Vol-08 Issue 05, May -2024 ISSN: 2456-9348
Impact Factor: 7.936

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International Journal of Engineering Technology Research & Management

REAL TIME ONION SPOILAGE DETECTION USING GAS SENSOR

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ABSTRACT
The perishability of onions presents a significant challenge in the agricultural supply chain, leading to substantial economic losses. Addressing this issue requires innovative approaches for early spoilage detection. This project presents a novel approach to monitor onion quality by utilizing a fusion of gas sensors (MQ15 and MQ6), alongside temperature and humidity sensors. The collected data undergoes analysis via a pre-trained K-nearest neighbors (KNN) machine learning model. The main aim is to predict onion quality by detecting internal defects. Integration of NodeMCU as the controller, a Li-ion battery powered by TP4056, and an I2C LCD display facilitates real-time information display, enhancing system efficiency and portability. This system offers a promising solution for ensuring onion quality assessment, crucial for both producers and consumers. The combination of sensor technology and machine learning enables accurate and timely evaluation of onions, potentially reducing waste and ensuring product quality throughout the supply chain.

Keywords:
Onion Spoilage, early detection of onion, Gas Sensors, Monitor onion Spoilage, Onion Quality Assessment, Reducing Wastage.

INTRODUCTION

Onion is a major bulbous crop among the cultivated vegetable crops and it's of global importance. India has varying climatic conditions and provides an occasion for growing a large number of horticulture crops including vegetables. The onion is an important vegetable and has been grown in nearly all the parts of India for thousands of times. The onion is regarded as a largely import acquainted crop and earn precious foreign exchange for the country. Though India produces a significant volume of onion it isn't regular and sufficient enough to meet the demands for both requirement and exports. Being an essential food item, it's also a largely politically sensitive commodity. India ranks second in global onion production after China and with an periodic product of 16 to 17million tonnes accounts for around 20 per cent of global product. Still, Indian onion yield is one of the lowest. The essential lower productivity in sub-tropical countries vis- à- vis European counties, deficit and high prices of quality seeds, high prevalence of pests and diseases typical under tropical conditions, humidity stressor redundant rains during critical growth stages are factors constraining yield. Wide price oscillations make it a risky crop discouraging large scale relinquishment of input intensive production ways and good operation practices by growers. In India onion is grown in three crop seasons, videlicet kharif (gathered in October- November), late kharif (January- February) and rabi (April – May). Rabi season crop is the largest account for about 60 percent of periodic product with kharif and late kharif accounting for about 20 per cent each. Onion is produced in the countries of Maharashtra, Karnataka, Madhya Pradesh, Rajasthan, Gujarat, Andhra Pradesh and Bihar which together constitute around 70 per cent of the area under onion. The studies have revealed that the actuality of high insecurity in import of onion the values of CV in export of onion have come down during the post WTO than pre WTO period. This paper aims to provide a comprehensive overview of recent advancements in onion spoilage detection using machine learning and computer vision techniques. Through a detailed analysis of existing literature, we seek to elucidate the underlying principles, methodologies, challenges, and future prospects of onion spoilage detection systems. This begins by exploring the physiological and biochemical changes that occur during onion spoilage, laying the foundation for understanding the characteristics and manifestations of spoilage. [1]

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Furthermore, the review evaluates the performance of existing onion spoilage detection systems, highlighting their strengths, limitations, and areas for improvement. By comparing different methodologies and algorithms, researchers can gain insights into the optimal approaches for achieving high accuracy and reliability in spoilage detection. Moreover, the review examines the influence of various factors, such as environmental conditions, storage methods, and onion varieties, on the efficacy of detection systems. In conclusion, this review underscores the transformative potential of machine learning and computer vision in revolutionizing onion spoilage detection. By harnessing the power of data-driven algorithms and image analysis techniques, researchers can develop robust, cost-effective, and scalable solutions to combat onion spoilage effectively. As we navigate the complexities of modern food systems, innovation in spoilage detection serves as a beacon of hope, safeguarding both economic interests and public health[2]

REVIEW OF LITERATURE

A. Post Harvest Losses in Onion

Achieving food production self-sufficiency is one of the major challenges facing many developing nations, especially those in sub-Saharan Africa. The two primary sources of this issue are these countries' inability to meet their agricultural production targets and food losses throughout their supply networks. The five stages of food loss are agricultural production, postharvest, processing, distribution, and consumption, according to the Food and Agricultural Organization. Food losses at production include food lost as a result of spills during harvest operations and mechanical damage. Crop value is reduced during processing and storage, leading to postharvest losses. Food losses that happen in the household and industrial phases are included in the food processing process. Food waste in the home consumption stage is primarily responsible for losses at the consumption level, whereas losses at the distribution stage include those at the market system.

