

# IOT Based Food Quality Monitoring System

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**Abstract:** Food safety and hygiene are among the key concerns in order to prevent the wastage of food. However, for lack of technology and ignorance about the effects of humidity, temperature, exposure to light and alcohol content on foods, food safety is not maintained well enough in Kenya. This has led to massive losses in many food stores resulting from food decay.

Currently, majority of food stores and warehouses still rely on manual monitoring of the atmospheric factors related to food quality. These conventional food inspection technologies are limited to weight, volume, color and aspect inspection and as a result do not provide a lot of information needed on quality of food. The quality of the food needs to be monitored and it must be prevented from rotting and decaying by the atmospheric factors like temperature, humidity and dark.

This project is focused on such a food monitoring system which suggests systematic use of various sensors to perform quality monitoring and control of food materials. More precisely, this system consists of gas, temperature, light and humidity sensors, which provide the essential information needed for evaluating the quality of the packed or stored product. This information is transmitted wirelessly to a computer system providing an interface where the user can observe the evolution of the product quality over time using the Internet of Things technology. Later, the environmental factors can be controlled like by refrigeration, vacuum storage and other appropriate control measures.

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**I. INTRODUCTION :** Food contamination can occur in the production process, but also a large part caused by the inefficient food handling because of inappropriate ambient conditions when the food is being transported and stored. There are many factors leading to food poisoning, typically changes in light intensity, temperature, alcohol content and humidity are important factors. A monitoring system capable of measuring temperature and humidity variability during transport and storage is of prime importance.

Today almost everybody is getting affected by the food they consume, it's not only about the junk food, but all the packed foods, vegetables, products consumed and used in daily life, as all of them do not offer quality since their temperature, moisture, oxygen content vary from time to time. Majority of consumers only pay attention to the information provided on the packaging, i.e. the amount of ingredients used and their nutritional value but they forget that they are blindly risking their health by ignoring the environmental conditions to which these packets are subjected. Every product making firm just want to attract more and more costumers towards them and their main motive is to sell the product anyhow like by adding more flavors, coloring chemicals and preservatives to increase the taste and appearance but they forget that these money making tactics are actually affecting the consumers' health.

High temperature and relative humidity favor the development of post-harvest decay organisms. More acidic tissue is generally attacked by fungi, while fruits and vegetables having pH above 4.5 are more commonly attacked by bacteria. A wide variety of foods can also undergo changes in color, flavor, and nutrient composition when exposed to light. The extent of these changes depends on many factors including the composition of the food and the light source. Light exposure could result in color and vitamin loss. Light also may be responsible for the oxidation of fats. Some types of yeasts can also lead to spoilage. True yeast metabolizes sugar producing alcohol and carbon dioxide gas. This process is known as fermentation. Hence by checking on alcohol quantity content one can detect the quality of food.

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## II.FOOD QUALITY

Food safety refers to practices and conditions that preserve food quality to prevent contamination and food-borne illnesses during preparation, handling, and storage. The correct Food Safety practices assure that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use. Food quality and safety are the main targets of investigation in food production. Therefore, reliable paths to detect, identify, quantify, characterize and monitor quality and safety issues occurring in food are of great interest.



Quality is the ultimate criterion of the desirability of any food product. The overall quality of a food depends on the nutritional and other hidden attributes, and sensory quality as assessed by means of human sensory organs. The absence of the nutritional qualities and possible presence of food toxins and chemical additives will affect the quality of food which in turn may harm the food consumer. For a food manufacturer the quality of raw material is very important as the end product quality entirely depends on it.

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## III. STORAGE OF FOOD

Proper food storage helps to preserve the quality and nutritional value of the foods you purchase, and also helps make the most of your food dollar by preventing spoilage. Additionally, proper food storage can help prevent food borne illnesses caused by harmful bacteria.



