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Analyzing The Quality Of Fruits Using Artificial Intelligence

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***Abstract* - The Quality of fruits or vegetables plays an important part in consumer consumption and thereby affecting its deals. Grading and bracket of fruits is grounded on compliances and through gests. All the business and associations that make, display, transport or prepare food for trade they will need to check food quality. However, also it will be veritably salutary to growers as they can optimize their harvesting, if we can identify the maturity of fresh fruit. This capability will help them avoid harvesting under- progressed or over-matured fruits. The system exerts Artificial Intelligence including image- processing ways and tackle for bracket and grading the quality of fruits. Two-dimensional fruit images are classified on shape and color-grounded analysis styles. still, different fruit images have different or same color and shape values. Hence, using color or shape analysis styles are still not that important effective enough to identify and distinguish fruits images. thus, computer vision and image processing ways have been set up decreasingly useful in the food assiduity, especially for operations in quality discovery. Research in this area indicates the feasibility of using computer vision systems to ameliorate product quality, the use of computer vision for the examination of food has increased during recent times. This proposed work presents food quality discovery system. The system design considers some point that includes fruit colors and size, which increases delicacy for discovery of roots pixels. In addition of it the system uses detectors to examine fruit physical characteristics to get high grade quality.**

Keywords—*Quality of fruits, Artificial Intelligence techniques, Image Processing*

I. INTRODUCTION

From the history, India was always generally an agricultural nation. The country produces a wide variety of fruits and vegetables throughout the seasons [1][2]. In the world, India is one of the largest directors of fruits. Due to the difficulty of classifying the quality of fruit using the traditional system in the agricultural or food sedulity, the image processing fashion was developed to classify vegetables and fruits. Agriculture has always been a major sector in perfecting the Indian economy indeed in critical times due to its huge product and also consumption. Food is vital for mortal life and the safety of food has always been the concern of multitudinous healthcare covenants. Effective vegetable and fruit quality checking are vital in the present trend. In the field of husbandry, from the farmers end to the consumer end performing the manual examination is a delicate task and time taking process [1][2][3][4].

still, we must suppose about his conventional way to examine or selection process of fruit, If your target view is Indian request common consumers also first. In conventional way they will check size and shape also color of fruit and any black spots or holes on it by visually examination, also check weight of fruit by feeling it using hand and ultimately they check fruit maturity by smelling it.

In this motorized world this manual process needs to be update. we take a small step in that elevation process by introducing this system. as we mentioned in over, we can divide conventional process in three corridor. and these three corridor of process further we carried out by some AI ways. abstract block illustration shown below

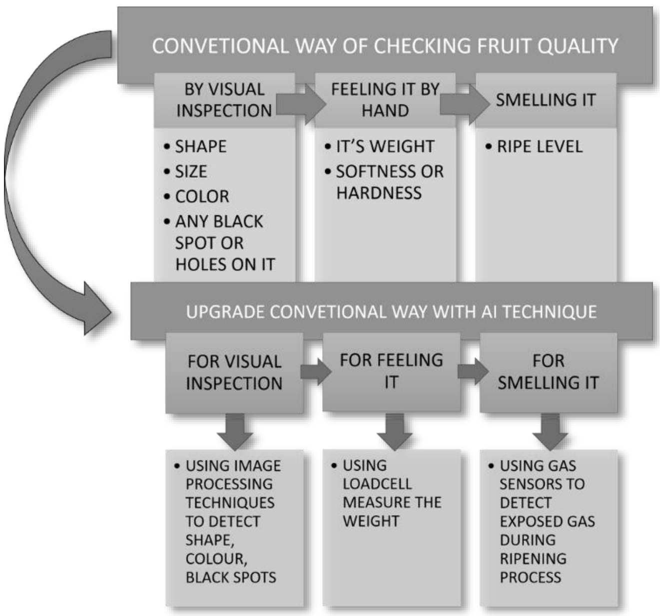

Fig. 1. conceptual block diagram

Fruit characteristics will be get examined, processed, and measured in this project. There are many issues in analyzing and identifying the fruit characteristics from various type of fruits at a same time. As a result, we designed system prototype for only single fruit that is apple.