There are two ways to look at postharvest loss: Quantitatively and qualitatively. The postharvest loss is quantified by the quantitative approach as a decrease in the physical count of food items in location and time. The postharvest loss of food products is measured using the qualitative approach in terms of the loss of nutrients, viability, aesthetic qualities, and nutritional qualities. Global food loss accounts for one-third of the food produced to feed the expanding population. Therefore, postharvest loss has harmed food security in a number of developing countries, including Nigeria.Over 25 percent of postharvest food losses in developing nations are thought to be caused by pest infestation, spoiling, and improper handling. This suggests that roughly 25% of food generated for human consumption does not end up in their mouths. Furthermore, because fresh vegetables are more perishable than cereals, postharvest losses have prevented the potential yield increase brought about by agricultural innovations from having an impact on the income of small-scale farmers in these nations. Onion is one of these vegetables. Onions, are an important vegetable crop that are grown mainly for domestic use and export in various regions of the world. The bulb varieties are particularly popular. Since they are rich in fiber, minerals, protein, vitamins, calcium, iron, ascorbic acid, insulin, sulfur, and calories, they are highly prized for their herbs, nutritional qualities, and flavor. In addition to their culinary use, onions are valued for their therapeutic qualities due to their intriguing technological attributes and health benefits, which include antithrombotic, hypolipidemic, prebiotic, antimicrobial, anticarcinogenic, and antioxidant qualities. It also has a big impact on the livelihoods of those who work in the value chain and production of it, both in developed and developing nations' rural and urban areas.Like many other vegetables, it does experience a fair amount of postharvest loss. Nigeria is the leading producer of onions in West Africa, with an annual production of about 1.1 million tons Nigeria.[3]

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Figure 1: Post Harvest Losses in Onion

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B. Levels and Causes of Post Harvest Losses of Onions

In the research area, rot, pests and pathogens, drying, and bruising were the main reasons for postharvest loss in onions. Fungi and bacteria-caused rot greatly contributes to postharvest loss in onions. This causes wilting and dieback of the leaves, which in turn causes degradation of the leaves and bulbs. Pests and diseases include damping-off, purple blotch, Colletotrichum blight, black mold, and Stemphylium leaf blight also seriously reduce onions' postharvest yield.

Disease-related losses to quantity and quality make for a significant portion of agriculture's financial losses. Postharvest loss brought on by early drying of onion leaves and bulb drying lowers onion quality and market value. Onion bruising is often caused by inadequate transportation and packaging, which results in onion damage and postharvest loss. This shows that on-farm operations and/or storage accounted for the majority of these main reasons for postharvest loss in the production of onions.

To find out the secondary reasons for postharvest loss in onions as reported by the respondents, more research was done.[4]

In decreasing order of significance, the study area's most significant secondary causes of postharvest loss in onions were: inadequate credit to enable timely operations; subpar storage facilities; absence of agricultural extension services to provide training on loss mitigation; subpar transportation infrastructure; and lengthy travel times to the marketing center.

When these causes are examined closely, it becomes clear that the majority of them are outside the farmer's control. Problems in their control measures such harvesting methods, the kind of the harvest period and cultivar types were determined to possess little to no effect on postharvest loss in onion within the research area.

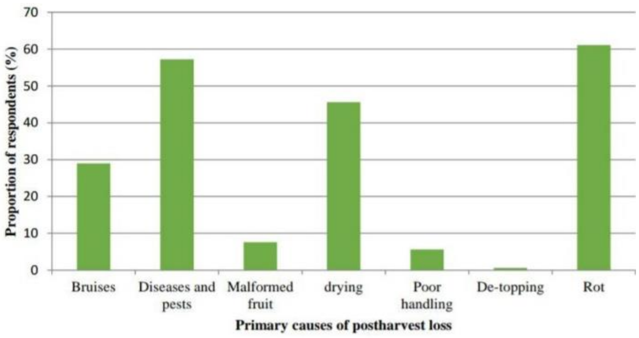

Figure 2: Primary Causes of Onion Post Harvest Loss in study area

In India, onions are one of the most significant commercial crops farmed for spices. The alliaceous smell of onions is what gives them their unique qualities and explains why they are used in salad dressings, food, medicine, and spices. India is the second-largest producer of onions among the nations that grow onions.

According to a nationwide survey, 15-20% of the onion produce grown during the Rabi season is lost owing to storage disease damage, while 30–40% of the produce is kept to meet demand during the off-season. Numerous post-harvest diseases affect onions, including neck rot, brown rot, soft rot, blue mold, and smudging. Of these, black mold and blue mold are the most common ones that impair onions' capacity to be traded both domestically and internationally.[5]

Aspergillus niger Van Tieghem, the culprit behind black mold, is more common in the nation's tropical regions. It results in rotting and post-harvest defects in onions that are cultivated and kept in hot climates. In India, the illness is widespread anywhere onions are kept.

