Food Quality Detection System

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Abstract— In this paper, we present the design and implementation of an Arduino-based food quality monitoring system. The system utilizes various sensors to assess environmental conditions and detect indicators of food spoilage. We discuss the methodology, challenges, results, and future directions for enhancing food quality monitoring using low-cost Arduino-based technologies.

Keywords— Arduino, food quality, sensor system, environmental monitoring, spoilage detection, IoT.

I. INTRODUCTION

Food safety and hygiene is a major concern in order to prevent food wastage. The Quality of the food needs to be monitored and it must be prevented from rotting and decaying by the atmospheric factors like temperature, humidity and darkness. Therefore, it is useful to deploy quality monitoring devices at food stores. These quality monitoring devices keep a watch on the environmental factors that cause or pace up decay of the food. Later, the environmental factors can be controlled like refrigeration, vacuum storage etc.

In this project, we aim at developing a food quality monitoring device that will be designed that will keep watch of environmental factors like temperature, humidity, alcohol content and exposure to light.

II. LITERATURE SURVEY AND RELATED WORKS

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S.no	Name	Author	Inference
1.	FOOD QUALITY MONITORING SYSTEM BY USING ARDUINO	P.A.Lovina, G.Shiva Kumari ,Ravichander.B	This paper proposes a food quality monitoring device built on Arduino UNO, integrating sensors for temperature, humidity, alcohol content, and light exposure. The device sends data to an IoT platform and displays on a character LCD. It uses electrical and biosensors to detect bacterial contamination and monitor gas levels when food is about to spoil.
2.	Food Monitoring System Using Iot	Dr. Girish V.Attimarad HOD,ECE, KSSEM, Bangalore	The Earth's atmosphere contains nitrogen, oxygen, trace gases, and other mixtures, which have increased concentrations and adverse effects on human health. This paper proposes an IoT framework for food monitoring using low-cost sensors to analyze temperature, humidity, and gas emissions, which affect food nutritional value. Results are displayed on LCD and sent via Telegram application.
3.	Food Quality and Spoilage Detection Using Arduino	M. Abdullah Khan	Food poisoning affects 600 million people annually, causing over 4,20,000 deaths. Decomposing foods release gases like Methane, Ethylene, and Ammonia, which can be detected by Arduino-based sensors.

	Gas Sensors		This research aims to identify early food rotting before symptoms appear. Fruits and vegetables have a respiratory system, and handling and packaging are crucial for maintaining freshness. Premature spoilage in perishable fruits is a major issue.
4.	Arduino Based Smart IoT Food Quality Monitoring System	Ashraf Ali Jamal Deen, Thivagar Chettiar Sarawanan	This paper proposes a food quality monitoring tool for fruits and vegetables, built on Arduino UNO and interfaced with sensors like DHT-22 for temperature and humidity, MQ3 for alcohol content, and LDR for light exposure. The system sends sensor data to an IoT system for logging and checking, enabling remote monitoring of food storage from anywhere.
5.	Food Spoilage Detection	Madhuri Voorugonda	This paper presents a food spoilage detection system using sensors and an LCD display, aiming to reduce food wastage by detecting gases from food and displaying the results on a 16x2 LCD.
6.	ARDUINO BASED SMART IoT FOOD QUALITY MONITORING	Kaviya (International Journal of Engineering Applied Sciences and Technology, 2020)	The growing interest in food quality and safety requires sensitive and reliable research methods. Chemical and biological sensors for food observation and packaging are being developed to measure freshness markers, allergens, pathogens, adulterants, and toxicants. Implementation in good packaging could improve food quality, reduce scraps, and extend shelf-life. However, challenges and opportunities for future analysis remain
7.	ARDUINO BASED SMART IOT FOOD QUALITY DETECTION TECHNOLOGY	N.Usharani, D.Suruthi, V.Sangeetha, L.Punitha	India faces high rates of food-borne illnesses, leading to hospitalizations and deaths. To combat this, a food detection system using IoT is being designed to test food freshness, using sensors like temperature, ph, and pollution. The system also uses image processing to test fruit freshness, thereby preventing foodborne illnesses and promoting healthy eating habits.
8.	Food Quality Monitoring System	Deepanshi Singh Rao , Debanshu Poddar , Aayan Singh , Dr. Prashant A. Athavale	Sanitation and cleanliness are crucial for preventing food wastage. Quality monitoring devices in food stores can monitor natural factors causing food spoilage, which can be controlled using refrigeration, vacuum capacity, and instantaneity.
9.	Detection of Food Adulteration using Arduino IDE	B. Perumal; Subash Balaji A; Vijaya Dharshini M; Aravind C; J. Deny; R Rajasudharsan	Regular monitoring of food quantity and quality is crucial for maintaining hygiene and safety. Businesses often add adulterants to satisfy selfish desires and profit from selling low-quality food at higher prices. To protect human health, a food adulteration monitoring system should be established. This system uses Arduino to regulate sensor use and records information on an LCD digital display. This method helps avoid poor-quality food consumption and is simple for consumers and food inspectors to use.

