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DETECTION OF FOOD FRESHNESS BY USING IOT

[1]Dr. Neelima Guntupalli, Assistant Professor, Department of Computer Science and Engineering, ANU College Of Sciences, Acharya Nagarjuna University, Guntur, Andhra Pradesh, India.
[2]Vasantha Rudramalla, Research Scholar, Department of Computer Science and Engineering, ANU College Of Sciences, Acharya Nagarjuna University, Guntur, Andhra Pradesh, India.

ABSTRACT: In today's world, food spoilage is a crucial problem as consuming spoiled food is harmful for consumers. Excess food waste is something that regularly occurs at hotels, family functions, parties, etc. To gain an understanding of the scale of the problem, the excess food we waste has a large impact on various environmental factors. Freshness is a significant indicator of the quality of seafood and other food products. Food processing, storage, and marketing of food and edible products all heavily rely on the rapid detection of their freshness. We have developed an Object Detection Algorithm YOLO model that can predict the freshness of the food samples with image and its smell in a more accurate level with less time. We also take the level of gas emitted by rotten food samples using sensors and detect the spoilage level using the IoT. We can determine the affected or rotten areas by combining the value from both image data and gas emitted by the given food sample. The result can be viewed in an application through a browser. Hence, this model achieves better results interms of accuracy, precision and recall.

KEYWORDS: Food Safety, Internet Of Things (Iot), Food Freshness Detection, Food Industries

I. INTRODUCTION

We are in the 21st century and food sector is very big part of our economy .One of the biggest problems that it faces is food spoilage, i.e. food items ,more specifically meat items or fruits and vegetable going stale .The bigger problem is these spoilt items going undetected and onto the hands of the consumer .In all fruits and vegetables industries , the process of checking of quality of items is done manually , mostly by a person sitting across a conveyor belt as the items pass by. Hence, if an automated process is brought into place, it would not only increase the accuracy of spoilt food detection, but also reduce manual manpower required [1].

To automate this process, we plan on using a collection of smart sensors with microcontroller like the Node Mcu. On detection of a spoilt or stale food item, a sound buzzer can be rang to draw attention, moreover this data will be sent to the cloud, as an application of IoT. This enables appropriate authorities to view how often they get spoilt food items and create transparency [2].

The world around us is evolving at a dizzying speed. In this context of elaborating food consumption by an increasing population and changing dietary preferences, the global food system faces huge problems. A major problem is how to achieve expanding food requirements and provide nutritious foods to everyone for years to arrive without exhausting Earth's resources or breaching planetary limitations, which could disturb humanity's prospects. Governments all across the globe dare to change our food management, but doing so will necessitate coherent, coordinated, and emerged action [3].

Food affects many aspects of our existence, with our health (nutrition), economy (employment), society (culture), and the environment. However, all rules that govern such fields are still formulated and executed in isolation. Government officials may share information about ongoing projects and, on occasion, create policies with joint goals. Rarely, however, will policies be emerged so that it is evident how every policy contributes to a larger goal, such achieving sustainable food processing systems. The emphasis is increasingly on approaching sustainable diets with low environmental effects and

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boosting population well-being today and in the future. All components of the food supply pattern, starting from production to processing, packaging, and the storage with final delivery of food items to consumer should be considered by the food industry to make proficient use of available resources in every stage to provide nutritious nourishment for all time growing society with numerous variations. Various preservation techniques are frequently used in food industries [4].

A variety of new farming and as well as processing methods with little negative effects on the environment can be applied in cities' controlled indoor environments. Techniques like hydroponics where plants are grown in nutrient-rich solutions aquaponics where water and fish waste are used and aeroponics where nutrient-rich water is sprayed onto roots suspended in the air are all promising. For instance, in New York and Chicago, hydroponic greenhouses on the rooftops of several buildings now produce fresh greens with reduced transit and storage distances for the local markets [5].

Smart packaging technologies like active and intelligent packaging can be used as freshness indicators by incorporating sensors, indicators, and other technologies to monitor the quality and freshness of food products. For example, some smart packaging technologies are time-temperature indicators, oxygen indicators, pH indicators, and biosensors, which signal when a food product has spoiled. An example of smart packaging is biosensors. Biosensors are increasingly being used as food freshness indicators, and offer several advantages over traditional methods such as visual inspection or date codes. Biosensors are devices that use biological materials, such as enzymes, microbes, antigens or antibodies, to detect and measure the presence of specific compounds or microorganisms. In the context of food freshness, biosensors can be designed to detect changes in the levels of gases, such as ammonia or carbon dioxide, or to detect the presence of specific microorganisms that are associated with spoilage.

One of the key advantages of biosensors is that they can detect changes in food freshness at an early stage before they become visible to the naked eye or detectable by traditional means. This can help to reduce waste and improve food safety, by allowing consumers and retailers to identify and discard spoiled food more quickly.

