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# Internet of Things-Based Onion Preservation System

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## Abstract

India ranks second in onion production in the world. Onion is extremely important not only as a vegetable but also as a foreign exchange earner amongst other fruits and vegetables. But due to the continuous change in the Indian climate onions can rot or decay. Therefore, onions should be preserved by maintaining the temperature given by the National Onion Association (NOA). Under the ambient condition, the onions are stored at temperature 0 to 4°C with humidity 60 to 70%. So the idea has come up to preserve onion.

In this project, we have designed an onion preservation system, which preserves an onion in a prescribed manner. In this system temperature, humidity sensors have been used to monitor temperature and humidity, respectively. Using the Peltier module, the air inside the tank is cooled and warmed to maintain the standard temperature range. By using the Internet of Things (IoT), making the proposed system smart and efficient, the user will get notification of the system anywhere in the world. Also, users will get recent onion market trends.

**Keywords:** Food preservation, Onion preservation, Peltier, Thermoelectric module.

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## Introduction

Losses in stored onion in Maharashtra is higher because of onion bulbs are having higher water content. It is estimated that out of the total production of 41 lakh tones of onion, 40 to 50% valued at more than Rs. 600 crores are lost due to desiccation, decay, and sprouting in storage. This results in a rise in their price to the four to five times. India produces all three varieties of onion, *viz.*, red, yellow, and white. The production, as well as, market value of this potential vegetable is increasing day by day. This states that onion desiccation, rotting, rooting, decay, and sprouting in onion storage sheds should be avoided**.** Onion is extremely important not only for vegetable internal but also as the highest foreign exchange earner among the fruits and vegetables. Onion farmers are trying to increase production year after year. However, onion price has been highly volatile and more recently the price has been sluggish. This has resulted in the Maharashtra State Agriculture Marketing Board seeking price support.

## Thermoelectric Module

The thermoelectric module consists of tiles generally known as Peltier tiles. These tiles having p- and n-type semiconductor arrays. The thermoelectric module works on the principle of the "Peltier effect." When voltage is applied to terminals of the Peltier module, one side gets hot but at the same time, another side gets cooled. If we reverse the polarity of the power supply, the hot side becomes cold and vice versa. Figure 1 shows the Peltier module in working condition.

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**Conflict of interest:** None

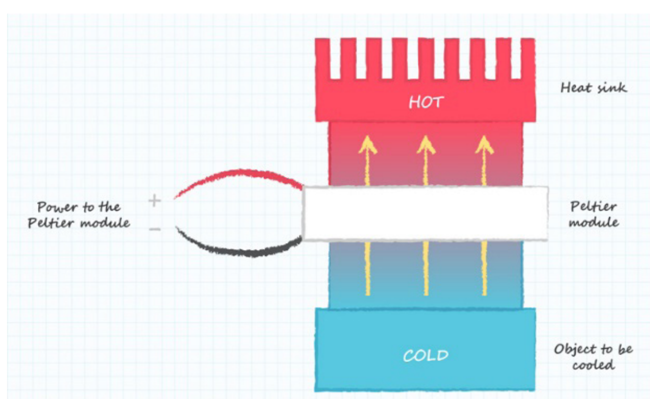


**Figure 1:** Thermoelectric module

## Literature Survey

The post-harvest onion storage methodology is designed and implemented to reduce its degradation.[1] Onion harvesting detection is done using Arduino, LM35 temperature sensor, humidity sensor, gas sensor, and GSM module. The objectives of this quality of onion using Arduino is to sense the ammonia gas, temperature, and humidity with the help of the LM35 temperature sensor, gas sensor MQ 137, and send SMS alerts to mobile numbers stored inside the Arduino program, if onion quality is selected using global system for mobile communication (GSM).

This paper introduces an advanced system that will help the user to control such parameters affecting positive feedback against different onion losses.[2] Shed net is used here because it improves the thermal behavior significantly decreasing the inside temperature. The system works on the principle of sensing emitted gases by onions and attempting to control them within the desired parameter range of temperature and so humidity and also gives an online record observation facility. In this novel methodology, a system is introduced, which is an IoT based food monitoring system.[3] In this system, sensors related to food safety, like $CO_2$, humidity, and nitrogen sensing elements are used, and IoT plays an important role as it gives the alert to users at a remote location.

## Methodology

In this paper, the quality and quantity of onion are maintained by using a thermoelectric cooling system and monitored using and IoT. The Wi-Fi module is used to send monitored data to the user at any remote location. Temperature controlling is the most challenging part of the system as the external environment impacts on inner tank temperature. An entire system can be divided into two parts.

