IOT Based Smart Food Dryer

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Abstract: The solar drying system utilizes solar energy to heat up air and to dry any food substance loaded, which is not only beneficial in that it reduces wastage of agricultural produce and helps in preservation of agricultural produce, but it also makes transportation of such dried produce easy and promotes the health and welfare of the people. This paper presents the design and construction of a domestic passive solar food dryer. The dryer is composed of solar collector (air heater) and a drying chamber containing fruits and vegitables trays both being integrated together. The air allowed in through air inlet is heated up in the solar collector and heaters through the drying chamber where it is utilized in drying (removing the moisture content from the food substance or agricultural produce loaded). The design was based on the hybrid system. which is more reliable system is obtained for proper design specification. Locally available materials were used for the construction, iron body of container(painted), inlet and outlet fans (air ventilation system), mild steel metal sheet and net trays for wastage.

Keywords: Solar drying; Solar collector; Agriculture produce; Optimum temperature.

I Introduction

Drying is one of the method of food preservation .Drying system preserve foods by removing enough moisture from food, the key is to remove spoilage .Drying of food, the key is to remove moisture as quickly as possible at a temperature that does not seriously affect the Flavour, texture and color of the food .Conventional method of drying such as sun Drying, hot air convection drying requires more time to completely dry the product.

In this paper, we designed a dryer for fast and efficient drying of agricultural products. we use a reduced pressure environment (vacuum) for drying the agricultural products which enables the liquid to evaporate without elevating the temperature. combined with heat vacuumcan be and effective method of drying. The smart dryer dries the products without losing its quality. The low cost of smart dryer makes it suitably for use in industrial as well as householdpurposes. The time required for drying is reduced as compared to conventional methods. The device mainly consists of a vacuum chamber, vacuum pump, heat source, temperature and humidity control system and some auxiliary systems. Compared with the conventional methods, this device just needs a small area and it can work under a completed indoor situationof natural environment. It shows high practical value and social economic benefits.

Drying is the oldest preservation technique of agricultural products and it is an energy intensive process. High prices and shortages of fossil fuels have increased the emphasis on using alternative renewable energy resources. Drying of agricultural products using renewable energy such as solar energy is environmental friendly and has less environmental impact.

Sun drying is a popular and economical method for drying of food materials in the developingcountries. But drying rate is very low and dependent on weather conditions. Inferior quality of sun-dried products is mainly due to uneven drying, mixing of dust and dirt, and contamination with insects and microorganisms.

Sometimes the whole amount of product is spoiled in adverse weather conditions. As an alternative to sun drying, solar drying is a promising alternative for drying of fruits and vegetables in developing countries. Mechanical drying, mainly used in industrialized countries, is not applicable to small farms in developing countries due to high investment and operating costs.

Solar energy for crop drying is environmental friendly and economically viable in developing countries. In natural convection solar dryers, the air flow is due to buoyancy-induced air pressure, while in forced convection

Solar drying is often differentiated from sun drying‖ by the use of equipment to collect the sun‘s radiation in order to harness the radiative energy for drying applications. Sun drying is a common farming and agricultural process in many countries, particularly where the outdoor temperaturereaches 30°C or higher. In many parts of South East Asia, spice s and herbs are routinely dried.However, weather conditions often preclude the use of sun drying because of spoilage due to rehydration during unexpected rainy days. Furthermore, any direct exposure to the sun during high temperature days might cause case hardening, where a hard shell develops on the outside ofthe agricultural products, trapping moisture inside. Therefore, the employment of solar dryer tapson the freely available sun energy while ensuring good product quality via judicious control of the radiative heat. Solar energy has been used throughout the world to dry products. Such is the diversity of solar dryers that commonly solar-dried products include grains, fruits, meat, vegetables and fish. A typical solar dryer improves upon the traditional open-air sun system in five important ways. It is more efficient. Since materials can be dried more quickly, less will be lost to spoilage Immediately after harvest.

This is especially true of products that require immediate drying suchas freshly harvested grain with high moisture content. In this way, a larger percentage of products Will be available for human consumption. Also, less of the harvest will be lost to marauding animals and insects since the products are in safely enclosed compartments. It is hygienic. Sincematerials are dried in a controlled environment, they are less likely to be contaminated by pests,and can be stored with less likelihood of the growth of toxic fungi. It is healthier. Drying materialsat optimum temperatures and in a shorter amount of time enables them to retain more of their nutritional value such as vitamin C. An added bonus is that products will look better, which enhances their marketability and hence provides better

Traditional drying / open sun drying system (OSD):

This is a traditional method for drying food items in this, the product is spread on ground in thin layer and directly exposed to solar radiation and dried up to safe moisture content. but in this type of drying method farmer facing some problems for example Dust. animals, over sun light, rain.

