Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Volume 13, Issue 02, February 2024

IOT-Based Food Spoilage Detection and Waste Management System

Dr.S.V.R.K.Rao, Gujjidi Nagabhushanarao,
Gali Sunil Kumar, Isukapalli Sharmila,
Sodasani Yogendra

Department of Electronics and Communication Engineering,
Godavari Institute of Engineering and Technology(A).

Abstract— **In order to solve the issues of food safety and effective food waste management, this abstract presents a novel solution: the IOT-based food spoilage detection and waste management system. With an emphasis on reducing foodborne dangers and maximizing waste reduction efforts, this system uses Internet of Things (IoT) technology to integrate many sensors and communication modules for the purpose of monitoring and managing the entire food supply chain, from production to consumption. The goal of the proposed IoT-based food spoilage detection and waste management system is to develop a comprehensive and environmentally friendly method of managing food. The system offers a holistic solution that decreases food waste, promotes public health, and helps create a more sustainable and responsible food ecosystem by combining waste management with food safety monitoring.**

Keywords— **IoT (Internet of Things), Food Spoilage Detection, Waste Management System, Sensors, Data Analytics, Smart Devices, Wireless Communication, Remote Monitoring**

I. INTRODUCTION

Food spoilage detection and waste management are two important areas where the Internet of Things (IoT) has had a substantial impact on numerous businesses. Using Internet of Things technology, this creative system develops an advanced and effective way to track and control perishable commodities quality along the whole supply chain. The system is able to gather data in real-time on temperature, humidity, and gas concentrations by integrating sensors into storage facilities, transportation vehicles, and even individual packing. After that, the data is sent to a centralized platform for analysis using machine learning and advanced analytics algorithms. The ability of the system to identify any departures from ideal storage conditions allows for the prompt detection of possible contamination or spoiling. Additionally, by combining with trash. Food safety and waste management have emerged as crucial concerns as the globe struggles to feed a growing population. The traditional approaches of reducing waste and keeping an eye on food quality are frequently labour-intensive, error-prone, and devoid of real-time insights. Food deterioration brought on by careless handling and observation not only costs money but also puts customers' health at danger. This emphasizes how urgently we need an advanced automated system that can transform real-time waste management and food quality monitoring.

II. LITERATURE REVIEW

The First article [1] P. P. Jose, N. D. Bobby, V. Ragul, P. L. Babu and P. J. J. Dinesh (2011): proposed a method for detecting spoiled food based on sensors. The spoiled solid food is detected by using the liquid sensors and the spoiled liquid food is detected by using the acidity sensors.

The Second article [2] Geoffrey C. Green1, Adrian D.C. Chan, and Rafik Gobran(2013): explained an approach for monitoring spoiled food with an electronic nose based on a metal-oxide sensor array. As a result, the e-nose discriminates food samples on a given day throughout the measurement period. The patterns that are formed from the result indicate how the food is spoiled at each measurement period.

The Third article [3] Parkash, Prabu V (2014): "IoT Based Waste Management for Smart City" the proposed system describes that the level of garbage in the dustbins is detected with the help of Sensor systems, and communicated to the authorized control room through GSM system. A microcontroller is used to interface the sensor system with the GSM system.

The Fourth article [4] Ki Hwan Eom, Min Chul Kim (2015): proposed "The Vegetable Freshness Monitoring System Using RFID with Oxygen and Carbon Dioxide Sensor". An oxygen and carbonic acid gas concentration observation system for freshness management, which supports radio frequency identification (RFID). Freshness can be checked by varying factors as well as wetness, temperature, oxygen, and carbonic acid gas.

The Fifth article [5] T. B. Tang and M. S. Zulkafli(2018): explained an approach for assessing the freshness of milk using an electronic tongue. The freshness of milk is assessed based on the pH value of milk. An e-tongue together with a graphical user interface has been designed and implemented in hardware.

