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A Perishable Food Monitoring Model Based On Iot And Deep Learning To Improve Food Hygiene And Safety Management

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ABSTRACT:

Food processing businesses play a crucial role in ensuring that people have access to nutritious food. These companies can either produce food directly for consumers or provide ingredients for other businesses to use in their products. Many food processing firms rely on interacting directly with customers to sell their products. However, this can be a challenge during the COVID-19 pandemic and other situations that limit face-to-face interactions. One potential solution to this issue is the use of computer vision to analyze food quality in an automated, non-invasive, and cost-effective way. This type of technology can help businesses ensure that they are providing high-quality products to their customers. A study has presented an OpenCV Python library-based system that uses the Convolution Neural Network (CNN) to identify and assess food quality. This system can perform tasks such as detecting the type of fruit and rating its quality based on accurate and trustworthy data. To sort the fruits, the suggested system includes a microcontroller, instruments, a camera, and a transporter belt setup. This helps to ensure that the fruits are separated accurately and efficiently. In addition, the system uses sensors to monitor the storage environment and transmits this data over the cloud using Internet of Things technology. This helps to maintain the quality of the fruit for longer periods of time, which is important for businesses that want to provide fresh and tasty products to their customers. Overall, the use of computer vision and other advanced technologies can help food processing businesses provide high-quality products to their customers in a cost-effective and efficient manner.

Keywords: Food quality, IoT, CNN, computer vison

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1. INTRODUCTION

Food hygiene and safety is a major concern for individuals and businesses around the world. Poor food safety practices can lead to foodborne illnesses, which can have serious health consequences for people who consume contaminated food. In addition, businesses that sell contaminated food can suffer from financial losses due to product recalls and legal action. To address these issues, it is important to develop effective food safety management systems that can help prevent food contamination and ensure that perishable foods are properly stored and handled [1], [2]. One promising approach to improving food hygiene and safety management is the use of Internet of Things (IoT) and deep learning technologies. These technologies can provide real-time monitoring of perishable food products, allowing businesses to detect and address potential issues before they lead to serious problems. In this research article, we propose a perishable food monitoring model based on IoT and deep learning to improve food hygiene and safety management [3], [4]. The proposed model utilizes sensors and other IoT devices to collect data on the storage and handling of perishable foods, which is then analyzed using deep learning algorithms to identify potential problems and suggest appropriate interventions [5].

Food hygiene and safety is a major concern for individuals and businesses around the world. Poor food safety practices can lead to foodborne illnesses, which can have serious health consequences for people who consume contaminated food. In addition, businesses that sell contaminated food can suffer from financial losses due to product recalls and legal action. To address these issues, it is important to develop effective food safety management systems that can help prevent food contamination and ensure that perishable foods are properly stored and handled [6], [7]. One promising approach to improving food hygiene and safety management is the use of Internet of Things (IoT) and deep learning technologies. These technologies can provide real-time monitoring of perishable food products, allowing businesses to detect and address potential issues before they lead to serious problems. In this research article, we propose a perishable food monitoring model based on IoT and deep learning to improve food hygiene and safety management. The proposed model utilizes sensors and other IoT devices to collect data on the storage and handling of perishable foods, which is then analyzed using deep learning algorithms to identify potential problems and suggest appropriate interventions[8], [9].

ISSN PRINT 2319 1775 Online 2320 7876

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IoT and deep learning technologies have the potential to revolutionize the way that businesses manage food safety and hygiene. IoT devices, such as sensors and cameras, can continuously collect data on the storage and handling of perishable foods, providing real-time information on the condition of the products. This data can be used to identify potential issues and trigger alerts when necessary [10], [11]. For example, sensors can detect changes in temperature, humidity, and other factors that can affect the quality of perishable foods, allowing businesses to take timely action to prevent contamination or deterioration.

Deep learning algorithms can analyze the data collected by IoT devices and identify patterns and trends that may indicate potential problems. For example, a deep learning model could be trained to recognize patterns of temperature fluctuations that are indicative of food spoilage, allowing businesses to take preventative action before the food becomes unsafe to consume. In addition, deep learning algorithms can be used to predict the shelf life of perishable foods based on various factors such as storage conditions and handling practices, helping businesses to manage their inventory more effectively and reduce waste[12]–[14].

