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IOT Based Monitoring of Fruit Freshness Using Arduino Nano

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Abstract - *To keep fruits fresh, there is always a need to create a device that can automate the process of detecting the freshness of fruit. The objective of this paper is to build a device that measures the quality of fruit and provides an output based on its gaseous contents. Arduino NANO (microprocessor) along with MQ3, MQ5 (gas sensors) and DHT11 (Temperature and Humidity sensor) are used to detect the concentration of Methane (CH4) and Ethylene (C2H4) in ppm (Parts per Million) temperature and humidity in degree Celsius. It was found that the excess ripening after which the fruit starts decomposing has a concentration of 300ppm (Ethylene) for all fruits and vegetables. The decomposition results in producing trace amounts of Ethylene gas, which is also detected using the MQ3 sensor. The result is calculated by the Arduino Nano and is displayed in a 16x2 LCD display. The testing process of the device involved many fruits. In this work three common fruits (Apple, Banana) will be deeply analyzed. Device can be implemented in all food-based industries where there is a necessity to compute the freshness of fruits and vegetables. The simplicity and cost-efficiency of the device makes it a perfect product that can be used by everyone a Fruit and vegetable vendors, every household, Packaging industry to sort fruits, Restaurants or entire chain of restaurants, Farmers can use it to gain more profit.*

Key Words: Arduino, MQ sensor, Fruits and Vegetables, Freshness estimation, Apple, Banana

1. INTRODUCTION

Fruits are an essential part of a healthy diet and are packed with vital nutrients vitamins, and minerals that promotes good health. However, the quality and freshness of fruits can vary significantly, depending on factors such as harvesting time, storage conditions, and transportation methods. This is where fruits sensors come in. A fruit sensor is a device that can measure various aspects of fruit quality, such as ripening, sweetness, acidity and overall freshness. By using advanced technology and data analysis, fruits sensors can provide farmers, distributors, and consumers with valuable insights into the quality and conditions of fruits. In recent years, the demand for fresh, high-quality fruits has increased significantly, and fruit sensors have emerged as a critical tool for ensuring that fruits meet highest standards of quality and freshness. From small-scale farmers to large-scale distributors, fruits sensors are being used to monitor fruits quality at every stage of the supply chain, from harvesting to consumption.

Hence, the handling and packaging of fruits are key toward maintaining their freshness until they reach the consumer. One of the major sources of premature spoilage in perishable fruits is during transport and storage. This is a key issue for fresh fruits, which gets very little quality monitoring after it has been harvested, treated, and packed. Fruits are necessary parts of the human diet, as they contain vitamins, minerals, antioxidants, fiber, and many other essential nutrients. Most countries suggest daily servings of fruits and vegetables in their dietary recommendation guides, emphasizing the importance of accessibility to good quality produce. The health and safety of the consumers are also important factors in the consideration of fruits quality. Many harmful microorganisms can infect fresh produce, especially through poor handling and processing practices. A majority of these pathogens are picked up during transport and storage and due to faulty packaging techniques. Due to the potential severity of these hazards, regulations on fresh fruits are stringent, particularly in the developed countries. Resellers take precautionary measures such as disposing of food that has passed its "best before" date, which the United States Department of Agriculture states is not a true indicator of spoiled food. Products are often still viable after this date, meaning that large amounts of unsold food are unnecessarily discarded.

2. Application

- It can be used by
- Vegetable vendores,
- Every household, packaging industry to sort fruits,
- Restaurant or entire chain of restaurants,
- Farmers can use it to gain profit,
- flavour, taste and overall precepitation of fruits quality than sweetness acidity, and ethylene, these three parameters provide a foundation chemical baseline for establishing and fruits quality.

3. Objective

Management of fruits is still avoided by the people. As if that fruit is kept properly at one place then it won't get rotten. So we are bringing an electronic non-invasive method to monitor fruits. So to reduce that waste of fruits with help of "IOT based Monitoring of Fruit Freshness using Arduino Nano". There are different types of fruits on basis of outer skin they are:

- Fruits with soft skin
- Fruits with moderate skin
- Fruits with hard skin

All of them are in need of monitoring so that we consume right fruit at right time.