Drawbacks Of Open Sun Drying (OSD):

- Slow process.
- Reduction in quality of product due to insects, micro-organism growth.
- spoilage of product due to rain, heavy wind, dust ,birds and animals.

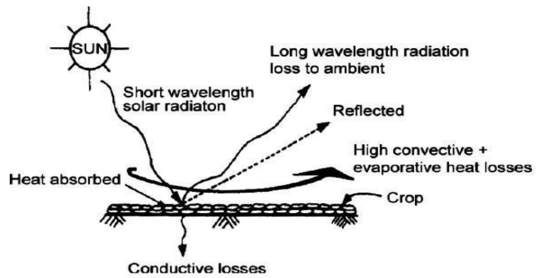

Fig.1 Sun Drying System

II Literature review

This involves the machinery to humidify and dry the paddy grains within the limited period of time. They used solar power as the energy source to two alternating batteries, the main source of energy in the system. It is programmed by the microcontroller to set the desired level of humidity and temperature according to the quantity of rice [1]. This method of drying is used to dry fruits with the help of microcontroller based system and also with the help of IR rays. Energy for this project is obtained from solar energy. Infrared rays are passed to hydrate the water content and blower is used for further drying [2]. The use of both solar and electrical energy so called hybrid solar energy. The air flow occurs inside the dryer by the motor fan arrangement and heating of substance is done by falling of the sunlight. Here the temperature is controlled by sensing the temperature and thus control the temperature of heating substance. Thus, it is a good example for future drying system [3]. The authors intended to implement a closed circuit which can monitor the utilization of electrical energy and its automatic control on it. The radio frequency signals emitted detects the electricity status in each room and power off the circuit when user leaves the room. A microcontroller is programmed to ensure safety measures [4]. This is the alternate method of drying the agricultural products under the sun with solar dryer which consist of a heating element. It is a cost-effective way and can be used in large scale by local people. The energy trapped by the absorbers is the main element of the system [5].

III System Design

In many parts of the world there is a growing awareness that renewable energy have an important role to play in extending technology to the farmer in developing countries to increase their productivity. Solar thermal technology is a technology that is rapidly gaining acceptance as an energy saving measure in agriculture application. It is preferred to other alternative sources of energy such as wind and shale, because it is abundant, inexhaustible, and non- polluting. Solar air heaters are simple devices to heat air by utilizing solar energy and employed in many applications requiring low to moderate temperature below 80 C, such as crop drying and space heating. Drying processes play an important role in the preservation of agricultural products.

They are defined as a process of moisture removal due to simultaneous heat and mass transfer. According to two types of water are present in food items; the chemically bound water and thephysically held water. In drying, it is only the physically held water that is removed. The most important reasons for the popularity of dried products are longer shelf-life, product diversity as well as substantial volume reduction. This could be expanded further with improvements in product quality and process applications. The application of dryers in developing countriescan reduce post-harvest losses and significantly contribute to the availability of food in these countries. Estimations of these losses are generally cited to be of the order of 40% but they can, under very adverse conditions, be nearly as high as 80%. A significant percentage of these losses are related to improper and/or untimely drying of foodstuffs such as cereal grains, pulses, tubers, meat, fish, etc.

The use of heat under regulated conditions to eliminate the water present in foods via evaporation to generate solid items is referred to as drying. Evaporation, on the other hand, produces concentrated liquid products. The primary goal of drying is to increase the shelf life of foods by lowering their in-water activity. In the absence of adequate water, microorganisms that cause food deterioration and decay, as well as numerous enzymes that induce undesirable changes in the chemical makeup of food, are unable to grow, proliferate, or operate

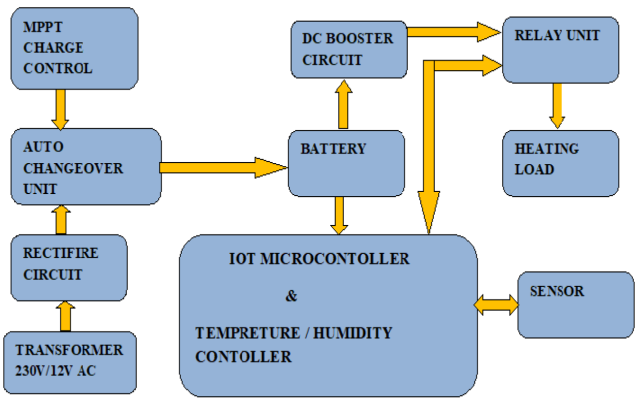

Fig.2 Block Diagram

Methodology:

In this study, a smart method that uses the drying kinetics of foods in the drying process has been developed. While developing the method, it was planned to use the moisture data in the drying environment regarding the drying kinetics. Using these data, drying curves were constructed for each food type. By using these curves during the drying process, the drying process is managed in real-time. In this way, drying can be made at the desired moisture rate and while this ratio is achieved, the total duration of the drying process can be calculated so the operation of the oven and thus the use of energy is optimized.

