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AI-Powered Hand-held Citrus Disease & Fruit Spoilage Detection System

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ABSTRACT: In food and agricultural technology, the use of image processing techniques has excellent indications and associations. These visual images are a significant source of information. Fruit classification has become one of the important applications which can be utilized not only in the supermarkets and grocery stores but also for the agriculturist to detect the diseases and work out different methods to ensure that these diseases did not occur in the next harvest. In order to address these identified problems, fruit classification and recognition of these diseases. We identified different methods which are commonly used in addressing vegetable and fruit classification and in recognizing diseases. And we used that surveyed image processing techniques for fruit disease detection, segmentation, and classification. The methods utilized in my project are able to distinguish among different types of citrus fruits and their diseases that are very alike in colour and texture.

With the expansion in technology, there's an increasing demand for solving lifestyle tasks. We know that refrigeration is the most commonly used technique for the storage of food, which works by lowering the reproduction rate of bacteria found in the food. Through this project, we are presenting the likelihood of solving the fruit spoilage problem, with technical assistance to spot the spoilage by continuous sensing. We expand a way to detect spoilage for fruits using sensor MQ135 sensor related to Arduino. The results of the findings are shown to support the freshness and quality of the fruit. the knowledge regarding the fruit spoilage is going to be conveyed to the purchasers using visual media by displaying the result to the user on the LCD screen

Keywords: Detection, Classification, MQ135 Sensor, Arduino

1. INTRODUCTION

The present method for fruit disease detection is naked eye observation, which is the crude method for observation. For further analysis of disease laboratory equipment and sophisticated devices are used. If the disease detection is not done appropriately it may lead to the addition of irrelevant pesticides that can cause long-term resistance and reduce the ability of the plant to fight back. We adopt AI image processing using Raspberry Pi hardware to detect citrus fruit diseases. This concept is low-cost and reliable method to verify if the fruit is fit for consumption or not. It is handy and portable and can be used by anyone like the common farmers, agriculturists, pomologists, etc. to detect the citrus fruit disease that affects the fruit. Hence, we are proposing a fruit disease detection project mainly based on the CNN strategy. It is a deep neural network most commonly applied to analyze visual imagery. Here we are running a convolution neural network on Raspberry Pi and the image is captured using a Raspberry Pi camera.

The atmospheric factors like humidity and temperature were checked with systems like refrigeration, vacuum storage, etc., hence quality monitoring tools or plans are required in the groceries or industries in order to minimize the wastage as well as to ensure appropriate ambient requirements during the transportation and storage.After harvesting fruits release gases. In some cases, these gases are more or less toxic. Gas sensors are electronic devices that detect gases and measure their concentration. Sensors help in detecting food spoilage and reduce wastage of food for consumers. Here we are using MQ 135 sensor which is an air quality sensor. We will connect the sensor to Arduino then it will sense the gases, and we will get the air quality

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LITERATURE REVIEW

Citrus fruit disease detection:

In paper [1], 'Plant Disease Detection using CNN & Remedy', the proposed system helps in the identification of plant disease and provides remedies that can be used as a defense mechanism against the disease. The database obtained from the Internet is properly segregated and the different plant species are identified and are renamed to form a proper database then obtain a test database which consists of various plant diseases that are used for checking the accuracy and confidence level of the project.

Then using training data trained their classifier and then output is predicted with optimum accuracy. They use Convolution Neural Network (CNN) which comprises different layers which are used for prediction

In paper [2] "Adapted Approach for Fruit Disease Identification using Images", an adaptive approach for the identification of fruit diseases is proposed and experimentally validated. The image processing based proposed approach is composed of the following main steps; in the first step K-Means clustering technique is used for the defect segmentation, in the second step some state-of-the-art features are extracted from the segmented image, and finally, images are classified into one of the classes by using a Multi-class Support Vector Machine.

Paper [10]- "Factors influencing the use of deep learning for plant disease recognition", This article provides an in-depth analysis of the main factors that affect the performance of deep learning-based tools for plant disease recognition under realistic conditions. This indicates that, currently, tools for automatic recognition of plant diseases, rather than offering a definite answer, can at most provide a very educated guess that will allow its users to take some action promptly, especially when specialized technical assistance is not available.

The hardware proposed by all these papers is not handy and expensive. So, we thought to bring a handy device which is cheap and reliable. The budget for all the models is quite high for common farmers. All those experiments they have done in leaves and fruits so here we are focusing mainly on citrus fruits and also, they are focusing on the classification of fruits. In the developing countries experts are required to identify the disease which is time cumbersome and immoderate. We are following the technical aspects mentioned in the papers but we are trying to make it economical and useful to common people

Fruit spoilage detection system:

In paper [5]' smart stale food detector using IOT (Internet of Things)', it deals with the technologies along with internet of things using Arduino which employs the script programming and sensors like DHT sensor, moisture sensor, MQ3 Sensor, Arduino UNO etc. In this paper, we develop a food quality sensing/detecting technique. The sensors will be associated with Arduino.

