components. The solar seed sprayer machine under research is composed of four main systems. The remote driving system, solar charging system, seed storage dispenser system, and impeller spreader system. Different experiments have been conducted to assess the performance of the machine. The performance of machine is indicated through the capability of machine on spreading different types of seeds with various size and shape. The spread seed count has been also tested as well with the area covered by the machine.

Keywords: Agriculture, Solar Powered, Seed Spreader Machine, Remote Controlled

1. Introduction

Agriculture is the practice of cultivating plants and livestock [1]. Growing crops is one of the most important activities through centuries. To increase efficiency of growing crops, tools were developed to save time and efforts in agriculture [2]. From the combination of tools and animals to modern machinery to fulfill the growing food demand by huge population of human society. In the twentieth century, industrial agriculture was developed to dominate agriculture output to society [3]. The technology of industrial agriculture including the agriculture machinery, genetic technology, and synthetic fertilizers. Till today, developing on agriculture machinery continue to fulfill the future demand of the world.

In this era, most common agriculture machinery are tractors powered by fuel. However, fuel powered machinery is not sustainable as fuel is one of the finite resources which is causing pollution to the environment. During the combustion of fuel, air pollutants such as carbon dioxide and nitrogen dioxide are emitted to the air and being harmful to the environment and life beings on earth. To solve this issue, this project aims to develop a seed sprayer machine that is purely powered by solar energy.

2. Methodology and Experimental Setup

This project focus on the broadcasting as it possesses the highest efficiency of seed sowing for those crop that does not require singular space [4]. Crops that are suitable with broadcasting method including wheat, corn, lettuce, carrot, and more. Further research was done on the principle of broadcasting, working system of ordinary broadcast spreader, and every part of broadcast spreader. Broadcast spreader is an equipment that spread the seed over the field using centrifugal force [5]. Seeds are stored in a hopper positioned above a spinning disk. The spinning disk rotates at high rotation speed. When seed drops from the hopper and fall on the spinning disk, the centrifugal force generated by the spinning disk will throw the seed out for a distance [6].

The seed sprayer machine is purely powered by solar energy. Photovoltaic is the conversion of light into electricity using semi conducting materials [7]. With an additional solar charge controller, photovoltaic...
The circuit used for the solar energy charging control system. After the solar charging system is installed, seed storage container has been built using 12mm plywood sprayed with waterproof layer, the dispenser mechanism is designed based on a cereal dispenser design [10]. By rotating a spinning paddle, the material in the storage container will be dispensed. The dispenser mechanism was 3D modeled and printed. Lastly, the impeller spreader system has also been modeled and printed. The electric motor used in dispenser system has a rotation speed of 40 rpm while the impeller spreader system has a rotation speed of 280 rpm. By attaching a spur gear set, the rotation speed of dispenser mechanism has been increased to 60 rpm and the rotation speed of impeller spreader system is increased to 700 rpm.

The fabrication work of the solar seed sprayer machine has started with 3D modelling design using CAD software. The popular CAD software, Auto-desk Inventor, has been used to complete all the 3D modelling for all parts needed in the proposed solar seed sprayer machine. The fabrication process has strictly followed the model designed in CAD software. Calculations are done to analyze the expected performance of the solar seed sprayer machine.

The solar charging system has been tested before installation. The solar power system is operating at 12V constant voltage to power the whole system of solar seed sprayer machine. The solar panel has a maximum power of 20W with 18V working voltage. Calculations are showing that a 12V-7Ah lead acid battery discharged to 50%, will take about 4 hours to be fully recharged.
3. Results and discussion

To test the seed spreading, ten different types of seeds and beans are prepared with same weight and dispensed by the machine. All the test using constant weight, 100g. The performance of the machine has been observed and recorded in Table 1 shown.

From Table 1, it can be observed that most of the seeds and beans are able to be dispensed but some are occasionally stuck. This can be attributed to the design flaw of dispenser mechanism; the seed will occasionally stick in between the edge of spinning paddle and the wall. As the torque of electric motor is 4.5kg.cm, the torque is not enough to overcome the resistance. However, with flow rate controlled, most of the seeds can be dispensed except the large ones such as the pumpkin seeds and the chickpeas. Further modification may be done to overcome these issues.

The next set of experiments are conducted to evaluate the seed dispense rate. The dispenser mechanism is switched on for 10 second and the seeds dispensed are collected. The collected seeds are weighted and recorded. Fig. 4 is showing the results.

Table 1 Capability of Seed Sprayer Machine on Different Types of Seeds

<table>
<thead>
<tr>
<th>Types of seeds</th>
<th>Size &amp; Shape</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sesame Seed</td>
<td>Dispense smoothly and seeds leaked when the machine was not operated.</td>
<td></td>
</tr>
<tr>
<td>Wheat Seed</td>
<td>Working but occasionally stuck</td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td>Dispense smoothly</td>
<td></td>
</tr>
<tr>
<td>Cracked Corn</td>
<td>Dispense smoothly</td>
<td></td>
</tr>
<tr>
<td>Pumpkin Seed</td>
<td>Stuck and may crush the seed</td>
<td></td>
</tr>
<tr>
<td>Green Bean</td>
<td>Dispense smoothly</td>
<td></td>
</tr>
<tr>
<td>Red Bean</td>
<td>Working but occasionally stuck</td>
<td></td>
</tr>
<tr>
<td>Soybean</td>
<td>Working but occasionally stuck</td>
<td></td>
</tr>
<tr>
<td>White Bean</td>
<td>Working but occasionally stuck</td>
<td></td>
</tr>
<tr>
<td>Chickpeas</td>
<td>Totally stuck in mechanism</td>
<td></td>
</tr>
</tbody>
</table>

The results have indicated that the average dispense rate of the machine is approximately 38g/sec at the maximum motor speed. The last set of experiments have been conducted to test the spreading area that can be covered by the machine. Different distances of 0.5, 1.0, 1.5, 2 meters from the machine are chosen. The machine has run for 10 seconds, and the seed count is recorded. The experiment has been repeated at
three different attempts and the average outcome is considered.

The most effective distance is 0.5 metre from the machine and the maximum distance is 2.5 metre from the machine. Since the seed spraying is taking a circular pattern with the machine at the center, the effective area covered by the machine is approximately 3.14 m². Fig. 5 is showing the average outcome of seed spreading coverage area.

4. Conclusion

The proposed seed spreading machine has shown successful outcome and achieving the objectives of this project. The solar seed sprayer machine has been purely powered by solar energy. The machine is capable to dispense most of the seeds and beans with small and medium size, the maximum spreading rate achieved is 1353 seed count per second, and the area covered by the machine is 3.14 m² along its running way.

The machine can be considered as a successful implementation of the sustainable development goals (SDG’s) in applying renewable energy for agriculture and fighting against poverty.

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Ms. Nor Fazilah Abdullah

She received her Bachelor’s degree in aerospace engineering (Hons) from IIUM, Gombak in 2010 and her Master’s degree in Mechanical Engineering from UKM, Bangi in 2015. Currently she is pursuing Doctoral of Philosophy programme at UCSI University, Kuala Lumpur. Her research interest in bio-based nanoparticles materials.