AUTONOMOUS FRUIT SORTING

[1]Vishal S. Jangale, [2]Rakesh B. Hande, [3]Tejas A. Kamble, [4]Waqaar I. Khatri, [5]Fr. Fabian Barreto

[1]Student, [2]Student, [3]Student, [4]Student, [5]Asst. Professor

[1]Department of Electronics and Telecommunication
[1]Xavier Institute of Engineering, Mahim, Mumbai.

Abstract : An autonomous system that can be used for automatic high-speed sorting is proposed. In this paper, we are using this system for sorting and picking fruits for ensuring faster production chain. The proposed approach takes into account different types of fruits. The main goal is to come up with a method for classifying these different types of fruits accurately and efficiently. We use Raspberry Pi, which is an open source Linux based board with OpenCV and Python for processing. Furthermore, we make use of camera module which captures the image of the object. Here we use different object detection modules provided in OpenCV, Google's object detection API and Tensor Flow libraries to detect fruits and sort respectively.

IndexTerms **- Raspberry Pi, Fruit Sorting, Open CV, Tensor Flow, Object Detection API, Python, .**

I. INTRODUCTION

Technological advancements especially in Computer vision technology, are gradually finding its applications in the field of agriculture and food, as an answer to one of the biggest challenge facing humankind, namely, sufficing the food requirements of the increasing population. Efforts are being initiated towards the replacement of human operator or human beings looking after the plants and providing and taking care of necessities of plants with automated systems, as human operations are time consuming and are inconsistent.

Autonomous system perform every action which is required to control a process at utmost efficiency using instructions that have been programmed into it or as a response to some activities. Autonomous systems in most cases are faster, durable and more accurate. However, there are some basic architectures which necessarily go hand in hand with automation. Computer vision is a comparatively young discipline with its origin traced back to the 1960s. Computer vision is an interdisciplinary field that deals with how computers can be made to gain high-level understanding from digital images or videos. From the perspective of engineering, it seeks to automate tasks that the human visual system can do. Computer vision is concerned with the automatic extraction, analysis and understanding of useful information from a single image or a sequence of images. It involves the development of a theoretical and algorithmic basis to achieve automatic visual understanding. As a scientific discipline, computer vision is concerned with the theory behind artificial systems that extract information from images. The image data can take many forms, such as video sequences, views from multiple cameras, or multi-dimensional data from a medical scanner. As a technological discipline, computer vision seeks to apply its theories and models for the construction of computer vision systems.

Computer vision is different from the prevalent field of digital image processing. It works to extract three-dimensional structure from images with the goal of achieving full scene understanding. Studies in the 1970s formed the early foundations for many of the computer vision algorithms that exist today, including extraction of edges from images, labeling of lines, non-polyhedral and polyhedral modeling and representation of objects as interconnections of smaller structures, optical flow, and motion estimation.

Computer vision systems are being used increasingly in the food and agricultural areas for quality inspection and evaluation purposes as they provide suitably rapid, economic, consistent and objective assessment. They have proved to be successful for the objective measurement and assessment of several agricultural products. Over the past decade advances in hardware and software for digital image processing have motivated several studies on the development of these systems to evaluate the quality of diverse and processed foods. The majority of these studies focused on the application of computer vision to product quality inspection and grading. Traditionally, quality inspection of agricultural and food products has been performed by human graders. However, in most cases these manual inspections are time- consuming and labor-intensive. Moreover the accuracy of the tests cannot be guaranteed. By contrast it has been found that computer vision inspection of food products, was more consistent, efficient and cost effective. Also, with the advantages of superior speed and accuracy, computer vision has attracted a significant amount of research aimed at replacing human inspection. Recent research has highlighted the possible application of vision systems in other areas of agriculture, including the analysis of animal behavior, applications in the implementation of precision farming and machine guidance, forestry and plant feature measurement and growth analysis.