Use fresh, perishable foods soon after they are harvested or purchased. Signs of spoilage that make food unpalatable but not a bacterial hazard are the rancid odor and flavor of fats caused by oxidation, slime on the surface of meat, and the fermentation of fruit juices due to yeast growth. Off-odors in foods and a sour taste in bland foods can indicate dangerous bacterial spoilage. However, food can be high in bacteria count even without such signals.

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## IV.PROPOSED SYSTEM

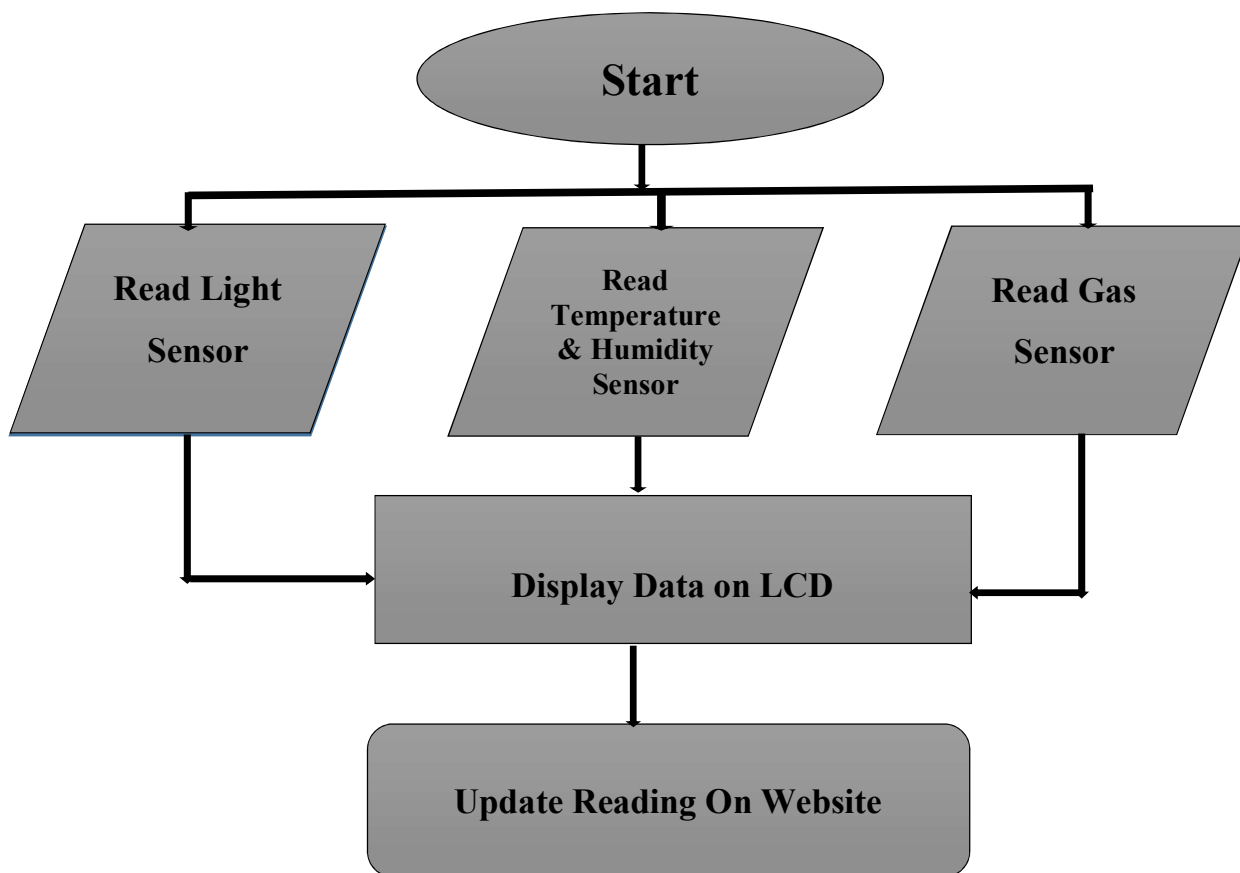
Spoiled food can be very harmful for people and should therefore not be consumed. Often, the growth of spoilage organisms results in the loss of whole batches of food. Food safety and quality has been a major challenge in the food supply chain, stores and warehouses. It is the responsibility of all food service establishments, stores and ware houses to ensure proper safety and quality of food to ensure the health of their customers. Their primary focus should be on implementing the required quality assurance guidelines and standards resulting in process monitoring systems and preventive control measures. It serves the purpose of preventive consumer health protection by maintaining the required standard ambient conditions needed to preserve the quality of food.