4. Literature Review

To estimate freshness of fruits we need some method that might be by putting any sensor into fruit but this can make fruit not applicable to eat. Before, methods used to determine freshness of fruits is with help of IOT (Internet of Things) and Deep Learning Prediction Algorithm:

a) Image Acquisition: Image is gotten under authentic lighting up, detachment and various factors affecting picture quality are taken into thought. This movement is crucial because picture quality plays a critical occupation in iris Localization.

b) Image Segmentation: In this movement, the fruit area is confined from the given picture. The fruit division is a crucial development for all around execution of the structure.

c) Feature extraction: In the component extraction stage, novel component from the partitioned fruit is removed to make a fruit design. This arrangement further used for affirmation.

d) Matching: The isolated models are arranged onto the models as of now isolated and set aside in data set. The degree of closeness picks whether the unmistakable confirmation is to be set up or not. [1]

Another method used before was with help of Protein-Based Edible Foil in this they used:

- Testing Platform Design and Fabrication: The microchip platform for testing the freshness of selected fruit and vegetable were designed in AutoCAD program. The sensing platform consists of two rectangular layers of foil and two electrodes between them
- Studied Samples: Tests were performed on fruit pear Williams (Pyruscom munis 'Williams') and vegetable zucchini (Cucurbita pepo). These selected samples are most common in markets and homes at this time of the year (autumn)
- Experimental Setup: Impedance measurements were performed using an experimental setup. It consisted of a Palm Sens4 device connected to the laptop via Bluetooth and a portable platform (microchip). [2]

Last method was with help of electronic sensor and wasp mote they:

- They used Wasp mote and connected it with following items
- For the reading of the oxygen gas, the SK-25F model sensor was selected.
- The sensor selection for the CO2 gas was model TGS4161.
- It has an interface card that allows the physical and logical interconnection between the sensors and the CPU of the main card.
- The implementation of the complete system involves the construction of a hermetic chamber to house the fruit and arrange the sensors in the upper lid, where the electronic circuit will be housed. [3]

5. Methodology

5.1 Hardware requirements

The experimental setup requires Arduino Nano microprocessor, MQ3 sensor which is used to determine alcohol level i.e. ethylene level in ppm, MQ5 sensor to detect natural gases like CO_2, Buzzer to give warning and LCD (Liquid Crystal Display) to give message and parameters to user. Information of these sensor is given below:

1. **Arduino Nano**
   Arduino is an open source microcontroller based electronic prototyping board that can be programmed using the Arduino IDE. Arduino is made up of parts: a physical programming circuit board and software.

Fig 1: Arduino Nano

2. **MQ5 Sensor**
   MQ5 Gas Sensor Module is used in gas leakage detection and is suitable for home and industrial

equipment for LPG, natural gas, and coal gas detection and monitoring. The sensitive material used in the MQ5 gas sensor is SnO2, which has lower conductivity in clean air. When the target combustible gases exist in the atmosphere, the sensor's conductivity increases with the gas concentration. It provides an analog output corresponding to the concentration of the gases in the air and an easy-to-use digital output.

Fig 2: MQ 5 Sensor

3. MQ3 Sensor
The MQ3 sensor module is convenient for detecting Alcohol, Methane, Hexane, Carbon monoxide, liquefied petroleum gas (LPG). The sensor contains tin dioxide. When the alcohol gas exists around, the conductivity of the sensor is higher. MQ3 gas sensor has an acute sensitivity to Alcohol and has excellent resistance to disturb smoke, vapor, and gasoline.

Fig 3: MQ 3 Sensor

4. DHT11 Sensor
DHT 11 is a Humidity and Temperature Sensor, which generates calibrated digital output. DHT11 can be interface with any microcontroller and get instantaneous results. DHT11 is a low cost humidity and temperature sensor which provides high reliability and long term stability.

Fig 4: DHT 11 Sensor

5. LCD Display
This display has 2 rows and can display 16 characters on each line. The Display Controller takes command and data from a microcontroller and drivers the LCD panel. This LCD display consist of 2 rows and 16 columns, it is used for displaying the output of the system and shows the quantity of fluid remaining in the bottle.