10.	FOOD SPOILAGE DETECTION SYSTEM	Simant Mishra, Chandu Surya Prakash Naidu	This paper presents a food detection system using Arduino, to detect and report food spoilage. The system uses a detection and recognition algorithm to automatically inform users about spoilage. Arduino interpretS input and output, turning on sensors based on these. The system aims to detect and inform users about perishables and items stored for short periods, reducing the bacteriological production rate in refrigerators. The system sends alert messages to registered mobile phones.
11.	Arduino Based Smart IoT Food Quality Monitoring System	Devika Sethu	Temperature, humidity, alcohol, light exposure and moisture are monitored using the Arduino board, DHT-22, MQ3, LDR and pH sensors. Measurements can be conducted as quickly as feasible because to its high sensitivity and quick reaction time. The ESP8266 Wifi Modem is connected to the internet via a Wi-Fi router via the Arduino. The sensor data is also shown on an Arduino UNO-connected character LCD.
12.	Food Quality Detection And Calorie Estimation Using Machine Learning	Prakash R, Vadlapatla Sathvik, Potru Teja Sri Venkata Satya Sai , Pothireddy Gopichand Reddy	In the proposed work, the aim is to detect spoilage in food items as a part of hardware and estimating calories in food as a part of software. With the help of sensor nodes placed near food items methane range and temperature data can be collected at regular intervals. In this project we have used industrial MQ3 and temperature sensors. NodeMCU is with Arduino Uno boards.
13.	Identifying Food is Stale or Fresh using Internet of Things	Madhumathi P, Varshitha M, Prof. Mrs Boyapati Sahithi Vedhavathi R and Yamuna P (IJCRT)	The proposed system aims to identify food freshness and quality using internet of things technology. Preserved vegetables pose health risks due to changes in nutrient value, oxygen, temperature, and moisture parameters. The system uses gas sensors to detect food spoilage and alerts individuals via SMS, ensuring safe consumption and preventing blindly believing in expiry data.
14.	IOT BASED ON FOOD QUALITY DETECTION WITH BIOSENSOR TECHNOLOGY	Divya bharathi.K, Rajalakshmi. M UG scholar, Department Of Electronics and Communication Engineering, Arjun College of Technology, Coimbatore.	Food contamination, caused by harmful chemicals and microorganisms, can lead to illness. The proposed scheme focuses on chemical contamination, preventing foodborne illnesses. Common causes include bacteria, viruses, chemicals, and poisonous metals. IoT-based monitoring systems use embedded sensors to detect bacterial contamination and report the quality of food to health centers. Symptoms include nausea, vomiting, fever.
15.	Food Spoilage Detection System (FSDS) Using Arduino	Vikas Nandeshwar, Srushti Bhuyar, Piyush Bhutada, Madhur Bhutada, Radha Bhutada, Vaibhav Bhuwaniya, Bhushan Berlikar	Food hygiene and safety are crucial to prevent food waste and protect against corruption and decay. High-quality surveillance systems in grocery stores can monitor environmental issues, such as temperature, moisture, alcohol position, and light exposure. An IoT contrivance, connected to sensors like DHT-11 and MQ4, measures these factors. Data from the system is displayed on a disposition TV connected to the Arduino UNO, using a bedded spot IoT platform for monitoring and work.

III. METHODOLOGY

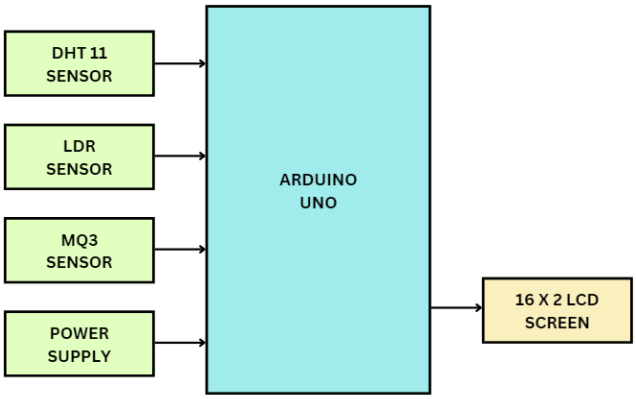


Fig. 1 Block Diagram of the proposed system

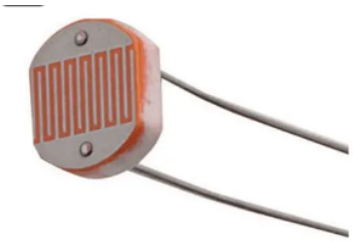
A. COMPONENTS

1) Arduino Board: The Arduino board serves as the central processing unit of the system. It receives sensor data, processes it, and performs actions based on the readings.

