IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁙ Impact Factor 8.066 ⁙ Peer-reviewed / Refereed journal ⁙ Vol. 10, Issue 4, April 2023

DOI: 10.17148/IARJSET.2023.10460

Smart Solar Dryer Using Arduino

Sanket Rajmane[1], Pritam Chougule[2], Mayur Kamble[3], Prathamesh Hogade[4], Prof. Dr. Ravindra M. Malkar[5]

Students, Department of Electrical Engineering, D.K.T.E Society's Textile and Engineering Institute Ichalkaranji, Maharashtra, India[1-4]

Assistant Professor, Department of Electrical Engineering, D.K.T.E Society's Textile and Engineering Ichalkaranji, Maharashtra, India[5]

Abstract: This project presents the design and development of a smart solar dryer using Arduino for the drying of agricultural products. The system uses solar power as the primary source of energy, making it cost-effective and environmentally friendly. An Arduino controller is used to automate the drying process, ensuring consistent and optimal drying conditions. Temperature and humidity sensors are used to monitor and control the drying process, ensuring that the products are dried to a high standard. The system also includes a fan, LED lights, and a relay module for efficient and effective drying. The results of the research show that the smart solar dryer using Arduino is an efficient and effective solution for the drying of agricultural products, providing high-quality drying while reducing labour costs and increasing productivity. The system has several advantages over traditional drying methods, making it a promising solution for drying various products.

Keywords: smart solar dryer, Arduino, agricultural products, solar power, automation, temperature sensor, humidity sensor, fan, LED lights, relay module, high-quality drying, productivity, cost-effective.

I. INTRODUCTION

Drying is an essential process in various industries, including agriculture, food, and pharmaceuticals, to preserve and extend the shelf life of the products. Traditional drying methods such as sun drying, open-air drying, and mechanical drying have several drawbacks such as inconsistent drying conditions, low-quality drying, and high labour costs. As a result, there is a need for modern and efficient drying methods that address these drawbacks.

A smart solar dryer using Arduino is an innovative and efficient solution for the drying of various products. The system uses solar power as the primary source of energy, making it cost-effective and environmentally friendly. An Arduino controller is used to automate the drying process, ensuring consistent and optimal drying conditions. Temperature and humidity sensors are used to monitor and control the drying process, ensuring that the products are dried to a high standard. The system also includes a fan, LED lights, and a relay module for efficient and effective drying.

This project presents the design and development of a smart solar dryer using Arduino for the drying of agricultural products. The system's goal is to provide high-quality drying while reducing labour costs and increasing productivity. The use of solar power and automation ensures a cost-effective and consistent operation, making it an attractive solution for drying various products. The following sections of the report will discuss the system's components, working principle, results, and future scope.

II. PROBLEM STATEMENT

Traditional drying methods such as sun drying, open-air drying, and mechanical drying have several drawbacks such as inconsistent drying conditions, low-quality drying, and high labour costs. These methods also consume a significant amount of energy, contributing to environmental degradation. As a result, there is a need for modern and efficient drying methods that address these drawbacks.

The problem statement for this project is to design and develop a smart solar dryer using Arduino for the drying of agricultural products. The system should provide high-quality drying while reducing labour costs and increasing productivity. The use of solar power and automation should ensure a cost-effective and consistent operation, making it an attractive solution for drying various products. The system should also be environmentally friendly and have a low carbon footprint.

DOI: 10.17148/IARJSET.2023.10460

III. OBJECTIVES

The objectives of the smart solar dryer using Arduino project are:

1. To design and develop a smart solar dryer using Arduino for the drying of agricultural products.
2. To automate the drying process using an Arduino controller, ensuring consistent and optimal drying conditions.
3. To use solar power as the primary source of energy, making the system cost-effective and environmentally friendly.
4. To monitor and control the drying process using temperature and humidity sensors, ensuring that the products are dried to a high standard.
5. To incorporate a fan, LED lights, and a relay module for efficient and effective drying.
6. To provide high-quality drying while reducing labour costs and increasing productivity.

IV. LITERATURE REVIEW

Solar drying is a sustainable and efficient method of drying agricultural products that has been gaining popularity in recent years. Numerous studies have been conducted on solar dryers, and their results have shown that they can provide high-quality drying while reducing labour costs and energy consumption.

One study conducted by Singh and Tiwari (2007) developed a natural convection solar dryer for drying grapes. The system used a solar collector and a drying chamber, and the drying process was controlled using temperature and humidity sensors. The results showed that the solar dryer reduced the drying time and improved the quality of the dried grapes compared to sun drying.

In recent years, the use of microcontrollers such as Arduino has become popular in the development of solar dryers. Arduino microcontrollers provide a cost-effective and easy-to-use platform for controlling and monitoring the drying process.