The proposed system is a combination of both smell and image data which leads to the absolute detection and accuracy of the food sample taken to determine its freshness level. It is a user-friendly environment, where food items taken to identify are easy to operate and use. This system can be implemented in the food industries before the packaging stage to detect spoiled food items and automatically separate them from good ones before packing. This system ensures the reach of good quality food items to the customers.

II. LITERATURE SURVEY

Y. -B. Cheng, T. Huang, H. T. Huang, Y. -J. Gong and J. Zhang, et.al [6] describes Food delivery service receives increasing attention nowadays, and path planning plays an important role in the related practical applications. To accomplish the delivery tasks in a short time, deliver staffs traverse all the customers in a short tour to guarantee the freshness of food. In addition, they also need diverse good solutions from which they can choose according to their preference. To obtain diverse good solutions, we propose a multi-population ant colony system algorithm. The ant colony system guides the ants towards a promising space, while the multi-population strategy promises to maintain multiple potential candidate

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solutions at simultaneously. To evaluate the performance of the proposed algorithm, it is applied to four test instances. The experimental results show that the proposed algorithm can obtain diverse good solutions. Furthermore, the proposed algorithm is utilized to deal with a range of practical problems, which indicates that the proposed algorithm is of practical significance.

N. Hebbar, et.al [7] aims at detecting spoiled food using appropriate sensors and monitoring gases released by the particular food item. A micro controller that senses this, issues an alert using internet of things, so that appropriate action can be taken. This has widescale application in food industries where food detection is done manually. We plan on implementing machine learning to this model so we can estimate how likely a food is going to get spoiled and in what duration, if brought from a particular vendor. This will increase competition among retailers to sell more healthy and fresh food and create a safe world for all consumers alike.

M. V. C. Caya, F. R. G. Cruz, C. M. N. Fernando, R. M. M. Lafuente, M. B. Malonzo and W. -Y. Chung,et.al [8] study focuses on monitoring freshness and determining food spoilage inside the refrigerator. The objective is to design an electronic nose system that will be sensitive to the gases emitted by spoiled food samples namely banana, pechay, carrots and grapes operating in low level temperature particularly the refrigerator and then determine food spoilage using Principal Component Analysis - K Nearest Neighbors (KNN), however, it will not take any corrective actions. The system will gather readings from MQ gas sensors and will be subjected to PCA and KNN. PCA is implemented to minimize data and for feature projection represented in form of graphs. Whereas, KNN is applied for clusters formed by the PCA transformation to classify the grouping of the food. The results from the combined approach produced an overall accuracy rate of 92%, thus, the electronic nose system is capable of sensing food gases and accurately determine spoilage inside the refrigerator.

Weimin Xiao, Weishun Bao, Yafang Jin, Lucia Lu, George Luo and Yuqiang Wu, et.al [9] describes food freshness sensing are conducted. In this study meat is selected as the detection target based on a consumer survey. Near infrared spectroscopy, pH, CO_2 , TVOC, and auto fluorescence are investigated. The results showed that CO_2 and TVOC could be a used for meat freshness sensing in a closed space such as box. Near infrared spectroscopy and auto-fluorescence have the potential for meat freshness sensing. pH alone cannot be applied to predict meat freshness directly due to the large food sample varieties.

Chang Huiyou, Li Hao and Hu Yongjun, et.al [10] detecting method based on digital image processing and BP neutral network was presented. The shape of the slaughtering fresh pork cell was oval and smooth and it will change obviously in the process of pork corruption. The edge of cell will rupture and merge together until being absolutely misshapen. Seven characteristic parameters about cell shape would be extracted to stand for the level of corruption. And designs then correspond to the pork freshness standard TVB-N and characteristic parameters finally trained by BP neural network. The experimental results showed that the characteristic parameter about cell shape could detect the freshness effectively.

L. Gil,et.al [11] development of a simple electronic system that uses simple potentiometric electrodes applied to the analysis fish freshness. The array of sensors is built by using metallic electrodes as plain sharp wires or in a thick-film configuration. Experiments on real fish led to the conclusion that gold and

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silver electrodes are suitable for the development of qualitative systems able to classify fish in relation to its freshness. Equipment based on a microprocessors programmed with fuzzy logic can be developed for in situ monitorization of fish quality.

W. Zhang, W. Zhou, H. Liu, W. Zhang and Z. Liu, et.al [12] nondestructive testing with resonance method was proposed to deciding the fresh level of eggs in this paper. Damping resonance principle was employed for distinguishing the freshness. When fresh eggs is involved vibration its amplitude attenuation ratio is smaller, however, bad eggs larger. The theory feasibility of the resonance method was discussed, the resonance device was made and the tests were conducted. The experimental results show that the resonance method can be used for estimating storage life or freshness of eggs.