2) DHT11 Temperature and Humidity Sensor: The DHT11 sensor measures temperature and humidity levels in the surrounding environment. It provides digital output signals to the Arduino board.

3) MQ3 Alcohol Sensor: The MQ3 sensor is used to detect alcohol levels in the air. It measures the concentration of alcohol and provides an analog output signal to the Arduino board.

4) LDR (Light Dependent Resistor)The LDR sensor measures the intensity of light in the environment. It provides an analog output signal to the Arduino board.



5) Breadboard and Jumper Wires: The breadboard and jumper wires are used to connect the sensors to the Arduino board, establishing the necessary electrical connections.

6) Power Supply: The system requires a power supply to provide the necessary voltage and current to the Arduino board and the connected sensors.

7) 16X2 LCD: The 16X2 LCD display is connected to the Arduino board by connecting its data pins to the Arduino board

B. CIRCUIT

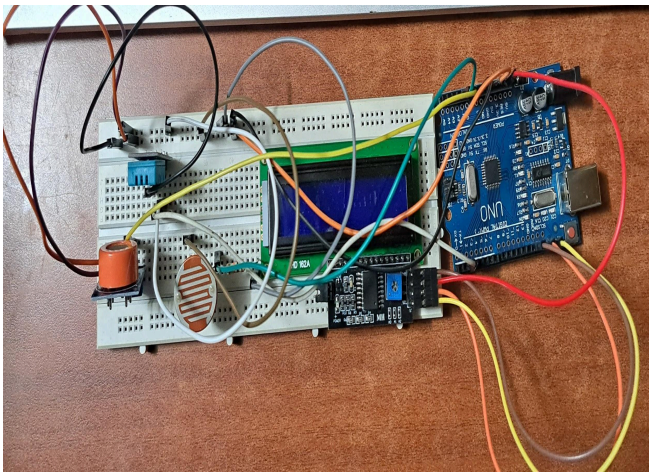


Fig. 2 Circuit of the proposed system

C. ALGORITHM

1) Initialization: Initialize the LDR, humidity and temperature sensors, and the MQ3 alcohol sensor. Set up the necessary connections between the sensors and the microcontroller.

2) Data Acquisition: Read the light intensity using the LDR sensor to assess the environmental lighting conditions. Obtain real-time humidity and temperature data from the respective sensors to monitor the environmental conditions crucial for food preservation. Utilize the MQ3 alcohol sensor to detect the presence and concentration of alcohol in the air, which serves as a key indicator of food spoilage.

3) Analysis and Decision Making: Process the sensor data to assess the freshness, nutritional value, and safety of the food items. Utilize the alcohol concentration data from the MQ3 sensor to determine the quality and potential spoilage of the food products.

4) Output and Action: Based on the sensor readings and analysis, trigger appropriate actions such as alerts, notifications, or control mechanisms to maintain food quality and safety.

5) Integration with Microcontroller: Interface the sensors with the microcontroller (e.g., Arduino) to enable real-time monitoring and decision-making based on the sensor data.

6) System Calibration and Fine-Tuning: Adjust the sensor thresholds and calibration parameters to optimize the system's performance in detecting and responding to variations in food quality indicators.

7) Continuous Monitoring: Implement a continuous monitoring system to ensure ongoing assessment of food quality and timely intervention when necessary.

IV. RESEARCH CHALLENGES

Developing and deploying a food quality monitoring system involves various challenges related to sensor accuracy, data processing, calibration, and environmental influences on sensor readings.

1) Sensor Accuracy: Ensuring the accuracy of sensor readings is crucial for reliable food quality monitoring. Challenges may arise in developing sensor systems equipped with passive RFID interfaces and extending their reading range using ultrawide-band communication and low-power analoguedigital converters.

2) Data Processing: Efficient data processing is essential for extracting meaningful insights from sensor data. Challenges may include the direct readout of accumulated sensor data by a tablet PC over a wireless LAN interface and the operation of Wireless Sensor Networks (WSNs) in the 2.4 GHz frequency range

3) Calibration: Proper calibration of sensors is vital for accurate measurements. Challenges may involve implementing comprehensive defense against adversarial attacks and ensuring the reliability of testing methods used in the food manufacturing process.

