An Artificial Intelligence Approach Toward Food Spoilage Detection and Analysis

Methodology

The motivation behind Monitoring and analysis of food spoilage using Machine Learning is to keep track and manage food products to avoid spoilage caused by climatic and atmospheric changes. Monitoring and analysis of food spoilage using Machine Learning saves time and provides accurate and consistent results. Bacteria, virus, protozoa, and fungi are factors of food spoilage. These factors can create harmful results for consumers, but we can apply prevention techniques to them to save the life and quality of food.

Component Used

- **Controller:** Arduino
- Raspberry pi
- Gas Sensor Detector: The gas sensor detects early spoilage via detecting a little amount of gas emission of the food items.
- Humidifier
- Heat Sensor
- Humidity Sensor: The humidity sensor senses the humidity of the environment.
- Temperature Sensor: The temperature sensor monitors the temperature for the predefined threshold value which is controlled by Arduino.
- Cooling module (TEC1-12715-Thermoelectric Cooler 15A Peltier Module)
- Light Sensor
- Camera Sensor: The camera sensor captures the image of fruit or vegetable.
- Fruits360 dataset,

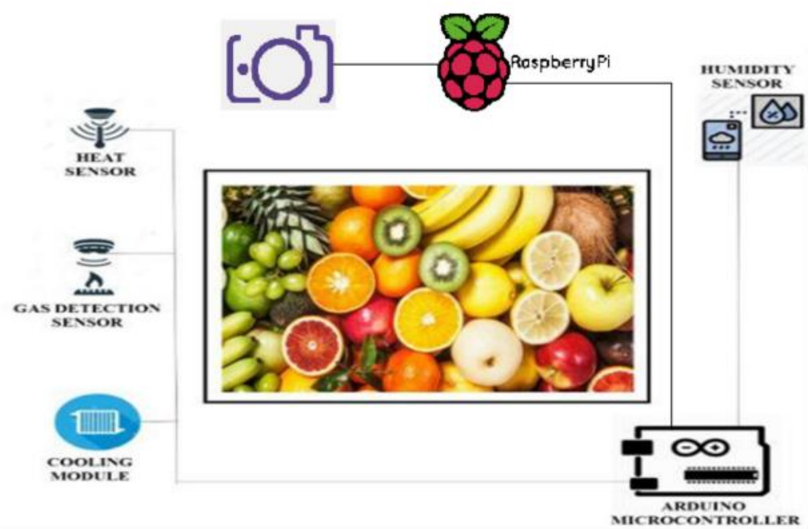

Figure 1: The Architecture of Monitoring and Analysis of Food Spoilage using Machine Learning

Algoritms

We proposed a CNN for object detection and prediction model. This is trained over three different classes. In our model, there are a total of 11 layers. The output layer is SoftMax, and there are four convolutional layers, four max pooling layers, and two fully connected layers. The model has been trained on 50 different types of fruits and vegetables, and it is also capable of identifying multiclass images.

