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PRESERVING THE TEXTURE AND NUTRITIONAL VALUE OF STORED MEAT USING IOT AND MACHINE LEARNING ALGORITHM

[1]A.S.Rasmika , [2]A.Akash ,[3] J.Monisha , [4]Ramanan sivakumar ,[5]A.E.Narayanan

[1,2,3,4]UG student, Department of Computer Science And Engineering, Periyar Maniammai Institute Of Science & Technology, Vallam , Thanjavur, India,

[5] Associate Professor, Department of Computer Science And Engineering, Periyar Maniammai Institute Of Science & Technology, Vallam , Thanjavur, India.

Abstract:

A large amount of meat is wasted in terms of quality as well as quantity, due to improper storage. This meat loss is caused by the presence of microorganisms in the storage field. The improper storage of meat make the breakdown of fat, protein and carbohydrates ,which results in the development of off-odors, off-flavor and slim formation which make the meat objectionable for human consumption which are caused by the growth of microbes like salmonella, Escherichia coli,etc., releasing toxic gases like CO_2 and Methane from the meat. IoT and machine learning are used to periodically monitor the micro organisms growth and minimize the meat loss by preventing the gas formation in the meat. The presence of gas formation in the stored meat is detected by collecting and analyzing the environmental sensor data using the proposed system. The authorities will be enabled to take necessary action to prevent the meat from spoilage by the use of GSM modules. This paper focuses on the design and development of a system to prevent the meat loss.

Keywords: Food detection software; electronic nose; visual odor; bacterial Contamination.

I. INTRODUCTION:

The food we eat can be contaminated by any type of contamination that occurs as a result of storage or chemical reactions. Within the food Food contamination is caused by a variety of viruses and bacteria, which may contribute to a variety of food-borne illnesses. Every year, the majority of people die from food poisoning around the world. People become sick as a result of food preservation and the use of chemicals to artificially extend the shelf life of food[29]. Meat is a nutrient-dense, protein-rich food that is perishable and has a limited shelf life unless it is preserved. Food quality degradation is exacerbated by pre-slaughter handling of livestock and post-slaughter handling of meat. Microorganisms, lipid oxidation, and autolytic enzymatic spoilage are the major causes of meat and meat products spoilage after slaughtering, as well as during processing and storage. Following the introduction and rapid growth of super markets, meat preservation became vital for transporting meat over long distances without losing its texture, colour, or nutritional value.To prevent such a situation and protect public health, every government should make developing techniques to ensure the protection and quality of meat a top priority.The texture, colour, and nutritional value of meat can be maintained by regularly tracking the atmosphere in which it is processed and taking appropriate measures to avoid the rotten process using Internet of Things and Machine Learning.

II. METHODOLOGY:

There are many methods to work on food processing, In such a way there are some methods to predict the stage of meat whether it is rotten or consumable. Different sensors are used to measure the quality of food, such as a temperature sensor to sense the temperature of the food, a pH sensor to test the salt content of the food, and a standard pH value is stored in the IOT server.In this way, we can effectively verify food quality in order to prevent food borne disease, purchase nutritious food, and make a healthy human.Our proposed device is intended to be small and portable, with the ability to detect and warn humans when they are near unhealthy food.

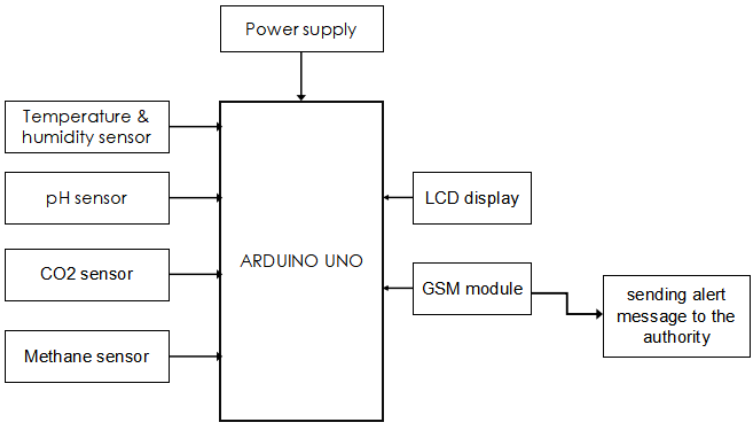

Fig 1: Block diagram

III. HARDWARE COMPONENTS:

3.1 MQ135-CO2 Sensor:

A carbon dioxide sensor or co_2 sensor is used as a device to measure the CO2 gas. During the process, as the meat is kept under observation after some period of time a certain amount of CO2 gas is pumped from the meat, in which the sensor detects and measures the CO2 content of the meat stage by stage. The observed value by the sensor is then sent to the arduino. The values which are calculated by these above sensors are given as “Binary values” as output.

3.2 DHT11-Temperature and Humidity Sensor:

The DHT11 is a temperature and humidity sensor with a simple design. It functions as a capacitive humidity sensor and a thermistor to track the temperature of the air around it. The sensor is used to monitor the temperature and humidity of the meat as it progresses through the process. The sensor's observed value is then sent to the arduino.