4) Environmental Influences: Environmental factors can significantly impact sensor readings. Challenges may include addressing the urban-heat-island effect in the context of air pollution monitoring and considering

the impact of industrial emissions on ambient air quality

5) Remote Monitoring and Biological Modeling: Deviations of fruit quality can be deduced from temperature data if remote monitoring is combined with biological modeling, presenting challenges in integrating these approaches effectively

6) Security and Privacy: Ensuring the security and privacy of sensor data is crucial. Challenges may include addressing privacy and security concerns, as well as enforcing security regulations and closed-loop monitoring in IoT contexts.

7) Transport Monitoring: Standard telematics systems for transport monitoring may provide limited information, and only a few systems offer interfaces for wireless temperature and humidity sensors, posing challenges in integrating these sensors effectively.

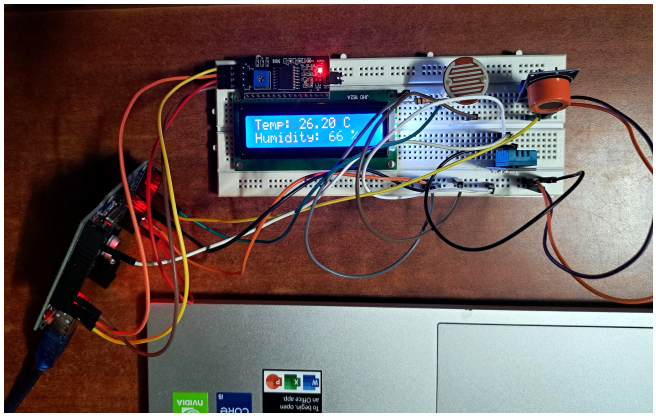
8) Quality Assurance: Quality assurance in the food industry involves consumer participation in evaluating new products and ensuring hazard analysis in the design and development of food products, presenting challenges in maintaining high-quality standards.

9) Training and Education: Workers in the food industry need to understand food safety, quality control, and regulatory compliance, presenting challenges in providing adequate training and education to ensure industry standards are met

10) Regulatory Compliance and Resource Allocation: Meeting regulatory requirements and finding adequate resources to support the monitoring and evaluation process are essential but challenging aspects of developing and deploying a food quality monitoring system

V. RESULTS

Fig. 3 Experimental Setup



A. OUTPUT IN NORMAL ENVIRONMENTAL CONDITIONS

Fig. 4 Readings in Normal Environment

B. OUTPUT WHEN PUT IN A BOX CONTAINING BANANA PEELS

Fig. 5 Readings when inside a box containing banana peels

Thus we found that the increase in gas values was due to the emission of gas by the spoilt food.

VI. CONCLUSIONS AND FUTURE WORKS

In conclusion, the integration of LDR, humidity and temperature sensors, and the MQ3 alcohol sensor in a food quality detection system provides comprehensive monitoring capabilities. The LDR sensor enables the system to assess light conditions, while the humidity and temperature sensors offer real-time environmental data crucial for food preservation. Additionally, the MQ3 alcohol sensor plays a vital role in detecting the release of gases like ethanol, which is a key indicator of food spoilage. By leveraging the capabilities of these sensors, the food quality monitoring system can effectively ensure the freshness, nutritional value, and safety of food items, thereby contributing to the reduction of food wastage and improved consumer health outcomes

The MQ3 alcohol sensor, in particular, is designed to detect alcohol concentrations ranging from 25 to 500 parts per million (ppm) and operates on 5V DC, making it suitable for integration with microcontrollers like Arduino. Its high sensitivity and fast response time make it a valuable component for detecting alcohol concentration, which is a crucial indicator of food spoilage. The sensor's ability to provide both digital and analog outputs further enhances its utility in food quality detection systems.

Overall, the combination of these sensors in a smart food quality monitoring system offers a comprehensive approach to ensuring the freshness and safety of food items, thereby addressing critical concerns related to food spoilage and quality maintenance.

VII. REFERENCES

[1] B. Perumal, S. B. A, V. D. M, A. C, J. Deny and R. Raja Sudharsan, "Detection of Food Adulteration using Arduino IDE," 2021 Second International Conference on Electronics and Sustainable Communication Systems (ICESC), Coimbatore, India, 2021, pp. 262-267, doi: 10.1109/ICESC51422.2021.9532720.