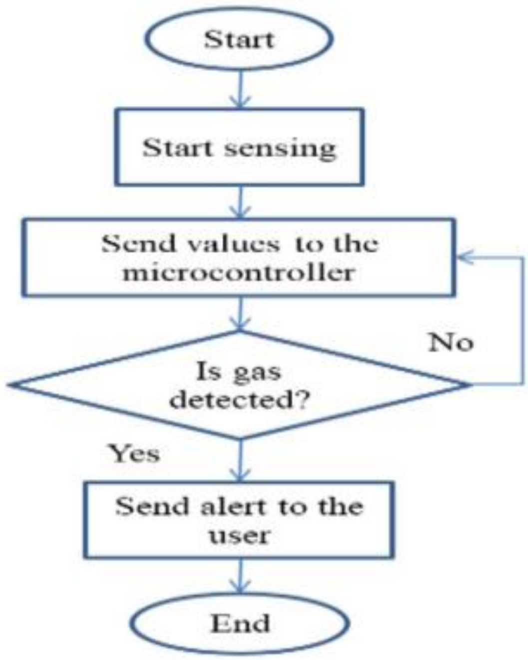

Figure 2: Gas Detection Sensor

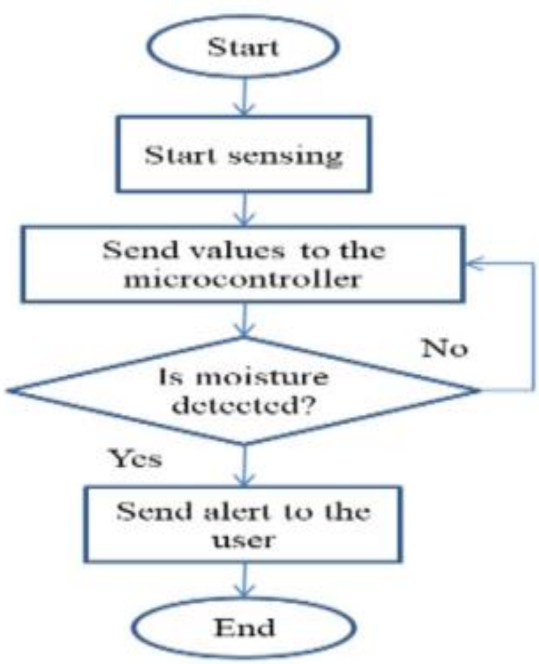

Figure 3: Humidity Sensor

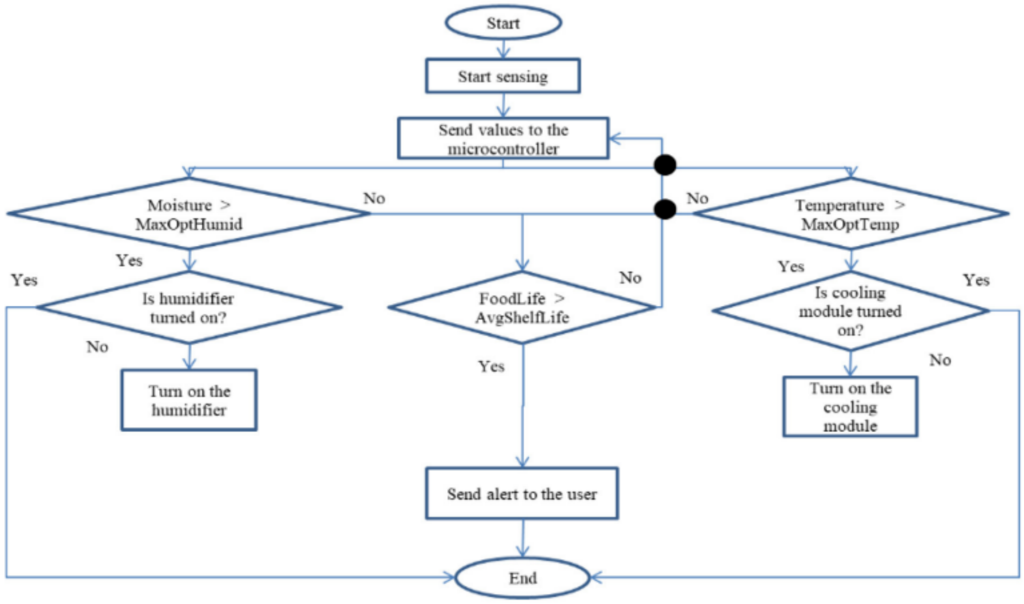

Figure 4: Heat Sensor and Cooling Module

Columns	Description	Value	Type
Names of fruits and vegetables	Different types of fruits and vegetables	NA	String
Minimum optimal storage temperature	Minimum temperature in which fruit or vegetable remain fresh	Multiple minimum optimal temperature values	Numeric
Maximum optimal storage temperature	Maximum temperature in which fruit or vegetable remain fresh	Multiple maximum optimal temperature values	Numeric
Freezing point	This cooling point in which fruit or vegetable remain fresh	Multiple freezing point values	Numeric
Minimum optimal humidity	Minimum humidity in which fruit or vegetable remain fresh	Multiple minimum optimal humidity values	Numeric
Maximum optimal humidity	Maximum humidity in which fruit or vegetable remain fresh	Multiple maximum optimal humidity values	Numeric
Minimum approximate storage life	At least number of days in which fruit or vegetable remain fresh	Multiple minimum approximate storage life values	Numeric
Maximum approximate storage life	At most number of days in which fruit or vegetable remain fresh	Multiple maximum approximate storage life values	Numeric
Average shelf life	Average of minimum (start spoiling) spoilage time and maximum (after spoiled) spoilage time	Multiple average shelf life values	Numeric

Table 1: Description of the Fruits and Veggies Dataset

Algorithm 1: Process (object).

1: Turn on the device
2: Capture the image of fruit or vegetable
3: Turn on the Cooling module
4: Turn on Humidifier
5: Store the optimal values of parameter according to captured object
6: Read the values of sensor for monitoring process of fruits or vegetables
7: **if** Gas content is detected **then**
8:     go to step 20
9: **else**
10:     go to step 21
11: **end if**
12: **if** Moisture content is detected AND moisture > maximum optimal humidity of object AND Humidifier is off **then**
13:     Turn on the humidifier
14: **else if** heat content is detected AND temperature > maximum optimal storage temperature of object AND cooling module is off **then**
15:     Turn on the cooling module
16: **else if** life of object > average shelf life of object **then**
17:     go to step 20
18: **else**
19:     go to step 21
20: **end if**
21: Send alert to the user
22: Capture an image of fruit or vegetable
23: go to step 7

