



## IoT (Internet of things): Fruits and Vegetables Quality Monitoring Systems

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**ABSTRACT:** The Internet of things (IoT) has emerged as a transformation technology, connecting everyday objects to the internet, and enabling seamless communication and data exchange. This research paper provides an overview of IOT technology, its application and, its potential impact on various aspects of daily life through a comprehensive review of existing literature and case studies, this paper aims to educate students about the significance of IoT in shaping the future of technology and society. Imagine a world where fridge Knows exactly what fruits and veggies you have and can remind you when they are running low. In this research paper, we introduce a user-friendly system that makes this reality by combining the power IOT (internet of things). With smart image recognition technology. System employes tiny sensors and cameras installed in refrigerator to continuously monitor that the freshness of fruits and vegetables. The system sends alert and notification to users We discuss the simplicity and convenience of such a system, as well as its potential impact on reducing food waste and promote healthier eating habits.

**Keywords:** IoT, smarter, Sensor, AI, devices, recognition, Prediction.

### INTRODUCTION:

IOT, or Internet of things refers to the network of physical objects, devices, vehicles, buildings, and other items embedded with sensors, software, and connectivity that enables them to collect and exchange data over the internet. Essentially, it is about connecting everyday objects to the internet and to each other to facilitate communication and automate task, leading to improved efficiency, convenience, and functionality in various aspects of life., we introduce a user-friendly system that make this reality by combining the power IOT (internet of things). With smart image recognition technology. System employes tiny sensors and cameras installed in refrigerator to continuously monitor that the freshness of fruits and vegetables. A machine learning model is trained to spot diseases and predict how long produce will stay fresh. Then, this model is used on the collected data. The results are shown on a web dashboard, giving updates on the produce's condition like temperature, humidity, disease detection, and how long it will stay fresh. This lets farmers and sellers check the storage conditions from far away and act fast if needed. The goal is to make the stored produce better, reduce losses from spoilage and diseases, and provide accurate data for better decisions. In the future, we can make the system even better.

### EVOLUTION AND GROWTH OF IOT

The evolution of IOT (Internet of things) has been remarkable. Initially, it was mainly about connecting devices to the internet for remote monitoring and control. Over time, it has grown to encompass advanced analytics and they were used in various industries like healthcare, manufacturing, and smart cities. The growth

continues as more devices connected, and the technology gets better at handling big projects involve lots of devices and different ways to use them. The evolution and growth of IoT (Internet of Things) in vegetable and fruit detection have been significant. Initially, simple sensors were used to monitor environmental conditions like temperature and humidity. Now, advanced IoT devices incorporate machine learning algorithms to identify ripeness, detect diseases, and even optimize harvesting times. This technology helps people in reducewaste and ensure higher-quality produce.

### IMPORTANCE IF IOT IN THE DIGITAL ERA:

In simple terms, IOT is important in the digital era because it connects everyday objects to the internet, making them smarter and more useful. This connectivity allows these objects to share information, automate tasks, and improve efficiency. For example, IOT can help us remotely control our home appliance, monitor our health with wearable devices, and optimize manufacturing processes in factories (Khumkar *et al.*, 2018). Overall, IOT makes our easier, businesses more efficient, and enables new possibilities for innovation and growth in the digital age.

#### Types of sensors in IOT:

There are many types of sensors used in various applications. Here are some common ones:

- 1. Temperature sensors:** Measure temperature changes.
- 2. Humidity sensors:** Detect moisture levels in the air.
- 3. Proximity sensors:** Detect the presence or absence of nearby objects.

4. **Motion sensors:** Detect movement or changes in motion.
5. **Light sensors:** Measure light intensity or detect the presence of light.
6. **Pressure sensors:** Measure pressure changes in gases or liquids.
7. **Accelerometers:** Measure acceleration, tilt, or vibration.
8. **Gyroscopes:** Measure angular velocity or orientation.
9. **Magnetometers:** Detect magnetic fields.
10. **Gas sensors:** Detect the presence of specific gases in the air.

These sensors are used in various industries and applications, including automotive, healthcare, environmental monitoring, and smart home technology.