While developing the most suitable model for the experimental data in food drying, humidity in the environment was used instead of a continuous measurement of the mass of the dried material. Using moisture data has been preferred to provide an easier solution in industrial environments. There are precision sensors on the market that have been developed for the monitoring of humidity in industrial environments

There is a rising realisation in many areas of the world that renewable energy may help farmers in underdeveloped nations enhance their output by extending technology to them. Solar thermal technology is fast gaining favour as a cost-effective energy-saving technique in agriculture. Because it is plentiful, limitless, and nonpolluting, it is favoured above other alternative energy sources such as wind and shale. Solar air heaters are simple devices that use solar energy to heat air. They are used in a variety of applications that need a low to moderate temperature below 80 degrees Celsius, such as crop drying and room heating.

The preservation of agricultural goods relies heavily on drying techniques. They are characterised as a moisture removal technique including both heat and mass transport. Food items include two forms of water: chemically bonded water and physically held water, according to experts. Only the physically retained water is eliminated while drying. The appeal of dried products is mostly due to their extended shelf life, product diversity, and significant volume reduction. With advances in product quality and process applicability, this might be pushed much further. The use of dryers in poor nations can help to minimise post harvest losses and increase the availability of food in these areas. The losses are usually estimated to be on the order of 40%, but they might be as high as 80% in extreme circumstances. Proper and/or timely drying of commodities such as cereal grains, legumes, tubers, meat, fish, and so on accounts for a major portion of these losses.

Solar Source:

Solar energy is a powerful source of energy that can be used to heat, cool, and light homes and businesses. More energy from the sun falls on the earth in one hour than is used by everyone in the world in one year. A variety of technologies convert sunlight to usable energy for buildings. The most commonly used solar technologies for homes and businesses are solar photovoltaics for electricity, passive solar design for space heating and cooling, and solar water heating.

Businesses and industry use solar technologies to diversify their energy sources, improve efficiency, and save money. Energy developers and utilities use solar photovoltaic and concentrating solar power technologies to produce electricity on a massive scale to power cities and small towns.

MPPT Charge Controller:

The **maximum power point (MPP)** describes the point on a current voltage (I-V) curve at which the solar PV device generates the largest output i.e. where the product of current intensity (I) and voltage (V) is maximum. The MPP may change due to external factors such as temperature, light conditions and workmanship of the device. In order to ensure maximum power output (Pmax) of a solar PV device in view of these external factors, **maximum power output trackers (MPPT)** may be operated to regulate the resistance of the device.

Anyone familiar with the charging and discharging characteristics of the battery is familiar to the fact that the voltage of the battery varies with its charge content. As current flows from a high potential to low potential, the steeper the gradient or voltage difference, the greater is the **flow of current**.

AUTO CHANGEOVER UNIT

The project is designed to automatically supply continuous power to a load through one of the four sources of supply that are: solar, mains, generator, and inverter when any one of them is unavailable. Two switches are used for four respective sources. These are connected to a microcontroller of 8051

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family that provides input signals to it. Whenever a switch is pressed it shows the absence of that particular source. A relay driver is used that receives microcontroller generated output and switches that particular relay to provide continuous power supply. A lamp is used as a load for demonstration purpose which draws power from main. When main fails to supply power, automatically next available source is used say inverter. If inverter fails then the next one is used and so on

Dc Booster Circuit:

A boost converter (step-up converter) is a DC-to-DC power converter that steps up voltage (while stepping down current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) containing at least two semiconductors (a diode and a transistor) and at least one energy storage element: a capacitor, inductor, or the two in combination. (supplyvside filter).

To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input In this tutorial we will learn how to build and how a DC to DC boost converter works. The circuit is very basic using just one diode, an inductor and a capacitor. The switch will be a MOSFET transistor and to create the PWM signal we will use a 555 timer in the PWM configuration, boost adjustable controller or one Arduino NANO. But first let's study a little bit of theory. We have the Boost converter circuit in the next figure where we can see the switch, inductor capacitor and of course we add a load to the output.

