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Machine Learning Algorithm Based Meat Spoilage Detection: To Avoid Foodborne Infection

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Abstract

People are becoming more health conscious and paying more attention to food safety in recent years. Instead of the fresh meat that is needed, spoiled meat are increasingly being sold in marketplaces. Meat spoilage is a major issue that affects everyone in the globe. Million instances of food-borne disease are recorded globally each year. This is a result of eating rotten meat. Meat that has been spoiled includes a number of toxic volatile organic chemicals. Thus, it is imperative to have a system that can identify food deterioration before any symptoms appear. Using the proper sensors and keeping track of gases produced from meat, the system seeks to identify freshness of meat. This study suggests utilising gas sensors to measure the level of gases released by raw meat, temperature and humidity in order to determine how fresh it is. It makes use of machine learning algorithms to distinguish between fresh and spoiled meat. Various sensors are used to detect various food properties, such as temperature, moisture, ammonia gas, H2S gas, or methane. The sensors provide readings to the microcontroller. These readings serve as the input for the machine learning algorithm that decides whether the meat has spoiled or not. The findings highlight potential benefits of predicting meat rotting level. The sensor data was clearly gathered, delivered to an IoT module for monitoring via the Cayenne app. Consuming fresh meat and avoiding food-borne diseases would be made easier as a result. Human errors that happen during the inspection can also be prevented with the aid of this device. There is no possibility of human mistake with our suggested system because it is based on real-time sensing and machine learning. Because of this, its accuracy has improved. When the meat is spoiled, the system detects it accurately. Due to the system's great efficiency, less time and money would be spent, which will benefit big businesses and small businesses.

1. Introduction

Meat quality is a critical factor in the food industry, and predicting meat quality accurately is of great importance to ensure customer satisfaction, reduce food waste, and maintain profitability. Quality assessment is traditionally carried out by human experts through visual inspection and physical

tests, which can be time-consuming and subjective. Machine learning (ML) and Internet of Things (IoT) technologies have become increasingly popular in the food industry and can be used to predict meat quality. (Kodogiannis and Alshejari)

Meat consumption has increased globally over the years along with global population growth. It has become increasingly difficult to judge the freshness of meat simply by just looking at it as the demand for it has increased over time. Hence, to address this issue, we put out a proposal in which the quality and freshness of the meat are anticipated using machine learning algorithms and sensors to gather data on the meat. (Kartika, Rivai, and Purwanto)

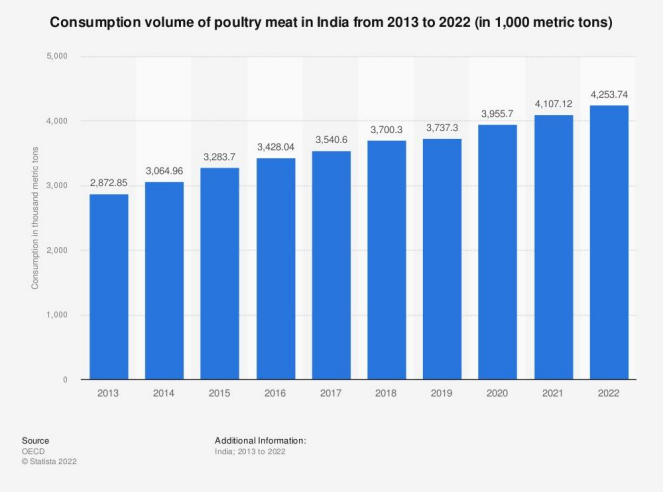

FIGURE 1. Meat consumption in india over the years

Today, a variety of industries, including the mechanical and aerospace industries, the textile business, and the electrical and electronic sector, place a high value on computer-aided inspection (CAI). (Swe et al.) The food industry, particularly the quality assurance stage of the manufacturing process, has shown interest in these systems. A significant development for the food sector is the ability to reliably and non-destructively examine samples.One method used to estimate quality features is physico-chemical analysis. With this study, the lipids and salt content, water activity, and characteristics relating to the colour of meat samples are all determined but we proposed another solution with sensors and Machine learning algorithms. (Ulucan, Karakaya, Turkan, et al.)