The Sixth article [6] Jessie R. Balbin, Julius T. Sese, Crissa Vin R. Babaan(2018): focused on the classification of bacteria in street food. Street food features a major impact

Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Volume 13, Issue 02, February 2024

on the culture and however, as a result of the dearth of information on correct food preparation, the cleanliness and quality of street food are neglected. "Detection and classification of bacteria in common street foods using electronic nose and support vector machine" was aimed to design an electronic nose with gas.

The Seventh article [7] Naveed Shahzad, Usman Khalid (2020): proposed "E Fresh – A Device to Detect Food Freshness" In this system used biosensor and electrical sensors to check out the freshness of food. A smart system that may sight the freshness of food like farm things, meat, and fruits.

III. METHODOLOGY

The very inventive IoT-based food spoilage detection and waste management system will contribute to the cleanliness of the cities. This setup keeps an eye on the trash cans and uses an Android app to notify users about the amount of waste that has accumulated within. In order to do this, the system places a ULTRASONIC sensor over the trash cans to measure the level of waste and correlate it with the depth of the cans. The Blynk app's LCD screen, an Arduino family microcontroller, and a Wi-Fi modem are all used by the system to transmit data. MQ6 sensor is also used to measure hazardous gasses.

CIRCUIT DIAGRAM

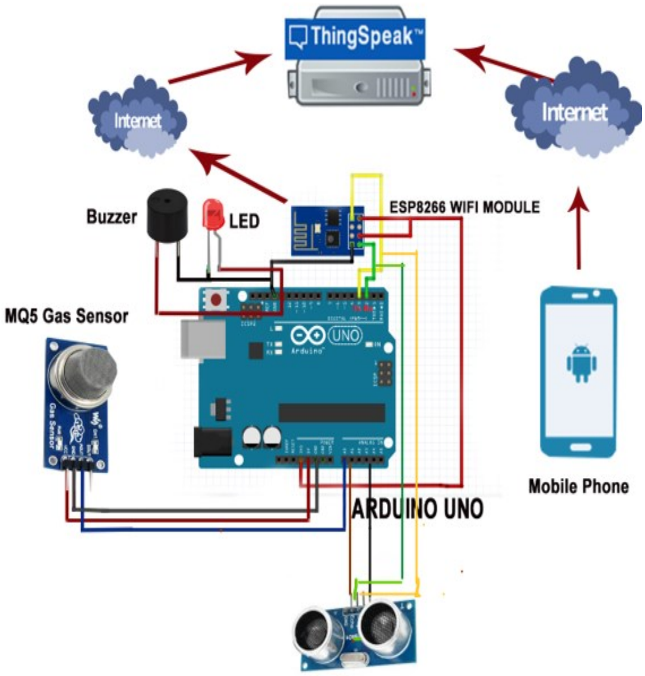

Fig.2. Circuit Diagram for IoT-based food Spoilage detection and waste management system

BLOCK DIAGRAM

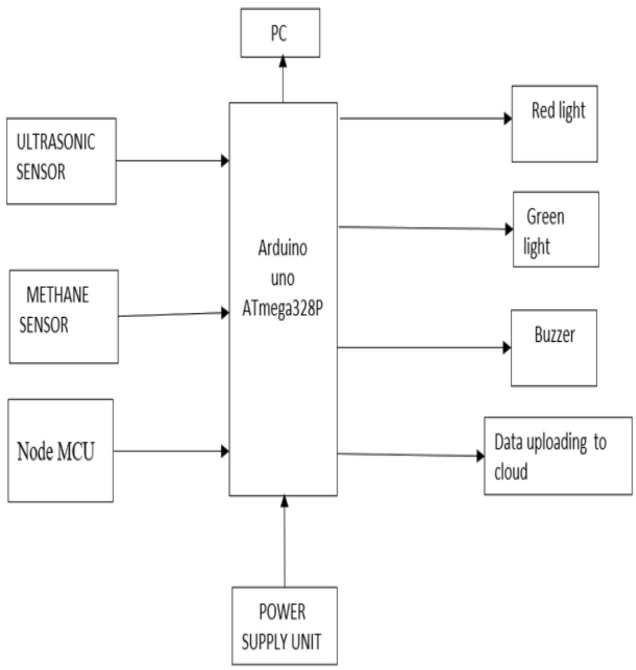

Fig.1. Block Diagram for IoT-based food Spoilage detection and waste management system

