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Automatic Solar Dryer

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Abstract-Solar drying is a renewable and environmentally friendly technology. Solar drying can be considered as an advancement of natural sun drying and it is a more efficient technique of utilizing solar energy.
Fruits are seasonal crop and get spoilt quickly. To make their usage efficient, they can be dried and preserved so that fruits can be used over a long period. The natural drying process has many drawbacks, such as requiring more time, large investment on space requirement and infrastructure for drying process, which cannot be afforded by a middle class farmer. The financial up gradation of a former in developed countries is possible by providing him the modern, automatic and low-cost fruit drying unit. This project describes a controlled environment which is suitable for small scale fruit drying process within a closed chamber, using Microcontroller. To start with, the sun rays are used to internally heat the fruit to remove the water content within the fruit. Then the air is blown inside the chamber to maintain the humidity below a specified level and exhaust the humid air out of the chamber.
Microcontroller is used to control the functions of heating, blowing the air, controlling the speed of exhaust fan and giving time indication & maintain constant temperature throughout the chamber. After the completion of the drying process a buzzer is activated for the duration of ten seconds to indicate the end of the drying process. A text message is also sent to the farmer through GSM to intimate him if he is not around. The graphs of time versus drying process obtained show that the automatic drying unit designed has worked as per the expectation by consuming less time compare to conventional drying process.

Keywords- Drier, GSM, Microcontroller, Sensors, Load cell.

I. INTRODUCTION

Sun drying is only possible in areas where, in an average year, the weather allows foods to be dried immediately after harvest. The main advantages of sun drying are low capital and operating costs and the fact that little expertise is required. The main disadvantages of this method are as follows: contamination, theft or damage by birds, rats or insects; slow or intermittent drying and no protection from rain or dew that wets the product, encourages mould growth and may result in a relatively high final moisture content; low and variable quality of products due to over - or under-drying; large areas of land needed for the shallow layers of food; laborious since the crop

must be turned, moved if it rains; direct exposure to sunlight reduces the quality (color and vitamin content) of some fruits and vegetables[1].Moreover, since sun drying depends on uncontrolled factors, production of uniform and standard products is not expected. The quality of sun dried foods can be improved by reducing the size of pieces to achieve faster drying and by drying on raised platforms, covered with cloth or netting to protect against insects and animals.

II. METHODOLOGY

The design used for fruit drying chamber needs the temperature to be maintained constant throughout the drying chamber and also removal of moisture content from the fruit. This automation process when completed is informed to the farmer. Solar energy is utilized for dehydrating the fruits .Over drying and under drying are harmful for agricultural products [2]. Over drying causes discoloration due to caramelization and reduction in nutritional value. On the other hand, under drying or slow drying results in deterioration of the food quality due to fungal and bacterial action.

Figure1. Solar cabinet dryer

The solar dryer chamber in its simple form comprises of a wooden box with certain length and width, insulated at its base and preferably at the sides and covered with a transparent roof .The inside surfaces of the box are coated with black paint and the product to be dried is kept in the trays made of wire mesh bottom. These trays are made up of metal coated with black pent loaded with product are kept through an open able door provided on the rear side of the drier. The air exit end of the dryer is raised and supported above the inlet side to provide a slope of some degrees to the horizontal, with the cover facing the south. Holes are provided on the upper sides of the dryer through which moist warm air removed as shown in Fig.1 The microcontroller is used and programmed to control and manage the overall process of the unit. Different fruits will have different temperatures to dry. Sensors are used to read the temperature in the cabinet connected to microcontroller. A display is use to see the process continuously for the temperature value. If the monitoring temperature is greater than the set temperature value, increase the speed of the fan else decreases. Once the process is completed generate the alarm and send SMS using GSM technique. The process of drying a wet object involves the transfer of heat to cause evaporation of the moisture. The rate of drying of fruit with an initial moisture content above 82 % during the early drying period is a function of external drying parameter that is, air temperature.

A cabinet dryer is a device that can dry a substance using a heat source. The source of heat is the largely available solar energy. It consists mainly of dryer chamber, ducting chamber and exhaust fan.

