Integrating Solar-Powered Smart Cold Storage to Support Small Scale Farmers

[1]R. Angayarkanni, [2]R.Sobika, [3]B S Subha devi, [4]M L Vaishnavi
[1]Assistant Professor, [2,3,4]Student, Department of ECE,
K L N College of Engineering, Sivagangai district, Tamil Nadu, India

***Abstract*— To develop a low-cost and sustainable solution for small-scale farmers by integrating solar-powered smart cold storage. By harnessing solar energy, we can provide farmers with a reliable and environmentally friendly way to preserve their produce. The system will utilize solar panels to generate electricity, which will be stored in batteries to ensure a continuous power supply. Energy-efficient refrigeration units and smart monitoring systems will be implemented to optimize energy usage and maintain proper temperature levels. This approach will enable farmers to extend the shelf life of their fruits and vegetables, increase market opportunities, and ultimately improve their income.**
***Search terms*— ESP 32, Xh w12 09 Temperature sensor, Load cell sensor**

I. INTRODUCTION

Solar powered smart cold storage provides improved access to reducing post-harvest losses and minimizing food waste. By preserving agricultural produce, it helps to maintain quality and freshness, leading to expanded market opportunities for small scale farmers. Smart cold storage has the ability to connect to the internet through Wi-Fi to provide special features. It is a smart way of dealing with the stock or items present in the storage. It includes flexible user- controlled cooling options, and t his prototype uses a load cell sensor to identify the weight of the object. Additionally,this solution is environmentally friendly, using solar power to promote sustainability in farming. Using C/ C++ programming the weight of the object when placed the storage box is identified.

.

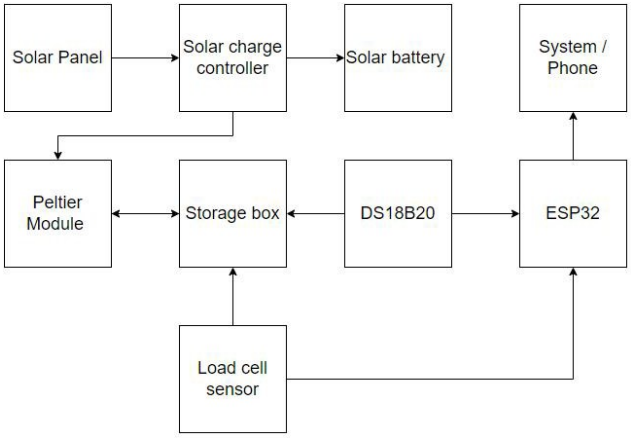

Fig. 1. Block diagram

Fig. 1 shows the main block diagram of the proposed proto type. Solar panel is where the sunlight is captured and converted into direct current (DC) electricity. Solar charge controller device protects the battery from overcharging by regulating the voltage and current from the solar panel. Solar battery stores the DC electricity generated by the solar panel.Peltier module is a device that can generate electricity, heat, or cooling by transferring heat from one side to the other. In this system, it is likely being used for generating electricity. Storage box is likely a container for the battery and other electronic implementation of the work.

The text at the bottom of the diagram indicates that the system also includes a DS18B20 temperature sensor and an ESP32 microcontroller. The DS18B20 is a digital temperature sensor, and the ESP32 is a microcontroller board that can be used to collect and record data from sensors. This suggests that the system is not only collecting data on solar

power generation, but also on temperature and possibly weight or force (from the load cell sensor). This data could then be used to monitor the system's performance and efficiency.
The electrical output given to Arduino, Arduino consists of data regarding temperature and weight of the products inside the storage box. Arduino is programmed so that the data present in it is given to ESP32. Using C + + programming the ESP32 analyses the data. An app is created to notify the user. The app consists of data base of product images of products present in the storage box, weight present on each weight scale and temperature inside the storage box.

B) PROCESS

1) Weight Identification

Weight identification involves identifying the weight of the object which is recognized in the process of object recognition. Each sample saved is specified with number, name and threshold value. These parameters are used in the weight identification. To identify the weight of the product placed in the storage box weight scales are used. These weight scales are constructed with load cell with a capacity of 5kgs. Whenever an object is placed on the weight scales, the resistance of strain gauge changes and produces proportional electrical output.