However, existing systems have been unable to provide food safety guarantees. Currently the performances and analysis of routine measurements, aimed at detecting changes in the nutritional or health status of the food does not guarantee that. To ensure food safety and to prevent food wastage, it should be monitored at every stage of supply chain. Food and nutrition monitoring and surveillance involves continuous description of the components of the food and nutrition system for the purposes of planning, policy analysis, program evaluation and trend forecasting. Information collected through monitoring and surveillance must be analyzed and transmitted to decision-makers in an appropriate format and in a timely fashion if it is to be of real value. Dissemination of

information must be an interactive process. Thus, integration of the sensors with remote web server for data logging and a software application which allows distribution of data is the need of the hour.

## V.WORKING METHODOLOGY

### Flowchart

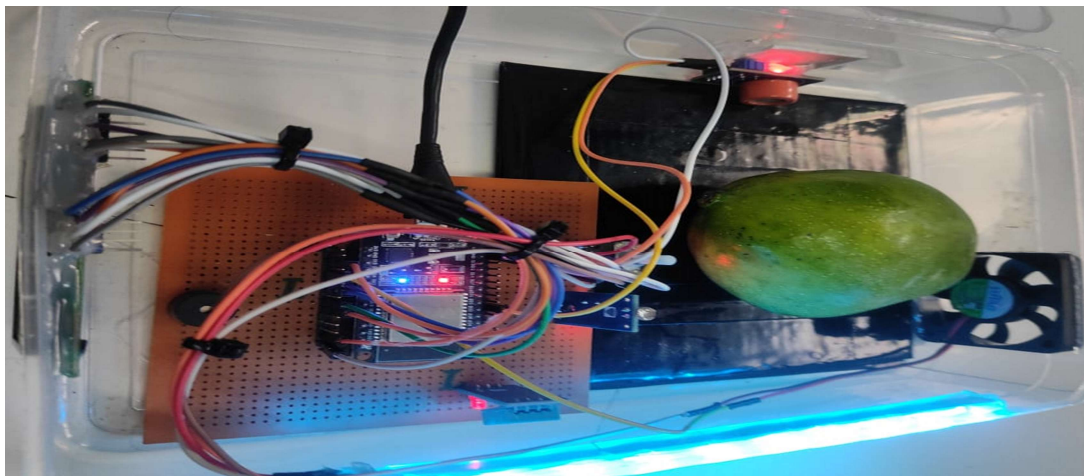


The **IoT-based Food Quality Monitoring System** is designed to ensure that food remains in optimal conditions during storage or transportation by continuously monitoring various environmental factors such as temperature, humidity, light, and gas levels. At the heart of the system is the **ESP32 microcontroller**, which functions as the main controller. This powerful microcontroller processes data received from various sensors, including a **temperature and humidity sensor**, **light sensor**, and **MQ3 gas sensor**, and takes actions based on the conditions it detects. The system also integrates an **RGB LED strip** for visual status feedback, an **LCD display** for real-time monitoring, and a **buzzer** for alerts when certain thresholds are exceeded.



The **ESP32** acts as the central unit, capable of both Wi-Fi and Bluetooth connectivity, allowing for seamless communication with other devices and the internet. It reads sensor data, processes it, and sends commands to connected peripherals such as the fan, light, and buzzer. The micro-controller also enables the system to upload real-time data to a cloud server or website, providing remote monitoring capabilities to users. This means users can access the system remotely via a web interface, receiving updates about the food's environmental conditions wherever they are.