There are a number of studies that have explored the use of IoT and deep learning technologies for food safety and hygiene management. One example is a study by Kim et al. (2019), which proposed a food safety monitoring system based on IoT and machine learning. The system used sensors to collect data on temperature, humidity, and other factors, and a machine learning algorithm to identify patterns and trends that may indicate potential problems. The study found that the system was able to accurately detect deviations from normal patterns and trigger alerts, improving the efficiency and effectiveness of food safety management.

Another example is a which proposed a deep learning-based approach to predicting the shelf life of perishable foods. The study used a deep learning model to analyze data on storage conditions, handling practices, and other factors, and found that the model was able to accurately predict the shelf life of various types of perishable foods. The study also found that the model was able to identify important factors that influence the shelf life of perishable foods, such as temperature and humidity, allowing businesses to make informed decisions about how to store and handle these products [15].

2. Proposed system

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11,Iss 8,Dec 2022

The proposed system consists of three sub-systems: a supercomputer vision system, a food storage unit nursing system, and a transporter belt framework, as shown in Figure 1.

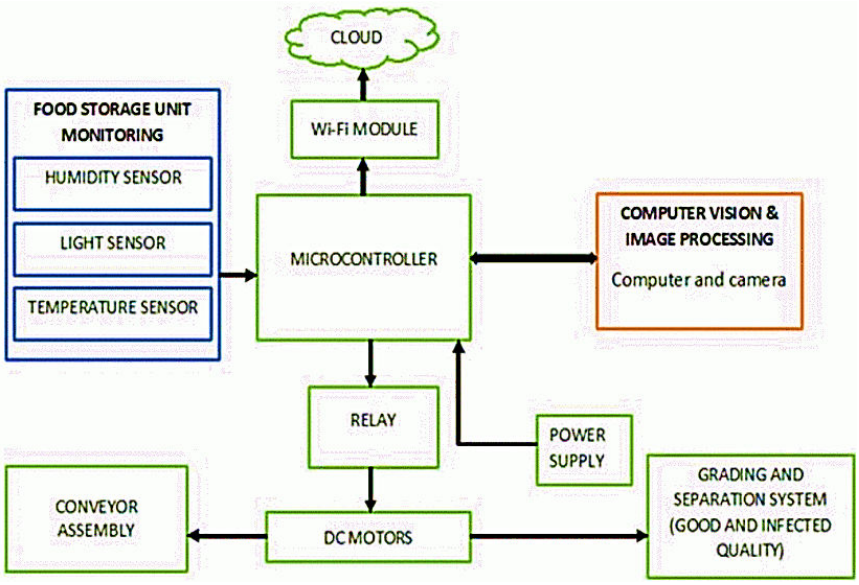

Fig. 1 layout of the proposed system

2.1 Computer vison approach

The proposed system follows a specific set of steps, which are shown in Figure 2. The system is designed to classify fruits into three different categories, with three different types of fruit assigned to each category. The dataset used to train the system consists of photographs of oranges, tomatoes, and bananas in a variety of sizes and shapes, which were captured using a camera and stored as arrays.

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Research paper UGC CARE Listed (Group -I) Journal Volume 11,Iss 8,Dec 2022