III. BLOCK DIAGRAM

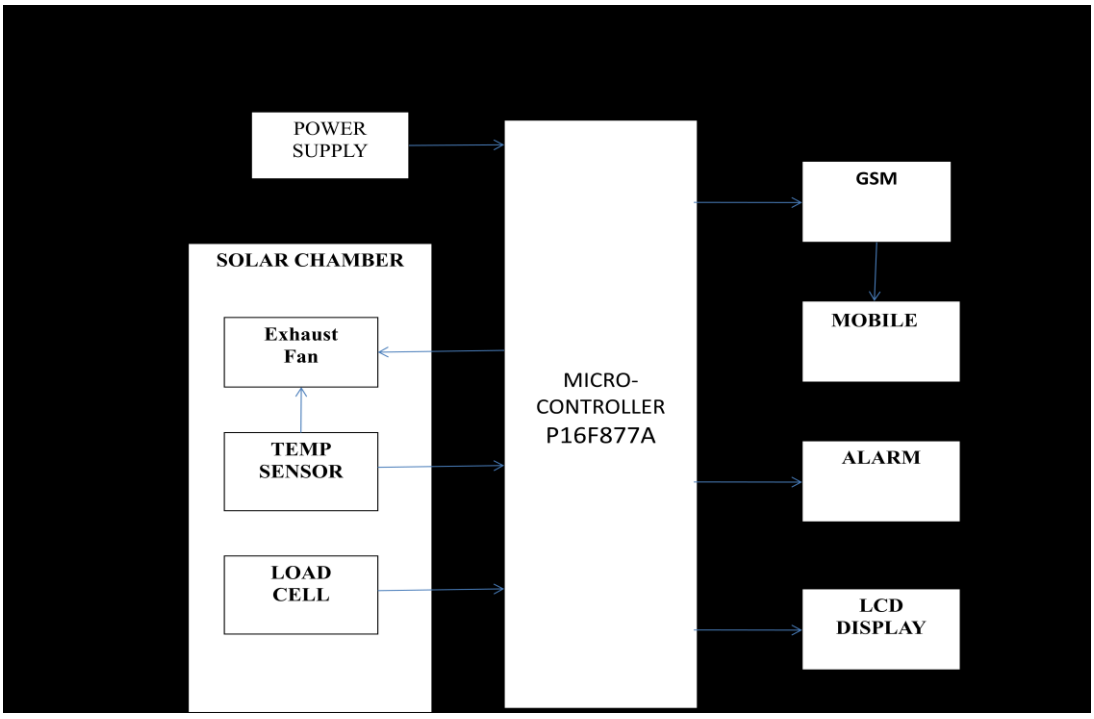

Figure2. Block diagram of solar dryer

IV. Circuit Diagram