### Maintaining Temperature inside the Tank

Maintaining temperature is one of the major tasks. The thermoelectric cooling system which is based on the Peltier effect is used to decrease the temperature inside the tank. As the power supply is given to the thermoelectric cooling module, one side of the Peltier starts to become cold. The exhaust fan attached to the cooling module blows cooling air from the thermoelectric module inside the tank. The temperature decreases exponentially. As temperature lies in between 0 to 4°C, the cooling module is turned off. As soon as the temperature increases again, the cooling module is turned on. If for any reason temperature goes below the prescribed range, the heating module is turned on.

### Monitoring and Logging Sensed Data on Google Cloud, and send it to the User

Parameters like temperature and humidity are monitored using LM35 and DHT11 sensors, respectively. The monitored data is logged on the Google cloud. This data can also send to the user. IoT plays an important role here. The quantity of onion is also updated to the user. So users get to know how much onion is in the store.

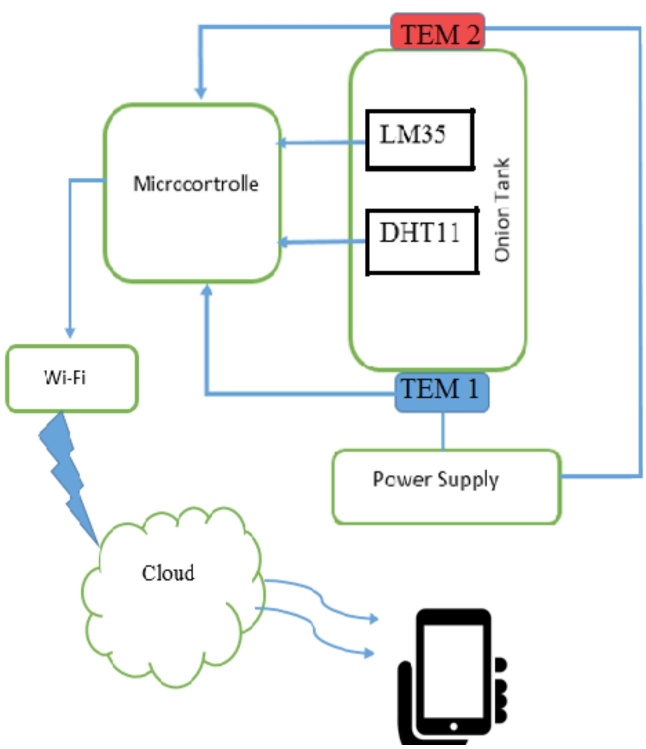


**Figure 2:** Block diagram

## System Design

Figure 2 shows the block diagram of the system. The elements of the system are discussed separately.

### Thermo-Electric Cooling Module (TEM)

As the name suggests, thermal effects can be achieved using electricity. Thermo-electric modules consist of two or more p- and n-type semiconductor blocks sandwiched between two plane ceramic substrate, commonly known as "Peltier tiles". The p- and n-type are connected in series electrically, while connected parallel thermally. When Direct Current (DC )voltage is applied to it, heat from one side is transferred from one side to another side. Hence, one side is cooled and the other becomes hot. Figure 3 shows the construction of the thermoelectric module.

### LM35 Temperature Sensor

For monitoring the temperature, LM35 temperature sensor is used. The main advantage of LM35 sensor is output voltage is more than the traditional thermocouple. Because of this no external signal conditioning circuitry is required and accuracy is 0.5°C. It operates from 4 to 30 volts. Figure 4 shows the LM35 mounted on the PCB along with male connector.

### DHT11 Humidity Sensor

DHT11 is a humidity sensor having a range of 20 to 95%, and it also measure temperature with a range of 0 to 50°C. Figure 5 shows the Pin details of the DHT11 sensor.

## ATmega328P Microcontroller

In this system, ATmega328P microcontroller is used to maintain the temperature inside the onion storage tank. Basically, it is an 8-bit low power microcontroller. The main feature is inbuilt 10-bit analog to digital converter (ADC) mainly used for temperature measurement. This feature makes this microcontroller suitable for this application. It also supports Inter-Integrated Circuits (I2C). Figure 6 shows the pin details of the ATmega328p microcontroller.

## Power Supply

The thermoelectric module requires constant DC voltage so the thermal effect can be achieved. Here, the power supply is designed for 12V 2A. Switch mode power supply (SMPS) is a good option as a power supply because less heat is generated through it. But, SMPS is complicated to design and implement. As compared to the linear power supply, SMPS is much better because switch mode stores less heat in the components, hence, the life of components is more as compared to linear.