The quality checking processed is goes through three stages similar to that old conventional ways but using AI techniques some methodologies which help us during our work are described in part II of this study, organized as follows. Section III explains the planned AI system for selecting fruit of high grade. Section IV Hardware implementation, Section V future scope and section VI concluded our project.

II. LITERATURE SURVEY

To find out good quality fruit in upgrade conventional AI ways we relate Real- time quality assurance of fruits and vegetables with Artificial Intelligence by Jagannadha Swamy Tata [1]. This proposed system will use image processing to classify and grade the quality of fruits and vegetables by rooting features similar as colour, shape, and overeater (Histogram of Gradient) to classify the given fruit or vegetable. Imagepre-processing ways like data- addition and normalization along with Principle- Component Analysis (PCA), and Deep literacy (CNN) are used for getting good delicacy and for dimensional reduction.

To identify visual examination, we relate machine literacy approach towards the quality assessment of fresh fruits using Non-invasive seeing. Fruit quality evaluation using machine literacy ways review, provocation, and unborn perspectives. This paper is written by Bhumica Dhiman & Yogesh Kumar & Munish Kumar [2]. The colorful kinds of features, videlicet, shape, size, color, or texture are uprooted, and for bracket, different machine literacy styles are applied similar as k- nearest neighbors, support vector machine, neural network, etc. In this composition, a comparison of different ways has been carried out that are put forward by experimenters for fruit quality discovery. the application of well- organized machine literacy models not only recognizes the conditions in their early stages but also categorizes them consequently. The main purpose of the paper is to punctuate the exploration that has been done in the field of fruit quality discovery using colorful machine and deep literacy ways.

"Non-invasive agreeableness bracket for citrus maxes" This paper is written by CherylV. Quinola, JetronJ. Adtoon, JayssaN. Lapitan, Maybell HopeS. Pelletero & Noel B [3]. Linsangan, according to a study, ripe fruit produces ethylene(C_2H_4) gas associate with fruit growing position. The odor comes from motes in the air that stimulate receptors in the nose. The senses of smell and taste are directly related because they use the same type of receptors. Since the senses of smell and taste are related to each other in this study the experimenter used the pomelo's smell or gas for the bracket of agreeableness. In this case, the experimenters produce an automated system that will classify the pomelo agreeableness innon-invasive procedure throughE-nose

"Design of an automatic apple sorting system using machine vision", Written byM.M. Sofu,O. Er,M.C. Kayacan,B. Cetisli [4]. It says that the weight of apples is a veritably important point used to classify apples. The weight demonstrates the apple's anecdotage. In utmost sorting machines, the weight of apples is measured with cargo cell detectors. We also measured the apple weights using two cargo cell detectors in a real- time operation. still, in this study, we also estimated the weight of apples from the image area using Least Places Estimation (LSE). We also studied estimation of apple weight using a alternate order polynomial using only the area of apple. We estimated the apple weights to within 5 – 6-gram error rates. This result is sufficient, but the rate between the weight and area changes according to the apple cultivar, apple life and apple- keeping conditions. For those reasons, using the cargo cell rather of estimation is more suitable to determine the apple weight. Experimental studies showed that while the imperfect region discovery is veritably easy for Golden Delicious and Granny Smith apple cultivars, it's veritably hard for Starking Delicious, due to dark and light colour shells. The weight is a veritably important point for all apple cultivars. For that reason, the traditional sorting systems generally sort apples using only the weight point. III.

III. PROPOSED SYSTEM

Along with Image processing software operations, some tackle like Cameras, Sensors, and Selectors are important factors in AI as well as in several operations like point birth, object discovery, and object bracket. Illustrated below is an overview of the procedure proposed in this study, which can also be applied in the discovery and bracket of other kinds of fruits that will concentrate on the process of image processing and improvement. The fruit used in this study is Apple. The proposed system illustration is shown in Figure 2.