In paper [6], "IoT based project for food quality and monitoring", the author proposed a device called Smart Plate consisting of a variety of sensors that are activated depending on the food item. This plate can be placed in any utensil and a panel can be used to select the type of food item.

Most of the programs used for the Arduino based sensors is written in java script. Java script does not have any multi processors or multi reading features and cannot be used for networking purposes as there is not sufficient assistance available. In our model we are using Arduino embedded C. Instead of MQ3 used in some models, we are selected MQ135 because of its efficacy and detection of air quality. MQ3 mainly used for alcohol ethanol and smoke detection purpose. But we are focusing on spoilage so we selected MQ135

2. EXPERIMENTAL METHODS OR METHODOLOGY

Proposed System

In the proposed system we use the CNN algorithm for detecting citrus fruit disease so that it will allow us to obtain maximum accuracy if the dataset is good. We collect the image using the Raspberry Pi camera module, then process

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and run it using the Python computer language and the Open CV image processing library to determine whether the fruit is diseased or not, and predict the disease.

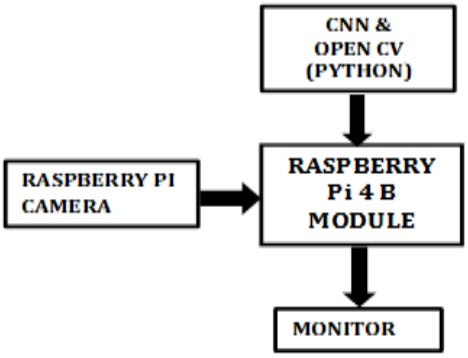

Fig 1. Citrus Fruit Disease Detection: Block Diagram

Proposed algorithm

- Collecting the Dataset- We need large amount of data to train our system, so that our model can learn from them by identifying out certain relations and common features related to the objects. This will help in training and testing our classifier. The dataset is created by downloading the images from Kaggle

- Building the CNN

The database has been pre-processed, including image resizing, reshaping, and array conversion. Our image dataset is used to train the system. When the camera captures a fruit image, the system uses a Convolutional Neural Network (CNN) algorithm to identify the fruit. Test images have also undergone similar processing. Feature extraction and classification are two characteristics of CNN.

Feature extraction: this is the process where the CNN will work a range of operations like the convolution and pooling . In this the CNN will distinguish and recognises the features.
Classification: Dependent or similar layers will assist as classifier. In our system the diseases are classifies in the order Class 1-Black spot, Class 2- Canker, Class 3- Greening, Class 4- Healthy, Class 5- Scab

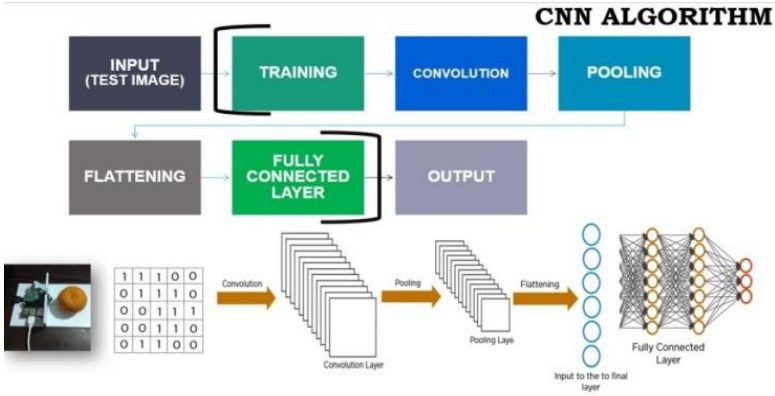

Fig 2. CNN Algorithm

- Data Augmentation

The data augmentation technique is used to enhance the number of images in a dataset by a large amount. We execute operations such as shift, rotation, zoom, and flip on the image dataset. Providing augmented photos to a model allows it

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to learn characteristics from various sections of the same image more quickly, allowing it to perform better on unseen image data.