FLOW CHART

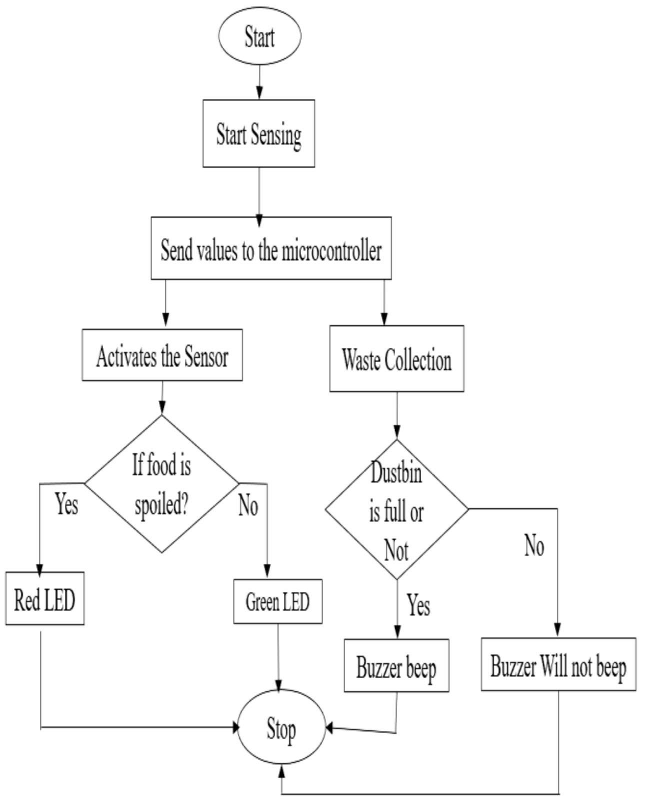

Fig.3. Flowchart For IoT-Based Food Poisoning and Waste Management System

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Volume 13, Issue 02, February 2024

COMPONENTS REQUIRED

1. ARDUINO UNO:

One of Arduino's standard boards is the UNO. Here, UNO is an Italian word for "one." To distinguish the initial release of Arduino software, it was given the designation UNO. Additionally, it was Arduino's first USB board to be released. It is regarded as a strong board that is applied to many different applications. The Arduino UNO board was created by Arduino.cc. The Arduino UNO microcontroller is built around the ATmega328P. In contrast to other boards, like the Arduino Mega board, etc., it is simple to use. The board is made up of shields, additional circuitry, and digital and analog input/output (I/O) pins. Six analog pin inputs, fourteen digital pins, a USB port, a power jack, and an ICSP (In-Circuit Serial Programming) header are all included in the Arduino UNO. The programming is done using IDE, which stands for The PWM pins can be used for pulse width modulation. The Arduino UNO's crystal oscillator operates at a frequency of 16 MHZ. Moreover, an Arduino Wi-Fi module is built within it. This Arduino UNO board is built on the ATmega328P microprocessor and integrated Wi-Fi ESP8266 module. The Arduino board's input voltage ranges from 7V to 20V.
The external power supply is automatically used to power the Arduino UNO. It is also capable of using USB power.