3.3 MQ7-Methane Sensor:

The MQ7 is a carbon monoxide (Methane) sensor suitable for sensing [CO] concentrations in the air. In the process we are using the methane sensor to measure the methane value produced from the meat. The observed value by the sensor is then sent to the arduino. The values which are calculated by these above sensors are given as “Binary values” as output.

3.4 pH Sensor:

The basic responsibility of the pH sensor is to calculate the level of Acidity or Alkaline of the water of a substance used. The same applies for the meat we use, the water content in the meat is calculated using the pH scale or sensor in other words.

3.5 GSM Module:

As the process goes on, in some way the controller of this device has to get an alert message regarding the state of the meat stage by stage without any delay. In order to do that, here the GSM module is used to interact with the user. By using the GSM communication between the kit and the warehouse authority who controls the kit a message is sent to their mobile number. This is done as a sim is attached to the GSM,from that number the message is received by the authorities mobile.

3.6 Arduino UNO(Micro Controller):

The internet of things (IoT) is a network of physical devices, cars, home appliances, and other objects that are embedded with electronics, software, sensors, actuators, and networking to communicate, store, and share data. Arduino (Micro controller) is a piece of open source hardware and software that plays a key role in the circuit. It manages all of the sensors, including temperature and humidity, CO2, methane, and pH sensors, as well as a GSM module for user interaction.

3.7 Machine Learning Algorithm:

Since it only includes the readily accessible sensor data in the database, a Machine Learning approach to environmental condition prediction is used. Furthermore, machine learning methods have shown to be reasonably effective in predicting short-term environmental conditions. For this project's no-training period, KNN was chosen as the regressor of choice. Since new data can be quickly applied before making predictions, the algorithm's accuracy will not be impacted. As a result, the KNN algorithm is much quicker than the others. SVM, Linear Regression, and so on. In terms of precision and computational complexity, KNN came out on top.

3.8 LCD Display:

The LCD display is used here to display the values which are calculated or measured to make work easier for the User .

IV. PROPOSED SYSTEM:

This system currently uses three or more sensors to improve the reliability of the system, in order to reduce the false negatives. Low cost moisture sensors, temperature and humidity, C02 sensors, are used. They continuously monitor the Storage field and send it to the Base station using Arduino (Microcontroller). Then Power supply is given the circuit. LCD display is fixed for the continuous monitoring of sensed data. When the sensor information coming from multiple sensor detectors is transmitted into the

data center of the processing system. The data are compared with the threshold values, and the decision should be taken. The system can collect the following information: temperature, humidity, pH range, methane gas and CO2. Real-time data includes the data collected by various sensors The data collected by the sensors will be uploaded by wireless transmission mode. The wireless communication module can transmit the data collected by the sensors to the data center. The collected information, including real-time data and historical data, can be intuitively stored in the database.

The system interacts with the physical environment , then the sensors continuously collect the environmental data in the warehouse. All the sensor data will be sent to the arduino and embedded c coding is used here. Threshold value is also fixed in this coding. The data will be collected for every 5 seconds. The meat will affect when the pH is below 10. In humidity, the range should be 64% to 66% if it has a sudden decrease below 30 then the meat will be affected. Likewise every parameter has its threshold value. After collecting all those sensor data it will compare with threshold value one by one. If any parameter crosses its limits by increasing or decreasing the threshold value it will intimate the authority. When the observation values of one or more sensors exceed the threshold value which was already fixed in the program, the warning system will be triggered.

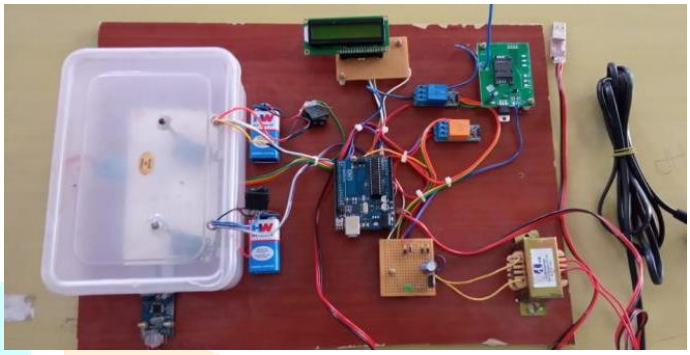

Fig 2: Circuit system

A machine learning approach to environmental condition prediction is used as it only requires the readily available sensor data in Database. KNN has been selected as the regressor of choice for this project for its no training period. Because before making predictions, new data can be easily added which will not impact the accuracy of the algorithm. This makes the KNN algorithm much faster than other training-based algorithms. Eg: SVM, Linear Regression etc.