Battery:

When the sulfuric acid dissolves, its molecules break up into positive hydrogen ions (2H+) and sulphate negative ions (SO4 —) and move freely. If the two electrodes are immersed in solutions and connected to DC supply then the hydrogen ions being positively charged and moved towards the electrodes and connected to the negative terminal of the supply. The SO4 — ions being negatively charged moved towards the electrodes connected to the positive terminal of the supply main (i.e., anode)

Arduino Micro-Controller:

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board -- you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

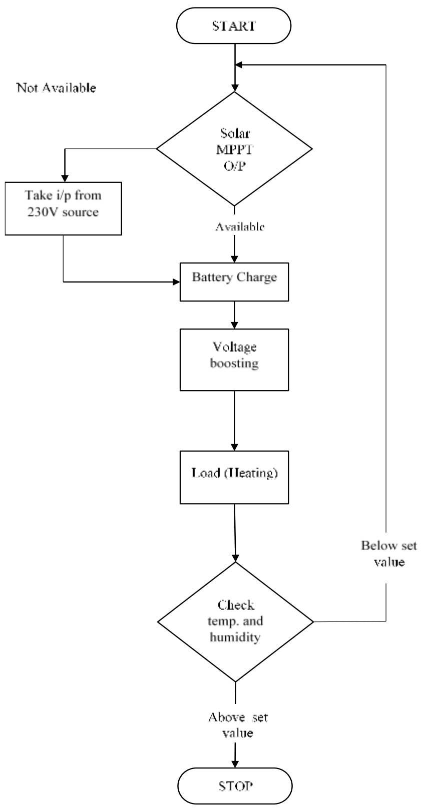

Fig. 3 Flow chart

IV Experimental Results

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Fig.4 Load box

Testing

In this image you can see heating element and air conditioning system is ON because we set the Tempreture limit is 32*C and that time container Tempreture is below 32*C so to maintain the Tempreture system is in ON Condition

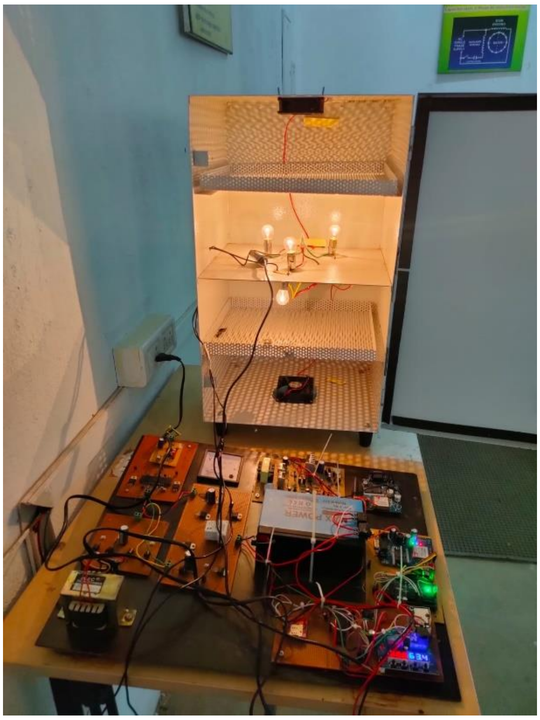

Fig. 5 Prototype model

Result

Our group tested this project and we put different ingredients in it and saw the time and temperature of drying and we got the following result.

Table 1 Results of hardware

Sr No	Food item	Sun Drying Time	IOT base Smart food Dryer time
1	Raw Cashew	2-3 days	6-7 Hours at 60-70*C temp
2	Chili paper	3-4 days	8-9 hours at 80*C
3	Yellow raisins	2-4 days	14 hours at above 50*C

V Conclusion

The developed smart system manages the drying process in real-time by using the humidity in the environment instead of weight together with the drying kinematics of the product is designed. So the complexity of the system is simplified. In addition to this, the system estimates the required duration to complete the drying process according to the input status of the products and gives feedback to the process owners. The model improves itself and can automatically control the process until the desired moisture is achieved. Since the duration of the drying process can be determined, the process owners can easily plan the before and after activities of the drying process.

In this process, the energy loss is also minimized by preventing the unnecessary opening and closing of the drying stages to measure the weight of the products. Finally, since the desired moisture level can be defined, unnecessary heating is prevented and thus energy is used optimally.

The capacity of the system developed in the project is limited. When systems with different capacities are desired to be developed or when uses other than full capacity in the existing system, a new problem arises that needs to be solved. This problem is the most appropriate positioning of the moisture sensors to be used in the oven. If the positioning is not optimal, the time estimates may be incorrect when the furnace first starts up. Also, deviations in drying rates may occur. As the next step, new studies can be made on furnace design and sensor positioning optimization.

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