Fig. 2. Identification of weights

2) Temperature Identification

The temperature inside the storage box is also notified to the user through app. So as to make the user know regarding the temperature in the box. DS18B20 temperature sensor is used. It gives linear relationship between output voltage and Celsius temperature. It gives -55 to 125°C (-67°F to +257°F) 9 to 12-bit selectable resolution. Uses 1-Wire interface- requires only one digital pin for communication.

3) Notifications

After the identification of the data regarding the weight of the products and temperature inside the storage box the user is notified through an app. An app named Blynk IoT. Using this mobile application, the weight of the product identified. The information regarding the weight of the product, and temperature inside the storage box are updated automatically in the mobile Application.

METHODOLOGY

Firstly, we start by installing solar panels to harness the power of the sun. These panels generate electricity, which is used to power the entire cold storage facility. Next, we incorporate sensors into the system. One of the sensors we use is the DS18B20 Temperature sensor. This sensor helps maintain a constant temperature within the storage

facility, ensuring that the produce remains in optimal conditions. Additionally, we integrate a Load cell sensor into the system. This sensor allows us to accurately identify the weight of the objects stored in the cold storage, providing valuable information for inventory management and quality control. To enable effective monitoring and notification, we implement a notification process. This process involves sending notifications to the user regarding the temperature and weight of the objects stored in the facility. This ensures that farmers can stay informed about the conditions of their produce remotely. Overall, the methodology involves the installation of solar panels, the incorporation of temperature and load sensors, and the implementation of a notification process. By combining these elements, we can create a solar-powered smart cold storage system that supports small-scale farmers in preserving their produce effectively.

HARDWARE

ESP32

The ESP32 has a dual-core processor, supports Wi-Fi and Bluetooth connectivity, has low power consumption, offers GPIO pins for easy interfacing, includes an ADC for analog signal measurement, supports multiple communication protocols, has built-in security features, and can be programmed with Arduino IDE. It's a versatile microcontroller with many capabilities.

Fig. 4.1 Basic diagram of Esp32

DS18B20 Temperature sensor

The DS18B20 is a temperature sensor that can measure temperature with high accuracy using a digital interface. It is commonly used in various applications for temperature monitoring and control. The DS18B20 temperature sensor is a versatile device known for its accuracy and reliability. It features a digital interface, allowing for easy integration with microcontrollers and other digital systems. It has a wide temperature measurement range and offers high resolution, making it suitable for a variety of applications. Additionally, the DS18B20 is designed to be easy to use,

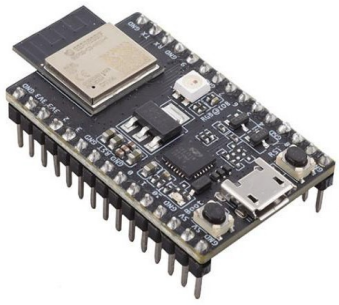

Fig. 4.2 Basic Diagram of DS18B20

with features like programmable resolution and unique 64-bit serial code for easy identification of multiple sensors on the same bus. Its low power consumption and compact size further enhance its appeal.

Load cell sensor

A load cell sensor is a device used to measure force or weight. It consists of a metal structure with strain gauges attached to it. When a force is applied to the load cell, the strain gauges deform, causing a change in electrical resistance. This change in resistance is converted into an electrical signal that can be measured and interpreted. Load cell sensors are commonly used in industries such as manufacturing, agriculture, and transportation for tasks like weighing objects, monitoring tension, or measuring force. They offer high accuracy and reliability, making them essential in various applications where precise force or weight measurements are required.

Solar Panel

A solar panel is a device that converts sunlight into electricity. It consists of multiple solar cells made from materials like silicon. When sunlight hits these cells, it excites the electrons, creating a flow of electrical current. This current can be used to power various devices or stored in batteries for later use. Solar panels are commonly used to generate renewable energy for homes, businesses, and even large-scale power plants. They are a sustainable and eco-friendly alternative to traditional energy sources, reducing reliance on fossil fuels and minimizing carbon emissions. Solar panels are becoming increasingly popular due to their long lifespan, low maintenance requirements, and the potential for cost savings on electricity bills.