The **temperature and humidity sensor**, **light sensor**, and **MQ3 gas sensor** work together in the Food IoT-based Quality Monitoring System to ensure optimal conditions for food storage and transportation. The **temperature and humidity sensor** continuously measures the temperature and moisture levels in the environment, allowing the system to adjust conditions if the temperature exceeds safe thresholds by activating a fan to cool the area. The **light sensor** monitors the ambient light levels, ensuring the area remains well-lit for food safety and visibility. If the light intensity drops below a preset level, the system automatically increases the brightness of the **RGB LED strip**. Meanwhile, the **MQ3 gas sensor** detects the presence of harmful gases, such as ethanol or carbon dioxide, which could indicate contamination or spoilage. If dangerous gas levels are detected, the system triggers a red alert on the LED strip and activates a buzzer to warn users of potential issues. Together, these sensors provide comprehensive monitoring and control, ensuring the environment remains conducive to food preservation.



In addition to local alerts, the system displays real-time sensor data on an **LCD display** so that users can easily monitor conditions at a glance. The LCD screen shows important parameters like temperature, humidity, light levels, and gas concentrations. This allows for immediate troubleshooting and provides essential information for food quality management. Furthermore, the data is continually updated and uploaded to a website, where users can remotely access the system's status, track trends over time, and receive notifications when any parameter goes outside the acceptable range. This **IoT-based food quality monitoring system** ensures that food remains in optimal conditions by continuously monitoring and controlling the environment.

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## VI. Advantages

1. **Real-time monitoring** of temperature, humidity, light, and gas levels for immediate corrective actions.
2. **Automation** with automatic fan and light control, reducing the need for manual intervention.
3. **Remote access** via a website for monitoring conditions from anywhere.
4. **Energy efficiency** by activating devices only when necessary, saving operational costs.
5. **Improved food safety** by preventing spoilage, contamination, and deterioration.
6. **Data logging** for trend analysis, helping to optimize food storage conditions over time.

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## VII. Applications

1. **Cold Storage and Warehousing:** Ensures that temperature, humidity, and gas levels are constantly monitored in food storage facilities, reducing spoilage and maintaining freshness.
2. **Food Transportation and Logistics:** Monitors environmental conditions during the transportation of perishable goods, ensuring that they remain within safe limits throughout the journey.
3. **Supermarkets and Grocery Stores:** Helps maintain the quality of food products on display or in storage areas by ensuring that they are kept in ideal environmental conditions, such as proper lighting and temperature.
4. **Restaurants and Catering Services:** Monitors the storage conditions of ingredients, ensuring that they are kept fresh and safe for preparation and consumption.
5. **Agricultural Storage:** Used in silos or storage areas for grains, fruits, and vegetables, ensuring proper humidity and temperature levels to prevent deterioration or pest infestations.
6. **Smart Homes and Kitchens:** Provides automated monitoring of the kitchen environment to ensure optimal conditions for food storage, such as controlling humidity in food storage areas or monitoring air quality.

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## VIII. Conclusion

The **Food Quality Monitoring System** was designed to effectively monitor and manage the environmental conditions within a food storage area. It successfully reads the **temperature** and **relative humidity** levels, ensuring that the food remains in an optimal environment to prevent spoilage. Additionally, the system senses the **light intensity** in the storage area,

ensuring adequate lighting for food preservation. The **MQ3 gas sensor** detects the presence of **ethanol gases**, which could indicate food spoilage or contamination. All data collected from the sensors is processed and displayed on an **LCD screen**, providing real-time information to users on the local system. Furthermore, the system is capable of transmitting sensor data online for remote monitoring, allowing users to access and track the conditions of the food storage area from anywhere.

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## IX. References

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