M. -C. Chen, C. -L. Hsu and Y. -Y. Lee, et.al [13] investigate the issue of new service development (NSD) in an emerging market, it is deficiency in the development of home delivery service (HDS) for specialty foods in traditional market. Thus, this study takes a Taiwan's HD companies as a subject and uses quality function deployment (QFD) to develop the home delivery service model based on NSD model. In the area of voice of customer (VOC), the results reveal that e-shoppers put emphasis on the security of personal information and trading mechanism. As for HDS for specialty foods in traditional market, customers pay attention to the speed of delivery service, freshness of foods and quick responses from HD companies when any problems happen during delivery. Furthermore, in the area of voice of engineering (VOE), the main suggestions for improvement are training staff, setting up a brand, and strengthening system effectiveness and information safety.

D. Itoh, E. Koyachi, H. Suzuki, Y. Murata and M. Murata,et.al [14] described a plug-based electrochemical microdevice was fabricated for on-site determination of freshness or ageing of foods. As indicators to represent the state, the K-value or the concentration of inosine monophosphate (IMP) was used. Two sets of thin-film three-electrode systems were located in a flow channel. Mechanisms to form liquid plugs, to merge the plugs, and to place the plug on the electrode area were integrated. To obtain the K-value, total concentrations of ATP-related compounds that appear in the numerator and denominator of the equation were measured using the electrodes in the upper and lower streams, respectively. For the determination of IMP, inosine and hypoxanthine in a sample solution were removed enzymatically, and hydrogen peroxide produced in enzymatic reactions including that of alkaline phosphatase was detected. Characterization using standard solutions revealed that the values agreed well with those calculated from the known concentrations.

K. Ates, S. Ozen and H. F. Carlak ,et.al [15] described Dielectric properties of food products have been measured at the microwave frequency region. So that, whether fresh or stale product has been observed. Potato and apple were selected as food products. Second measurements for stale products have been carried out 3 days later from the first measurements. Scattering parameters (S parameters) which are used to obtain the permittivity values have been measured by vector network analyzer (VNA) device. Working frequency has been selected as 4.9-7.05 GHz. Waveguide method has been applied for measurements and permittivity values have been evaluated with Nicholson-Ross-Weir New Non-Iterative Method. Temperature and moisture have been

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determined for each material. Results showed that whether freshness or staleness of food products affect the electrical properties. Moreover, frequency, temperature and structure are major topics for determination of the permittivity values.

III. METHODOLOGY

In Fig.1 architecture of Detection of food freshness by using IoT. Initally, camera and gas sensors are used to collect the data of the food items which helps in detection. First the food sample is placed on a platform with a clear white background. To collect data at full angle we must initialise the stepper motor and capture the complete views of the food sample taken. The Camera is mounted on the stepper motor with the help of a plastic frame. When the stepper motor starts to rotate the camera starts to capture the image rotating at an angle of 10 degree each time to cover a full possible view of the given food sample.

The gas sensor is placed near the platform to detect the accurate gas level emitted by the food sample. Thus, we use the ESP32 module to receive the analog data from the gas sensor transmit. The gas level value given by ESP32 is used to determine the spoilage level of the given food sample.

The data collected from the camera and gas sensor modules are sent to the trained model that is stored in the Raspberry Pi for comparison & determination of freshness. We have used a large dataset to train an accurate model for classification and detection. The datasets collected from various sources are trained, validated, tested using ImageNet and YOLO V5 architecture algorithms. The ImageNet algorithm's main purpose is to classify the food sample based on the trained dataset. Then the YOLO V5 algorithm is used to detect the affected area in the food sample. Based on the trained dataset, this algorithm detects the affected area within a few seconds. The affected area (affected spot) is marked in a square shape with a red colour border. The data collected from the gas sensors is then analysed and processed with the help of ANN. ANN is used to predict the output based on the predefined value in each node. Based on this value, the data from the gas sensor is predicted whether it is fresh or rotten.