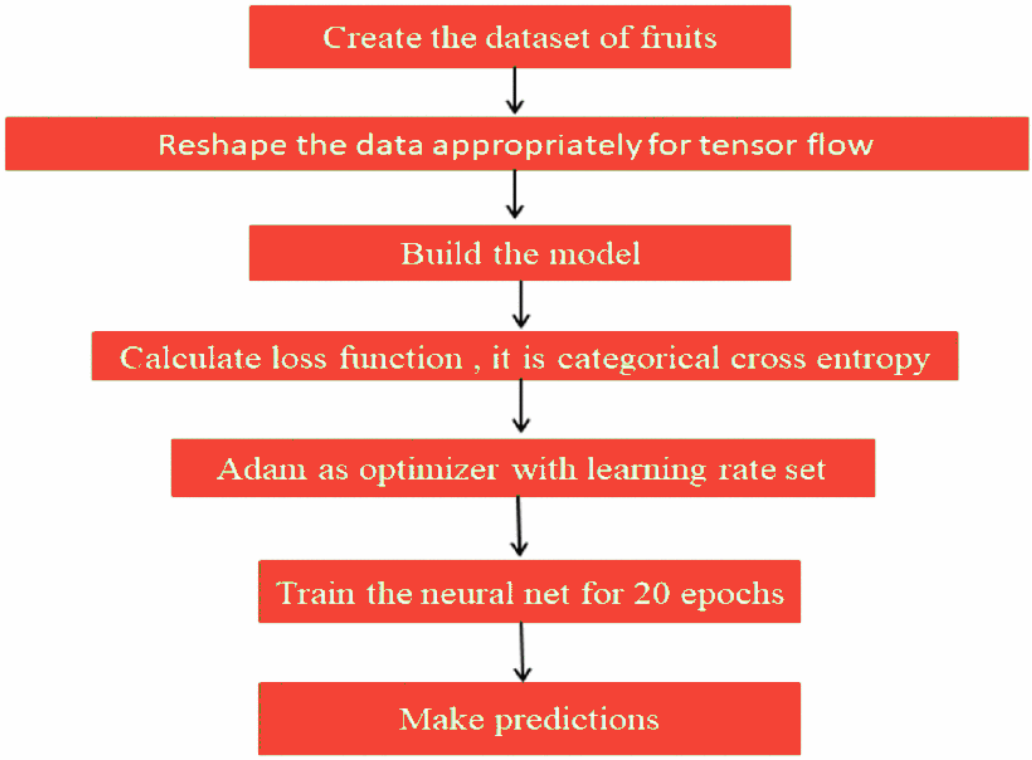

Fig. 2 Computer vision flow chart

To construct the sequential model, a list of layer objects is provided. The model has a total of 12 layers. There are 3 main parts to the construction of the model: a convolution layer for extracting visual features, a subsampling or combining layer that focuses on the maximum significant features and a completely linked layer that uses a firmed representation of the topographies contained in the units above to generate an image estimate. The model is run over the data 20 times to train and refine the predictions.

Once the model is trained, it can be used to classify the type and quality of the fruit, and communicate the relevant information to the controller (an Arduino device) via a serial connection. For example, the model might output a "A" for bad and a "B" for good fruits. The fruit is then assessed, with the results displayed as "Rotten Fruit" or "Normal Fruit" on an LCD screen.

The system includes three motors to facilitate the sorting process. Motor 2 is used to spin the fruit onto the transporter belt, while Motors 1 and 3 are automated to spin to the correct for faulty fruit and to the left for good fruit. This helps to separate the fruits into the appropriate categories, as shown in Figure 3. The system is designed to improve the efficiency and

ISSN PRINT 2319 1775 Online 2320 7876

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accuracy of fruit sorting, while also providing reliable information on the quality of the fruits being processed.