[2] Food Spoilage Detection System (FSDS) Using Arduino by Vikas Nandeshwar, Srushti Bhuyar, Piyush Bhutada, Madhur Bhutada, Radha Bhutada, Vaibhav Bhuwania, Bhushan Berlikar Department of Engineering, Sciences and Humanities (DESH) Vishwakarma Institute of Technology.

[3] ARDUINO BASED SMART IoT FOOD QUALITY MONITORING by Kaviya Department of ECE Saveetha School of engineering, Chennai, International Journal of Engineering Applied Sciences and Technology, 2020 Vol. 4, Issue 12, ISSN No. 2455-2143, Pages 592-597.

[4] IOT BASED ON FOOD QUALITY DETECTION WITH BIOSENSOR TECHNOLOGY by Divya bharathi.K, Rajalakshmi. M , UG scholar, Department Of Electronics and Communication Engineering, Arjun College of Technology, Coimbatore, 2018 IJCRT | International Conference Proceeding ICLIASET 2018 March 2018| ISSN: 2320-2882 2nd International Conference on Latest Innovations in Applied Science, Engineering & Technology & IJCRT.ORG 2018.

[5] Deepanshi Singh Rao , Debanshu Poddar , Aayan Singh , Dr. Prashant A. Athavale, 2022, Food Quality Monitoring System, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 11, Issue 07 (July 2022).

[6] FOOD QUALITY MONITORING SYSTEM BY USING ARDUINO P.A.Lovina, G.Shiva Kumari,Ravichander.B , Assistant Professor, Dept. of ECE, St.Martin's Engineering college, Dhulapally.

[7] FOOD SPOILAGE DETECTION SYSTEM Simant Mishra, Chandu Surya Prakash Naidu, Electronics & Communication Engineering, Lovely Professional University, Professor Kanwaljeet Kingh, Embedded Systems, Lovely Professional University, International Research Journal of Modernization in Engineering Technology and Science, e-ISSN: 2582-5208.

[8] REMOTE MONITORING OF FOOD SPOILAGE USING SMART TECHNOLOGY by B.Sai Akhilesh(317126512123) G.Manoj(317126512134) P.Uma Prakash (317126512163) Y.Arjuna Rao(317126512179) Under the guidance of Mr.S.Srinivas M.Tech,Ph.D(IIT Hyd) Associate Professor.

[9] R. Raju, G. E. Bridges and S. Bhadra, "Wireless Passive Sensors for Food Quality Monitoring: Improving the Safety of Food Products," in IEEE Antennas and Propagation Magazine, vol. 62, no. 5, pp. 76-89, Oct. 2020, doi: 10.1109/MAP.2020.3003216.

[10] F. Ying and L. Fengquan, "Application of Internet of Things to the Monitoring System for Food Quality Safety," 2013 Fourth International Conference on Digital Manufacturing & Automation, Shinan, China, 2013, pp. 296-298, doi: 10.1109/ICDMA.2013.71

[11] E. Henrichs and C. Krupitzer, "Towards Adaptive, Real-Time Monitoring of Food Quality Using Smart Sensors," 2022 IEEE International Conference on Autonomic Computing and Self-Organizing Systems Companion (ACSOS-C), CA, USA, 2022, pp. 70-71, doi: 10.1109/ACSOSC56246.2022.00034.

[12] Y. Chen et al., "Disposable colorimetric geometric barcode sensor for food quality monitoring," 2017 19th International Conference on Solid-State Sensors, Actuators and Microsystems (TRANSDUCERS), Kaohsiung, Taiwan, 2017, pp. 1422-1424, doi: 10.1109/TRANSDUCERS.2017.7994325

[13] Park, Y.W., Kim, S.M., Lee, J.Y. et al. Application of biosensors in smart packaging. Mol. Cell. Toxicol. 11, 277–285 (2015). https://doi.org/10.1007/s13273-015-0027-1

[14] Atchareeya Nopwinyuwong, Sudsai Trevanich, Panuwat Suppakul, Development of a novel colorimetric indicator label for monitoring freshness of intermediate-moisture dessert spoilage, Talanta, Volume 81, Issue 3, 2010, Pages 1126-1132, ISSN 0039-9140, doi.org/10.1016/j.talanta2010.02.008.

[15] M. J. I. Tutul, M. Alam and M. A. H. Wadud, "Smart Food Monitoring System Based on IoT and Machine Learning," 2023 International Conference on Next-Generation Computing, IoT and Machine Learning (NCIM), Gazipur, Bangladesh, 2023, pp. 1-6, doi: 10.1109/NCIM59001.2023.10212608.