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IoT BASED FRUITS AND VEGETABLES STORAGE MONITORING AND MACHINE LEARNING BASED SHELF-LIFE AND DISEASE DETECTION SYSTEM

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Abstract: We propose a novel system using Convolutional Neural Networks (CNN) on Raspberry Pi, integrated with a DHT-11 sensor for temperature and humidity monitoring. This system enables real-time monitoring of the storage environment, early disease detection, and accurate shelf-life prediction for fruits and vegetables. By ensuring optimal conditions and detecting diseases promptly, the system reduces food waste, prevents spoilage, and improves produce quality and safety.

***Index Terms* – Raspberry Pi 3, DHT-11, CNN**

I. INTRODUCTION

The agricultural industry faces significant challenges in terms of proper storage and handling, leading to the loss of produce and economic losses. To address these issues, this study proposes a novel solution: an IoT-based fruits and vegetables storage monitoring system integrated with machine learning-based disease detection and shelf-life prediction. By leveraging technologies such as the Internet of Things (IoT), computer vision, and machine learning, the system aims to provide efficient and effective storage and monitoring of fresh produce. The system utilizes a Raspberry Pi platform as the central controller, connected to sensors and cameras. The DHT11 sensor measures temperature and humidity levels inside the storage area, while the Pi camera captures images of the produce. Computer vision techniques, including image segmentation, feature extraction, and classification, are employed to process the images and sensor data. A machine learning model trained to detect diseases and predict shelf-life accurately is then applied to the processed data. The system's output is presented on a web dashboard, offering real-time information on the status of the stored produce, including temperature, humidity, disease detection, and remaining shelf-life. This enables farmers and retailers to remotely monitor the storage environment and take prompt action if necessary. The proposed system aims to improve the quality and freshness of stored produce, reduce economic losses due to spoilage and diseases, and provide accurate and real-time data for effective decision-making. Further enhancements can be explored to enhance the system's efficiency and effectiveness in the future

II. LITERATURE SURVEY

The documentation of a thorough analysis of the published and unpublished work from secondary sources data in the areas of the researcher's particular interest is known as a literature survey. It is crucial to collect secondary data for the study because it could end up being highly beneficial. Paper [1] focuses on real-time monitoring of storage conditions and employs an Artificial Neural Network for decision support. Paper [2] utilizes image analysis to identify fruit diseases with high accuracy. Paper [3] proposes a system for detecting spoiled food using sensor data and machine learning. Paper [4] describes quality assessment methods for strawberries, including subjective and objective measures. Paper [5] presents a method for identifying apple fruit diseases using image processing and a neural network. Paper [6] enhances images, applies feature extraction, and utilizes CNN and clustering for classification. Paper [7] uses deep learning to predict a fruit disorder and identifies relevant regions for classification. Paper [8] detects fruits, vegetables, and diseases using CNN. Paper [9] investigates the effects of storage duration on tomato quality attributes. Paper [10] proposes a model for predicting shelf life based on storage temperature. These studies contribute to the development of technologies and methods for maintaining and assessing the quality and freshness of fruits and vegetables throughout storage and transportation processes.

III. SYSTEM DESIGN AND IMPLEMENTATION

The block diagram represents an IoT-based system for monitoring the storage of fruits and vegetables. The Raspberry Pi serves as the central controller and receives inputs from the DHT11 sensor, Pi camera, and a machine learning model. The DHT11 sensor measures temperature and humidity, while the Pi camera captures images of the produce. The machine learning model processes the images to detect diseases and predict the remaining shelf-life of the produce. The output from the Raspberry Pi is transmitted to a LAMP server, which utilizes Linux, Apache, MySQL, and PHP to create a web dashboard. This dashboard provides real-time information on temperature, humidity, disease status, and shelf-life. The data flow between the Raspberry Pi and the LAMP server occurs through the internet or a local network using protocols like HTTP or MQTT. The system begins by collecting temperature and humidity data from the DHT11 sensor and capturing images with the Pi camera. The Raspberry Pi then performs image processing techniques, including segmentation, feature extraction, and classification, using the machine learning model. The processed images are analyzed for disease detection and shelf-life prediction. The results generated by the machine learning model are sent to the LAMP server, which creates a web dashboard. This dashboard presents the information in a user-friendly interface, allowing users to monitor the storage conditions, disease status, and remaining shelf-life remotely. Overall, the system utilizes IoT technologies to ensure the freshness and quality of stored fruits and vegetables. By combining temperature and humidity sensing, image processing, machine learning, and web development, it provides an integrated solution for effectively monitoring produce and taking appropriate actions to maintain its freshness and prevent spoilage.