Fig 5: LCD Display

5.2 Design

Firstly, we need to give it a external power socket of 5V which is required for all sensors. Arduino is connected with external power supply of 5V. The MQ5 sensor, MQ3 sensor, DHT11 sensor, Buzzer and LCD display are connected to Arduino Nano pins. After sensors generate data in analog format it is converted to digital format by Arduino Nano program. It will show output on LCD screen and buzzer will buzz if values are above threshold value. All of these is represented in fig 6. **[3]**

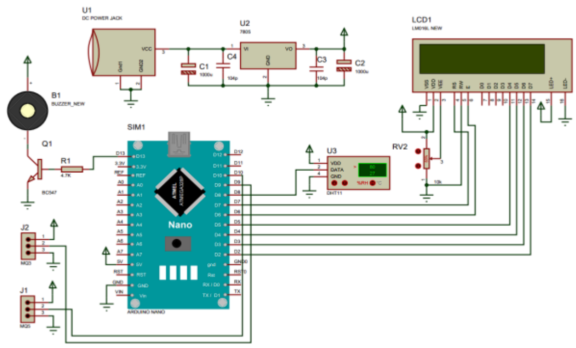

Fig 9: Circuit diagram of proposed system

5.3 Flowchart

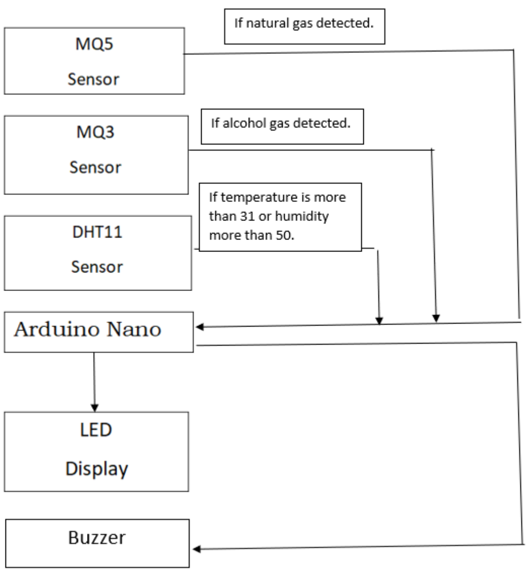

Fig 10: Flowchart of IOT based Fruit Freshness Detector Using Arduino Nano

The figure 10 shows the flow of Fruit Freshness Detector system after giving power supply system starts. Once system starts MQ5, MQ4 and DHT11 sensors sense Natural gases, Alcoholic gases, and Temperature and Humidity respectively and gives input to Arduino Nano. Arduino Nano has program setup which has all the parameters. If the parameters are beyond set limits Arduino Nano gives input to buzzer and it starts giving sound signals to person who is monitoring it. The analog input is converted to Digital by Arduino Nano.

5.4 Software Used

ARDUINO IDE

Arduino is open source electronics platform that uses simple hardware and software to make it easy to use. Arduino boards can take inputs- such as light from a sensor, finger on button, etc. and convert them to outputs- such as turning on an LED, triggering a motor, or publishing anything online. The Arduino Integrated Development Environment (IDE) is a C and C++ based cross platform application (for Windows, Mac OS, and Linux). It's used to write and upload programs to Arduino-compatible boards, as well as other vendor development boards with the support of third-party cores. The Arduino IDE uses unique rules of code organization to support the languages C and C++. The Arduino IDE comes with a software library from the Wiring project that includes a number of common input and output functions. User written code just needs two simple functions to start the sketch and run the main program loop, which are compiled and linked with a programme stub main() into an executable cyclic executive programme using the GNU network.

5.5 Overview of Work

When the device is made ON, initially it calculates resistance of MQ sensors to get the known concentration of gases around the sensor without the presence of other gases. MQ3 sensor calculates ethylene level to know if fruit is fresh to eat or shouldn't be ate.MQ5 sensor is used to detect natural gases content in atmosphere of fruit. The atmosphere of fruit is crucial for it to be in good condition. These conditions are temperature and humidity which are calculated by DHT11 sensor. This sensor gives exact temperature and humidity so we can keep it in control with help of cold storage. We used buzzer and LCD screen to let user know what condition of fruit and its atmosphere is. If threshold value of MQ3 sensor is achieved i.e. 250ppm it will show on screen "DON'T EAT" and buzzer will buzz. **[4]** Now if the MQ5 sensor is achieved i.e. 500ppm it will show "GASES RELEASING "on screen. And at last if temperature level is higher than 15ºC which standard is temperature for fruits and vegetable storage it will show "HIGH TEMPERATURE" and if humidity is higher than 90% it will show "HIGH HUMIDITY". **[5]** In program to calculate analog value to ppm value one formula is applied i.e.