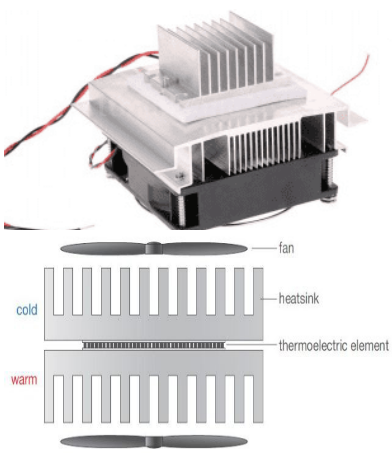


**Figure 3:** Thermoelectric cooling module

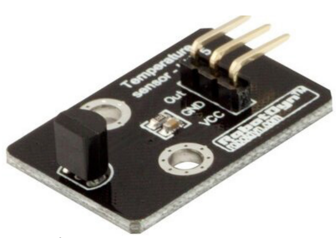

**Figure 4:** LM35 sensor


**Figure 5:** DHT11 humidity sensor

## ESP32 Wi-Fi Module

It is an integrated system-on-chip (SoC) used to connect the device to the world. It is a wireless trans receiver. It also supports WPA/WPA2 security mode. Even we can connect sensors directly to it. It supports Bluetooth 4.2. It gives wireless connectivity to the devices so it can connect and communicate with other systems. It operates at a voltage range of 2.2 to 3.6V. Figure 7 shows the ESP32 wifi model which can be easily mounted on the top of the microcontroller.

# Flowchart Development

The circuit diagram for the temperature controlling system is shown in Figure 8.

