

# Intelligent Fruit Drying System using Infrared Radiation Heating Mechanism

Dr. Madhukar S. Chavan<sup>1</sup>, Mr. Ketan V. Hulle<sup>2</sup>

<sup>1</sup>Professor, Electronics and Telecommunication Engg. Department, P.V.P.I.T. Budhgaon, Sangli. Maharashtra, India

<sup>2</sup>Student Electronics and Telecommunication Engg. Department, P.V.P.I.T. Budhgaon, Sangli.

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**Abstract - Drying is one of the traditional methods for food preservation. Drying of grapes produces raisins. Sun drying and shade drying methods need more space and there is possibility of contamination due to external environment conditions. Present days there Microwave (MW) dehydration, Automatic Solar fruit dryers and Infrared radiation dryers have been utilized for the grape drying process. In this paper modified technique of present grape drying method using IR radiation is suggested. It is distinctly different from conventional or natural drying. The infrared radiations accelerate drying process with a better control to achieve uniform drying and reduced drying time. The proposed system makes the use of vacuum chamber which is weather independent and improves the quality by maintaining texture and colour of raisins. The operation of the system makes use of nonconventional source of energy so it is cost effective. Efficient utilization of this system by the farmers will lead to profit optimization.**

**Key Words:** Grape drying, Infrared radiation, Controller, Vacuum chamber, Raisins

## 1. INTRODUCTION

In the drying method moisture content from the grapes is removed. In India, raisin is mostly produced in Sangli, Solapur and Nasik districts of Maharashtra and Bijapur district in Karnataka. Around 1.2 million tones of grapes are produced in India every year [1]. In India during raisin production shade drying, sun drying are the traditional type of drying methods used [2]. The quality of the raisins depends on size, texture, sugar content and type of drying method used. Certain Pre-treatments are made before the final drying process. In pre-treatment process bunches of grapes are dipped in Ethyl oleate (2%), Potassium Carbonate (2.5%) and water (95.5%) to get non-sticky and soft texture [3]. After dipping process grapes are dried by conventional methods. Sun drying is the most cost effective with some limitations. Sun drying and shade drying methods need more space and there is possibility of contamination due to external environment conditions. The direct exposure to the sunlight affects the quality of raisins. Above drying methods rely on weather conditions and takes long-time to complete the drying process (15-20 days) [4]. In recent years there has been a remarkable achievement in grapes drying methods due to continuous research and development. Microwave (MW) dehydration, Automatic Solar fruit dryers and Infrared radiation dryers have been utilized for the grape drying process. Infrared radiation is electromagnetic radiation produced by any object above the temperature of absolute zero degrees and can be used to dry food and agricultural products. It improves the quality of raisin by maintaining texture and colour of raisins by uniform drying.

## 2. BLOCK DIAGRAM OF FRUIT DRYING SYSTEM

The proposed system that overcomes the drawbacks of traditional drying methods by implementing Infrared Radiation technique for grapes drying i.e. raisin production is shown in Fig.1. The proposed system uses vacuum chamber based drying process. The tray of grapes to be dried is to be placed in vacuum chamber. Load cell monitors weight of the grapes. On the top of the vacuum chamber aperture plate and Infrared radiation (IR) filter allows only IR radiation to penetrate in the chamber is present. When sun light enters chamber the light is filtered allowing only IR radiations to penetrate in the chamber. The penetration of infrared rays in the vacuum chamber generates heat energy that evaporates moisture from grapes [6]. The moisture content in vacuum chamber is removed by vacuum pump, this speed-ups the drying process. Due to evaporation of moisture content from grapes weight reduces. When weight of grapes becomes when 30% of the original weight load cell and related electronics generates alarm. Once alarm is generated, the ON/OFF mechanism turns off penetration of IR radiation into the vacuum chamber.