In this project, we will use ML and IoT to predict meat quality by analyzing various factors such as temperature, humidity, NH3 gas emission and H2S gas emission of the meat. The IoT sensors will collect real time data on these factors, and the ML algorithm will analyze the data to make predictions about the quality of the meat. (Alshejari, Kodogiannis, Petrounias, et al.)

This project has significant implications for the food industry and households, as it will allow producers and processors to predict the quality of meat accurately, reducing the amount of waste and enhancing the quality of the final product. (Johnson et al.) The application of IoT and ML technologies in the food industry is a growing field, and this project will demonstrate the potential for these technologies to improve food quality, reduce waste and improve sustainability by optimizing the use of resources and reducing the environmental impact of meat production. (Ajaykumar and Mandal)

2. Literature Survey

The writing here of the document implies the knowledge of the meat quality prediction and situations occurring in the working system.

(Pereira, Lins, and Gaspar) One of the most popular food items are steaks made from beef, however this food item is quite perishable and has a high potential for microorganism growth. The technology described in this paper, which is based on image analysis, can guarantee the quality of the meat while it is being purchased. The created technology simply requires a smartphone running a special algorithm to swiftly determine meat quality. In the lab, mesophilic and psychrotrophic microbial counts as well as measurements of beef colour were performed. A link between the hue and the microbiological conditions was established by analysis of the collected data and reference to the AMSA (American Meat Science Association) standard. To validate the experiments, an Analysis of Variance followed by a Tukey's test was conducted. The outcomes show that the method is capable of reliably assessing the real state of the meat by linking the microbes and the measured colour.

(Bakhoum, Cheng, and Kyle) In this research, a brand-new method for spotting meat deterioration is presented. Although extremely accurate and trustworthy, the technology is inexpensive, making it easily accessible to customers and businesses. The method is based on the idea of using specific chemi-

cally sensitive dyes to identify volatile organic compounds (VOCs) generated during the decomposition of meat. A bar code made from a collection of chemically reactive colours is printed on paper. The meat packing is then sealed with the bar code. The dyes alter their hue when exposed to VOCs. The bar code is then scanned with a low-cost handheld device, which immediately applies pattern recognition techniques to find changes in the dyes colours. Within a nanosecond, the device provides a report on the product's state of spoiling.

(Raju and Bridges) Nowadays, it is necessary to keep an eye on food goods during long-term storage while maintaining quality and safety. The quality of high-value food items, such as milk and meat products, is monitored in this article using a small, reasonably priced quasi-chipless sensor. To receive, modify, and retransmit the interrogator signal, the sensor makes use of a dual-band, dual-polarized annular ring antenna that also functions as a sensor. A varactor—pH electrode-based transduction system is used to sensitise the resonant frequency of the antenna's receiving mode to the parameter being monitored. Before retransmission, the received signal is doubled using a diode frequency doubler circuit to reduce environmental noise. The sensor's use for pH monitoring is demonstrated. It was demonstrated that the sensor could effectively track the sour milk process.

(Huang et al.) By remotely monitoring pH level changes in food with a flexible pH sensor integrated in a batteryless radio-frequency (RF) transponder, we describe a novel technique for managing the quality of food. A flexible pH sensor based on tiny iridium oxide (IrO x) and silver chloride (AgCl) detecting electrodes integrated on a malleable substrate is included in the wireless sensor tag, along with battery-free wireless communication electronics. In particular for large-quantity applications and continuous monitoring from the site of production to retail outlets, the sensor tag and reader system is intended to enable easy, long-term, and on-demand wireless in food quality monitoring. Flexible sensing films with a sensitivity of -49.7 mV/pH were created on polymeric substrates using a low-cost IrO x sol-gel production technique. The reader's electromagnetic energy is used through inducting coupling to power the transponder circuits that send the sensor-data modulated signals back to the reader. The device achieves a sensitivity of 633 Hz/pH by converting the electrochemical potential generated by the IrO x/AgCl sensor electrodes to a modulated frequency. The wireless pH sensor device was put to the test for continuous monitoring of the fish meat deterioration processes for more than 18 hours. It has been shown that it is feasible to wirelessly monitor fish meat pH levels in order to detect distant spoiling.