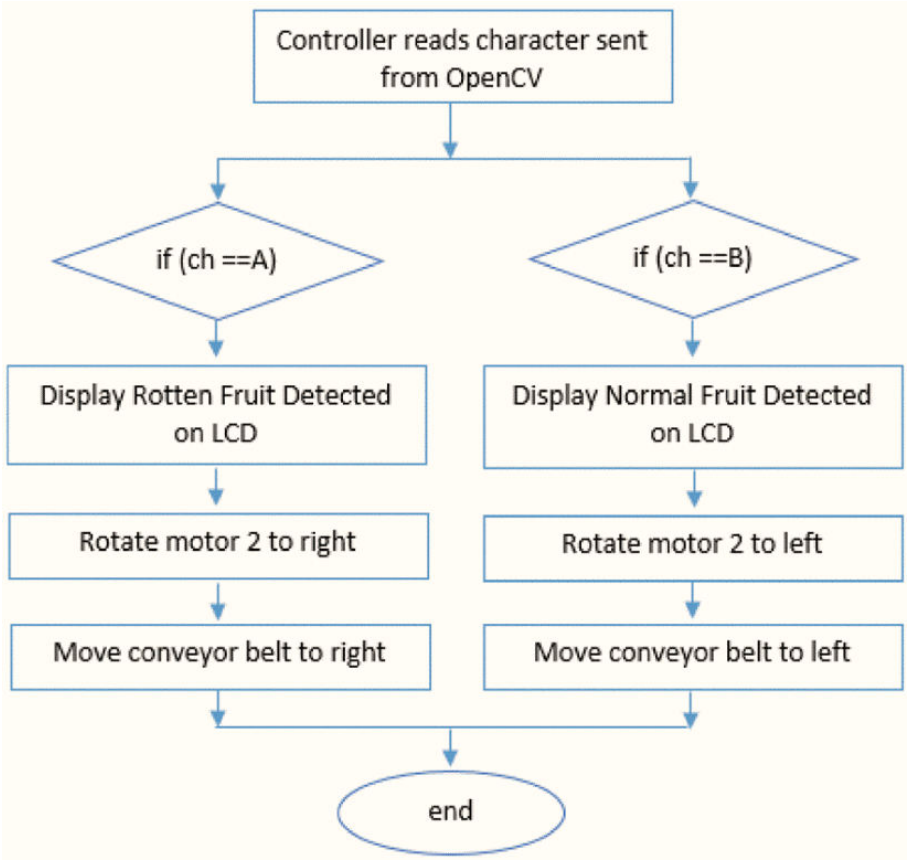

Fig. 3 Food segregation flow diagram

2.2 IoT for Food quality monitoring system

The temperature and moisture sensors, and light dependent resistor (LDR) are key components of the food storage unit nursing system. These sensors are used to gather real-time data on the conditions inside the storage unit, which can be used to identify potential issues and take appropriate action to preserve the quality of the stored food. The DHT11 sensor is a commonly used device for measuring humidity and temperature. It consists of a humidity and temperature sensor mounted on a small circuit board, along with a microcontroller that processes the data and communicates it to other devices. In the proposed system, the DHT11 sensor is used to monitor the humidity and temperature of the storage unit. This information is crucial for maintaining the quality of perishable foods, as fluctuations in temperature and humidity can cause the food to spoil or become contaminated.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11,Iss 8,Dec 2022

The LDR, also known as a photoresistor, is a type of sensor that measures the intensity of light. It is often used in lighting control systems, as well as in other applications where it is important to monitor light levels. In the proposed system, the LDR is used to monitor the light intensity inside the storage unit. This is important because light can affect the quality of some types of food, such as fruits and vegetables, which can be damaged by exposure to light. To transmit the data collected by the sensors to a central location for analysis and storage, the proposed system uses the NodeMCU, which is a microcontroller with an embedded Wi-Fi module. The NodeMCU is programmed to connect to the ThingSpeak IoT platform, which is a cloud-based service that allows users to collect and analyze data from sensors and other devices. The NodeMCU sends updates on the atmospheric conditions to the ThingSpeak platform, which stores the data and makes it available for analysis.

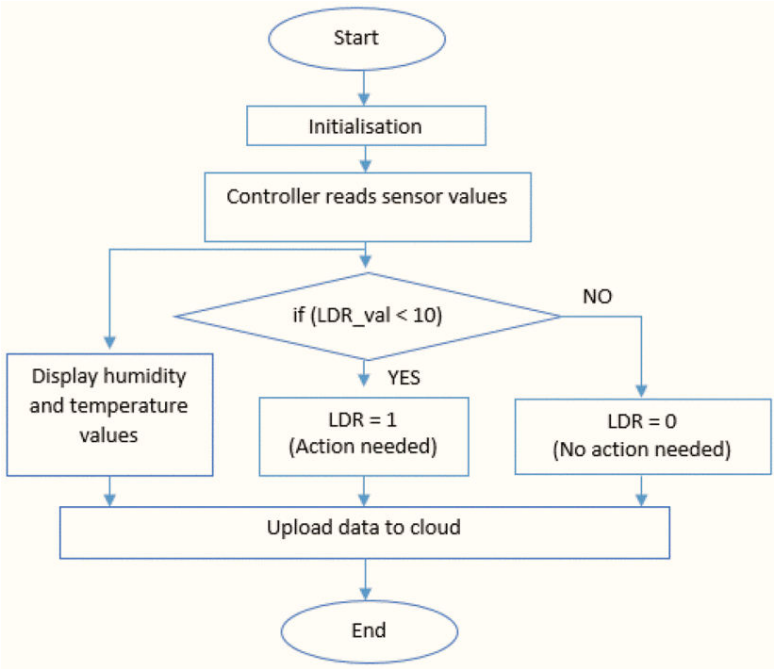

Fig. 4 IoT implementation flow diagram

Overall, the temperature and humidity sensors, and LDR play a crucial role in the food storage unit nursing system, allowing businesses to continuously monitor the conditions inside their storage units and take timely action to preserve the quality of their perishable foods. The NodeMCU and ThingSpeak platform provide a reliable and convenient way to transmit and analyze the data collected by these sensors, helping businesses to make informed

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11,Iss 8,Dec 2022

decisions about how to manage their food products. The implementation of IoT is described in figure 4.