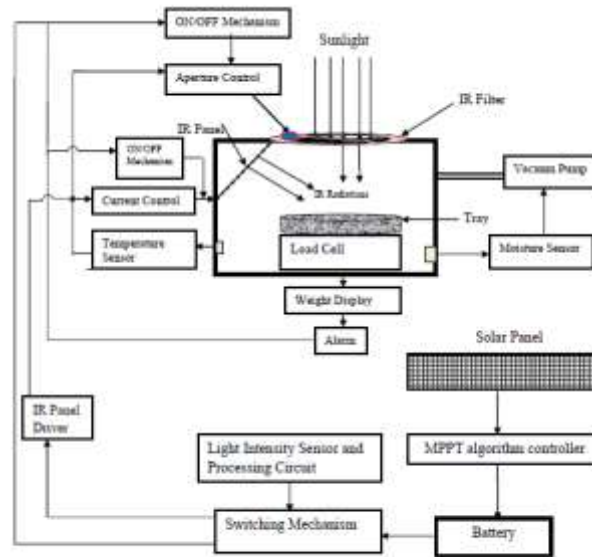


Fig.1 Fruit Drying System

Then the raisins are taken out from the chamber and are ready to use. Separate solar panel is used to charge the batteries that provides power to the IR radiators during night time (absence of sunlight) The light Intensity sensor continuously monitors intensity of light. In the absence of light automatic switching mechanism turn on power to Infrared radiators. The vacuum is created by vacuum pump in the vacuum chamber [1]. For removing moisture from vacuum chamber a closed loop system is designed by using moisture sensor, vacuum pump and related electronics. The temperature in vacuum chamber is maintained by closed loop control system designed using temperature sensor, aperture control mechanism and related electronics. Maximum Power Point Tracking (MPPT) control algorithm is used to charge the battery using solar. This algorithm avoids overcharging and deep charging of battery [7]. The Arduino controller is used to develop battery charge control [8].

### 3. SOFTWARE DESIGN

The entire hardware system alone cannot serve the purpose, unless the real-time program instructions are flashed into the hardware. The software part plays an important role to coordinate and control all the peripherals connected with the controller, the system becomes functional by configuring and initializing the peripherals as per the software instructions.

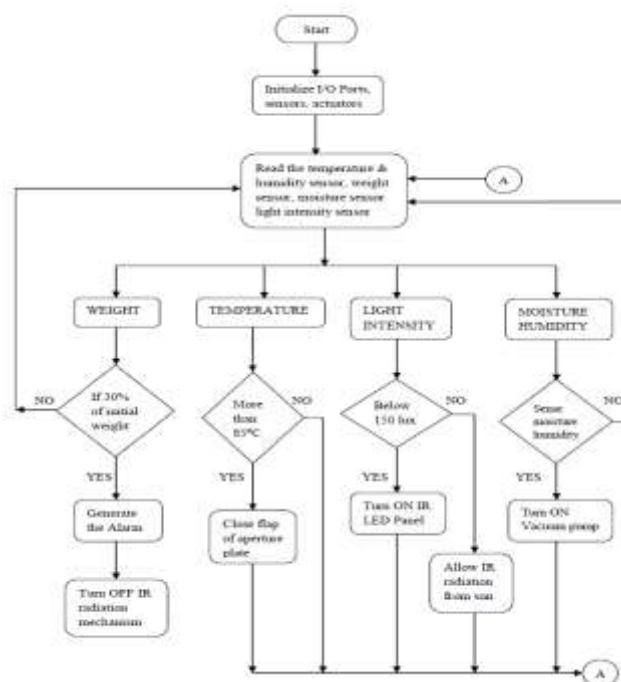


Fig. 2 Flowchart

In the beginning all the sensors, controllers and entire components are initialized. At first the grapes are placed in tray which is mounted on weighing sensor. The sensor reads the weight and displays the same on LCD. The weight is continuously monitored, when the weight goes 30% of its initial weight alarm is generated and weight is displayed on LCD. The temperature in the chamber is monitored by temperature sensor. When the temperature crosses the set point the aperture plate is closed and the incoming radiations from sun are reduced. The light intensity sensor monitors the lux in the sun light. As the light intensity of sun reduces the IR panel from the vacuum chamber is turned ON. The moisture humidity sensors sense the moisture inside the vacuum chamber. The vacuum pump extracts the moisture and maintains vacuum in chamber.

#### 4. HARDWARE IMPLEMENTATION

##### 4.1 MICROCONTROLLER:-

A 89C52 microcontroller is used for controlling and monitoring the fruit drying process automatically. It is a low power, high performance CMOS 8 bit microcontroller. The entire fruit drying process is controlled automatically using microcontroller. Various sensors data is collected by the microcontroller. Based on the sensors reading the microcontroller provides the real time information regarding environmental condition of fruit drying system. The user can retrieve updated information about different parameters like temperature, moisture, light intensity and weight. Microcontroller controls the ON/OFF mechanism switching depending on the sensors information and eliminates the manual interference in fruit drying process.