(Fang) Food rotting is one of the most significant issues with food safety. A design strategy of a food spoilage intelligent detection system based on embedded arm and integrated DSP is provided in order to increase the capacity to intelligently detect food spoilage. The hardware platform and software design make up the majority of the system design. The system is built on an integrated DSP development platform with embedded Arm. output regulation module and central controller module. The embedded arm and integrated DSP system are utilised to construct the interface in the human-computer interaction unit, and the technology of DSP bus development is used to realise the adaptive receiving, transmitting, and converting control of the food mildew information sensor. The system's compatibility and human-machine interface may be enhanced by using an object-oriented design for food rotting intelligent detection based on GUI rendering instructions. The optimised design of the food rotting intelligent detection system is achieved, together with the integrated development and system testing of the system, in an embedded environment. The system's test findings demonstrate that it can successfully identify food deterioration, and that artificial intelligence may be detected with greater precision.

(Hindle et al.) Today's society has a significant issue in reducing food waste. A complex combination of trace gases that may be utilised as indications of food spoiling will be produced as a result of microbial activity during the preservation of foodstuffs packed within a protective environment. The production of hydrogen sulphide in the headspace of a sealed plastic tray holding a piece of salmon fillet has been seen using THz waves.

2.1. Disadvantages

Among the various proposed solutions for meat spoilage detection,many of the system relies on

using image processing to find meat spoilage.This have a huge disadvantage as depending on the image quality ,the output differs.Other than image processing based on pH value the meat spoilage can be found but it's not possible for finding the quality of tons of meat and have to take the pH value carefully without touching the meat, So Hygiene of the meat is not provided. Depending upon the meat,the process for various solutions differs and needs a lot of work.

3. Methodology

Data is a vital part of every machine learning system. We chose to concentrate on the collection of Goat meat's data for implementing the system. The Data is collected from fresh meat to rotten meat, the data for this process takes place everyday. To make sure the system works efficiently. The data collected are crucial for predicting the quality of the meat. The collected data is further classified into train data and test data, train data is used for training the system with data, the test data is used to check whether the system is able to predict the quality of meat and possibility of meat spoilage accurately. Partitioning data for instance, let's suppose that 75 percent of the data is utilized for the model's training and the remaining 25 percent is reserved for testing the model. There would be sensors for factors such as temperature, humidity, ammonia gas and hydrogen sulfide gas. Real time data change is observed and noted down.

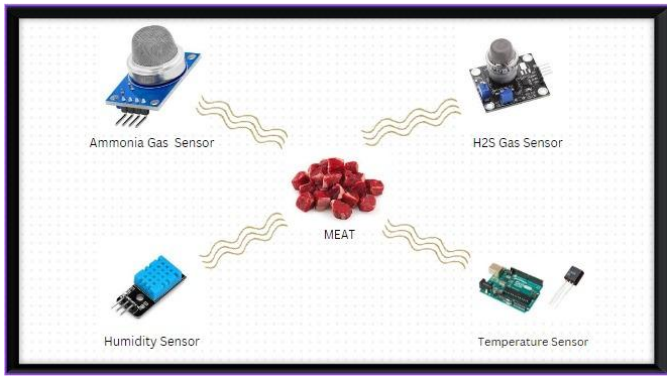

FIGURE 2. Four sensors to monitor real time data

The real time data for the meat is collected on a regular basis, in our case data is collected everyday for a few days. With the collected data, after the data analysis machine learning algorithms such as KNN (K-Nearest Neighbors) can be helpful in predicting the quality of the meat. The proposed solution makes use of four sensors, sensors for temperature, humidity, ammonia gas and hydrogen sulfide gas to note down real-time data changes.

Among various machine learning algorithms we decided to use KNN algorithm,KNN works by identifying the "k" closest data points to the one being predicted and then predicting the outcome based on the majority class of those k data points. In the case of meat spoilage prediction, KNN can take into account a variety of factors that may impact spoilage, such as temperature, humidity, and storage conditions. By analyzing past data on spoilage and using this information to predict the likelihood of spoilage in the future, KNN can help ensure that meat is safely consumed before it goes bad, reducing the risk of foodborne illness.

4. Implementation

Over the decades meat consumption all over the world, with increase in world population. With demand for meat getting higher over the years, it's complex to assess the freshness meat just by seeing it. So, to overcome this problem, we proposed a solution in which the freshness of the meat is predicted by collecting data for the meat using sensors and machine learning algorithms.