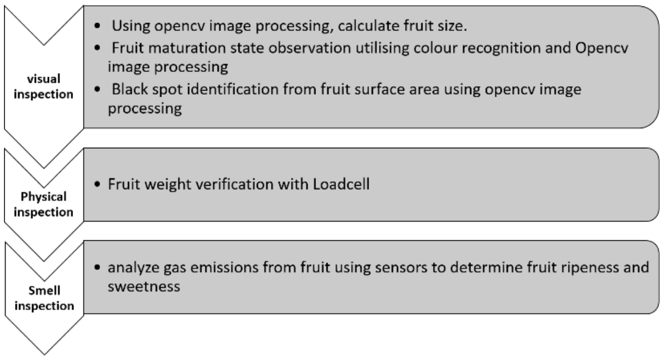

Fig. 2. Overall system flow diagram

We'll employ heat and gas detector sensors, which assist us to determine when the fruit is ripe, in this system. In order to analyze fruit surfaces from every angle, we are implementing a stepper motor mechanism in this system. The Raspberry Pi functions as a computer and is connected to sensors, a camera, and a stepper motor in order to collect various input data and carry out operations based on it. The Raspberry Pi gathers all input data, which is then processed and analyzed using a Python program. The method of processing and analyzing the input data is described below in accordance with the flow diagram in Fig 2.

A. *Visual inspection* [13]

We photograph the fruit for visual assessment using a camera. We suggested a stepper motor system to rotate the fruit in order to bring its complete surface area inside the camera's capture area because the camera's steady position only allows it to capture 30% of the fruit's total surface area. A Python software is used to regulate stepper motor steps, giving rotation of 90 degrees. The motor comes to a complete stop and the camera records an image of the surface after each 90-degree revolution. This produced four photos with angles of 0°, 90°, 180°, and 270°. We may examine 360°, or the target fruit's entire surface, in those 4 photos.

Firstly, through the application of image processing techniques, we are able to classify the maturity of the fruit into three stages. Using Python's OpenCV library, the target fruit photographs are evaluated, and the images are processed to separate the three-color channels. Based on the RGB color values in the image, we determine the maturity stage of the fruit. This automated analysis eliminates the subjectivity and variability associated with manual visual inspection, providing a more objective assessment of fruit ripeness.

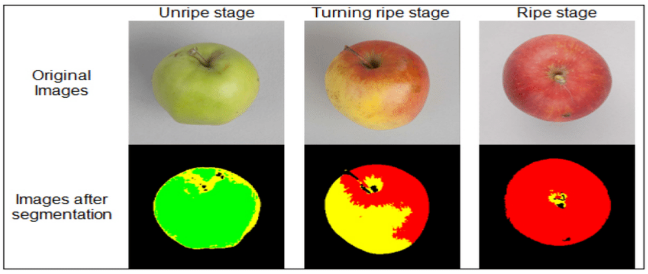

Fig. 3. Classification of the fruit into three stages on the basis of the maturity

Secondly, we utilize OpenCV image processing techniques to perform threshold value analysis. By implementing filters and comparing pixel values to a selected threshold, we are able to generate mask images where intact areas are represented as white and damaged areas as black. This approach allows us to identify defective apples by analyzing color photographs of the target fruit. By quantifying the total number of black pixels in the mask image, we can determine the extent of skin defects and assess the quality of the fruit. This analysis enables us to separate damaged or poor-quality fruit from intact and high-quality fruit, aiding in quality control efforts.

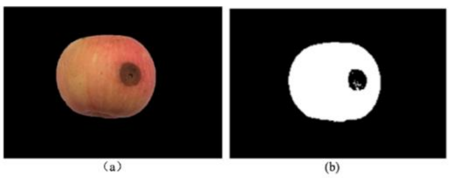

Fig. 4. (a) original image of damaged skin apple (b) mask image of damaged skin apple

Lastly, we incorporate the measurement of the apple's contour from the photographs to further enhance the analysis process. Using OpenCV image processing techniques, we can detect the contours of the target fruits, specifically apples. By accurately identifying the apple contour against a white background within an enclosed box, we can extract information about the apple's height and width. This data, combined with the consideration of size and weight ratios, allows us to establish meaningful correlations and patterns that would be difficult to perceive through manual inspection alone. By leveraging AI-based image processing analysis, our aim is to streamline and optimize the fruit inspection process, reducing human error and ensuring consistent and reliable assessments.