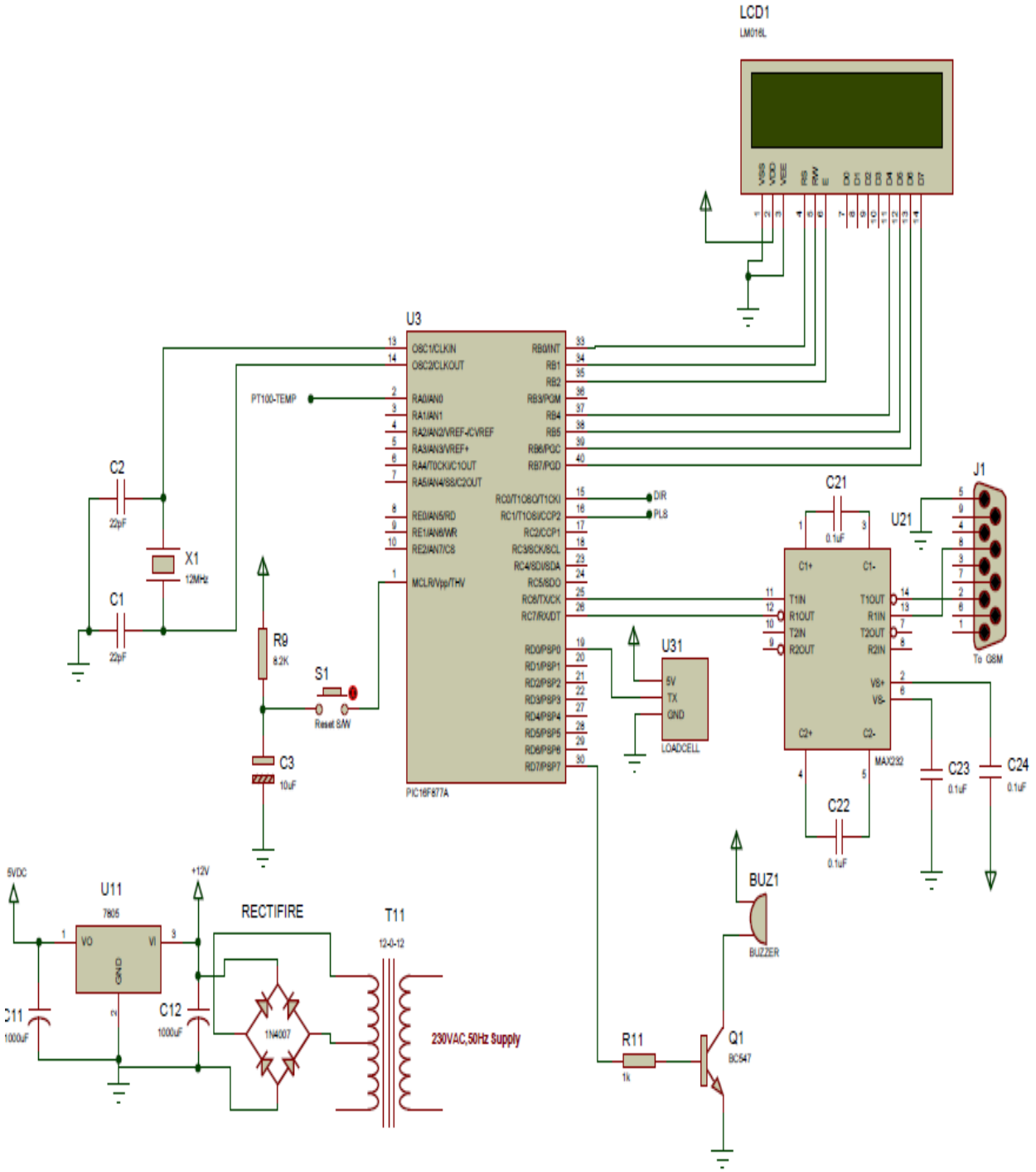

Figure3. Circuit diagram of solar dryer

4.1.Interfacing of PT100 and Fan with Controller:

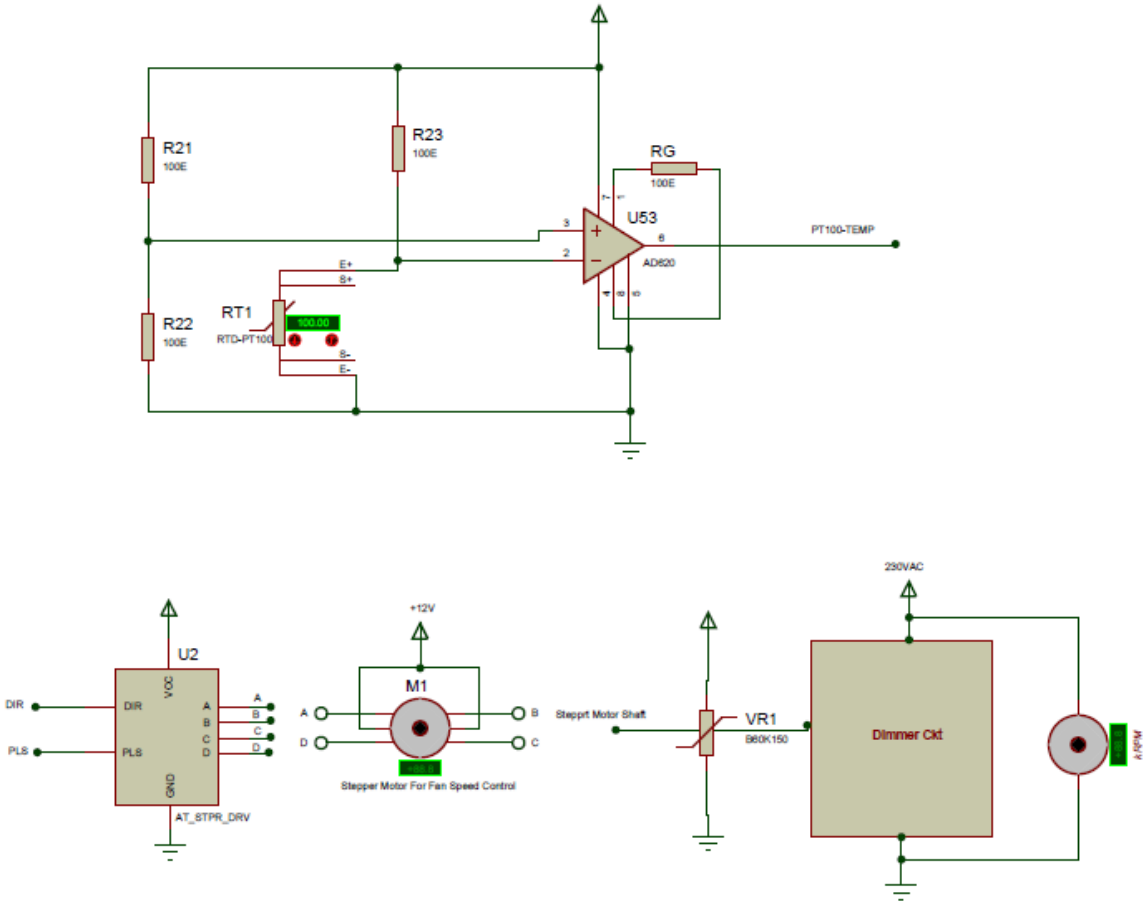

Figure4. Interfacing of PT100 and fan with controller

The 5V power supply given to the monitoring and controlling unit with microcontroller (PIC16F877A) as central console using basic full wave rectifier and regulator. Once unit is turn on, temperature is continuously sensed by temperature sensors i.e. PT100. The sensor are mounted in cabinet and interfaced with PIC16F877A microcontroller,

The microcontroller has 8 channel 10bit ADC with dedicate ADCON register for configures the functions of the analog input port pins[3]. This in turn helps to compare the reference chamber temperature and display on LCD connected to PIC16F877A microcontroller as shown in Based on comparison of reference temperature value and sensor value the fan will be run to glow the air in the chamber to maintain uniformity and reduce the chamber temperature, by automatically controlling speed of fan[3]. The hot air created in the chamber, passes over the trays where it comes into contact with the substance to be dried and carries away the moisture.

The humid air is thus expelled out from the chamber through a moisture exhaust. The load cell is used to measure the weight. Drying controlling and monitoring circuit diagram once the process is completed, generate the alarm by turning on buzzer circuit and send SMS to the farmer to indicate status of the drying process through GSM module which is interface with UART module of microcontroller.

V. RESULT

It was observed that automatic drying unit gives better performance in terms of drying rate compared to conventional method. The temperature to be maintained within the chamber depends on the initial contents of the fruits and the effect of temperature on the contents. The temperature and humidity are dependent on the user requirement. Humidity gradient to remove the water content in the fruit was varied by varying the fan speed. It was thus observed that the temperature gradient plays an important role in the initial period of the drying phase and the Humidity gradient plays an important role in the later part of the drying phase to retain the original flavor of the fruit and to avoid caramelization.

VI. CONCLUSION

The system requires lower space and minimal installation time, less time to dry the product (as compared to natural drying), is durable with minimal maintenance. Unit can be made available in varied capacities, depending on the effective tray area and user requirement. Dust does not come in contact with the produce thereby ensuring good quality of the dried product. The system can be made more economical by making a provision for drying variety of fruits in a single unit. This arrangement can be made possible by using sensor networks for various fruits. To make it economically viable for farmers, an application specific integrated circuit by embedding the digital circuit into a chip can be produced in a large scale.

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