## LITERATURE SURVEY

The IoT-based system for monitoring fruits and vegetables in storage, along with machine learning and IOT (Internet of things) for shelf-life and disease detection, offers a promising solution for maintaining produce quality. The system integrates sensors, cameras, and machine learning algorithms to accurately assess produce condition, with real-time updates available on a web dashboard (Akash *et al.*, 2023). Upon activation, the device displays "IOT FRUIT FRESHNESS DETECTOR" and utilizes sensors like DHT11, MQ3, and MQ5 to monitor temperature, humidity, and gas levels (Soham *et al.*, 2023). It alerts users to high temperatures, humidity, and unsafe gas concentrations, enhancing food safety. Another aspect of the research explores automatic vision-based sorting and grading of fruits based on color (Seiichi Uchida and Takashi Akagi 2022). This system detects defects and categorizes fruits into different quality levels, influenced by factors like conveyor speed and camera resolution. The study emphasizes the cost-effectiveness of IoT solutions for food monitoring, addressing the importance of maintaining optimal moisture and temperature levels to reduce food waste (Shaik and Sivaraj 2022). Additionally, an automatic fruit grading system is proposed, leveraging color and edge detection techniques for accurate sorting. Mechanical components like DC motors, Arduinos, and software such as Python with OpenCV are utilized for efficient fruit grading compared to manual methods. Furthermore, a project focuses on monitoring storage conditions using Raspberry Pi and various sensors to ensure the quality of stored items, particularly frozen products. Lastly, tomato sorting using image processing techniques and machine learning is discussed, highlighting the KNN (k nearest neighbor) approach is 88% accuracy in fruit quality classification (Riyaz *et al.*, 2022). This method aims to improve fruit grading efficiency and minimize wastage. In this study, the aim is to develop a method to detect and classify infected regions on fruits' external surfaces (Venkata *et al.*, 2022). The proposed approach categorizes the level of infection into six categories: low, average, medium, high, extreme high, and fully infected. Using a dataset of infected fruit images, the method was tested across

various fruits like apples, oranges, mangos, and watermelons. The next steps involve extending the method to process multiple images, grading them according to predefined criteria, and sorting them into clusters based on infection levels for storage in respective databases (Hina and Imran 2021).

## Application of fruit and vegetables Quality Monitoring Using IOT (Internet of things)

The application of IoT in monitoring the quality of fruits and vegetables in a fridge offers several benefits for both consumers and producers:

1. **Remote Monitoring:** IoT sensors installed in the fridge can continuously monitor temperature, humidity, and other environmental conditions. Users can access real-time data through a mobile app or web interface, allowing them to remotely monitor the status of their fruits and vegetables from anywhere.
2. **Alerts and Notifications:** If the temperature inside the fridge fluctuates outside of the optimal range for storing fruits and vegetables, the IoT system can send alerts and notifications to user's smartphone. This allows users to take immediate action, such as adjusting the temperature settings or consuming the produce before it spoils (Yadav *et al.*, 2018).
3. **Shelf-life Prediction:** By analyzing data collected from sensors over time, machine learning algorithms can predict the remaining shelf-life of fruits and vegetables stored in the fridge. This information helps users plan their meals more effectively and reduces food waste by consuming items before they expire.
4. **Energy Efficiency:** IoT-enabled fridges can also optimize energy usage by adjusting cooling settings based on real-time data and user preferences.
5. **Quality Assurance:** By monitoring parameters like temperature and humidity, IoT systems can ensure that fruits and vegetables are stored or transported under optimal conditions, thereby preserving their quality and freshness.
6. **Predictive Analytics:** Machine learning algorithms can analyze data collected by IoT sensors to predict the remaining shelf-life of fruits and vegetables. This enables suppliers and retailers to better manage inventory and reduce food waste.
7. **Consumer Confidence:** With IoT-enabled traceability solutions, consumers can access information about the journey of their fruits and vegetables, including cultivation practices, storage conditions, and transportation details. This fosters trust and confidence in the quality and safety of the produce.

## CONCLUSIONS

In conclusion, the combination of IoT technology for monitoring fruit and vegetable storage, along with machine learning algorithms to predict shelf-life and detect diseases, shows great promise in maintaining produce quality and freshness. By utilizing sensors, cameras, and machine learning, the system accurately identifies diseases and forecasts shelf-life, with real-time updates available via a web dashboard. However, there is room for improvement through the integration of blockchain, wireless sensors, predictive maintenance,

cloud analytics, and mobile apps. These upgrades could enhance data accuracy, transparency, and user experience, while reducing maintenance costs and downtime. Further research in these areas could lead to a more efficient and effective system for ensuring top-quality produce for consumers and retailers alike.

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