Image of citrus fruit image is captured and identified using CNN algorithm. The collected and identified image is then analysed for disease detection in the next stage. One of the most significant operations is the normalization of image size and format. Hereby using the Open CV framework and CNN algorithm the images are converted in some pixel size and some dots per inch

- Storage: This output is stored in python H5py file

Fruits Spoilage Detection System using Arduino

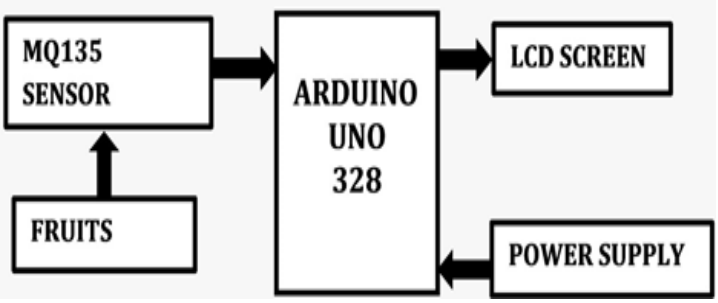

Fig 3. Fruits Spoilage Detection using Arduino: Block Diagram

In this system the gadget comprises of microcontroller Arduino UNO, MQ135 sensor and an LCD screen. MQ135 sensor detects the air quality changes and the microcontroller choose the results with the predefined calculation. The outcome is as 'fit for consumption' and not great to consume based on the sustenance freshness level

3. RESULTS AND DISCUSSION

Citrus Fruit Disease Detection System

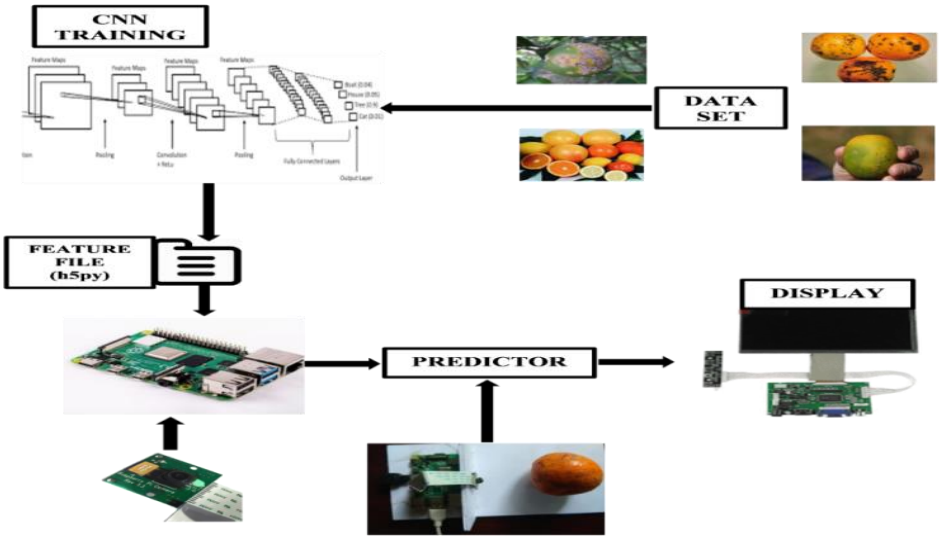

Fig 4. Experimental Setup for Citrus disease detection

The healthy and diseased citrus (for demonstration we have taken only two diseased ones greening and canker) fruits are taken and placed in front of the raspberry camera module as shown in (fig 5) then it is uploaded to the system and makes a comparison between the test image and the trained model, which is followed by the display of the disease. So, if there is any defect or disease in the fruit the software will displays it on the monitor like in the (fig6).

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Fig 5. Raspberry Pi camera capturing image of diseased citrus(i)Canker (ii) Greening

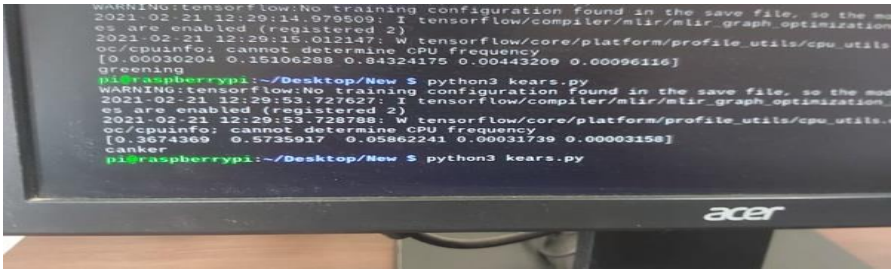

Fig 6. Displaying results for diseased citrus fruit (i) Greening (ii) Canker

FRUITS SPOILAGE DETECTION-MQ135 ANALOG SERIAL VALUES

In this session we will be discussing about how the Arduino based MQ135 sensor has able to sense the air quality change and there by detecting the degree of spoilage of three types of fruits. As the Arduino based MQ135 sensor is highly sensitive even low amount of air quality change in an air tight container can be identified which is generated by the decayed fruits. The levels of gas emission for three types of fruits have identified, and below we will present the table and the graphs for the experiments taken.