The algorithm is performed optimally in terms of accuracy and computational complexity. The freshness of the meat is divided into 4 categories: “OK” , “DAMAGED”, “BADLY DAMAGED”, “ ROTTEN”. When the collected sensor values cross the threshold value, it is considered that the meat has been rotten by microorganisms. If the meat is going to get damaged ,then some environmental changes will occur in the warehouse like temperature gets increased or moisture content is increased, by sensing those data by every few seconds and sending an alert message to a particular authority. For eg the message will be sent like meat is slightly damaged. By intimating the authority before the meat affection will reduce the quality loss.

V. RESULTS AND DISCUSSIONS:

Embedded C requires compilers to build files that will be downloaded to the micro controllers where they will need to run. Embedded compilers give access to all tools for desktop computer applications that are not supported in compilers.

- **Temperature:** 25°c to 40°c
- **pH range:** 16%- 10%
- **Atmospheric RH** should be in approximately 66%

Table 5.1: Statistical threshold values

S.no	STATUS	HUMIDITY	pH	Co_2	METHANE
1.	Fresh	64-66%	12-16	0	0
2.	Slightly damaged	75-88%	8-10	1	0
3.	Damaged	90-95%	7-6%	1	1
4.	Rotten	<=30%	>=6%	1	1

These are the approximate threshold values to prevent the microbes growth in the stored meat. These values are fixed at the program (Embedded C) where the collected sensor data are compared to take decision whether the meat is affected or not.

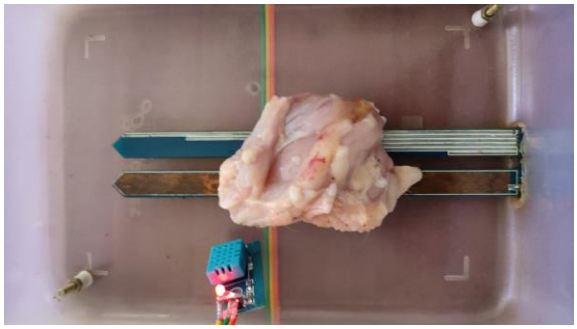

Fig 3: Fresh meat

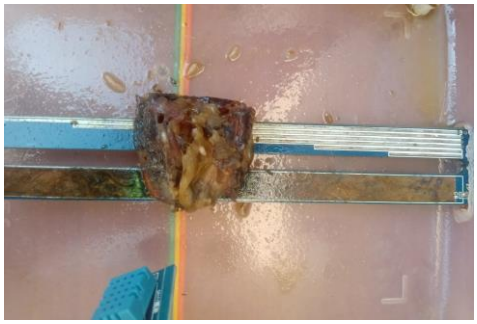

Fig 4: Rotten meat

When the meat is kept at room temperature, the results are as follows. The difference in meat is mentioned in these readings. When observing rotten meat, we can see that the atmospheric RH value is 30 compared to 65 for fresh meat. Because of the intense microbial development, all of the moisture and minerals in the meat appear to leak out. As a result, the meat would become hard and dry, making it unfit for human consumption.

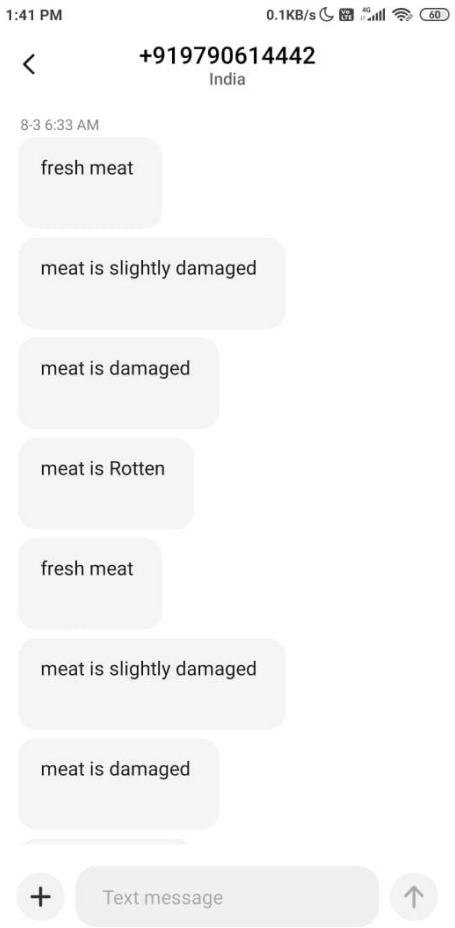

Fig 5: Alert message sent to the authority using GSM module

These states are now notified of the application of the GSM module by the warehouse authority on a regular basis. When the quality of meat exceeds the threshold values, an SMS is sent to the warehouse authority indicating whether the meat is fresh, damaged, or rotten.

VI. CONCLUSION:

The objective of this paper is to reduce the spoilage of meat due to the growth of microbes and certain atmospheric conditions during the storage period. By applying the latest technologies like IoT and Machine Learning algorithms the meat spoilage can be minimized by monitoring and analyzing the environmental conditions of the storage that are sensed by the sensor devices and using machine learning algorithm. By this project the stored meat can be preserved effectively from spoilage and can be made acceptable for human consumption.

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