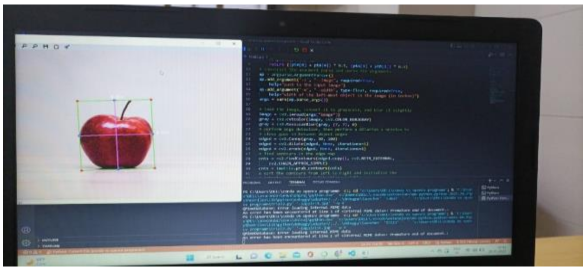

Fig. 5. Fruit size mesurements using image processing

Through the integration of these three types of analysis – maturity classification, threshold value analysis, and contour measurement – we are able to replace labor-intensive and subjective manual visual inspection with a more objective, efficient, and accurate computerized system. This automated AI-based image processing analysis offers significant benefits, including improved productivity, enhanced quality control, and standardized assessment of fruit quality in the industry."

B. Physical inspection [7]

In the conventional way of physically inspecting fruit, weight plays a crucial role. By taking the fruit in hand and assessing its. However, solely relying on weight for analysis may not provide an accurate comparison, especially when considering the size of the fruit.

Small-sized fruits tend to be lighter in weight, while larger-sized fruits are typically heavier. Comparing the weight of a small apple to that of a larger apple and deeming the smaller one unhealthy solely based on its lighter weight would not be an accurate assessment. To overcome this limitation, we need to consider the ratio of size and weight to determine the healthiness of the fruit.

To incorporate this aspect into our inspection system, we use a load cell with an HX711 converter. The load cell is connected to the Raspberry Pi (RPI) computer through the SPI protocol. The load cell, with a capacity of 5 kg, is integrated into the system. It is calibrated using a known weight, such as a plate or the dead weight of the stepper motor.

By combining the measured size of the fruit and the actual weight obtained from the load cell, we can calculate the ratio of size and more accurate assessments of fruit quality, enhancing the overall effectiveness of our inspection system.

In summary, the physical inspection of fruit involves utilizing a load cell and HX711 converter connected to the Raspberry Pi to measure the actual weight of the fruit. By combining this weight measurement with the size of the fruit, we calculate the ratio of size and weight, which provides valuable insights into the fruit's quality and healthiness.

C. Smell inspection

In the final stage of the fruit assessment process, our system incorporates the sense of smell to determine the fruit's anecdotage. In the conventional way, we calculate on our sense of smell to descry whether a fruit has a sweet aroma, indicating its anecdotage and overall quality. To achieve this electronically, we use gas detectors to descry the feasts faded from the fruit, which can vary in composition and quantum depending on the growing stage.

One of the gas detectors used in our system is the Mics 5524multi-gas detector, which operates grounded on the Metal Oxide Semiconductor (MOS) fashion. MOS detectors use the resistivity of essence composites to measure the gas attention in the air. The detector consists of an essence strip or film that is exposed to the target gas. An electric current run through the strip, and as the gas comes into contact with the essence, it undergoes chemical responses that alter the resistivity of the essence. By analysing the changes in resistance, we can determine the attention of the target gas. Different essence used in the detector will reply to different feasts.

The Mics 5524 detector can descry colorful feasts, including ignitable feasts. Although it is not a devoted ethylene detector, which is the primary gas released during the fruit growing process, we can still use it to descry completely ripe fruits. As the fruit matures, it releases adding quantities of ethylene gas, and the detector can descry the elevated situations. This detector was chosen due to its affordability, as devoted ethylene detectors are precious and not suitable for our target consumers.