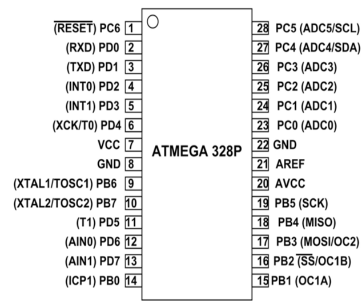


**Figure 6:** ATmega328P microcontroller

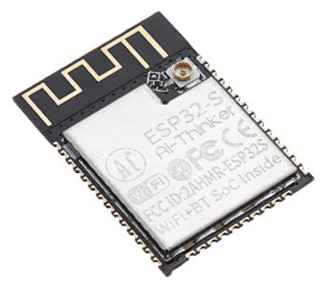

**Figure 7:** ESP32 Wi-Fi module

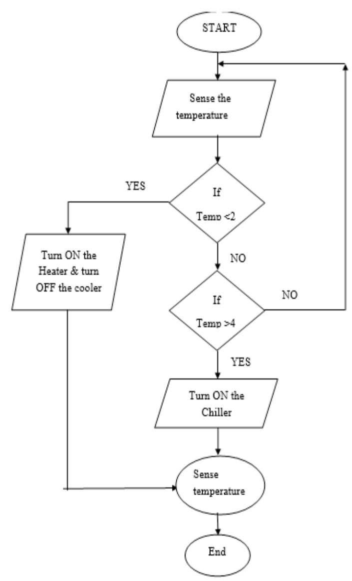


**Figure 8:** Flowchart of the system

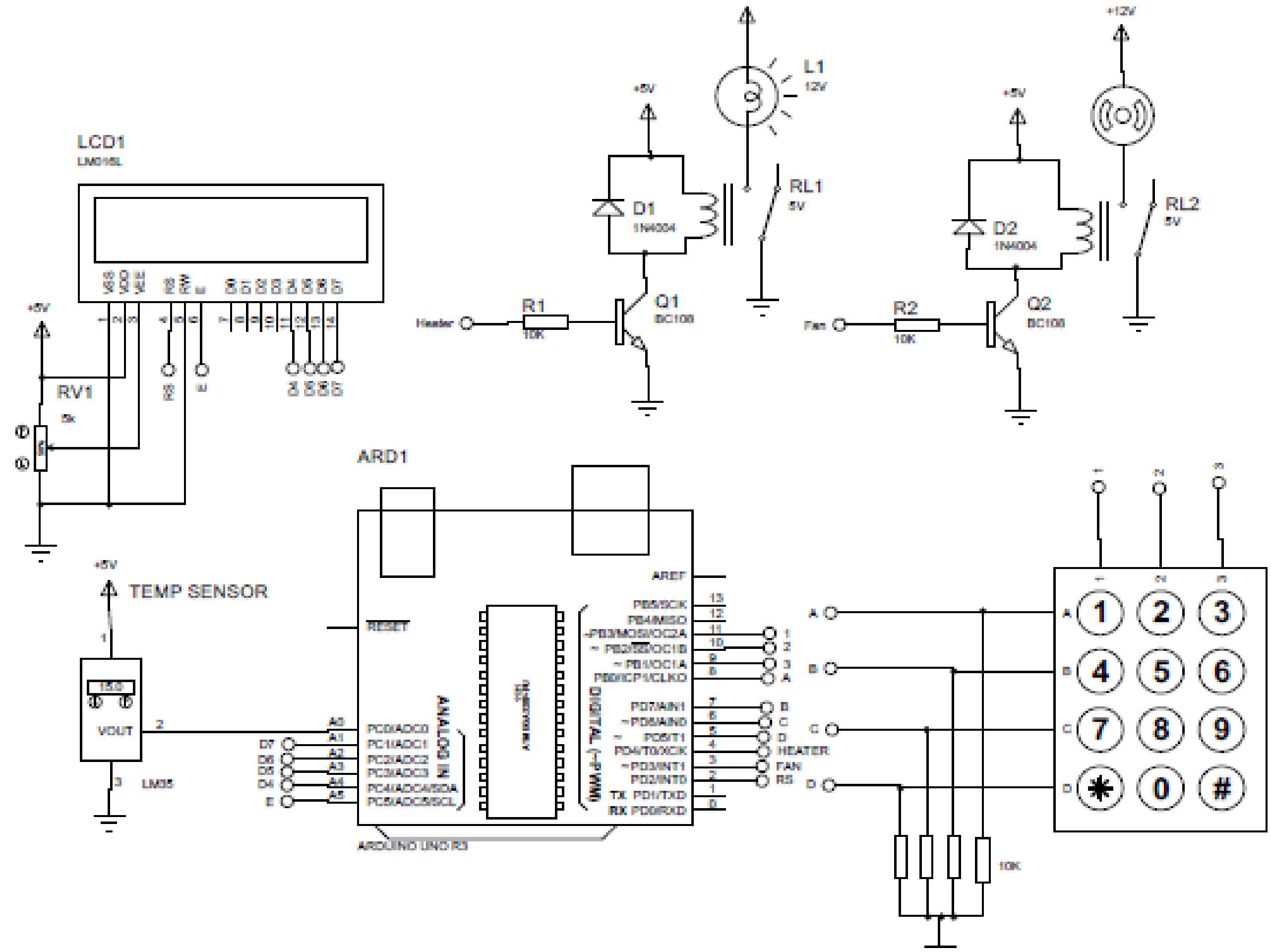


**Figure 9:** Temperature controlling module using ATmega328P

## SIMULATION

For simulating the temperature controlling part, Proteus IDE is used. As shown in the images, the temperature controlling setup is shown. A keypad is provided to set the desired temperature. Here LM35 temperature sensor is acting as input to the microcontroller. For testing purposes, Arduino Uno is used. The organic light emitting diode (OLED) display is used. The lamp and motor act as a heating and cooling module, respectively. According to the circuit diagram shown in the Figure 9, Simulation is executed in the proteus.

### Case I

Refer to Figure 10 set temperature, i.e., "Temp Ref." is 2°C, now current temperature, i.e., "Temp" sensed by the temperature sensor is 15.1°C. So, to get the desired temperature, the cooling fan is turned on, i.e., the cooling module. After the current temperature reaches the set temperature, the cooling module is turned off.

### Case II

Here, the set temperature is kept constant. But current temperature is below the set temperature. By referring to Figure 11, we can see that the lamp is turned on, i.e., the heating module. At the same time, the cooling module turned off.

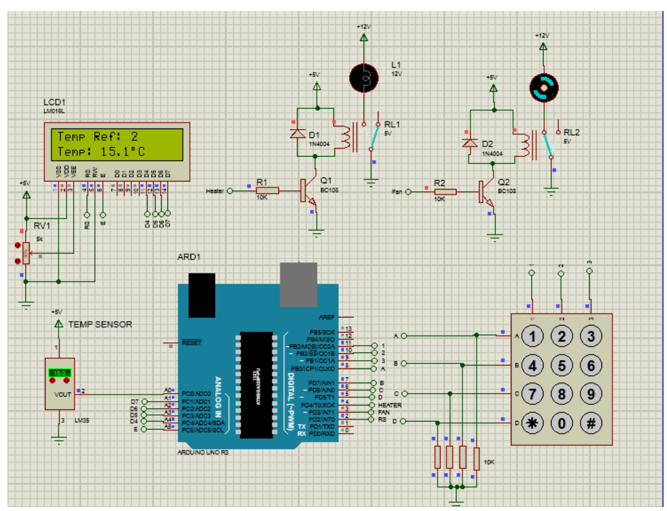


**Figure 10:** Temperature above reference temperature

## RESULTS

The single cooling module is tested using thermocol (polystyrene) box, as shown in Figure 12, having dimensions