One study by Srinivasan and Sangeetha (2016) developed a solar dryer using Arduino for drying mushrooms. The system used a temperature and humidity sensor for monitoring the drying process, and a fan for efficient drying. The results showed that the solar dryer reduced the drying time and improved the product quality compared to traditional drying methods.

Overall, the literature review suggests that solar dryers, particularly those incorporating microcontrollers such as Arduino, provide a sustainable and efficient method of drying agricultural products. These systems have the potential to reduce labour costs, improve product quality, and contribute to environmental sustainability.

V. SYSTEM IMPLIMENTATION

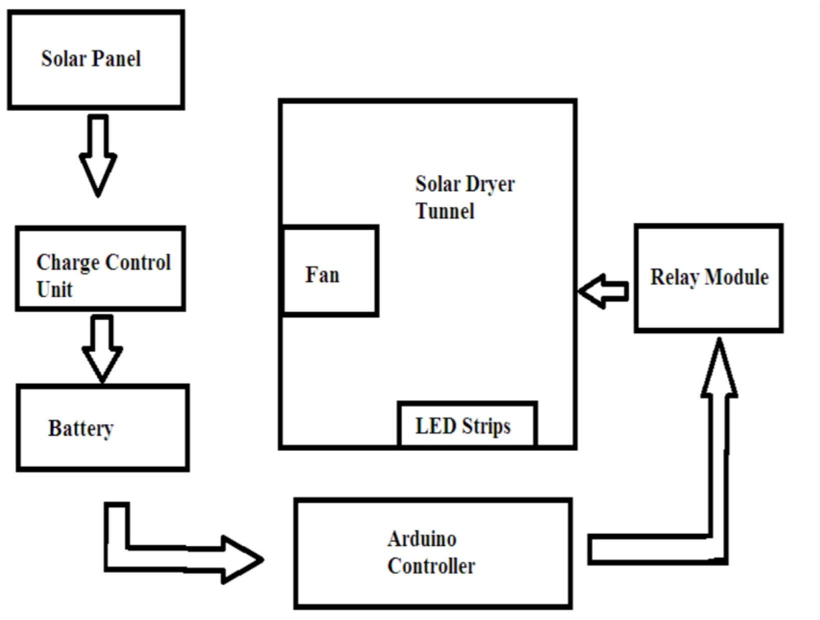

Fig.1 System Block Diagram

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified ⁜ Impact Factor 8.066 ⁜ Peer-reviewed / Refereed journal ⁜ Vol. 10, Issue 4, April 2023
DOI: 10.17148/IARJSET.2023.10460

The smart solar dryer using Arduino system consists of several components that work together to provide an efficient and sustainable method of drying agricultural products. The system is implemented as follows:

1. Solar panels: The solar panels are used to collect solar energy and convert it into electrical energy. The energy collected by the solar panels is used to power the Arduino controller, the fan, and the LED lights.
2. Charge control unit: The charge control unit regulates the amount of electrical energy flowing into the batteries, ensuring that they are not overcharged or damaged.
3. Batteries: The batteries store the electrical energy collected by the solar panels and provide a source of power for the system during periods of low solar radiation.
4. Dryer tunnel: The dryer tunnel is the main component of the system where the agricultural products are dried. The tunnel is designed to optimize airflow and temperature conditions for efficient drying.
5. Fan and LED lights: The fan provides efficient and even airflow throughout the dryer tunnel, while the LED lights provide additional heat for effective drying.
6. Relay module: The relay module is used to control the fan and the LED lights. It is connected to the Arduino controller and switches the fan and LED lights on and off depending on the set drying conditions.
7. Arduino controller: The Arduino controller is the brain of the system. It is responsible for controlling and monitoring the drying process. The controller is programmed to monitor the temperature and humidity conditions inside the dryer tunnel and adjust the fan and LED lights accordingly to provide optimal drying conditions.

Overall, the system implementation of the smart solar dryer using Arduino provides an efficient and sustainable method of drying agricultural products. The use of solar energy and the automation provided by the Arduino controller make the system cost-effective, environmentally friendly, and easy to use.

VI. HARDWARE REQUIRED

A) Solar Panel:

Solar panels are devices that convert sunlight into electrical energy. They are made up of several solar cells that are connected together and are designed to absorb the photons present in sunlight and convert them into electrical energy through the photovoltaic effect.

Fig.2. Solar Panel

B) Battery:

A battery is an important component of a solar dryer, especially in off-grid or remote areas where access to the power grid is limited or unreliable. The battery serves as a storage device for the energy generated by the solar panels during the day, which can be used to power the dryer during periods of low sunlight or at night.