1. For MQ3 Sensor

$$Voltage\ of\ device = Analog\ value\ of\ MQ3\ sensor * \frac{5}{1023} \quad (1)$$

Here 5 is total voltage provided and 1023 is number of bits for analog value.

$$ppm\ value = (Voltage\ of\ device - 0.1) * (\frac{100}{0.8})$$

2. For MQ5 Sensor

$$Voltage\ of\ device = Analog\ value\ of\ MQ3\ sensor * \frac{5}{1023} \quad (2)$$

Here 5 is total voltage provided and 1023 is number of bits for analog value.

$$ppm\ value = (\frac{(Voltage\ of\ device - 0.1) * (\frac{1000}{0.8})}{4})$$

6. CONCLUSIONS

In this proposed approach,

1. Firstly when we provide power to device we can see initial screen i.e. "IOT FRUIT FRESHNESS DETECTOR"

2. After initial screen DHT11 sensor detects value and sends it to microcontroller, microcontroller then shows those values on LCD Display.

3. If Temperature is higher than 15°C it will show "HIGH TEMPERATURE" on screen and Buzzer will buzz.

4. If Humidity is higher than 90% it will show "HIGH HUMIDITY" on screen and Buzzer will buzz.

5. After this it detects value of MQ3 sensor and if value is greater than 250ppm it will show "DON'T EAT" which is indication that fruit is harmful to eat.

6. Value of MQ5 sensor is detected and if it is greater than 500ppm it shows "GASES RELEASING" which is indication that fruits are releasing gases or those fruits are in harmful gaseous environment.

7. We tested our product on Apple and Banana which are common fruits in all season.

8. We found that highly decayed fruit has 300ppm value of alcohol.

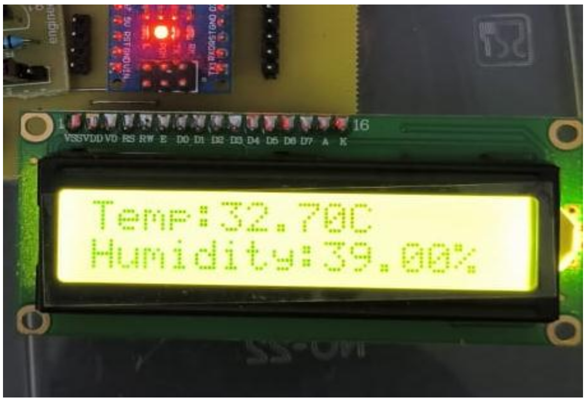

Fig 11: Values of Temperature and Humidity are displayed on screen

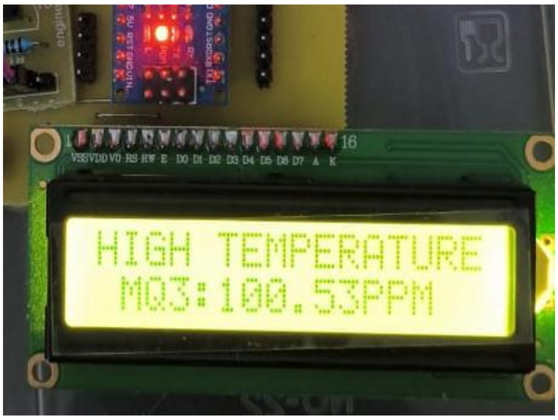

Fig 1**2:** As high temperature above 15 C is detected it shows that High Temperature.

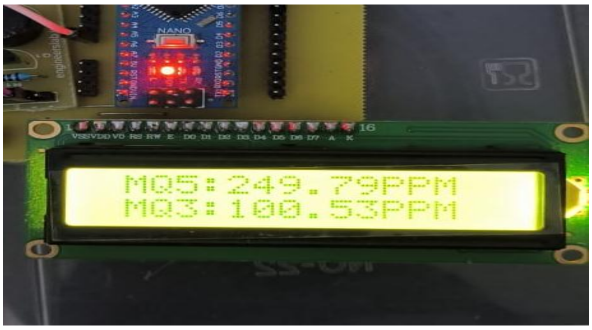

Fig 13**:** Values of MQ3 and MQ5 sensor are displayed on screen

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