The alternate detector used in the system is the Winsen MH Z19b NDIR CO2 detector. It utilizes theNon-Dispersive Infrared (NDIR) fashion. When infrared radiation interacts with gas motes, the gas motes absorb the infrared light at a specific wavelength, causing vibration. NDIR detectors descry the drop in transmitted infrared light, which is commensurable to the gas attention. In our case, the detector detects the attention of carbon dioxide (CO_2), which is another by- product of the fruit growing process. By covering the CO_2 situations under the box where the fruit is placed, we can estimate the stage of anecdotage. Both detectors employ different ways to assay the feasts emitted by the fruit.However, it serves as a confirmation of the final result, If either detector reading aligns with the outgrowth of the visual examination. The system collects the results from all three examination styles visual examination, physical examination (including size and weight rate), and smell examination.

Using a Python- grounded AI model, the system generates the final assessment of whether the fruit is healthy or unhealthy for the consumer. The assessment results are displayed on an OLED display located on the system's body, which also shows a progress bar to indicate the assessment process's duration. This way, the client can track how important time the system takes to assess a single fruit.

IV. HARDWARE IMPLEMENTATION

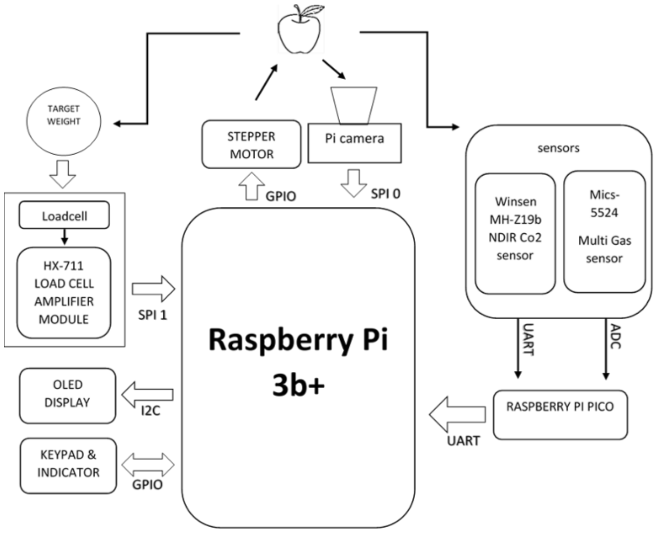

Fig. 6. Hardware setup

In above figure described a hardware setup for a system where a Raspberry Pi 3B+ is used as the main computer, and a Raspberry Pi Pico is used as a slave computer. Various peripherals are connected to this system, and communication between the peripherals and the main computer is facilitated through specific protocols.

The system includes the following components:

1. Raspberry Pi 3B+: This serves as the main computer in the setup.
2. Raspberry Pi Pico: This acts as a slave computer and communicates with the main computer.
3. Load Cell and HX-711 Load Cell Amplifier Module: The load cell is connected to the HX-711 load cell amplifier module, which communicates with the Raspberry Pi 3B+. This setup allows for the measurement of weight or force.
4. Pi Camera: A Pi Camera is used to capture images.
5. Stepper Motor: A stepper motor is employed to rotate the target fruit or object.
6. OLED Display: An OLED display is used to show the progress of the assessment process and convey system messages to the user.
7. Keypad: The keypad consists of three keys, with two used for starting and stopping the process and the third key kept for future use. The keypad provides inputs to the Raspberry Pi 3B+.
8. Indicators: There are three indicators in the system. One indicator blink to show that the process is running, while the other two indicate the final results, either a healthy or unhealthy apple. A green indicator lights up for a healthy outcome, while a red indicator lights up for an unhealthy outcome.
9. Winsen MH Z19b NDIR Sensor: This sensor communicates with the Raspberry Pi Pico board, which then transfers the sensor data, after processing, to the Raspberry Pi 3B+. This sensor is used to measure specific gases, such as carbon dioxide (CO_2).

10. Mics 5524 MOS multi Gas sensor: this sensor communicates with the Raspberry Pi Pico board on ADC channel, which then transfers the sensor data, after processing, to the Raspberry Pi 3B+. This sensor is used to measure multiple gases, but in this system, it uses for ethylene gas (C_2H_4).

