Solar Powered Seed Sprayer Machine

Ammar A.M. Al- Talib[1], Yap Chee Xian[2], Ain Atiqa[3], Nor Fazilah Abdullah[4]
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 fulfil 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 fulfil 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

system could be used to generate electricity and stored in rechargeable battery. However, the voltage and current generated by the solar panel are floating depending on the sunlight. Thus, solar charge controller is used to avoid battery damage due to excessive charging or discharging [8].

To achieve remote control feature of solar seed sprayer machine, research is done on the wireless communication. Some common wireless communication method includes radio frequency, infrared, WiFi, and Bluetooth. WiFi and radio frequency are implemented in the project to control the solar seed sprayer machine remotely [9].

Fig. 1 is showing the circuit used for the solar energy charging control system.

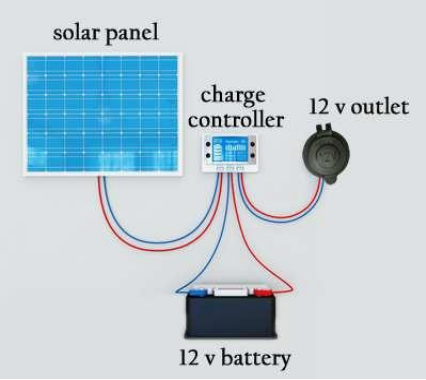

Fig. 1 The circuit used for the solar energy charging control system

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.

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.

Fig. 2 and 3 are showing the schematic diagram of the system and the fabricated prototype. Experiments has been conducted to test the performance of the proposed solar seed sprayer machine. Three different sets of experiments are conducted to test the functionality, the efficiency, and the area that could be covered by machine. Different types of seeds and beans with varies size and shape are prepared and dispensed by the machine.

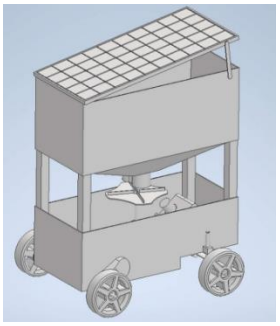

Fig. 2 The schematic diagram of the machine

Fig. 3 The testing prototype

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 Table1 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.

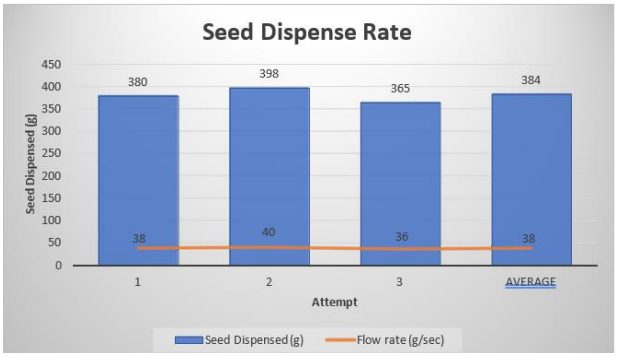

Fig. 4 Seed dispense rate experiment data

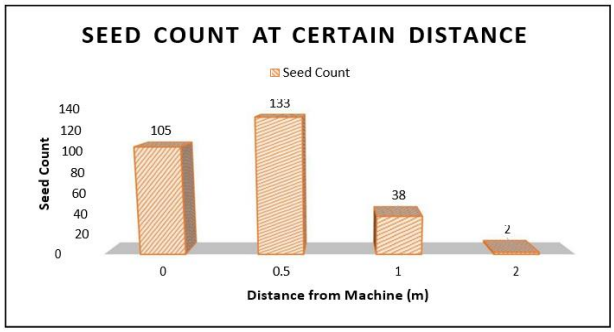

Fig. 5 Average Outcome of seed spreading area

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

Types of seeds	Size & Shape	Potential
Sesame Seed		Dispense smoothly and seeds leaked when the machine was not operated.
Wheat Seed		Working but occasionally stuck
Rice		Dispense smoothly
Cracked Corn		Dispense smoothly
Pumpkin Seed		Stuck and may crush the seed
Green Bean		Dispense smoothly
Red Bean		Working but occasionally stuck
Soybean		Working but occasionally stuck
White Bean		Working but occasionally stuck
Chickpeas		Totally stuck in mechanism

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 m^2. 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 m^2 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.

Acknowledgment

The authors would like to express the gratitude towards the school of engineering at UCSI University for the support throughout the research. Special thanks would be extended to CERVIE office at UCSI University for the endless support to research.

References

1. Agriculture: definition and overview. (2014). Harris, D.R. & Fuller, D.Q.
2. Food and Agriculture Organization of the United Nations.
3. Lichtenberg, E. (2002). Agriculture and Environment. Handbook of Agriculture Economics,2,1249-1313.
4. Luna, T., Wilkinson, K. M., & Dumroese, R. K. (1949). Seed germination and sowing options. Nursery manual for native plants: A guide for tribal nurseries, 1, 133-151.
5. Balfour, J. R., & Shaw, M. (2011). Introduction to photovoltaic system design. Jones & Bartlett Publishers. Peter Grandics (2013).
6. New Concepts for the Reversal of Gravity and Time and Some Practical Derivations,
7. Solar Energy Perspective: Executive Summary. (13 January 2012). International Energy Agency, 2011.
8. Kannan, N., & Vakeesan, D. (2016). Solar energy for future world: -A review. Renewable and Sustainable Energy Reviews, 62, 1092-1105.
9. What is wireless communications? Everything you need to know, Chuck Moozakis & Sean Michael Kerner, (2022).
10. An automated cereal/grain dispenser, S.M. Karmusel, Afrin Momin, Jui Paranjape , Snehal Patil , Ankita Sawant, International Journal of Research in Engineering and Science (IJRES) ISSN (Online): 2320-9364, ISSN (Print): 2320-9356, Volume 9 Issue 5 ǁ 2021 ǁ PP. 38-43.

Authors Introduction

Ammar Abdulaziz Al Talib

Dr. Ammar Al Talib has finished his B.Sc and M.Sc degrees in Mechanical Engineering from the University of Mosul/Iraq. He has finished his Ph.D degree from UPM University / Malaysia. He is also a Chartered Engineer and Member of the Institute of Mechanical Engineers / UK. (CEng. MIMechE). He has developed all the Postgraduate Programs at the Faculty of Engineering at UCSI University / Malaysia and worked as the Head of Postgraduate and Research department at the same faculty for the years 2010-2018.

Mr. Yap Chee Xian

Yap Chee Xian is currently further his Bachelor's Degree in Mechanical Engineering at UCSI University, Kuala Lumpur. His field of research is renewable energy.

Ms. Ain Atiqa

She received her Master's degree from the Faculty of Electronic & Computer Engineering, Universiti Teknikal Malaysia Melaka, Malaysia in 2017. She is currently a Tutor under department of Mechanical and Mechatronics Engineering, UCSI University, Kuala Lumpur. Her field of research is renewable energy.

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.