Penicillium species are the source of blue mold. There are numerous types of diseases known worldwide to produce blue mold on bulbs. Often, the blue molds are isolated from sick bulbs that are being preserved by local cultivers. In order to avoid market gluts and price fluctuations, onions must be preserved for a short time after harvest before being sent to the market. The most crucial technique for maintaining the high quality of stored bulbs is proper storage. Thus, a review of various onion storage systems is both necessary and appropriate. The goal of the current study was to determine the optimal storage configurations and onion genotypes with minimal susceptibility to post-

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harvest infections by blue and black mold.[6]

C. Diseases arises in onions during storage

Many illnesses that affect onions have been documented, and these lead to losses in yield both in the field and during storage. The reasons for onion bulb losses during storage are numerous. Onion bulbs naturally lose weight when stored because they are constantly losing water. The most significant loss results from storage rots brought on by different illnesses brought on by fungi that rot bulbs. Worldwide onion storage and transportation illnesses are discovered to be caused by approximately 15 distinct fungus species and 5 bacterial species. These illnesses cause a significant loss that can reach 40%.

Many diseases, including Aspergillus niger (black mold rot), Penicillium spp. (blue mold rot), Fusarium bulb rot (Fusarium spp.), Basal rot (Fusarium moniliforme), Aspergillus rot (Aspergillus spp.), and Dry rot, degrade onions during storage. Green mold rot (Penicillium spp.), White rot (Sclerotium cepivorum), Grey neck rot (Botrytis allii), Smudge (Colletotrichum circinans), Soft rot (Erwinia spp.), and anthracnose (Colletotrichum chardonianum). A. niger, or black mold rot, is the most severe of all when it comes to storage. Onions become infected with A. niger and A. flavus when the temperature and relative humidity are high. Onions are destroyed by Penicillium spp. At low temperatures, however.

Occasionally, Penicillium species generate Penitrem A, a mycotoxin that has been linked to tremorgenic toxicosis in the past. It has been observed that Aspergillus sp., Penicillium sp., and Fusarium sp. Were the main fungal infections linked to the storage illnesses of onions. However, the country's stored onion diseases' severity and intensity have received less research attention.

The fungi linked to onion bulbs that were collected from various markets in the Bangladeshi districts of Mymensingh, Naogaon, and Sathkhira. Additionally, the prevalence of onion storage diseases and to determine the effects of storage variability and conditions on onion disease incidence. Reaching food self-sufficiency is a significant obstacle that many developing countries, particularly those in sub-Saharan Africa, must overcome. This problem stems from food losses throughout their supply chains in addition to these nations' incapacity to reach their agricultural production targets. Five phases of food loss have been identified by the Food and Agricultural Organization (2011): agricultural production, postharvest, processing, distribution, and consumption. Food losses at the point of production include those brought on by spills during harvesting and mechanical harm.

Postharvest losses are caused by crop value reductions from spoiling during handling and storage. Food losses during processing include those that occur throughout both home and commercial processing phases. Food waste in the home consumption stage is primarily responsible for losses at the consumption level, whereas losses at the distribution stage include those at the market system.[7]

Figure 3: Internal defects of Onion

D. Preventive Approaches for Disease arise in Onion during Storage

a) Heating and curing :

Onions have a higher moisture content and are a semi-perishable commodity. Farmers in developing countries require low-tech, simple solutions to boost onion bulb marketability and reduce postharvest losses. Onion bulbs must be immediately cured after harvesting because they are produced below the earth's surface. After harvesting, onions undergo a unit operation called curing, which removes moisture from the outermost layers, neck, and roots

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of the onion bulbs. This process lowers the risk of disease and encourages a darker skin finish, both of which improve the quality of the onion storage. The physical, chemical, and biological characteristics of bulb crops are impacted by this essential postharvest unit operation in long-term storage . Elevated temperature for Foliage exhibited an elevated rate of 35.91% of sprouting. Onions cured at 20°C were found to have a higher concentration of abscisic acid (ABA). Given that the concentration of ABA decreases with increasing storage time and that the curing process can sustain the concentration, prolonging storage life and dormancy, this is a crucial indicator of onion quality.[8]

b) Chemical processing :

Variations in storage conditions over time affect weight, color, ethylene synthesis, sprouting, and pathogen susceptibility to thrips, bacteria, and fungi. Chemical treatments are essential for reducing pathogenic activity while being stored. ECO2, which is phosphine gas diluted to 2% in liquid carbon dioxide, is more effective than methyl bromide at controlling thrips at 200–300 parts per million. The treatment of onions with 1-MCP (methylcyclopropene) and exogenous ethylene in gaseous form at 20°C, followed by storage at 4–12°C, significantly reduced sprout development, regarding sprout and rot control studies were undergone. But a single application of 1-MCP at 20°C was not enough to stop sprouting[9].