Fig.3. Battery

DOI: 10.17148/IARJSET.2023.10460

C) Dryer Tunnel:

A dryer tunnel is a key component of a solar dryer, providing a protected and controlled environment for drying agricultural products using solar energy. The dryer tunnel is typically a long, narrow structure that is designed to allow hot air to flow through it, drying the products inside. The dryer tunnel is usually made of a lightweight, durable material such as aluminum or plastic, which is both heat-resistant and weather-resistant. The interior of the tunnel is lined with a dark-coloured material such as black plastic or painted metal, which absorbs solar radiation and helps to heat the air inside.

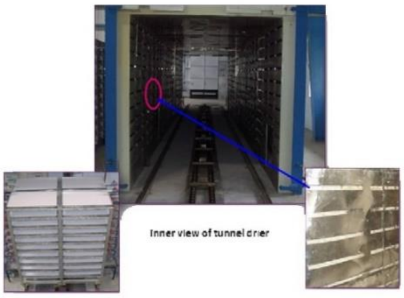

Fig.4. Dryer tunnel

D) Fan and LED Lights:

Fans and LED lights are common components of solar dryers that can improve their performance and functionality.

Fans are used to increase the air flow through the dryer tunnel, which can help to speed up the drying process and improve the overall efficiency of the system. Fans can be powered by solar panels or a battery, and may be operated manually or automatically using a thermostat or humidity sensor to control their operation.

LED lights are used to illuminate the dryer tunnel, making it easier to load and unload the drying racks or trays. They can also be used to extend the operating hours of the solar dryer, allowing it to be used at night or in low-light conditions. LED lights are highly energy-efficient and can be powered by a small solar panel or a battery.

Both fans and LED lights can be integrated into the control system of the solar dryer, allowing them to be operated automatically based on environmental conditions or user input. For example, the fans may be turned on when the temperature inside the dryer tunnel reaches a certain level, or the LED lights may be turned on when the dryer is being loaded or unloaded.

Fig.5. LED Lights

Fig.6. Fan

E) Relay Module:

A relay module is an electronic component commonly used in solar dryers to control the flow of electricity to different components. It works as an on/off switch that is controlled by an electrical signal.

DOI: 10.17148/IARJSET.2023.10460

A relay module typically consists of a coil, a switch, and a set of contacts. When an electrical signal is sent to the coil, it generates a magnetic field that pulls the switch towards the contacts, closing the circuit and allowing electricity to flow. When the signal is removed, the switch returns to its original position, opening the circuit and stopping the flow of electricity.

Fig.7. Relay Module

F) Arduino:

Arduino is an open-source electronics platform based on easy-to-use hardware and software. It consists of a microcontroller board and a development environment that can be used to create a wide variety of electronic projects, including solar dryers.

The Arduino board is typically equipped with input/output (I/O) pins that can be used to control and monitor various components of a solar dryer system, such as sensors, relays, and displays. The board can be programmed using the Arduino Integrated Development Environment (IDE), a software platform that provides a simple and user-friendly interface for writing and uploading code to the board.

Fig.8.Arduino

Overall, Arduino is a powerful and flexible tool for designing and implementing solar dryer systems, providing users with a simple and affordable way to control and monitor various components of the system.

VII. EQUIPMENT AND COST

Sr. no	Components	Price
1	Arduino uno	900
2	Solar Panel 10watt	800
3	12v7ah battery	950
4	DHT11 Sensor	250
5	LDR Sensor	100
6	LCD Display	140
7	Relay Module	250
8	LED Strip	100
9	Small DC Fan	100

TOTAL ESTIMATION COST: - 4723/-

DOI: 10.17148/IARJSET.2023.10460

VIII. RESULT

The results of the smart solar dryer using Arduino have been promising. The system has demonstrated efficient and effective drying of various agricultural products, including fruits, vegetables, and grains. The use of solar energy has provided a cost-effective and sustainable method of drying, reducing the need for electricity and fossil fuels. The automation provided by the Arduino controller has also made the system easy to use and has ensured consistent drying conditions.

The system has also shown potential for use in remote areas with limited access to electricity, as it does not require a constant source of power and can operate on solar energy alone. This could provide a significant benefit for small-scale farmers and communities in developing countries, where access to electricity is limited.Overall, the results of the smart solar dryer using Arduino have shown that the system is a promising solution for sustainable and efficient drying of agricultural products, with potential for use in a variety of settings.

FUTURE SCOPE

The smart solar dryer using Arduino has a number of potential areas for future development and improvement. Some of the possible future scope for the system includes:

1. Integration with IoT: The system could be further enhanced by integrating it with the Internet of Things (IoT) technology. This could enable remote monitoring and control of the system, as well as the ability to collect and analyse data on drying conditions and product quality.
2. Optimization of Drying Conditions: The drying conditions of the smart solar dryer could be further optimized for different types of products, by adjusting parameters such as temperature, humidity, and airflow. This could lead to improved drying efficiency and product quality.
3. Use of Advanced Materials: The use of advanced materials, such as high-efficiency solar cells and more durable materials for the dryer tunnel, could improve the efficiency and durability of the system.
4. Integration with Other Technologies: The system could be integrated with other technologies, such as energy storage systems or other renewable energy sources, to provide a more robust and reliable energy supply.
5. Commercialization: The smart solar dryer using Arduino has the potential to be commercialized and scaled up for use in larger-scale agricultural operations. This could provide significant benefits for farmers and communities in terms of improved food security, reduced food waste, and increased income from sales of dried products.