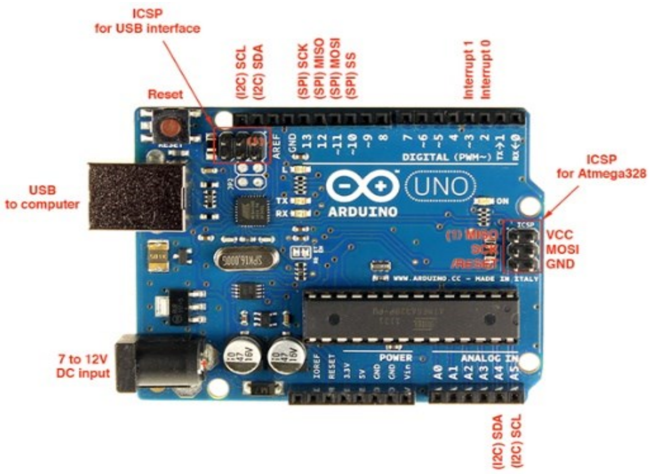

Fig.4. Arduino UNO

2. NODE MCU:

An open-source hardware platform and firmware called NodeMCU is built around the ESP8266 Wi-Fi module. The integration of integrated Wi-Fi capabilities with a microcontroller unit (MCU) facilitates the effortless and economical construction of Internet of Things (IoT) projects. NodeMCU is especially well-liked by developers and enthusiasts because of its ease of use and compatibility with the Arduino IDE. It is a flexible option for a range of Internet of Things applications since it allows users to remotely operate devices, gather data, and link their projects to the internet. With its support for the Lua programming language and ability to speed up prototyping, the platform is used by both novice and seasoned IoT developers. Espressif, a Chinese firm, manufactures the ESP8266, a System on a Chip (SoC). It is made up of a Wi-Fi transceiver and a 32-bit Tensilica L106 micro controller unit (MCU). In addition to an analog input, it contains 11 GPIO pins.

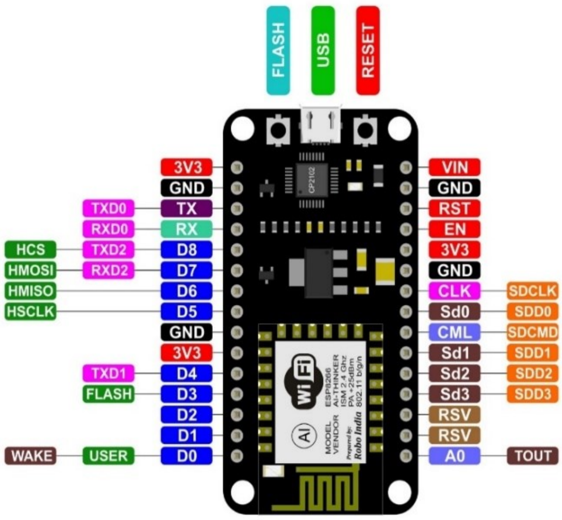

Fig.5. NodeMCU

3. MQ4 SENSOR:

The MQ4 methane gas sensor is a MOS (metal oxide semiconductor) type sensor that is used to measure the amount of methane gas in the air at homes or businesses. It reads the concentration and produces an analog voltage as an output. In this case, the detecting range of concentration is 300 pm to 10,000 ppm, which is suitable for leak detection. The primary component of this gas sensor is a ceramic detecting element made of aluminium oxide (Al2O3) that is covered in tin dioxide (SnO2) and placed inside a stainless-steel mesh. The MQ4 methane gas sensor is widely used in industries such as CNG gas and methane (CH4) to detect gas leaks at home. Potentiometers can be used to alter the sensitivity of this gas sensor because of its quick response time and high sensitivity. As part of the MQ sensor series, this analog output sensor is utilized similarly to a compressed natural gas (CNG) sensor. Thus, this sensor can be used to measure the amount of natural gas in the air, such as methane. This sensor's output voltage will rise in response to an increase in gas concentration. This sensor uses 750 mW of power and operates at 5V DC.

Fig. 6. MQ4 sensor

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Volume 13, Issue 02, February 2024

4. ULTRASONIC SENSOR:

Ultrasonic sensors are electronic devices that use ultrasonic sound waves to measure a target's distance and then translate those waves into electrical signals. Ultrasonic waves are emitted at a pace quicker than sound waves that can be heard. The transmitter and receiver are the two primary important components. The transmitter produces sound using the piezoelectric crystals, which then carry the sound to the target and return it to the reception component. The sensor determines the target's distance from it by calculating the time it takes for sound waves to travel from the transmitter to the receiver. An ultrasonic sensor typically consists of a transmitter and a receiver. These segments are positioned closely together to ensure that sound travels from the transmitter to the target and back to the receiver in a straight line. Ensuring that the distance between the transmitter and receiver sections is as little as possible helps to reduce calculation mistakes. The computation is carried out as D is equal to half of T * C. where the time in seconds is represented by the letter "T." The sound speed, represented by the letter "C," is 343 mts/sec.