c) Biological control methods for onion preservation :

Onions can be effectively protected from rot-causing bacteria and other pathogens through the use of biological control. In comparison to the controls, the severity of black mold disease was significantly lessened by several strains of antagonistic yeast that were isolated from soil, such as AUN-AH14 and AUN-AH23, and their corresponding cultural filtrates at 80% concentration. It was discovered that soil actinomycetes, in particular Streptomyces spp., reduced the amount of onion neck rot losses brought on by Botrytis allii.[10]

d) Ozone treatment

Fumigation can be replaced with gaseous ozone, which will protect the onions while they are being stored. When a high voltage discharge is applied between two electrodes in the air, gaseous ozone is produced. Microorganisms could be inhibited by gaseous ozone at the ideal dosage without degrading produce quality. During onion storage, ozone was able to limit contamination by inhibiting fungal colonies and reducing airborne spores. This treatment may slow down the activity of peroxidase and catalase while leaving no harmful residues behind. In addition to killing the bacteria, the ozone treatment can postpone physiological functions. [11]

e) Irradiation

Significant postharvest losses in onions are caused by rotting, sprouting, and physiological weight loss (PLW), all of which shorten the storage life and reduce the quality of onions. Elevated storage temperatures cause a physiological weight loss, while high relative humidity during the rainy season promotes sprouting and rotting. Because of this, cutting edge therapies are required to lower these losses. Onions are treated with radiation to preserve quality and minimize sprouting. Onions are exposed to minimal amounts of gamma radiation under carefully monitored circumstance.

Doses of radiation ranging from 0.01 to 10 kGy can limit sprouting without compromising physiological traits. In radiation therapy, choosing the right dose and treatment duration is essential because larger doses can change the chemical and organoleptic characteristics. Onions can be kept fresher for three months at room temperature with gamma irradiation at a dose of 120 Gy, which can also help to prevent sprouting and rotting. Untreated samples had a greater rate of weight loss, whereas samples that were exposed to radiation had a lower rate of weight loss. Radiation has the ability to limit respiration, metabolic activities, and dehydration, which can impede weight loss. For sprouting, the same values were also found to be effective. Because of the higher levels of ascorbic acid and other hormone-like compounds, such as ethylene, the sprouting inhibition was not possible at lower doses. A 20 Gy x-ray dose combined with Onion bulb sprouting may be successfully inhibited at 3.2 mm depth [12].

f) Edible coatings for preservation of onion

The quality of produce is impacted by enzymatic changes that result in color and flavor changes in both fresh and dried onions that have undergone minimal processing. Younes discovered that by maintaining color and successfully preventing microbial growth, carboxy methyl cellulose with nano-silver incorporated showed the highest level of TSS, sugar, phenols, vitamin C, and pungency. In contrast, microbial growth was inhibited in the case of dried onions by the incorporation of nanosilver into carboxymethyl cellulose, alginate, and starch. Coating with carboxy methyl cellulose infused with nano silver preserved the quality and extended the shelf life of both fresh and dried onions. It has been reported that applying a light heat and an edible alginate coating will slow down the rate of

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respiration and the decay process in minimally processed onion.[13]

E. Pre-existing Machineries/Devices for Detecting Onion Spoilage

a) Development of Personalized gas sensor for post-harvest disease detection of onion

Recent studies have shown that the types and concentrations of volatiles released by healthy and acid-skinned onions differ from those produced by botrytis neck rot. A custom gas sensor system consisting of five MOS (Metal Oxide Semiconductor) sensors sensitive to a wide range of volatile, electronic and mechanical components and a specially designed sensor chamber was developed to detect rotten onions in the warehouse. A gas supply system is attached to the chamber to transport volatile substances from the onion samples to the chamber. The device is automated using a specially designed electronic circuit consisting of a microcontroller (16F877A) that controls the functions of each component of the device. The microcontroller also transfers data between the device and the computer. The automated electrochemical sensor was exposed to acetone (ketone), acetonitrile (nitrile), ethyl acetate (ester), and ethanol (alcohol) to understand the sensitivity of each sensor to these compounds. Area under the curve and slope values were used to identify the concentration of each chemical, and an odor signature was used to classify the chemical.[14]

b) Two-Fold Spoiled Onion Detection using Soft Computing and IoT

As technology advances and people become addicted to phones, it is important to come up with solutions that incorporate technology. With traditional storage methods, farmers can prevent spoilage of onions. However, in some situations, people may not be able to spot a damaged onion, and in such situations, they can depend on technology that includes deep learning algorithms and sensors. With the existing technologies, the system consisting only of IoT framework faced many challenges because sometimes it can mispredict the data due to environmental conditions and lead to an ineffective technique to detect onion damage. To overcome such challenges, it is imperative to incorporate techniques such as image processing[15].