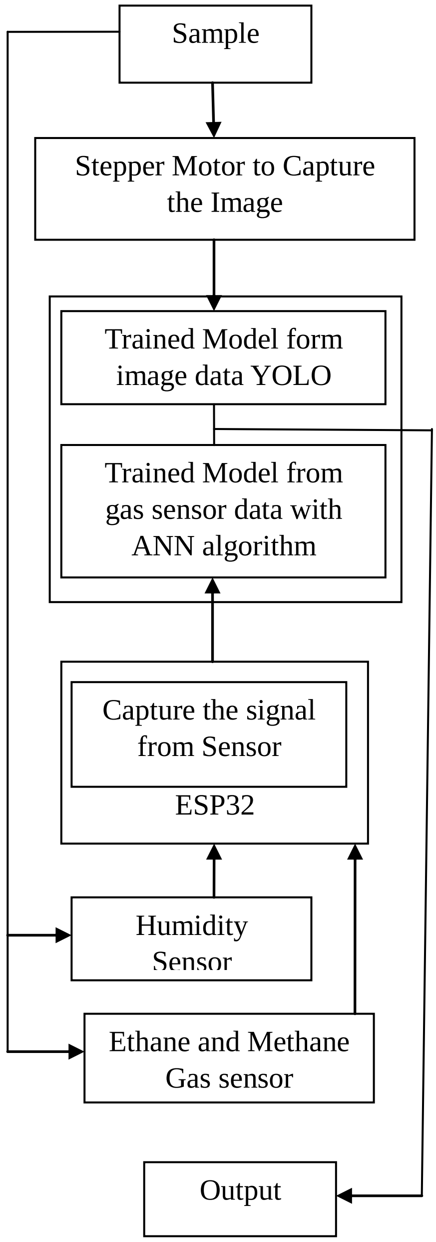

Fig.1 Architecture Of Detection Of Food Freshness By Using IoT

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IV. RESULT ANALYSIS

The performance analysis of detection of food freshness by using IoT is observed in this section.

Table.1 Performance Analysis

Parameters	KNN	NSD	YOLO
Accuracy	98	91	99.5
Precision	89.9	90.4	96.8
Recall	92.7	88.6	98.1

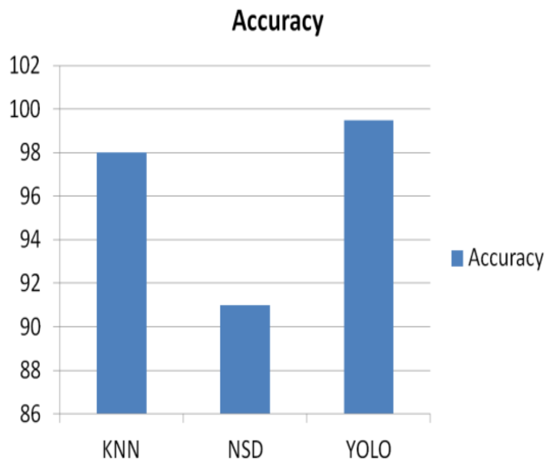

Fig.2: Accuracy Comparison Graph

Accuracy comparison graph is seen in Fig.2 between KNN, NSD and YOLO.

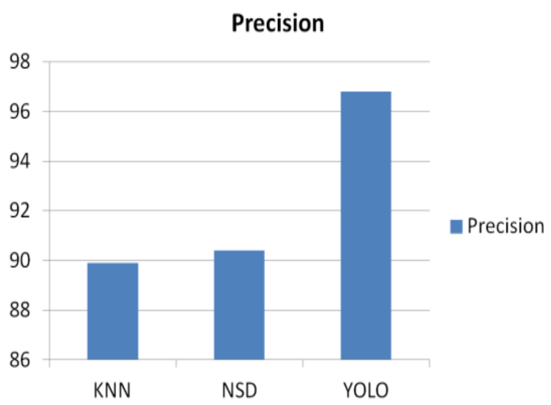

Fig.3: Precision Comparison Graph

In Fig.3 precision comparison graph is seen between KNN, NSD and YOLO.

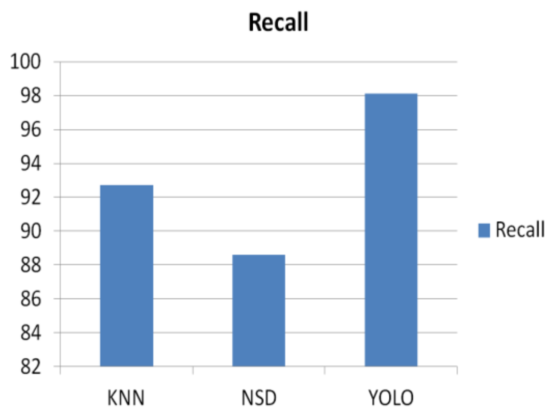

Fig.4: Recall Comparison Graph

Recall comparison graph is seen in Fig.4 between KNN, NSD and YOLO. YOLO achieves better recall.

V. CONCLUSION

The Proposed System provides a real time detection of food samples. It takes a 360-degree view of the food sample and detects the rotten spots using its image captured through camera and smell using a gas sensor. This system provides better results. This system helps food preparing centres, food packing industries and other food related companies to prove the quality of the food items they use. Being this much faster and accurate in detection of rotten or spoiled food items is the topmost advantage of our project. A large-scale implementation of this proposed system can help in delivering and consumption of fresh food items to stay healthy in this fast-moving world.

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