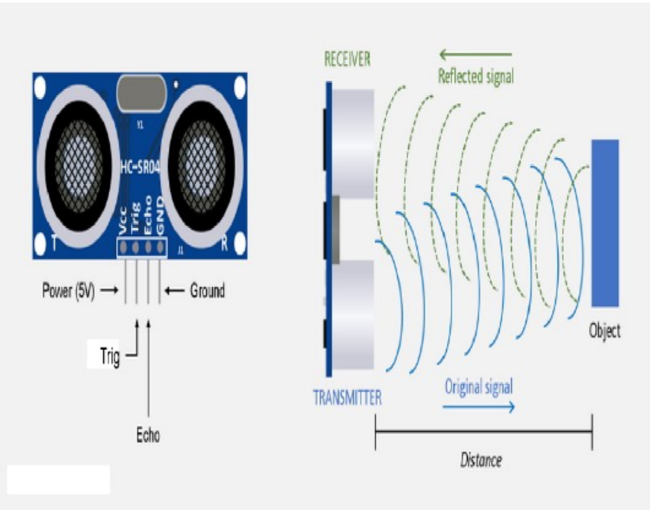

Fig.7. Ultrasonic sensors

5. BUZZER:

Piezo buzzers, sometimes referred to as piezo electric buzzers, are straightforward gadgets that emit sound in response to an electrical input. The Greek word "press" or "squeeze" is where the word "piezo" originates. This phrase has a connection to the piezoelectricity principle in the field of electronics. The piezoelectric effect is the basis for how piezo buzzers work. An electric charge causes a piezoelectric element, which is often composed of ceramic or crystal material, to distort. A buzzing sound is produced as a result of this distortion. A range of tones can be produced by adjusting the input current, which also affects the sound frequency.

Fig.8. Piezo buzzer

6. LED:

A semiconductor device known as a light-emitting diode (LED) releases light when an electric current passes through it. An LED emits light when current flows through it because the electrons recombine with the holes. LEDs permit current to flow in one direction while blocking current flow in the other. P-N junctions with heavy doping are used in light-emitting diodes. When forward biased, an LED will produce coloured light at a specific spectral wavelength depending on the semiconductor material and doping level. An LED is encased in a transparent cover, as seen in the figure, to allow light to be released.

Fig.9. LED

IV.RESULTS AND DISCUSSIONS

The Arduino Uno and Node MCU serve as the central microcontrollers, facilitating seamless communication between the various components. The ultrasonic sensor plays a crucial role in monitoring the distance between products, ensuring optimal storage conditions. Meanwhile, methane sensors detect potential gas emissions, providing an additional layer of spoilage detection. In case of detected anomalies or potential spoilage, the system activates the red LED to visually alert stakeholders. Simultaneously, the buzzer produces an audible signal, ensuring that immediate attention is drawn to the issue. The integration of green LEDs signifies normal operating conditions, providing a quick visual confirmation of product integrity. The Blink app acts as an interface for real-time monitoring and management, allowing stakeholders to access critical data on food quality and waste management efficiency.

Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Volume 13, Issue 02, February 2024

The app provides instant notifications in response to spoilage events, enabling swift decision-making and preventive actions. Through extensive testing and simulations, the system demonstrated its ability to accurately detect environmental variations, potential spoilage conditions, and optimize waste management practices. The combination of these components creates a responsive and efficient IoT-based system that enhances food safety, reduces waste, and contributes to overall sustainability in the food supply chain.

Fig.10.Hardware implementation for IoT-based food Spoilage detection and waste management system

Fig.10. Result for IoT-based food Spoilage detection and waste management system

Fig.11. Timeline for IoT-based food Spoilage detection and waste management system

V. FUTURE SCOPE

It would be beneficial to have this system installed in multiple city areas as some areas might not have a constant power source, which would hinder the system's effectiveness. In the future, solar panels can be used to solve this problem. Solar batteries, which don't need a constant power source, can be utilized with solar panels. Secondly, the wet waste can be directly sucked out of the bin and dumped in the dump yard by adding suction pipes with compressors at the bottom of the bins. This idea can give towns hoping to become smarter and greener a competitive advantage.