To facilitate data acquisition from sensors that require analog-to-digital conversion (ADC), the Raspberry Pi Pico board's built-in ADC is utilized, as the Raspberry Pi 3B+ does not have an ADC on board. The Raspberry Pi Pico reads sensor data using MicroPython and provides the essential summarized data to the Raspberry Pi 3B+. The communication between the Raspberry Pi 3B+ and the Raspberry Pi Pico is done through a UART interface.

Overall, this setup enables the Raspberry Pi 3B+ to receive data from various sensors and peripherals through the Raspberry Pi Pico, process the data, and control the system components accordingly.

V. RESULT AND DISCUSSION

In this section of the paper we discuss the different test cases that are performed on implementation of fruit quality detection using AI techniques. The results show the success rates of the basic three types of fruit ripening stages on which we work. To determine the success rate, we test each type of fruit for certain number of times. Each time different types of an Apple fruit are given to analyze by the same system. For example, if the user is offer unhealthy fruit like unripe or overripe to system for analyzing then the system should give the same and expected results, that is, detected that fruit as unhealthy. This success rate is presented in the paper with the help of a graph where the X-axis depicts the no. of tests dataset and the Y-axis depicts the percentage of success received after testing for certain number of times.

If we discuss about the graph of success rate we can clearly observe that unripe and overripe fruit detection rate is Gretter than ripe fruit detection graph. In short, we say that we successfully achieved our system goal that is unhealthy fruit detection.

As we discussed earlier system has some limitations due to economical aspect. We get result or success rate from 75 to 90 %. If we overcome economical aspect and used more sensitive, dedicated relatively costly sensors as well as include internal flow detection then our success rate definitely will rise above 90 to 95%.

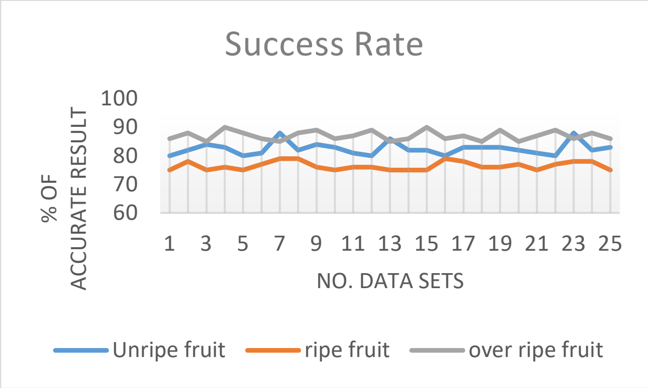

Fig. 7. Graphical representation of system success rate

VI. FUTURE SCOPE

Our system represents a preliminary step towards the advancement of conventional fruit quality assessment methods to AI-based computerized assessment methods. While developing the system, we encountered certain limitations due to economic constraints, which prevented us from incorporating certain desired features.

One limitation is that instead of using a dedicated ethylene gas sensor, we utilized multiple gas sensors. Although this approach enhances the assessment capabilities of the system, it falls short of the desired level of accuracy. Additionally, our system focuses solely on analyzing the surface area of the fruit and does not provide insights into its internal composition. To address this, techniques such as x-ray examination or ultrasonic examination could be explored to detect internal flaws within the fruit.

To achieve a 90% accurate outcome, we attempted to incorporate thermal imaging techniques. We believed that this approach could offer an economically viable solution for detecting internal flaws. However, due to the limitations of available affordable sensors, we were unable to obtain satisfactory results. Consequently, we made the decision to exclude thermal imaging from our system.

Maintaining a consistent temperature within the portable box holding the fruit could greatly improve the accuracy of sensor readings. This is because the accuracy of gas detection sensors and the release of ethylene gas are influenced by temperature variations.

In summary, our system has certain boundaries and limitations, but it serves as a stepping stone towards the integration of AI-based computerized fruit quality assessment methods. Future advancements and considerations, such as dedicated ethylene gas sensors, techniques for internal flaw detection, and temperature control, could further enhance the accuracy and capabilities of the system.