Solar charge controller

A solar charge controller is an essential component in a solar power system. Its main function is to regulate the flow of electricity from the solar panels to the battery bank. The solar charge controller ensures that the batteries are charged efficiently and prevents overcharging or over-discharging, which can damage the batteries. It acts as a middleman between the solar panels and the batteries, optimizing the charging process and protecting the battery life.

Solar charge controllers come in different types, such as PWM (Pulse Width Modulation) and MPPT (Maximum Power Point Tracking). PWM controllers are more affordable and suitable for smaller systems, while MPPT controllers are more efficient and can harvest more power from the solar panels, making them ideal for larger systems.

Solar battery

A solar battery is a device that stores energy from the sun using solar panels. It's like a regular battery, but it gets charged by sunlight instead of electricity. This stored energy can then be used to power various devices like lights, appliances, or even charge your phone. It's a cool way to harness renewable energy and reduce our reliance on traditional power sources.

Peltier module with heat sink

Fig 4.3 Peltier module with heat sink

A Peltier module, also known as a thermoelectric cooler, is a small device that can generate both heat and cooling effects. It works based on the Peltier effect, which is the transfer of heat between two different materials when an electric current is passed through them. The Peltier module consists of two different semiconductor materials sandwiched together with a series of P-type and N- type elements. When an electric current is applied, one side of the module becomes hot, while the other side becomes cold. This allows it to be used for both heating and cooling purposes.To enhance the cooling effect and prevent overheating, a heat sink is usually attached to the hot side of the Peltier module. The heat sink helps to dissipate the heat generated by the module, allowing it to operate efficiently. It typically consists of metal fins or plates that increase the surface area for better heat dissipation. So, by using a Peltier module with a heat sink, you can create a cooling effect on one side while the other side gets hot. It's commonly used in applications like refrigeration, temperature control, and even in some portable coolers. fig 4.4 Hardware connection

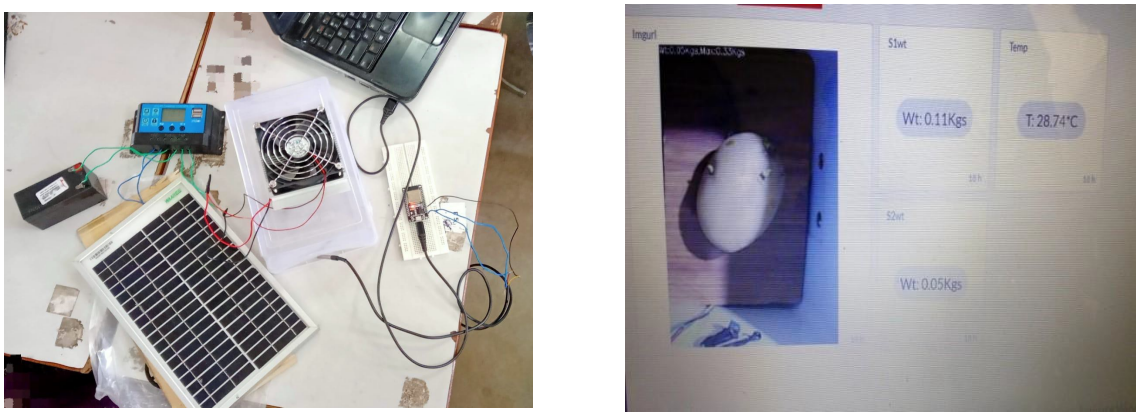

Fig 5.1 Display of Presence of the object and its weight

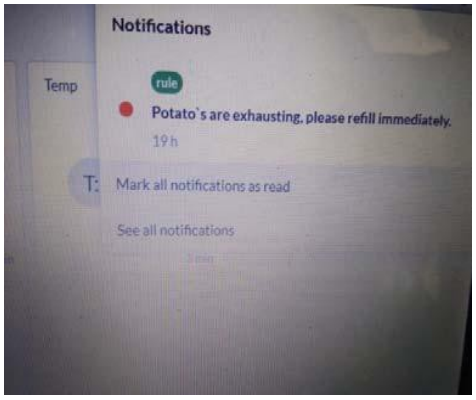

Fig 5.2. Alert message to the user

CONCLUSION

In this paper, we proposed and developed a prototype of an efficient, cost effective and accurate smart cold storage system using ESP32. Our smart cold storage system is more accurate and capable of notifying the detail about the weight of the object to the user. Temperature inside the storage system will also be indicated in the specified app through the user's smart phone. Overall this project promotes sustainability and reduces post-harvest losses. This

technology empowers farmers, improves their livelihoods, and contributes to the development of the agricultural sector as a whole.