##### 4.2 MPPT UNIT

The MPPT (Maximum Power Point Tracking) unit in photovoltaic power systems increases the system efficiency by increasing the output power. Generally the PV panel generates nonlinear voltage-current characteristics and its unique point varies with solar irradiation where the maximum power is produced. To extract maximum power from the solar panel, it needs to operate the photovoltaic (PV) system at the maximum power point (MPP) or unique point. The Intelligent Fruit Drying System uses solar energy for drying fruits. The IR panels are operated using solar charged batteries.

##### 4.3 HUMIDITY SENSOR

The humidity sensor module ST-HS-220 senses the relative humidity. The module converts the relative humidity to the output voltage. It operates on 5V DC voltage. It operates upto 60°C and storage temperature upto 85°C. The sensor is installed inside the vacuum chamber. The humidity sensor module is connected to 8 bit microcontroller.

##### 4.4 LIGHT INTENSITY SENSOR

LDR is used to sense the light intensity. The resistance is inversely dependent on amount of light falling on it. It uses active semiconductor layer deposited on insulating substrate. It has low cost photo sensitive element. At constant temperature the illumination is upto 150 lux.

##### 4.5 WEIGHT SENSOR

The weight sensor HX711 is mounted inside the chamber. It is 24 bit analog to digital converter (ADC). The input multiplexer selects channel A or B differential input to the low-noise programmable gain amplifier (PGA). Channel A can be programmed with a gain of 128 or 64, corresponding to a full-scale differential input voltage of  $\pm 20\text{mV}$  or  $\pm 40\text{mV}$  respectively, when a 5V supply is connected to AVDD analog power supply pin. Channel B has a fixed gain of 32. On-chip power supply regulator for load-cell and ADC analog power supply. Due to on chip power supply regulator there is no need for an external supply regulator to give analog power for the ADC and the sensor. Clock input is flexible. On-chip oscillator requires no external component with optional external crystal. On-chip power on-reset circuitry simplifies digital interface initialization.

#### 5. RESULTS AND OBSERVATIONS

Sr. No.	Parameters	Observations	Results
1	Weight	When the weight of grapes in chamber goes 30% of initial weight.	Alarm generated
2	Temperature	Temperature above 85°C.	Flap of aperture plate operated. Below set temperature flap mechanism is OFF.
3	Light Intensity	Light intensity below 150 lumens	IR Panel turned ON below set point IR panel is OFF
4.	Moisture Humidity	Moisture in vacuum chamber above set level	Vacuum operates and extracts moisture.

## 6. CONCLUSION

In this paper existing natural grape drying process is modified with suitable enclosure containing IR radiators and allied systems. Appropriate sensors are used to measure parameters like humidity, temperature and weight of sample. Experimental analysis done with the help of dryer proves the uniform drying of the grapes with the help of infrared radiation. The original colour of grapes is better conserved as the drying takes place at low temperature. The drying time is reduced to a significant level as compared to natural drying process. The use of vacuum solar dryer is efficient and time saving, it should be preferred where good quality of raisins and minimum time is required. But when that is not the case then it will not be preferred as it requires vacuum pump and water pump which requires the electric supply and natural drying does not require any kind of power supply.

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## 8. BIOGRAPHIES



Dr. Madhukar S. Chavan, M.Tech & M.E. degree in E&TC Engg. from Rajasthan Vidyapeeth and Shivaji University. M.B.A.(Marketing) from Yashwantrao Chavan Open University and Ph.D. degree in Electronics Engg. from Shivaji University. Currently working as Professor and PG Co-ordinator in E&TC Engg. Department of P.V.P. Institute of Technology Budhgaon, Sangli



Mr. Ketan V. Hulle  
B.E. (Electronics) from P.V.P. Institute of Technology, Budhgaon, Sangli and PGDBM from Welingkar Institute of Management, Mumbai. Presently working as lecturer in Electronics and Telecom. Engg. in L. E. S. Polytechnic, Sangli