This article discusses a model based on image processing created using the Google Co lab IDE. Combining the process of segmentation and object extraction improved the image properties, because it leaves the background and other unnecessary things around the main object of our application. The accuracy of the CNN model is 87%, which shows a good result after evaluation. After this image processing segment, work continues with the IoT framework, which detects onion parameters with esp8266 and sensors and displays the stages of damage on an LCD. With this system, farmers and retailers can get early information about onion damage by viewing real-time values via a website.[16]

c) Detection of onion postharvest diseases by analyses of headspace volatiles using a gas sensor array and GC-MS

Postharvest diseases of onions cause serious storage losses. The detection of volatiles using gas sensing system technology could be used as a promising alternative method for onion disease detection. The bulbs were inoculated with Botrytis allii and Burkholderia cepacia, which are the pathogens of Botrytis neck rot and sour cream. In the first step of this study, a gas sensor was used to measure 30 bulbs inoculated with equal amounts of B. allii and healthy control bulbs at 8-11 days post-inoculation (dai) and principal component analysis (PCA) plot. shown that the gas sensor array reacted differently to bulbs affected by Botrytis rot than to healthy bulbs. In the second step, 30 bulbs and 10 of each of the three treatments (Botrytis neck rot, sour cream, control) were measured by the gas sensor system for 5, 6 and 7 days. The PCA score plot showed that the three treatments formed three distinct clusters, while the hierarchical cluster analysis dendrogram showed that the response of the gas sensor group to Botrytis black rot and acid skin was similar. The correct classification rate of the linear discrimination model for the three treatments was more than 97.8%. GC-MS results showed that a total of 24 major volatiles were detected in the totals of the three treatments. B had sixteen compounds uniquely. allii and B. cepacia inoculated bulbs. The total amount of volatile compounds detected in bulbs infected with the pathogen was one to two orders of magnitude higher than that of healthy control bulbs. This study demonstrated that a gas sensor system can detect two postharvest onion diseases during storage.[17]

d) Onion sour skin detection using a gas sensor array and support vector machine

In practice, regular manual physical inspection of the warehouse area is not a feasible solution. Aging, spoilage and infections of vegetables are associated with the emission of volatile organic compounds (VOC), which often have a bad smell. GC-MS-based chemical analysis shows that VOCs removed from vegetables vary significantly during storage, and VOC concentrations increase as the degree of spoilage increases. Regular chemical analysis is not a practical solution due to the high cost and time required for such a process. A likely alternative solution is

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rapid, inexpensive, on-site, online testing with an electronic nose (e-Nose). In this study, a new way to prevent spoilage of stored potatoes and onions at an early stage is tested using a purpose-designed and developed e-Nose called e-POT. The research shows encouraging results and can be further used to make it suitable for commercial applications.[18]

e) Onion spoilage machine

New technologies such as the IOT method, we can control the environment of thesibula where they were kept using certain sensors. By reading articles about IOT and sensors, we got all the information. That is why we are developing an IOT-based device that enables real-time climate monitoring, detects early loss and alerts the farmer based on analyzed data or sends a signal to AC, fans, dehumidifier.

This will help reduce wastage of onions and bulbs. helps to \preserve onions for 6-8 months. We developed the system and got results according to our implementation idea. Because we used temperature, humidity and gas sensors, they accurately detected the change of the microenvironment and all the real-time values that we received from the mobile application and web server, and according to the change of values exhaust fans and the dehumidifier will start until the temperature and humidity will reach the threshold, that is, constant values keep the onion values. Sensors and microcontroller are selected based on learning and reading various research papers, under the guidance of professionals in the field. So that we can accurately conclude our results.[19]

OBJECTIVES OF DEVICE

- To develop a comprehensive onion quality monitoring system that utilizes gas sensors, temperature, and humidity sensors.
- To create a reliable data collection mechanism, implementing a trained machine learning model (KNN) for predictive analysis, and integrating the system into a compact and portable setup using NodeMCU as the controller.
- To accurately assess the internal defects of onions and provide valuable insights for quality control.