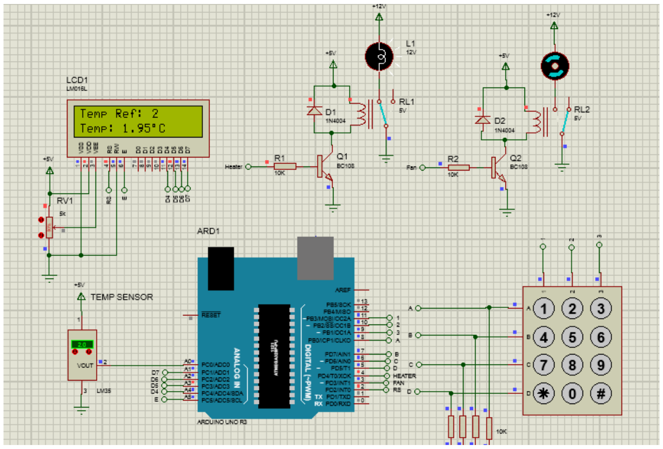


**Figure 11:** Temperature below reference temperature

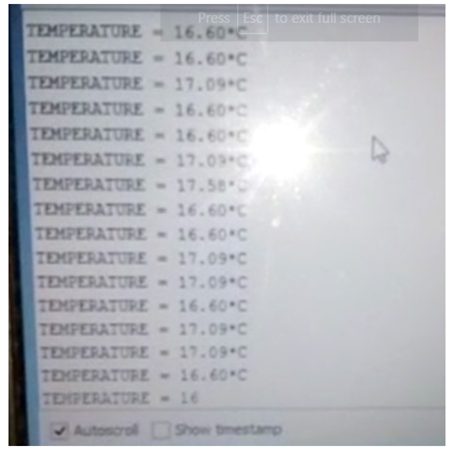


**Figure 13:** Serial Monitor output

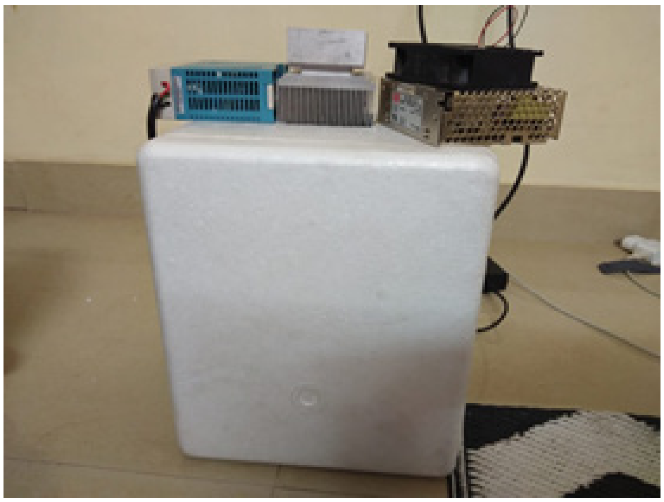

**Figure 12:** Testing module

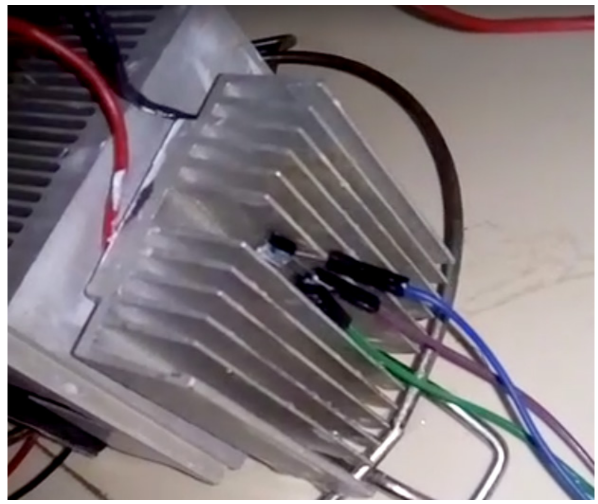

**Figure 14:** Testing Module-2

of 140 × 80 × 104 mm. Its storage capacity is 10 kg. As shown in Figure 13, the temperature is reduced to 15 from 27°C. It took around 1.5 hour (Figure 14).

## Conclusion

To preserve the onion, a thermoelectric cooling system has been introduced. This system can control the temperature inside the cell required for the onion preservation by using Peltier tiles. According to the quantity of onion, this system can be easily modified and implemented. By taking Google's assistance, users will get updates regarding system conditions and also current rates of onion.

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