Findings

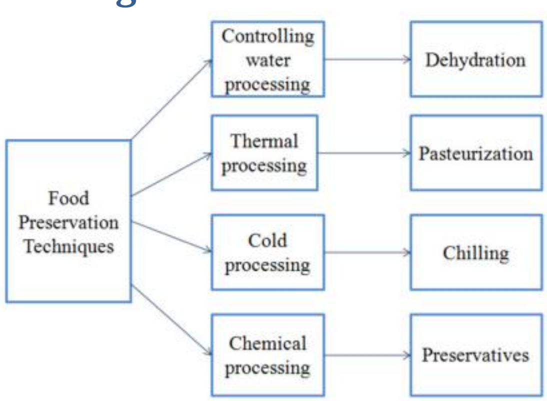

Figure 5: Food Preservation Techniques

Preservatives	Food
Sorbic acid	Syrups, sweets, dairy products, fruit products, fermented products, beverages
Tert butyl hydroquinone (TBHQ)	Fats, oils, snack foods
Tocopherols (vitamin E)	Oils
Ascorbic acid (vitamin C)	Fruit and acidic products
Butylated hydroxyanisole (BHA) and Butylated hydroxy -toluene (BHT)	Fats and oils, bakery products, cereals
Sodium sorbate	Mayonnaise, processed meats, dairy products, fermented products
Sodium and calcium propionate and Potassium propionate and propionic acid	Breads and other baked goods
Benzoic acid and sodium benzoate	Fruit products, margarine, and acidic foods
Calcium lactate	Olives, frozen desserts, jams, jellies, and dairy products
Calcium sorbate	Mayonnaise, dairy products, syrups, and margarine
Ethylene diamine tetra acetic acid (EDTA)	Dressings, canned veggies, and margarine
Methylparaben	Relishes, dressings, and beverages
Propylparaben	Cake, pastries, beverages, and relishes
Sodium nitrate and nitrite	Cured meats, fish, and poultry

Table 2: Different Types of Food Containing Various Kinds of Preservatives

Preservatives	Cancer possibility (Yes/No)	Asthma possibility (Yes/No)	Hypersensitivity possibility (Yes/No)
Calcium/Potassium/Sodium propionate and propionic acid	No	Yes	Yes
Sodium and potassium nitrate	Yes	No	Yes
Sodium nitrite	Yes	Yes	Yes
Butylated hydroxyanisole (BHA)	Yes	Yes	Yes
Butylated hydroxytoluene (BHT)	Yes	Yes	Yes
Tert butyl hydroquinonesynthesiz-ed (TBHQ)	No	Yes	Yes
Sodium benzoate	Yes	Yes	Yes
Potassium and calcium sorbate and Sorbic acid	No	Yes	Yes
Benzoic acid	No	Yes	Yes
Propylparaben	No	Yes	No
Sulfur dioxide	No	Yes	Yes
Potassium bisulfite	No	Yes	Yes
Hexamethylen-etetramine	Yes	No	No
Sodium metabisulphite	No	Yes	No

Table 3: Dangerous Food Preservatives Cause Various Diseases

Name of fruits or vegetables	Minimum temperature (°F)	Maximum temperature (°F)	Average shelf life (days)	Maximum approximate storage life (days)	After experimental analysis (days)
Broccoli	32	32	11	14	16
Cabbage (Early)	32	32	41	42	44
Carrots (Immature)	32	32	35	180	181
Cauliflower	32	32	14	120	122
Cherries	30	31	6	14	15
Grapes	31	32	6	56	55
Kohlrabi	32	32	7	90	91
Gooseberries	31	32	3	28	29
Leeks	32	32	11	90	91
Parsley	32	32	6	90	91
Plums	31	32	4	35	36
Eggplant	46	54	2	7	9
Blackberries	32	33	6	3	4
Corn (Sweet)	32	32	7	8	9
Cucumbers	50	55	11	14	15

Table 4: Experimental Analysis of Fruits and Vegetables

Novelty

This study presents a novel technique for Monitoring and analysis of food spoilage using a sensor bases system. The device proposed in this study is able to preserve food for more days. Additionally, food items can be prevented from getting spoiled by increasing their lifespan. It monitors the quality of food items and keeps notifying the user with voice-activated commands or via display, and it also generates alerts to the user with the predicted remaining time of the food spoilage.

Analysis

The proposed device shows an accuracy of 95%.

Future Work

The proposed smart device can be improved by applying image processing and machine learning algorithms to detect early spoilage. This can be utilized in refrigeration systems for detecting food items, spoilage, and monitoring for prevention of food spoilage. The device can be incorporated into food transportation containers which would allow tracking and detecting the spoilage if any during transportation. The device could also be tested for different varieties of foods as well.