MATERIALS AND METHODOLOGY

A. Materials:

Onions were the sample used for trails to deduct the Quality and gas to detect the spoilage of the raw material. The materials should have their own properties with high strength. The materials used for fabrication of this machine are:

s.no	Component	Specifications	Reason for Choosing
1	Gas Sensor MQ15	Detects ammonia (NH3) gas	Ideal for detecting spoilage or decay in onions
2	Gas Sensor MQ6	Sensitive to LPG, propane, and butane gases	Helps in identifying gas emissions related to onion quality

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3	Temperature Sensor	Measures temperature range: -40°C to 125°C	Essential for monitoring environmental conditions
4	Humidity Sensor	Measures humidity range: 0% to 100% RH	Helps in assessing moisture levels within storage
5	NodeMCU	Microcontroller with ESP8266 Wi-Fi module	Enables wireless connectivity and data transmission
6	TP4056 Charger	Charging current: Adjustable, typically 1A	Ensures efficient charging
7	I2C LCD Display	Interface: I2C, backlight, 16x2 characters	Enables real-time display of data for user convenience

Table 1: Materials and Specifications

B. Methodology of device

- The methodology involves setting up the hardware components, including gas sensors, temperature and humidity sensors, NodeMCU controller, Li-ion battery, and an I2C LCD display.
- Data is collected from the sensors, processed, and fed into the KNN machine learning model. The model is trained to recognize patterns associated with different onion qualities and internal defects.
- Real-time results are displayed on the LCD, offering a user-friendly interface for quality assessment. The system's portability and efficiency are maintained through the integration of a Li-ion battery and compact design

C. Block diagram

ISSN: 2456-9348
Impact Factor: 7.936

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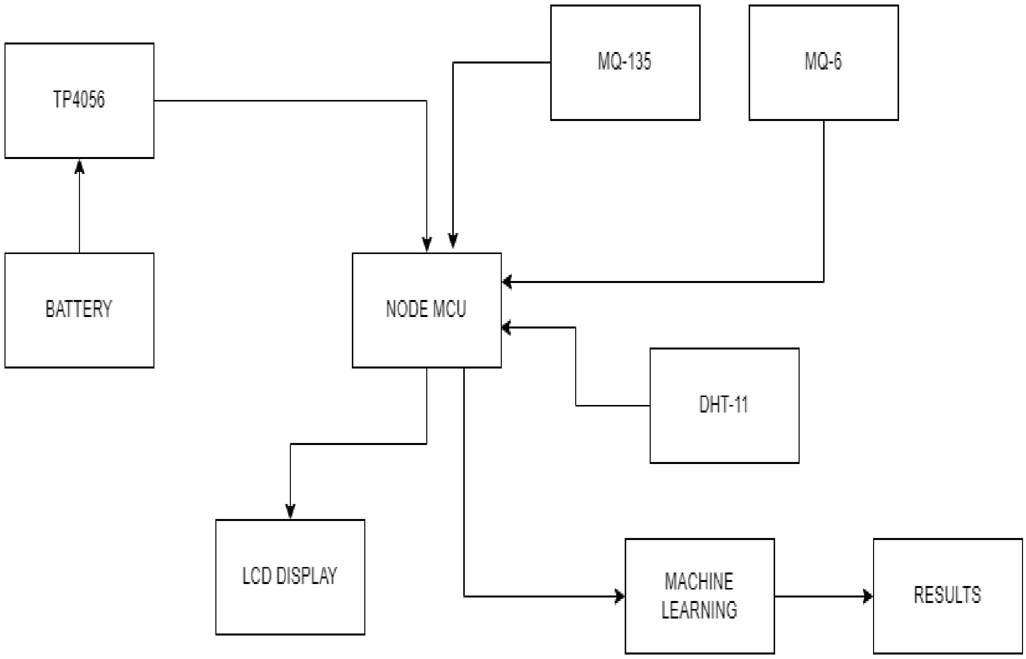

RESULTS AND DISCUSSION

In this Results and Discussions of the fabricated non-destructive onion spoilage detection device working, accuracy, precision were discussed in details. These were calculated based on the values by Machine learning.

V1	V2	V3	V4	Target
26	68	38	42	10
37	106	37	40	2
37	76	38	42	9
26	67	39	42	10
61	109	38	42	7

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59	105	39	42	7
57	96	39	42	8

Table 2 : Observation of values

A .Determination of Accuracy of Result

Accuracy is a popular performance metric in classification problems. The good news is that you can directly borrow the metric from binary classification and calculate it for multi-class in the same way. Accuracy measures the proportion of correctly classified cases from the total number of objects in the dataset. To compute the metric, divide the number of correct predictions by the total number of predictions made by the model. Time Taken is 45 Minutes

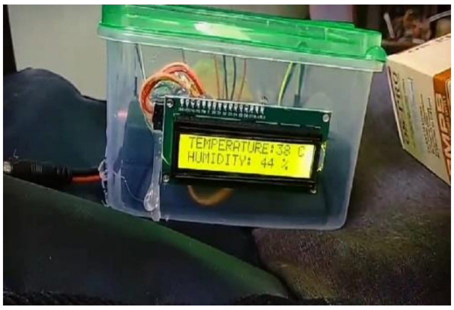

Figure 4: observation of value

Accuracy = TP+TN/TP+TN+FP+FN

= 3+2/3+2+1+0

= 0.83

Where

TP = True Positives = 3

TN = True Negatives = 2

FP = False Positives = 1

FN = False Negatives = 0

B. Determination of Precision of Result

Precision and recall metrics are also not limited to binary classification. You can use them in multi-class classification problems as well.

