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# A Smart IoT Solution for Monitoring and Predicting Grocery Freshness and Quality

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**Abstract** – According to the statistics,40% of the food produced is wasted before it reaches the consumers. The core problem lies in logistics and infrastructure. Firstly weather varies widely and it makes generalization difficult. This makes it impossible for perishables to naturally survive long-haul transport. Secondly, cold storage facility is not available and affordable to all farmers. Today food spoilage is a crucial problem. The food we consume can affect in any form of contamination that may occur due to storage or chemical changes within the food. This makes it necessary to develop a system that can help people to identify and predict the freshness of food or quality of food items. A smart grocery management system helps users manage groceries in large warehouses and long transportations. Users no longer have to worry about continuous food monitoring. This project aims to ensure the freshness of grocery by predicting the spoilage of grocery in prior and to notify the user about the same so that he can take necessary precautions to prevent grocery spoilage.

Continuous analysis of temperature and humidity of the grocery is carried out by using DHT11 Temperature and Humidity sensor to monitor varying parameters of the grocery. ESP8266 Node MCU is used as the main controller of the system which is used to control the sensing action of the sensor. Data collected from the sensor is used to analyse the variations in the values of temperature and humidity when the grocery is fresh and when it is completely spoilt. The humidity and temperature data are sent to the cloud storage by using the Wi-Fi module which is inbuilt to the Node MCU. ThingSpeak cloud platform is set up for the storage purpose which is retrieved back to use it for predicting the spoilage of the grocery which is the main goal of the system. A prediction algorithm is used for this purpose which is basically a combination of machine learning and data mining approach for forecasting or predicting the future values based on some past set of values. The values of fresh grocery has been given as the input to prediction algorithm which is used to predict the future values of temperature and humidity. Predicted values obtained is compared with the spoilt values measured earlier to detect the spoilage of grocery. Predicted status of the grocery has been notified to the user through SMS.

***Key Words***: food, grocery, freshness, prediction

## 1.INTRODUCTION

The Internet of Things represents physical objects connected to sensors, controllers, software, and other technologies that connect and exchanges data with other devices and systems via the Internet or other communication networks. The IoT enables detection and remote control over existing network infrastructure. This improves accuracy and economic benefits.

It is now possible to visualize the Internet of Things (IoT) in everyday life. It is equipped with transceivers, microcontrollers, and embedded systems for electronic communication between things, allowing them to communicate with each other and with users. The IoT has applications in a variety of areas, including industrial automation, home automation, mobile care, medical tools, intelligent energy and traffic management, smart grids, and more. A smart grocery management system helps users manage groceries in large warehouses properly. Users no longer have to worry about continuous food monitoring.

This project aims to detect the freshness and quality of food by monitoring the temperature with temperature sensor. Data regarding temperature and humidity is collected from sensors and sent to Node MCU which has inbuilt Wi-Fi module. The data is stored in cloud which is then fed to the prediction algorithm. The prediction algorithm predicts the spoilage and notifies the user.Data storage is done using cloud technology that enables better management of storage systems. This application displays grocery freshness and quality.

The IoT will certainly be an effective technology in the future. IoT-enabled devices can be found everywhere from the industry to the home.

The proposed system has a future scope to monitor large scale industry of food grocery likely to be vegetable and fruits. It finds wide application in large farm storage in the remote and urban areas. This system can also monitor and simultaneously update the freshness and quality of the grocery in long distance transportation. The parameters such as color, pH and weight of the grocery can also be considered for the freshness measurement.

## 2.METHODOLOGY

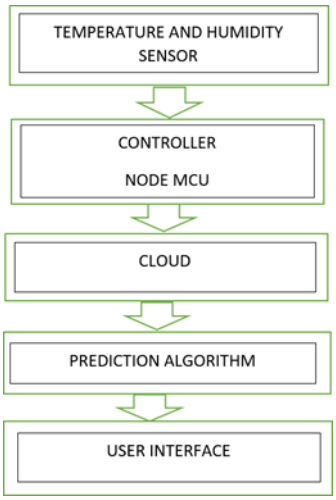


**Fig -1**: Block Diagram

### Components Used:

DHT11 sensor:It consists of 2 main parts – one is wetness sensing element and alternative is NTC temperature detector (or Thermistor). The semiconductor could be a resistor that revises its resistance with change in temperature. They each sense the temperature and wetness of space and provides the output to the Controller. Moisture sensor ensures the freshness of food and tells whether to eat it or bin it. It concerns about the user's health