REFERENCES

[1] Aysha Qaiser and Shoab A Khan, "Automation of Time and Attendance Using RFID System" IEEICET 2nd International Conference on Imaging Technology, 2006.

[2] Sato DCS & Labeling Worldwide, "The RFID Guidebook (Revision 8)", 2004

[3] Wayne Wolf, ''A Decade of Hardware/ Software Co-design'' IEEE 5th International Symposium Multimedia Software Engineering (MSE), 2003.

[4] C.Nagarajan and M.Madheswaran - 'Experimental verification and stability state space analysis of CLL-T Series Parallel Resonant Converter' - Journal of ELECTRICAL ENGINEERING, Vol.63 (6), pp.365-372, Dec.2012.

[5] C.Nagarajan and M.Madheswaran - 'Performance Analysis of LCL-T Resonant Converter with Fuzzy/PID Using State Space Analysis'- Springer, Electrical Engineering, Vol.93 (3), pp.167-178, September 2011.

[6] C.Nagarajan and M.Madheswaran - 'Stability Analysis of Series Parallel Resonant Converter with Fuzzy Logic Controller Using State Space Techniques'- Taylor & Francis, Electric Power Components and Systems, Vol.39 (8), pp.780-793, May 2011.

[7] C.Nagarajan and M.Madheswaran - 'Experimental Study and steady state stability analysis of CLL-T Series Parallel Resonant Converter with Fuzzy controller using State Space Analysis'- Iranian Journal of Electrical & Electronic Engineering, Vol.8 (3), pp.259-267, September 2012.

[8] Nagarajan C., Neelakrishnan G., Akila P., Fathima U., Sneha S. "Performance Analysis and Implementation of 89C51 Controller Based Solar Tracking System with Boost Converter" Journal of VLSI Design Tools & Technology. 2022; 12(2): 34–41p.

[9] C. Nagarajan, G.Neelakrishnan, R. Janani, S.Maithili, G. Ramya "Investigation on Fault Analysis for Power Transformers Using Adaptive Differential Relay" Asian Journal of Electrical Science, Vol.11 No.1, pp: 1-8, 2022.

[10] G.Neelakrishnan, K.Anandhakumar, A.Prathap, S.Prakash "Performance Estimation of cascaded h-bridge MLI for HEV using SVPWM" Suraj Punj Journal for Multidisciplinary Research, 2021, Volume 11, Issue 4, pp:750-756

[11] G.Neelakrishnan, S.N.Pruthika, P.T.Shalini, S.Soniya, "Perfromance Investigation of T-Source Inverter fed with Solar Cell" Suraj Punj Journal for Multidisciplinary Research, 2021, Volume 11, Issue 4, pp:744-749

[12] C.Nagarajan and M.Madheswaran, "Analysis and Simulation of LCL Series Resonant Full Bridge Converter Using PWM Technique with Load Independent Operation" has been presented in ICTES'08, a IEEE / IET International Conference organized by M.G.R.University, Chennai.Vol.no.1, pp.190-195, Dec.2007

[13] M Suganthi, N Ramesh, "Treatment of water using natural zeolite as membrane filter", Journal of Environmental Protection and Ecology, Volume 23, Issue 2, pp: 520-530,2022

[14] M Suganthi, N Ramesh, CT Sivakumar, K Vidhya, "Physiochemical Analysis of Ground Water used for Domestic needs in the Area of Perundurai in Erode District", International Research Journal of Multidisciplinary Technovation, pp: 630-635, 2019

[15] Claudio Talarico, Aseem Gupta, Ebenezer Peter, Jerzy W. Rozenblit, "Embedded System Engineering Using C/C++ Based Design Methodologies" 12th IEEE International Conference And Workshop on The Engineering of Computer-Base System, 2005.

[16] Yuanrui Zhang and Mahmut Kandemir, ''A Hardware-Software Codesign Strategy for LoopIntensive Applications'' IEEE 7th Symposium on Application Specific Processors (SASP), 2009