II. OBJECTIVE

The main objective of the project is to detect a fruit, necessarily to distinguish between an Apple and a Banana. The computer program will capture the image from the camera and the image will be processed using image processing of computer vision technology and machine learning , based on a program, after which the computer will decide whether the object placed is a banana or an apple then robotic arm will pick the fruit and place it in the assigned position.

III. PROBLEM STATEMENT

In agricultural sector the efficiency and the accurate grading process is very essential to increase the productivity of produce. Everyday high-quality fruits are exported to other countries and generate a good income. That is why the grading process of the fruit is important to improve the quality of fruits. However, fruit grading by humans in agricultural industry is not sufficient, requires large number of labors and causes human errors. Automatic grading system not only speeds up the process but also gives accurate results. Therefore, there is a need for an efficient fruits grading or classification methods to be developed. Fruit's color, size, weight,

component texture, ripeness are important features for accurate classification and sorting of fruits such as orange's, apple's, mango's etc. Objective of this paper is to emphasize on recent work reported on an automatic fruit quality detection system.

IV. BLOCK DIAGRAM

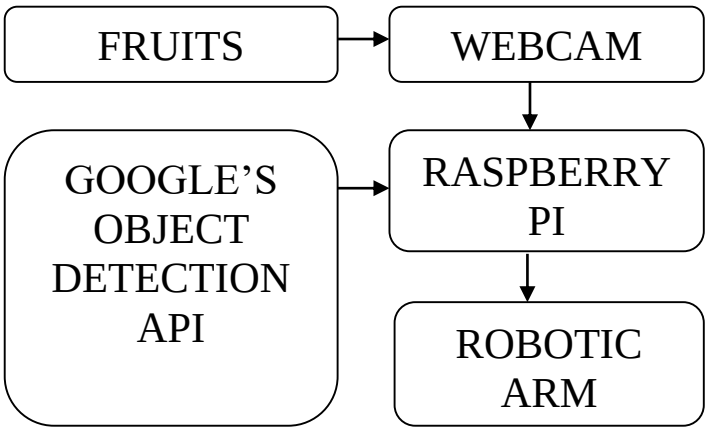

Figure 1 Block Diagram

V. LITERATURE REVIEW

5.1 Multiple Fruit and Vegetable Sorting System Using Machine Vision.

The image captured is through a mobile camera of 3.2 megapixels with an Android application „Ip webcam" for transferring the image from the captured image to the processing software MATLAB. The algorithm was developed in MATLAB with the software designed functions. To physically represent the system an Arduino microcontroller equipped with sensors and relays are used to show how the system is designed to work practically. There are three color models used for this sorting system viz. RGB, L*a*b, HSV. In RGB color model The image transferred into MATLAB is in the form of Red, Green and Blue (RGB) color model. This model uses the combination all the three components for creating a color. The segmentation using this particular model is less efficient as lighting, reflection and other factors disrupt the different and hence consistent segmentation cannot be achieved. Now using L*a*b This color model has three components the luminescence (L) and two chromaticity index 'a' and 'b' respectively. The luminescence is used to determine the whether the image is dark or light in color. Higher the value of luminescence the brighter the image and lower the value the darker the image. The pure color of the image is determined using the two chromaticity features 'a' and 'b'. For segmentation purpose using K-Means clustering is done in this color model. K-Means clustering is an in-built function in MATLAB. The image processed is in the L*a*b* color model. The image is segmented into three clusters. The first cluster to be formed is the blue color region. Hence for ease of segmentation a blue coin is used. The blue coin is used for size measurement purpose. The pixels occupied by the blue coin are used to determine the size of the fruit or vegetable as the position of the camera is not constant. Hence by knowing the size of the blue coin physically, a relationship with the pixel and a size measuring unit can be determined. Different background had little effect on the segmentation of the image. The different background conditions not only refer to the background color but also to the variation in lighting. Various fruits and vegetables were successfully segmented. The image only represents only few of the fruits and vegetables. The segmented image is converted to HSV color model for further color extraction. The HSV color model consists of three features the Hue (H), Saturation (S) and Value (V) to represent an image. The hue component is used for representing the pure color usually varying from 0 to 360 with each value representing a color. The saturation component determines the white pigments in the color and the value component determines the brightness of the image. This color model can be used to determine the pure color with a single component. Hence for fruit and vegetable color identification the image is converted to HSV color model.