protection by maintaining the desired customary to preserve the standard of food. The food isn't fresh all the time. So the analysis of routine measurements aims to find changes within the biological process worth of food.
Node MCU: Node MCU is a low-cost open source IoT platform based on ESP8266 architecture which can connect objects and allows data transfer using the Wi-Fi protocol. We have used it as Node MCU consumes low power, high memory and built-in Wi-Fi present. Though Arduino has got 19 GPIO pins, internet is required while working on IoT. So, you'll have to connect an ESP8266 (Wi-Fi shield) externally. Whereas, Node MCU has ESP8266 as its core along with 13 GPIO pins. So, Node MCU is best suited for IoT projects. Hypertext

Transfer Protocol (HTTP):Most internet traffic is carried by employing a protocol called Hypertext Transfer Protocol (HTTP). Hypertext Transfer Protocol is an application layer protocol. It is modelled for distributed, collaborative information systems. This protocol is used as it offers lower CPU and memory usage due to less simultaneous connections and offers reduced network congestions.
HTTP offers users a way to interact with web resources such as HTML files by transmitting hypertext messages between the client and servers. Its client generally are transmission control protocol (TCP) connections to communicate with servers.

## 3. IMPLEMENTATION

The cloud initially performs data collection, storage and management. Therefore, the incoming data are stored which are then followed by Anticipative Analysis. It helps in obtaining the results that can be expected in the future. The algorithm for the Anticipative Analysis is developed from analyzing the current incoming results and the past historical results. Then the analyzed data from the cloud platform can be visualized in the embedded models like apps or websites.
Procedures to store the data collected from the Node MCU in ThingSpeak cloud storage platform:
ThingSpeak Cloud platform after inserting network credentials, channel number and API key, upload the code to board.
1.Sign in to ThingSpeak using your MATLAB account.
2.Select Channels > My Channels.
3.Select the channel to get the read API key.
4.Click the API Keys tab and copy the key from the Write API Key parameter.
5.Open the ThingSpeak Read block in your model and paste the copied API key in the Write API key parameter.
The data stored in the ThingSpeak cloud platform is then fed to the prediction algorithm. Steps for prediction algorithm in machine learning with python:
**Gathering data:** Data collection can take up a considerable amount of time. However, more the data, more accurate will be the predictions. The data are collected from multiple sources, so there is a need of unitary approach to all the collected data.
Therefore, the data collection phase is crucial to make accurate predictions.
**Preparing the data:** One of the critical challenges when dealing with the massive amounts of data is to process them. Identifying the best dataset for the model is essential for good performance. This is where data processing comes in. Data is stored in the form of CSV file. Only the essential data from the CSV file is extracted for further processing.

**Choosing a model:** Various predictive analytics model are used such as classification or clustering models. This is where predictive model building begins. In this step of predictive analysis, we employ several algorithms to develop prediction models based on the data from the sensor. Open-source programming language like Python consist of countless libraries and packages that can efficiently help us develop any form of machine learning model. It is also essential to re-examine the existing data and to determine if it is the right kind for the predictive model.
**Training:** Train/Test is a method to measure the accuracy of your model. It is called Train/Test because you split the data set into two sets: a training set and a testing set.80% for training and 20% for testing. Prediction: Prediction refers to the output of an algorithm after it has been trained on a historical dataset and applied to new data when forecasting the likelihood of a particular outcome.

## 4. RESULTS

Node MCU sends the collected data to ThingSpeak cloud platform.