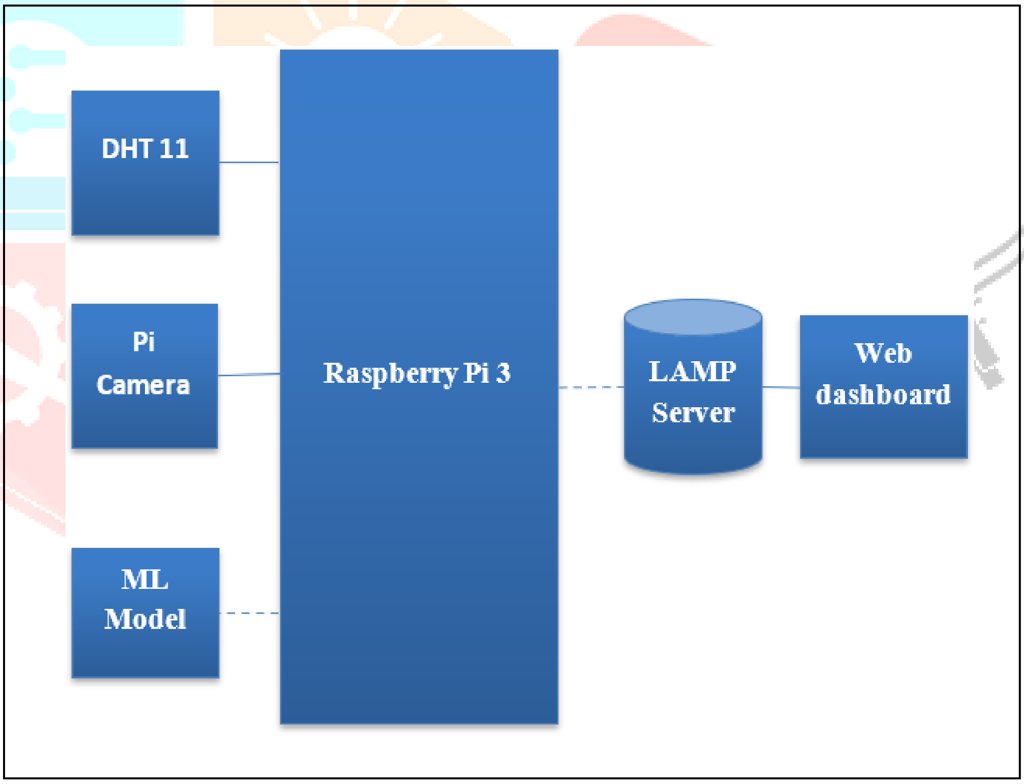

Fig: BLOCK DIAGRAM OF THE PROJECT

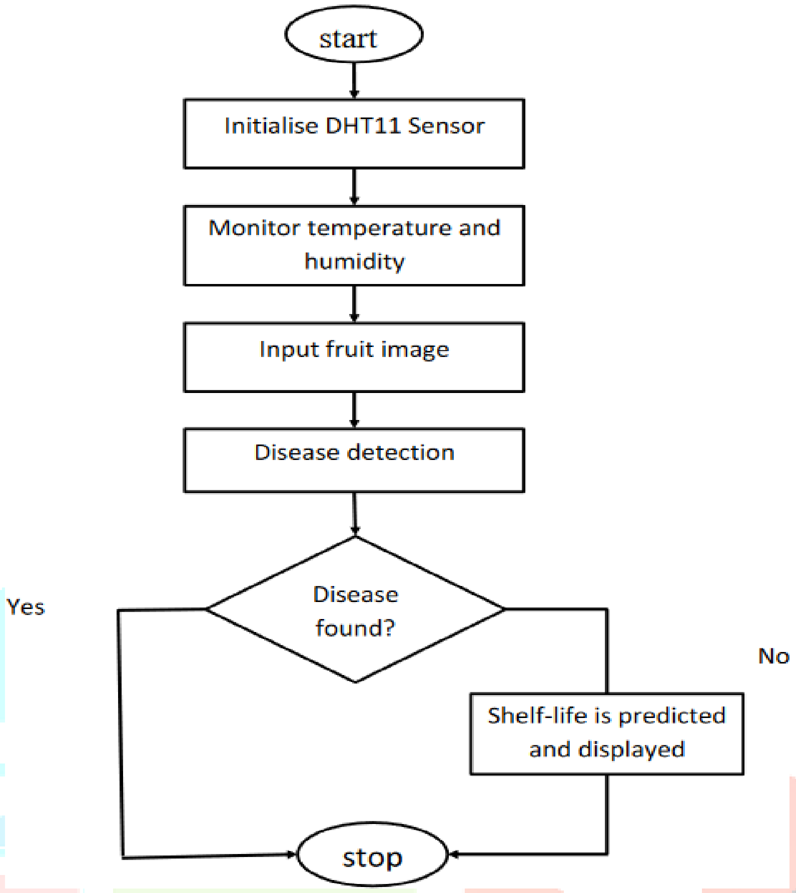

Fig: FLOW CHART OF THE PROJECT

The study used the Stock returns are as dependent variable. From the share price of the firm the Stock returns are calculated. Rate of a stock salable at stock market is known as stock price. The flowchart outlines the process of an IoT-based fruits and vegetables storage monitoring system that uses machine learning techniques to detect diseases and predict the shelf-life of the produce. The flowchart begins with starting the system and initializing the DHT11 sensor, which is a temperature and humidity sensor commonly used in IoT applications. The next step is to monitor the temperature and humidity levels inside the storage area using the DHT11 sensor. This information is important for maintaining the quality and freshness of the stored fruits and vegetables. Then, the system prompts the user to input an image of a fruit or vegetable for disease detection.The machine learning algorithm then processes the image and checks for any signs of disease. If the algorithm detects a disease, the system will stop and alert the user. If no disease is found, the system proceeds to predict the shelf-life of the stored produce using the same machine learning algorithm. The predicted shelf-life is then displayed to the user, whocan use this information to manage the storage and distribution of the fruits and vegetables. Finally, the system stops, and the process is complete. Overall, this IoT-based storage monitoring system helps to ensure the quality and freshness of the stored produce by detecting diseases and predicting shelf-life, which can help reduce waste and improve profitability for producers and retailers.

IV. CONCLUSION AND FUTURE WORK

As a conclusion, the IoT based fruits and vegetables storage monitoring and machine learning based shelf-life and disease detection system is a promising solution for ensuring the quality and freshness of stored produce. The system's use of sensor s, cameras, and machine learning algorithms accurately detects diseases and predicts the remaining shelf-life of the stored fruits and vegetables, while the web dashboard provides real-time information on the produce's status. However, with advancements in technology, the system has the potential for further enhancement through the integration of block chain technology, wireless sensor networks, predictive maintenance, cloud-based data analytics, and mobile application integration. These enhancements can provide more accurate and reliable data, improve transparency and traceability, reduce downtime and maintenance costs, and provide a more user-friendly interface for consumers and retailers. Thus, exploring these areas for future work can help make the system even more efficient and effective in ensuring high-quality produce for both consumers and retailers. Future work can focus on

Integration with Block chain Technology, Wireless Sensor Network (WSN) Integration, Predictive Maintenance, Cloud-based Data Analytics, Mobile Application Integration.

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