5.2 Orange Sorting by Applying Pattern Recognition on Color Image.

This paper includes the research that was done on determining the maturity of oranges on the basis of image processing in "Vidarbha" region of Maharashtra, India. This research is carried out with an aim to design a pattern recognition based automated Orange sorting software. System designed can automatically classify an Orange fruit based on its maturity, given its single color image of 640 × 480 pixel resolution taken inside a special box designed. Only 4 features are used to classify oranges into four different classes according to maturity level and it can also predict the size of the fruit. In this research two novel techniques based on Pattern Recognition are proposed – Edited Multi Seed Nearest Neighbor Technique and Linear Regression based technique; although Nearest Neighbor Prototype technique is also deployed. Linear Regression based technique can explicitly predict the maturity of the unknown orange fruit, enabling classification into multiple classes with desired lifespan. The software developed can further be embedded in an automated machine, like the one designed for the grading of mangoes. Pattern Recognition used involved three steps Data acquisition and pre-processing in which the data from the surrounding environment is taken as an input and given to the pattern recognition system. The raw data is then pre-processed by either removing noise from the data or extracting pattern of interest from the background so as to make the input readable by the system. Feature extraction in which the relevant features from the processed data are extracted. These relevant features collectively form entity of object to be recognized or classified. Decision making in which the desired operation of classification or recognition is done upon the descriptor of extracted features.

5.3 Automatic Sorting Using Computer Vision & Image Processing For Improving Apple Quality.

This paper presents the recent developments of image processing and machine. This paper presents the image processing techniques for feature extraction and classification for fruit quality measurement system. Vision system in an automated fruit quality measurement system The system includes the capturing, processing, analysing& sorting images, facilitating the objective and non-destructive assessment of visual quality characteristics in fruit products. First camera capture the image of apple then captured apple image send to computer for the purpose of analyzing using MATLAB. Using MATLAB calculate area & size of that captured apple image. The captured apple image can be compare with stored database and if match with database it will be selected for further process and sort the apples grade wise (Grade A or Grade B or Grade C) otherwise it will not selected. Amongst all these steps sorting and grading are major processing tasks associated for preserving the quality of fresh-market stuff. Sorting of agricultural products is done based on appearance of fruits. Whereas grading is done based on the overall quality features of a fruits, by considering a number of attributes like shape, size, color etc. Classification is necessary for the quality evaluation of agricultural produce like fruits and vegetables. Fresh market fruits like apples, oranges, bananas are graded into categories based on several factors such as color, shape, size and presence defects or bruises, blemishes on it.

5.4 Automatic Sorting Using Computer Vision.

This paper presents a object sorting system solution based on color with the application of image processing. In many packaging industries, color object counting and sorting is the major task that needs to be done. Traditionally, the object sorting process was done by the manually. However, this method has some disadvantages such as increase in the cost of the product, slow, and inaccuracy due to the human mistake. Existing sorting methods are used to set of inductive, capacitive and optical sensors do industry differentiate color. MATLAB is used in system for detecting the color of the object. Microcontroller is the central processing unit, used to control all the functions of other blocks in this robot system. MATLAB using camera is start detecting that particular color object. Microcontroller takes or read data from color from MATLAB software and controls all the other functions of the system by manipulating these data. Microcontroller control the motor on the robotic arm to pick a particular color object, as per the signal from image processing microcontroller can understand the color of the object, it control the arm motor to move towards the specified location, again control the gripper motor to release the object into that particular location.