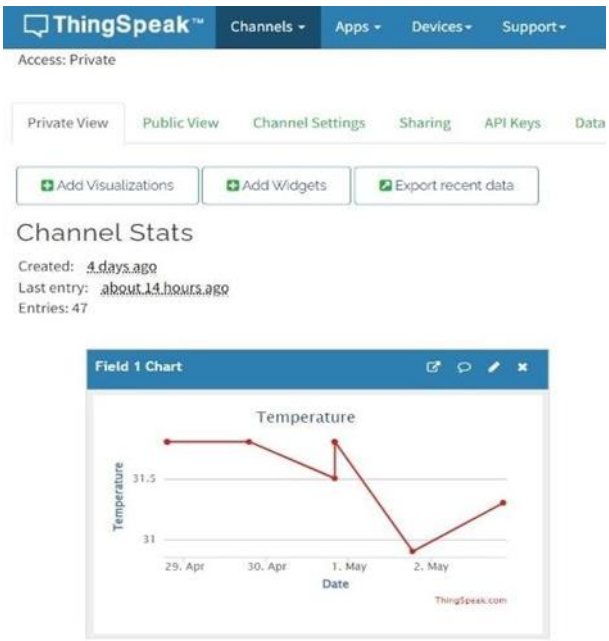


**Fig-2**: Display of temperature and humidity on ThingSpeak cloud platform

Here, the collected data is not only displayed but also subjected to prediction. The data collected from the sensors is fed into a predictive model, likely built using machine learning techniques such as regression analysis. This model analyzes historical data to predict future trends in temperature and humidity. The predicted values are then displayed alongside the real-time data on the ThingSpeak platform, allowing users to anticipate changes and take appropriate actions if necessary.

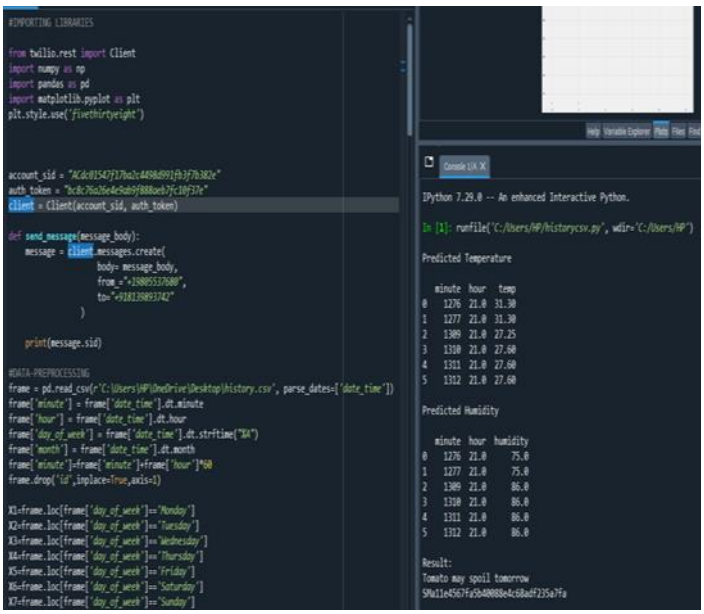


**Fig-3**: Predicted temperature and humidity

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The data collected will be fed to a chosen model and trained accordingly to obtain the desired output.

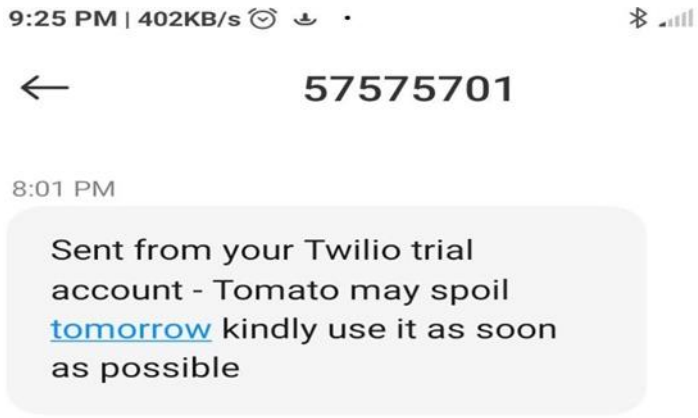


**Fig -3:** Message notification received by the user

In this scenario, the system is set up to alert users when certain conditions are met, such as the spoilage of tomatoes due to unfavorable temperature or humidity levels. When the predictive algorithm detects that the conditions for spoilage are likely to occur, it triggers a message notification to be sent to the user. This notification could be in the form of an email, SMS, or push notification on a mobile app, depending on the user's preferences. Linear regression, a statistical method used for modeling the relationship between variables, is mentioned here as the algorithm used for prediction. This suggests that the system employs a linear regression model to predict the likelihood of tomato spoilage based on the collected data on temperature and humidity. If the predicted values exceed certain thresholds indicating spoilage risk, the alert is triggered, prompting the user to take preventive action. An alert notification regarding the spoilage of the tomato will be sent to the user based on Linear regression used in prediction algorithm.

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