The first step is to collect dataset for the process,the dataset is prepared by taking down readings of real-time data changes which are shown in the sensors. There are four sensors which are used in the proposed solution, they are four considering factors such as ammonia, hydrogen sulfide, humidity and temperature.

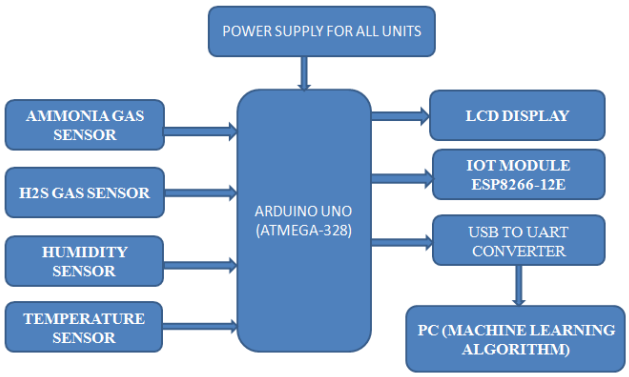

FIGURE 3. Architecture Diagram

The Figure 3 tells the working of the project , here we get the input from 4 sensors and the arduino

helps to connect the machine learning model and IoT module.The machine learning model get the data through USB to UART converter and predict the percentage of meat spoilage. The monitoring of real time change in input data will be done in cayenne app using IoT module. The LCD display is used to show the percentage of spoilage in meat.

Sensors used are: Ammonia gas sensor, Hydrogen Sulfide gas sensor, Temperature sensor and Humidity sensor.

Gas sensors are used to detect the gases produced by bacterial growth, which can indicate spoilage. In our system we have used Goat meat for spoilage detection.

Ammonia and hydrogen sulfide gas sensors are utilised in our system and different kind of meat produces different gases with varying volume of gas.Temperature sensors and humidity sensors are used to monitor the conditions in which the meat is stored, as these can affect the rate of bacterial growth. Humidity sensor is used to detect the humidity of the environment in which the meat is stored.

The prepared dataset should be divided into two: train data, test data.The train data is used to train the machine learning model with KNN algorithm to predict freshness of meat. The test data set is used to check whether the machine learning model predict accurately or not. The dataset is prepared by noting down real time data changes using sensors.The dataset for the meat is collected in two ways:The one in which the meat is frozen and the other in which the meat is not frozen.The real time data changes in the sensor for both frozen and unfrozen meat is noted down

Next step is to train the model with the dataset, Machine learning is used to analyze the data from the sensors and detect patterns that indicate spoilage.

The system works by continuously monitoring the gases, temperature, and humidity in the environment in which the meat is stored. The data is then analyzed using machine learning algorithms, which can detect patterns that indicate spoilage.

These patterns can include changes in the levels of gases, increases in temperature or humidity, or combinations of these factors.

Once the system detects spoilage, an alert can be sent to the appropriate personnel, allowing them to take action before the meat becomes unsafe for consumption. If the refrigerator in restaurants maintains the spoiled meat upto some limit then our system will send message to food department inspection unit so that can be aware of restaurants which uses spoiled meats.

TABLE 1. Depending upon the data obtained from the sensors, freshness of the meat can be predicted

Meat Quality	Temperat	Humidity	Ammoni Gas	H2S Gas
Spoiled	41^0F or above	30%or below	>730mV	Present
Fresh	40^0F or above	85% to 90%	<730mV	Absent

TABLE 2. Based upon the ammonia released from the meat freshness of the meat can be predicted

Status	NH_3 sensor output(mV)	Content
High	<630	Very fresh
Medium	630-730	Can be eaten
Low	730-1000	Food Poisoning may occur
Spoilage	>1000	Spoilage

FIGURE 4. LED display shows possibility of meat spoilage

The use of machine learning allows for the detection of subtle changes in the environment that may not be detected by human senses or pH testing.

The proposed system for detecting meat spoilage using gas sensors, temperature sensors, humidity sensors, and machine learning offers a more reliable and efficient method of detecting spoilage compared to conventional techniques.

5. Conclusion

In conclusion, the use of IoT and machine learning for predicting meat quality is a promising application that has the potential to revolutionize the meat industry. By using sensors and IoT devices to collect real-time data on various factors such as Temperature, Humidity, and Ammonia (NH3), Hydrogen Sulfide (H2S), Machine Learning algorithms can analyze this data to predict meat quality and ensure the safety of meat products. The use of meat quality prediction in the food sector can help households significantly in determining the meat's quality.