3. Result and Discussion

Computer vision is a powerful tool for assessing and testing food quality in a non-destructive and cost-effective way. It is well-suited for use in the food processing industry, where it can be used to quickly and accurately analyze the quality of various types of food products. Figure 5 shows a image of the prototype module for the proposed food quality assessment system. The module includes a camera and a convolutional neural network (CNN) model, which is trained to recognize and classify various visual features and patterns. The model is able to accurately identify different types of fruits, as shown in Figure 6.

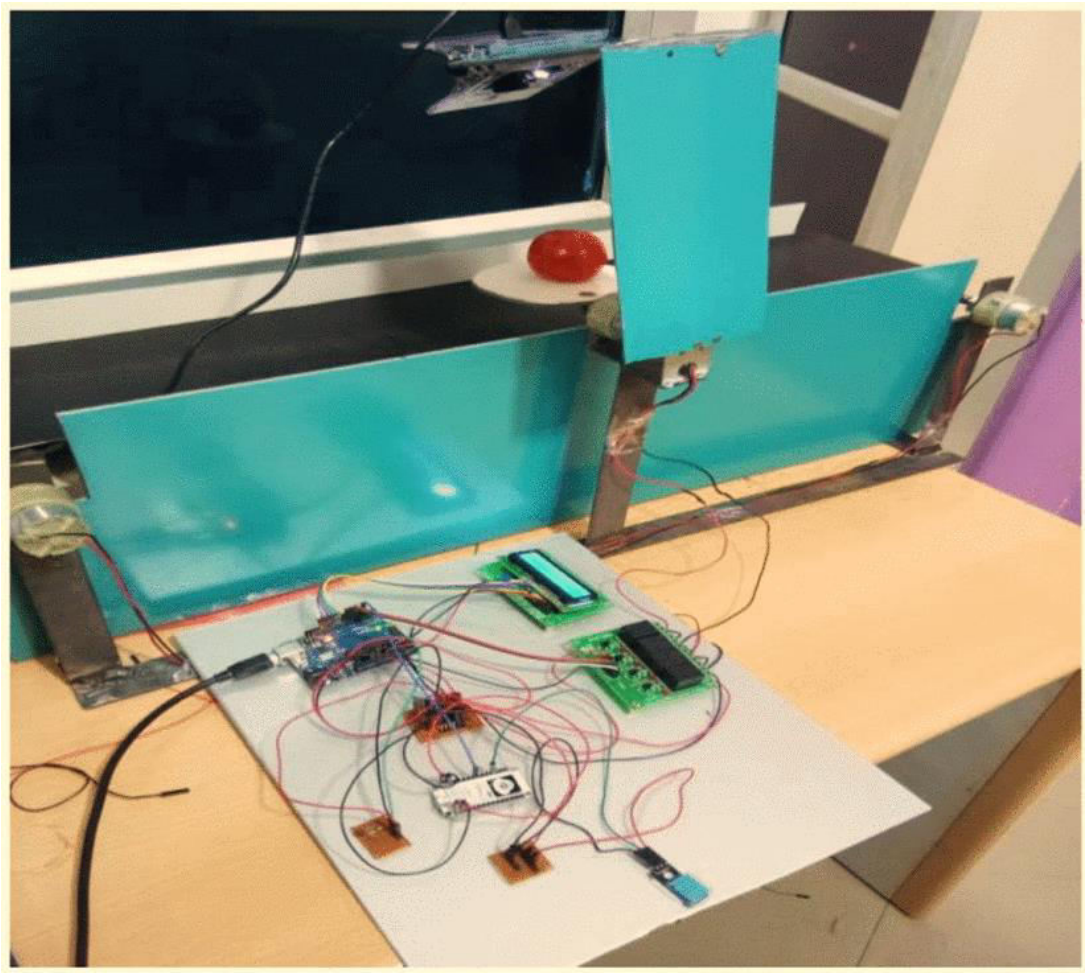

Fig. 5 System developed in this research

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11,Iss 8,Dec 2022

One of the key advantages of using computer vision for food quality assessment is its ability to analyze the appearance of the food in a reliable and objective way. For example, as shown in Figure 7, the model is able to correctly identify the quality of a beautiful orange as high-grade. On the other hand, if a tomato is photographed while it is wilting, the model will classify the fruit as having low quality.