Mango

Fig 7. Fresh mango and spoiled mango taken as sample for experiment

Tomato

Fig 8. Fresh Tomato and spoiled tomato taken as sample for experiment

From the experiments that we carried out we observed the MQ135 Analog serial value range of fresh and spoiled Mango and Tomato at time intervals 5, 15 &30 minutes respectively. Hence, we arrive at the inferred average ranges of

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fresh and spoiled Mango and Tomato as shown in the above Fig 9 and Fig 10.

	READING 1			READING 2				READING 1				READING 1				READING 1			
	5 min	15 min	30 min	5 min	15 min	30 min		5 min	15 min	30 min		5 min	15 min	30 min		5 min	15 min	30 min	
DAY 1	153	187	188	153	189	188	DAY 2	252	288	333	DAY 1	100	97	96	105	95	94	DAY 2	116	132	143
	154	190	190	154	190	190		252	288	334		100	97	95	105	95	94		117	132	143
	153	190	190	154	190	192		253	288	333		101	97	95	105	95	93		116	131	142
	155	192	192	155	192	193		252	289	333		98	96	95	105	94	94		117	132	143
	154	193	193	154	193	195		252	288	334		99	95	95	104	95	94		117	132	143
	155	186	195	155	186	196		253	289	333		100	95	94	105	94	95		116	131	143
	155	196	196	154	196	197		253	288	334		99	95	95	104	94	94		117	131	142
	155	198	198	155	198	197		253	289	334		100	94	94	103	95	96		117	132	141
	154	199	199	155	199	199		253	288	334		100	95	95	105	95	93		117	131	142
	155	199	199	155	199	199		253	289	334		100	94	94	104	94	93		117	131	140
AVG RANGE	153-155	186-199	188-199	153-155	186-199	188-199		252-253	288-289	333-334	AVG RANGE	98-101	94-97	94-96	103-105	94-95	93-96		116-117	131-132	140-143

Fig 9. MQ135 Analog serial values for Fresh Mango and Spoiled mango

	READING 1			READING 2				READING 1				READING 1				READING 1			
	5 min	15 min	30 min	5 min	15 min	30 min		5 min	15 min	30 min		5 min	15 min	30 min		5 min	15 min	30 min	
DAY 1	94	88	86	95	86	86	DAY 2	119	117	115	DAY 1	109	112	113	108	111	113	DAY 2	112	126	140
	93	87	86	94	86	87		119	116	115		110	111	113	109	111	113		112	126	140
	93	88	85	93	85	85		117	117	114		109	112	114	108	112	114		113	126	139
	94	87	86	94	86	86		118	116	114		110	111	113	109	111	113		113	126	138
	93	88	85	93	85	85		117	117	115		109	111	114	110	111	114		113	126	139
	94	87	86	94	86	87		118	116	114		110	112	113	109	112	113		113	126	138
	93	87	85	93	85	86		117	116	114		110	111	114	110	111	114		113	126	136
	94	88	86	93	86	86		118	116	114		110	112	114	110	111	113		113	127	134
	93	87	85	93	85	87		117	116	114		110	112	114	110	112	114		113	126	134
	93	88	86	93	86	85		117	116	114		110	112	114	110	112	114		113	127	133
AVG RANGE	93-94	87-88	85-86	93-95	85-86	85-87		117-119	116-117	114-115	AVG RANGE	109-110	111-112	113-114	108-110	111-112	113-114		112-113	126-127	133-140

Fig 10. MQ135 Analog serial values for Fresh Tomato and Spoiled Tomato

CONCLUSION

In the present scenario accurate detection of disease and spoilage in fruit is gaining more importance for the successful crop cultivation. This can be carried out by digital image processing. Our motive is to develop a system that can detect fruit disease and its spoilage. So in our project, we adopt AI image processing technology using Raspberry Pi for disease detection.

Raspberry Pi improves the accuracy and speed of detection and classification of fruit disease. Here we are running a convolution neural network on Raspberry Pi and the image is captured using a Raspberry Pi camera. Also, this proposed system is able to solve the fruit spoilage problem with the help of Arduino and sensors. The network is trained in a systematic manner where we fruit images as input to the network and fruit diseases as the output of the network. After the training, the CNN model can predict disease of the fruit. We proposed a gadget based on Arduino UNO which is a well-known prototyping board. We can identify spoilage by continuous sensing. So for the spoilage detection system, we use an MQ135 sensor and Arduino boards. MQ 135 sensor is used for detecting the air quality. Our system will easily detect the freshness of any edible fruit and also a person consuming this fruit is aware of the quality before usage. Apart from that common farmer can use this portable device to detect the disease that affects the fruit. Our idea is cheap and reliable moreover the system is handy and can be used by anyone to make sure their fruit is spoiled

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