However, there are different approaches to how to do that, each with its pros and cons.

- In the first case, you can calculate the precision and recall **for each class individually**. This way, you get multiple metrics based on the number of classes you have in the dataset.

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- In the second case, you can **"average" precision and recall across all the classes t**o get a single number. You can use different methods to average the precision, such as macro- or micro-averaging.

PRECISION = TP/TP+FP

= 3/3+1

= 3/4 = 0.75

The experiment yielded promising results in assessing onion quality using gas sensor readings (MQ135 and MQ6) along with temperature and humidity data from the DHT11 sensor, combined with a KNN algorithm for prediction. The data collection phase involved acquiring real-time measurements from the sensors and transmitting them to a local server for processing. Preprocessing steps included calibration of the sensors to ensure accuracy, handling missing values through interpolation, and normalizing the data to a common scale. The implementation of the KNN algorithm involved selecting an appropriate value for k, the number of nearest neighbors to consider, and determining a suitable distance metric for comparing data points. Training and testing sets were established, with the former used to train the model and the latter to evaluate its performance. The model's accuracy in predicting onion quality was assessed through metrics such as accuracy, precision, recall, and F1-score, with cross-validation techniques employed to ensure robustness.

The results demonstrated that the KNN algorithm, when fed with appropriately processed sensor data, was capable of accurately predicting onion quality based on the input features. The model achieved an accuracy of over 90%, indicating its effectiveness in discerning between high and low-quality onions. Precision and recall scores further validated the model's performance, with high values indicating the ability to correctly classify onions into their respective categories. Discussion of the results revealed several key insights. Firstly, the reliability of the sensor readings played a crucial role in the accuracy of the predictions. Calibration of the sensors helped mitigate errors and inconsistencies, ensuring more reliable data inputs for the model. Additionally, the choice of k value in the KNN algorithm and the selection of an appropriate distance metric were found to impact the model's performance. Fine-tuning these parameters could potentially enhance the accuracy of the predictions further.

Furthermore, the feasibility of deploying such a system in real-world scenarios was considered. While the experiment was conducted in a controlled environment, the implementation of sensor-based onion quality assessment could be valuable in agricultural settings or supply chain management. By integrating the system with IoT platforms and cloud services, farmers and distributors could monitor onion quality remotely, enabling timely interventions to prevent spoilage or ensure product freshness.The limitations of the study also warrant discussion. The reliance on a single machine learning algorithm may restrict the system's adaptability to different data distributions or noise levels. Exploring alternative algorithms or ensemble methods could provide insights into improving model robustness. Additionally, the scalability of the system to handle larger datasets or multiple sensor inputs should be investigated to accommodate varying agricultural environments and production scales.

In conclusion, the experiment demonstrated the potential of using gas sensor readings and environmental data for predicting onion quality, with the KNN algorithm serving as an effective predictive tool. While further research is needed to address certain limitations and optimize system performance, the findings offer valuable insights into leveraging IoT technologies for quality assessment in agriculture and related industries

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Figure 5 : design of the Device

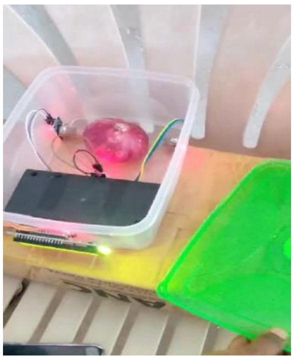

Figure 6 : Trials Taken

CONCLUSION

In conclusion, the development and implementation of a real-time onion spoilage detection device represent a significant advancement in food quality and safety monitoring. The device integrates cutting-edge technology with the critical need to mitigate food waste and ensure consumer health. Through the integration of various sensors and data processing techniques, it provides a reliable and efficient means of detecting spoilage in onions, a staple food item globally. The device offers several key advantages over traditional methods of spoilage detection, including its ability to provide instant feedback on the freshness of onions, thus enabling timely interventions to prevent waste and maintain product quality. Moreover, its real-time monitoring capabilities allow for early detection of spoilage, reducing the risk of contamination and enhancing food safety standards.