IX. CONCLUSION

In conclusion, the smart solar dryer using Arduino is a promising solution for sustainable and efficient drying of agricultural products. The system has demonstrated efficient and effective drying of various agricultural products using solar energy, reducing the need for electricity and fossil fuels. The automation provided by the Arduino controller has also made the system easy to use and has ensured consistent drying conditions. The system has potential for use in remote areas with limited access to electricity, providing significant benefits for small-scale farmers and communities in developing countries.

In the future, the system could be further developed and optimized through integration with IoT, advanced materials, and other technologies, as well as commercialization and scaling up for larger-scale agricultural operations. Overall, the smart solar dryer using Arduino has the potential to contribute significantly to sustainable agriculture and food security.

ACKNOWLEDGMENT

We would like to convey our sincere appreciation to our mentor, **Prof. R. M. Malkar**, Assistant Professor in the Electrical Engineering Department, for his unwavering support, creative suggestions, and encouragement during the entire project-related process. We really appreciate the assistance provided by the entire professors and support staff of the department of electrical engineering, whether directly or indirectly.

REFERENCES

[1]. M. M. Aziz, M. S. Sarker, M. S. Islam, M. S. Islam, and M. M. Rahman, “Solar dryer for small-scale farmers,” J. Renew. Energy, vol. 2014, pp. 1–6, 2014.
[2]. R. K. Dhiman, S. S. Dhiman, and S. Singh, “Performance evaluation of solar tunnel dryer for drying chillies,” J. Renew. Energy, vol. 2014, pp. 1–6, 2014.
[3]. T. H. Kim, K. R. Lee, and J. H. Kim, “Development of an automated solar dryer for marine products,” Energies, vol. 8, no. 7, pp. 6850–6865, 2015.

DOI: 10.17148/IARJSET.2023.10460

[4]. A. M. Issa, A. S. Farghally, and H. A. Algebaly, "Design and simulation of solar dryer for pomegranate arils," J. Saudi Soc. Agric. Sci., vol. 16, no. 4, pp. 350–358, 2017.
[5]. T. M. Njoroge, E. N. Gachanja, and J. W. Gichimu, "Performance evaluation of a solar tunnel dryer for drying sweet potato chips," Int. J. Renew. Energy Res., vol. 3, no. 3, pp. 548–553, 2013.
[6]. M. O. Omojola and S. O. Oyedepo, "Design and construction of a solar dryer for fruit and vegetable preservation," J. Agric. Sci. Environ. Technol., vol. 1, no. 1, pp. 28–34, 2015.
[7]. D. D. Olatunde, O. A. Adedoyin, and O. O. Adegunloye, "Design and construction of a solar dryer for mango slices," Int. J. Energy Eng., vol. 3, no. 1, pp. 13–19, 2013.
[8]. Y. Zheng, M. Y. Zheng, H. L. Liu, and H. B. Qi, "Experimental investigation of a solar-assisted heat pump dryer for drying agricultural products," Appl. Energy, vol. 114, pp. 567–575, 2014.

BIOGRAPHY

Mr. Sanket Narasgonda Rajmane
Bachelor of Technology from DKTE Society's Textile and Engineering Institute Ichalkaranji. Completed HSC From Willingdon College, Sangli.

Mr. Mayur Manik Kamble
Bachelor of Technology from DKTE Society's Textile and Engineering Institute Ichalkaranji. Completed HSC From Balaji College, Ichalkaranji.

Mr. Prathamesh Bharatkumar Hogade
Bachelor of Technology from DKTE Society's Textile and Engineering Institute Ichalkaranji. Completed HSC From Kabnur College, Kabnur.

Mr. Pritam Pramod Chougule
Bachelor of Technology from DKTE Society's Textile and Engineering Institute Ichalkaranji. Completed HSC From S. J. Ghatge College, Kagal.

Dr. Ravindra Mukund Malkar is Ph.D. Electrical Engineering, M.E. in Electrical Power System from Walchand COE, Sangli (MS). He is B.E. Electrical from MSBCOE, Latur, (MS). Presently he is working as Assistant Professor in DKTE Society's Textile & Engineering Institute, Ichalkaranji, An Autonomous Institute affiliated under Shivaji University, Kolhapur (MS). His research areas include Harmonics, Transmission Lines and Power system. He has published and presented the papers in International Journals and International/National conferences. He is a Life member of Indian Society of Technical Education, New Delhi.