In addition to it, spoilage of meat can be found as soon as possible.Through the use of machine learning models, it is possible to detect early warning signs of spoilage and take appropriate action to prevent contamination and wastage. While there are numerous benefits to using IoT and machine learning for meat quality prediction, there are also some challenges that must be addressed. One of the main challenges is ensuring the accuracy and reliability of the sensors and other monitoring equipment. This can lead to increased efficiency and reduced costs for meat producers, as well as improved quality and safety for consumers.

Furthermore, the use of IoT and machine learning for meat quality prediction can help reduce the reliance on manual inspection and subjective assessments, providing more objective and accurate results. As technology continues to advance, we can expect further developments and improvements in this field, leading to even greater benefits for the meat industry and consumers alike.

6. Future Scope

In future, the meat quality prediction system can be integrated with the refrigerator to show the details about the quality of meat, possibility of meat spoilage and the environment for storing meat is suitable for it, depending on that temperature can be increased or decreased. To ensure the quality of meat in logistics,the system can be integrated with the trucks, airplane to predict the possibility of meat spoilage and change the environmental temperature to ensure the quality of meat.

7. Authors' Note

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the pa-per was free of plagiarism.

References

Ajaykumar, V J and Prabhat Kumar Mandal. "Modern concept and detection of spoilage in meat and meat products". *Meat Quality Analysis* (2020): 335–349.

Alshejari, Abeer, Vassilis S Kodogiannis, Ilias Petrounias, et al. "A rapid detection of meat spoilage using FTIR and neuro-fuzzy systems". *2015 SAI Intelligent Systems Conference (IntelliSys)* (2015): 576–584.

Bakhoum, Ezzat G, Marvin H M Cheng, and Roger A Kyle. "Low-Cost, High-Accuracy Method and Apparatus for Detecting Meat Spoilage". *IEEE Transactions on Instrumentation and Measurement* 65.7 (2016): 1707–1715.

Fang, S. "Design of Intelligent Detection System for Food Spoilage". *2018 11th International Conference on Intelligent Computation Technology and Automation (ICICTA)*. IEEE, 2018. 190–194.

Hindle, Francis, et al. "Spoilage of Salmon fillets as observed by THz waves". *2019 44th International Conference on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz)*. IEEE, 2019. 1–1.

Huang, Wen-Ding D, et al. "A Passive Radio-Frequency pH-Sensing Tag for Wireless Food-Quality Monitoring". *IEEE Sensors Journal* 12.3 (2012): 487–495.

Johnson, Joel, et al. "Determining meat freshness using electrochemistry: Are we ready for the fast and furious?" *Meat Science* 150 (2019): 40–46.

Kartika, Vinda Setya, Muhammad Rivai, and Djoko Purwanto. "Spoiled meat classification using semiconductor gas sensors, image processing and neural network". *2018 International Conference on Information and Communications Technology (ICOIACT)* (2018): 418–423.

Kodogiannis, Vassilis S and Abeer Alshejari. "An Extended NRBF Model for the Detection of Meat Spoilage". *2020 IEEE 10th International Conference on Intelligent Systems (IS)* (2020): 451–456.

Pereira, Leandro Martins, Romulo Gonçalves Lins, and Ricardo Gaspar. "Camera-based system for quality assessment of fresh beef based on image analysis". *Measurement: Food* 5 (2022).

Raju, Robin and Greg E Bridges. "A Compact Wireless Passive Harmonic Sensor for Packaged Food Quality Monitoring". *IEEE Transactions on Microwave Theory and Techniques* 70.4 (2022): 2389–2397.

Swe, Mon Myat, et al. "Monitoring the Freshness Level of Beef Using Nanocomposite Gas Sensors in Electronic nose". *2019 IEEE International Conference on Consumer Electronics - Asia (ICCE-Asia)* (2019): 100–103.

Ulucan, Oguzhan, Diclehan Karakaya, Mehmet Turkan, et al. "Meat Quality Assessment based on Deep Learning". *2019 Innovations in Intelligent Systems and Applications Conference (ASYU)* (2019): 1–5.

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