VI.CONCLUSION

To sum up, the Food Spoilage Detection and Waste Management System, which is based on the Internet of Things, presents a revolutionary approach to addressing the critical issues of waste management and food safety. This algorithm that is particularly well-suited for face detection. system offers a way to monitoring and managing food waste and quality that is dynamic and real-time by integrating smart technologies into the complex web of the food supply chain Continuous data collection is made possible by the placement of sensors at strategic locations along the supply chain. This provides previously unheard-of insights into the environmental factors influencing food quality. By using machine learning and advanced analytics, the system can anticipate and recognize possible spoiling events, giving stakeholders the ability to take preventative action to reduce health risks and save financial losses.

Additionally, the system optimizes waste disposal procedures in addition to managing food quality.

Sensor-equipped smart garbage receptacles help in recycling efforts, environmental impact reduction, and effective waste collection. Stakeholders will always have instant access to critical information thanks to the centralization of data into an intuitive dashboard, which will speed up decision-making and enable prompt intervention when needed. In the end, the Internet of Things-based Food Spoilage Detection and Waste Management System improves food safety, lowers waste, and strengthens the resilience of the global food supply chain overall while also being cost-effective and environmentally sustainable.

VII. REFERENCES

[1] P. P. Jose, N. D. Bobby, V. Ragul, P. L. Babu and P. J. J. Dinesh 2011: "A Device to Detect Food Freshness ": International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-8 Issue-3.

[2] B.Ravi Chander Geoffrey C. Green1, Adrian D.C. Chan and Rafik A.Goubran 2013 Dept. of ECE "FOOD QUALITY MONITORING SYSTEM BY USING ARDUINO", St.Martin's Engineering college, Dhulapally(v), kompally,Secunderabad 500100 Telangana state, India. Journal of Engineering Sciences (JES) Vol 11, Issue 4.

[3] Parkash, Prabu V 2014 "food wastage reduction through donation using modern Donation", C International Journal of Recent Trends in Engineering & Research (IJRTER).

[4] Ki Hwan Eom, Min Chul Kim 2015 "An Intelligent IoT-Based Food Quality Monitoring" Approach Using Low-Cost Sensors. Summery EISSN 2073-8994, published by MDPI.

[5] T. B. Tang and M. S. Zulkafli 2016 An "Efficient System to Detect Freshness and Quality of Food" Dept. Of Information Technology, KBT College of Engineering, Maharashtra, India Assistant Professor Dept. of Information Technology, KBT College of Engineering, Maharashtra, India. International Research Journal of Engineering and Technology (IRJET), Volume 7.

[6] By Hai Jessie R. Balbin, Julius T. Sese, Crissa Vin R. Babaan 2018 EE world online resource. "Aurdino Based Smart IoT Food Quality Monitoring System".

[7] Naveed Shahzad, Usman Khalid 2019 "Food Spoilage: Microorganisms and their prevention" Pelagia Research Library-Asian Journal of Plant and Science and Research.

[8] Moqsud M. Azizul and Shigenori Hayashi 2020, "An Evaluation of Solid Waste Management Practice in Japan" Daffodil International University Journal of Science and Technology, Vol. 1(1), pp39-44.

[9] Navghane S.S., Killedar M.S., Rohokale Dr.V.M,2020 "IoT Based Smart Garbage and Waste Collection Bin", International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE).

[10] Sahu R.M., Akshay Godase, Pramod Shinde, Reshma Shinde 2021," Garbage and Street Light Monitoring System Using Internet of Things", International Journal Of Innovative Research In Electrical, Electronics, Instrumentation And Control Engineering.

[11] Gaikwad Prajakta, Jadhav Kalyani, Machale Snehal,2021 "Smart Garbage Collection System" Resedential Area, International Journal of Research in Engineering and Technology.