VII. CONCLUSION

In the traditional system of classifying and grading fruit or vegetable, there is a lot of mortal energy and time involved. By using the proposed system, we can reduce mortal sweats and time consumption. The delicacy and effectiveness of the system are innovated on two aspects which are point birth algorithms and the database used. With the help of Artificial Intelligence, the prosecution speed is further increased. The introductory end of this design is to grade the fruit or vegetable so that growers can get added value for the products and the guests can get high quality and healthy products in requests. The proposed system can be installed in a tackle device and run. which will be helpful in fast processing and in gaining advanced delicacy.

VIII. REFERENCES

[1]. Real- Time Quality Assurance of Fruits and Vegetables with Artificial Intelligence Jagannadha Swamy Tata, Naga Karthik Varma Kalidindi, Hitesh Katherapaka, Sharath Kumar Julakal, Mohan Banothu 2022.

[2]. Fruit quality evaluation using machine literacy ways review, provocation and unborn perspectives Bhumica Dhiman1 & Yogesh Kumar 1 & Munish Kumar 2 2021.

[3]. Non-invasive agreeableness bracket for citrus maxes" This paper is written by CherylV. Quinola, JetronJ. Adtoon, JayssaN. Lapitan, Maybell HopeS. Pelletero & Noel B

[4]. Design of an automatic apple sorting system using machine vision", Written byM.M. Sofu,O. Er,M.C. Kayacan,B. Cetisli

[5]. P. Pathmanaban,B.K. Gnanavel, andS.S. Anandan, " Recent operation of imaging ways for fruit quality assessment, " Trends in Food Science and Technology,vol. 94.pp. 32 – 42, 2019.

[6]. Seema,A. Kumar, andG.S. Gill, " Automatic Fruit Grading and Bracket System Using Computer Vision A Review, " 2015 Second International Conference on Advances in Computing and Communication Engineering, 2015,pp. 598- 603, DOI10.1109/ICACCE.2015.15.

[7]. Nandhini. P,Dr.J. Jaya, " Image Segmentation for Food Quality Evaluation Using Computer Vision System ", Nandhini. P et al Int. Journal of Engineering Researchwww.ijera.com ISSN 2248- 9622, Vol. 4, Issue 2(Version 5), February 2014, pp.01- 03.

[8]. N.M.Z. Hashim,N.H. Mohamad,Z. Zakaria,H. Bakri,F. Sakaguchi, " Development of Tomato Inspection and Grading System using Image Processing ", International Journal of Engineering And Computer Science Volume 2 Issue 8 August 2013.

[9]. Wang, Haoxiang." Design of a Food Recommendation System using ADNet algorithm on a Hybrid Data Mining Process." Journal Journal of Soft Computing Paradigm December 2022,

[10]. P. Pathmanaban,B.K. Gnanavel, andS.S. Anandan, " Recent operation of imaging ways for fruit quality assessment, " Trends in Food Science and Technology,vol. 94.pp. 32 – 42, 2019.

[11]. Seema,A. Kumar, andG.S. Gill, " Automatic Fruit Grading and Bracket System Using Computer Vision A Review, " 2015 Second International Conference on Advances in Computing and Communication Engineering, 2015,pp. 598- 603, DOI10.1109/ICACCE.2015.15.

[12]. Nandhini. P,Dr.J. Jaya, " Image Segmentation for Food Quality Evaluation Using Computer Vision System ", Nandhini. P et al Int. Journal of Engineering Researchwww.ijera.com ISSN 2248- 9622, Vol. 4, Issue 2(Version 5), February 2014,pp.01- 03.

[13]. N.M.Z. Hashim,N.H. Mohamad,Z. Zakaria,H. Bakri,F. Sakaguchi, " Development of Tomato Inspection and Grading System using Image Processing ", International Journal of Engineering And Computer Science Volume 2 Issue 8 August 2013.

[14]. Wang, Haoxiang." Design of a Food Recommendation System using ADNet algorithm on a Hybrid Data Mining Process." Journal Journal of Soft Computing Paradigm December 2022,