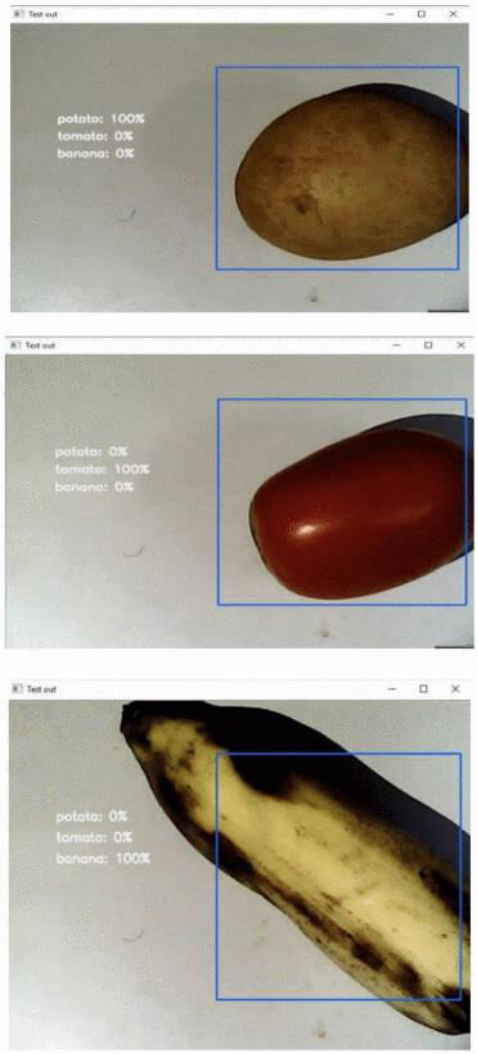

Fig. 6 Quality of the fruits identified by the system

In addition to analyzing the visual appearance of the food, the proposed system also includes sensors to monitor the storage environment and transmit this data over the cloud using Internet of Things (IoT) technology. Specifically, the system includes a humidity sensor, a temperature sensor, and an LDR to measure humidity, temperature, and light intensity inside

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11,Iss 8,Dec 2022

the storage unit. These values are efficient every 15 seconds and transmitted to the ThingSpeak IoT platform, where they are stored and made available for analysis.

As shown in Figure 8, the ThingSpeak platform provides graphical representations of the data collected by the sensors, allowing users to track changes over time and identify potential issues. For example, if the temperature inside the storage unit is consistently too high, this could indicate that the food is at risk of spoiling. By monitoring the sensor data and taking appropriate action, businesses can improve the quality and safety of their food products.

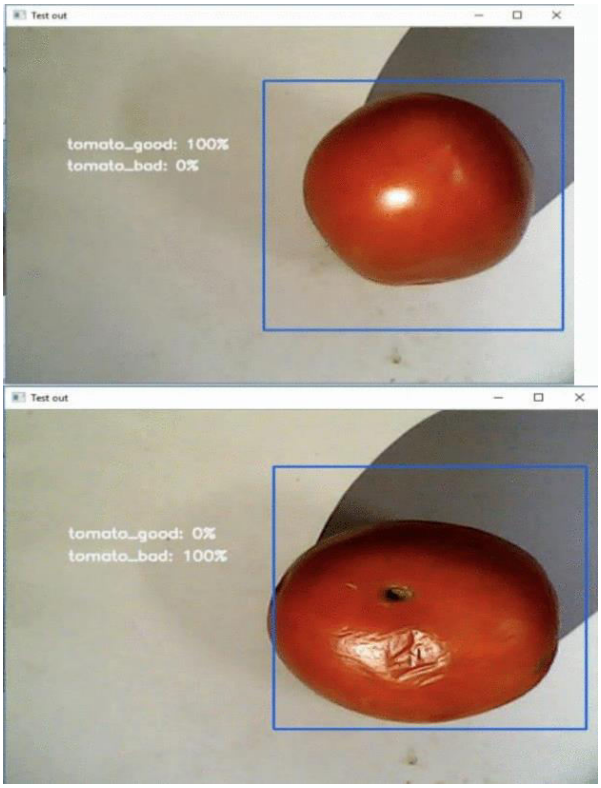

Fig. 7 Quality of the tomato identified by the system

In conclusion, the proposed food quality assessment system based on computer vision and IoT technologies has the potential to significantly improve the way that businesses manage the quality and safety of their food products. By continuously collecting and analyzing data on the appearance and storage conditions of perishable foods, businesses can identify potential issues and take timely action to prevent contamination or deterioration.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11,Iss 8,Dec 2022