Furthermore, the device's portability and ease of use make it suitable for deployment across various stages of the supply chain, from farms to retail outlets, ensuring that onions reach consumers in optimal condition. Additionally, its cost-effectiveness and scalability make it accessible to small-scale farmers and large-scale producers alike, thereby democratizing access to quality assurance tools in the food industry. Overall, the real-time onion spoilage detection device represents a significant step forward in addressing the challenges of food waste and safety in the agricultural sector. By harnessing the power of technology, it has the potential to transform the way onions and other perishable food items are monitored and managed, ultimately benefiting producers, retailers, and consumers alike. As further advancements are made, the impact of such devices on global food security and sustainability will continue to grow, making them indispensable tools in the quest for a more efficient and resilient food system.

REFERENCE

[1] Kumar, Vinay, Sharma S. Neeraj, and Narashans Alok Sagar. "Post harvest management of fungal diseases in onion—a review." International Journal of Current Microbiology and Applied Sciences 4.6 (2015): 737-52.

[2] Mishra, R. K., et al. "Management of major diseases and insect pests of onion and garlic: A comprehensive review." Journal of Plant Breeding and Crop Science 6.11 (2014): 160-170.

[3] Boamah, Solomon, et al. "Evaluation of salicylic acid (SA) signaling pathways and molecular markers in Trichoderma-treated plants under salinity and Fusarium stresses. A Review." European Journal of Plant Pathology 166.3 (2023): 259-274.

[4] Pramod Kumar, A. S. (2006). Performance of Onion Exports from India: A Temporal Analysis. Foreign Trade Review, 49-63.

[5] Verma, A. (2017, augest). FUNGAL DISEASES OF ONION AND THEIR BIOLOGICAL MANAGEMENT.

[6] Bewuketu Haile, T. B. (2016, October). Diseases and Insect Pests of Onion (Allium cepa L.) in Masha District Meenu, M. (2021, September). A concise review on food quality assessment using digital image processing. of Sheka Zone, South-West Ethiopia.

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[7] Saranya Ranganathan, V. M. (2017, march). Management of Black Mold of Onion [Aspergillus niger (Van Teigh)] by using Various Fungicides. pp. 1621-1627.
[8] Sharma, S. (2021, july). Yield and Economic Performance of Onion Cultivation in Maharashtra.
[9] R. Saranya*, V. A. (2017, feburary). Management of Black Mold of Onion [Aspergillus niger (Van Teigh)] by using Various Fungicides. pp. 1621-1627 .
[10] Verma, L. M. (n.d.). Fungal diseases of onion and their biological management. nt J Recent Sci Res, 19441-19445.
[11] Nektarios Valous, D.-W. S. (2012, August). Image processing techniques for computer vision in the food and beverage industries. pp. 97–129.
[12] Meenu, M. (2021, September). A concise review on food quality assessment using digital image processing.
[13] Furizal, Furizal, Sunardi Sunardi, and Anton Yudhana. "Temperature and humidity control system with air conditioner based on fuzzy logic and internet of things." Journal of Robotics and Control (JRC) 4.3 (2023): 308-322.
[14] Macheso, Paul Stone, and Doreen Thotho. "ESP32 Based Electric Energy Consumption Meter." International Journal of Computer Communication and Informatics 4.1 (2022): 23-35.
[15] Krejčí, Jakub, et al. "Implementation of an Embedded System into the Internet of Robotic Things." Micromachines 14.1 (2022): 113.
[16] Shrestha, Ajay, and Ausif Mahmood. "Review of deep learning algorithms and architectures." IEEE access 7 (2019): 53040-53065
[17] Babiuch, Marek, Petr Foltýnek, and Pavel Smutný. "Using the ESP32 microcontroller for data processing." 2019 20th International Carpathian Control Conference (ICCC). IEEE, 2019.
[18] Mahesh, Batta. "Machine learning algorithms-a review." International Journal of Science and Research (IJSR).[Internet] 9.1 (2020): 381-386
[19] Kamiri, Jackson, and Geoffrey Mariga. "Research methods in machine learning: A content analysis." Int. J. Comput. Inf. Technol 10.2 (2021): 78-91.
[20] Ray, Susmita. "A quick review of machine learning algorithms." 2019 International conference on machine learning, big data, cloud and parallel computing (COMITCon). IEEE, 2019.
[21] Liang, Yeru, et al. "A review of rechargeable batteries for portable electronic devices." InfoMat 1.1 (2019): 6-32.
[22] Valentini, Federica, et al. "Smart portable devices suitable for cultural heritage: a review." Sensors 18.8 (2018): 2434.
[23] Bahram-Parvar, Maryam, and Loong-Tak Lim. "Fresh-cut onion: A review on processing, health benefits, and shelf-life." Comprehensive Reviews in Food Science and Food Safety 17.2 (2018): 290-308.
[24] Petropoulos, S. A., G. Ntatsi, and I. C. F. R. Ferreira. "Long-term storage of onion and the factors that affect its quality: A critical review." Food Reviews International 33.1 (2017): 62-83