5.5 Object Sorting Robot Using Image Processing.

This Paper is about the design and development of an autonomous ball picking robot. It aimed to improve the capabilities of a pre-existing 6-Axis robot. Image Processing was done using two cameras and an external computer. One camera finds the location and also determines the color, while other camera is used for feedback control of the robotic arm. Robotic sorting arm system which could sort objects based on its colour was presented in this paper. Object position is determined by calculating the object mass centre in image. Using Inverse Kinematics algorithm, the control input for the robotic arm is calculated and then sent to an Arduino microcontroller. This sorting system can be made to operate faster by using a more powerful microcontroller. More complex image processing can be done to identify objects of multiple colours and multiple shapes. It gives an easy and less expensive way to implement an object sorting system. In this project, Robotic arm, Microntroller, webcam, geared DC motors, Image Processing was used, to implement the system.

5.6 Automation of Object Sorting System Using Pick & Place Robotic Arm & Image Processing.

The paper presents a smart approach for a real time inspection and selection of objects in continuous flow. The Project deals with an automated material handling system. It aims in classifying the colored objects by colour, size, which are coming on the conveyor by picking and placing the objects in its respective pre-programmed place. The project involves sensors that senses the object's colour, size and sends the signal to the microcontroller. The microcontroller sends signal to circuit which drives the various motors of the robotic arm to grip the object and place it in the specified location. Based upon the detection, the robotic arm moves to the specified location, releases the object and comes back to the original position. he basic theme of this project is object flowing on conveyor are sensed, selected and sorted depending on their colour and size. For this, camera is used as input sensor, camera is overhead camera which will be mounted on PC, and will be connected to PC by USB. The camera will take a snap and it will feed to PC for color processing. In PC MATLAB is used for processing on colour, depending on this signal will be given to microcontroller Atmega 328. The microcontroller the microcontroller used here is with the support of Arduino kit. There are two main steps in sensing part, objects detection and recognition. This was a cost-effective Mechatronics system designed using the simplest concept.

5.7 Low cost object sorting robotic arm using Raspberry Pi.

In this paper raspberry pi was used with Arduino and Raspberry Pi was used with Arduino, Raspberry Pi captured the image with Pycam and processed it with the help of python and OpenCV, OpenCV was mainly used for image processing purpose. Python script was developed in such a way that the object can be classified on the biases of three different shapes and colors, i.e. Square, Circle and Triangle (As seen from the Top-View of a Cube, Sphere/Cylinder and Triangular Prism aligned vertically) and RGB colors i.e. Red, Blue and Green respectively. The object was detected and IR sensor was used to calculate the distance of object by raspberry pi and all the information regarding the position of the object was end to Arduino serially the Arduino was used to move the arm in pre-defined position.

5.8 Robotics and Computer Integrated manufacturing.

This paper mainly focuses on the way to effectively use a robotic arm. In this the platform is centered on a 6 Degree of Freedom (DOF) serial robotic arm and the proposed framework combines robot modeling and control and image-processing to perform desired operations. In a typical application, once a user's command is encountered, the whole workspace is scanned and corresponding images are captured. These images are processed to identify target object(s) and their coordinates. The acquired coordinates are then passed to the developed IK model to compute the joint angles required to reach the target position and orientation. Provided the computed angles fall in Range of Motion (ROM) of the arm joints, they are mapped to low-level encoder ticks to execute the user command.

VI. Expected Outcome

Using Tensor flows deep learning object detection Algorithm and OpenCV for image processing the algorithm would be able to differentiate between two different fruits.

VII. Acknowledgment

This our privilege to express our sincerest regards to our project coordinator, Fr. Fabian Barreto, for her valuable inputs, able guidance, encouragement, wholehearted cooperation and constructive criticism throughout the duration of our project. We deeply express our sincere thanks to our Head of Department Dr Prof. Suprava Patnaik for encouraging and allowing us to present the project on the topic —Autonomous Fruit Sorting at our department premises.

We take this opportunity to thank all our lecturers who have directly or indirectly helped our project. We pay our respects and love to our parents and all other family members and friends for their love and encouragement throughout our career. Last but not the least we express our thanks to our friends for their cooperation and support.

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