One of the key benefits of this system is its ability to operate in an automated and non-destructive manner, which helps to reduce the time and cost of quality assessment. Additionally, the use of deep learning algorithms allows the system to learn from and adapt to new data, improving its accuracy and reliability over time.

There are several potential directions for future research in this area. For example, it would be interesting to explore the use of additional sensors and data sources, such as RFID tags and supply chain data, to enhance the capabilities of the system. It would also be useful to study the impact of different storage conditions on the quality of different types of foods, and to develop more advanced algorithms and models for predicting shelf life and identifying potential issues.

Overall, the proposed food quality assessment system represents a promising approach for improving food hygiene and safety management in the food processing industry, and has the potential to have a significant impact on the way that businesses operate and the quality of the products they provide to consumers. So, it can be a valuable addition to the food processing industry.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11,Iss 8,Dec 2022

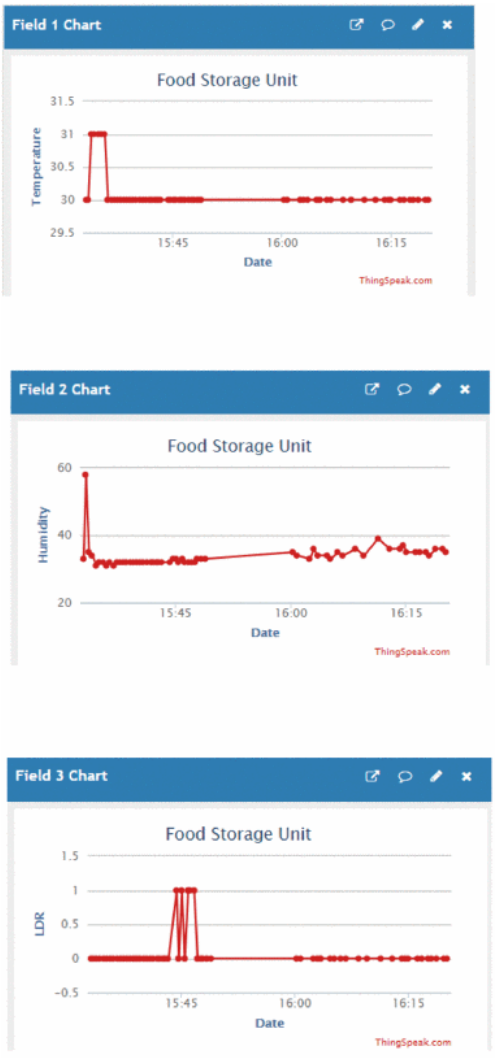

Fig. 8 Food storage unit uploaded to the Thinkspeak

CONCLUSION

In conclusion, the proposed food quality assessment system is a valuable tool for businesses in the food processing industry that are concerned with maintaining the quality and safety of their products. By using computer vision and IoT technologies, the system is able to identify bruising and other defects in a non-destructive and cost-effective way, helping businesses to improve the quality of their products and reduce waste. One of the key benefits of the system is its ability to operate in an automated and objective manner, eliminating the risk of mistakes caused by human inspection. This not only saves time and reduces the workload of human inspectors, but also ensures that the quality assessment process is consistent and reliable.

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In addition to detecting quality issues, the proposed system also includes a food storage room monitoring and management system that uses IoT technology to collect data on the storage conditions of perishable foods. This allows businesses to identify potential issues and take timely action to preserve the quality of their products, helping to ensure that they are providing high-quality, safe products to their customers. Overall, the proposed food quality assessment system represents a promising approach for improving food hygiene and safety management in the food processing industry, and has the potential to have a significant impact on the way that businesses operate and the quality of the products they provide to consumers. As such, it is a valuable addition to the food processing industry and could be an important tool for improving the quality and safety of food products.

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