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Fruit Sorting Robotic Arm Based on Image Processing

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Abstract: ***This paper present the smart approach of sorting the fruit. This food sorting system is based on image processing and it gives us various information like color, shape, size, defect, etc of fruit. In today's world image processing grabs exceptionally large attention it possibilities of widen application in many field of higher technology. The system consist of one digital USB camera, personal computer, PIC micro-controller, DC motor. The samples of different fruits are situated in front of camera and are calibrated off line and stored in different storage. A regular USB digital camera was used to acquire the images and all process were in matlab environment. The performance of system strongly depends on the thresholds used, although optimal thresholds tend to vary with images but developed method did not require an adjustment of threshold values for fruit detection from each image because image segmentation was conducted based on classification models generated in accordance with the color, shape, texture and size of the images. The DC motor is used for the movement of the robotic arm. Manual method is slow, costly and also lacks reliability and objectivity required in competitive food industries. In this project embedded system is designed for multi sorting and it is implemented through Matlab. External inspection is done through image processing. The system utilizes image-processing techniques to classify and grade fruits.***

Keywords: PIC Microcontroller, MATLAB GUI, Robotic system, Camera, Image processing

I. INTRODUCTION

A computer system processes images acquired from an electronic digital camera, which is like the human vision systems where the processing images derived from the eyes. Thereby eliminating the monotonous work done by human, achieving accuracy and speed in the work. The project involves color sensors that senses the object's color 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 color detected, the robotic arm moves to the specified location, releases the object and comes back to the original position [1].

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Computer king maker vision has been used for quality measuring of fruits. Qualities of fruits have two different objectives: quality evaluation and defect finding. In this paper, we are also explaining how direct color mapping technique is implemented for grading [2].
This present paper relates to an apparatus and method for classifying the fruit on the basis of the color, shape, size of the fruit. Its aim is classifying the fruit by picking and placing the fruit in its respective pre-programmed place Thereby eliminating the monotonous work done by human, achieving accuracy and speed in the work. This project uses the MATLAB for the color, shape, size detection of the fruit according to the features of the fruit the fruit is classified or identified 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 and comes back to the original position [1].

II. SYSTEM MODEL

The Fig.1 shows the block of the system The basic theme of this project is fruit is selected and sorted depending on their color and size. For this, camera 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 color, depending on this signal will be given to microcontroller PIC16F877A. The microcontroller in turn will control the DC motor by using the motor drivers. These DC motor will control the movement of robotic arm, by controlling their angular movement. Thus the robotic arm will be fully controlled by DC motor. The gripper of robotic arm will pick the object place it depending on its size. This is full automatic process no manual support is needed. Thus the real time, continuous fruit sorting and grading id done can be done[5]. Generally, the gripper is a device that is capable of generating enough grip force to retain an object while the robot performs a task on the part such a pick-and-place operation. Any gripper must be capable of performing the task of opening and closing with a prescribed amount of force. The most commonly used grippers are finger grippers.

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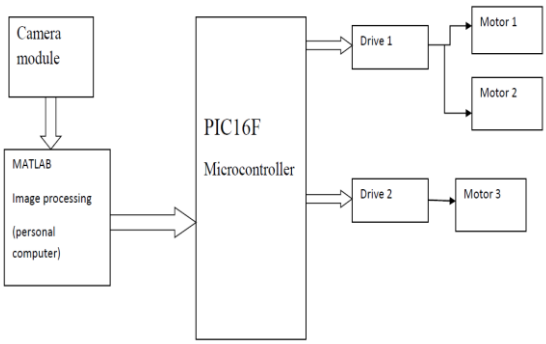

Fig.1 Block Diagram

A. Microcontroller

The PIC16F877A microcontroller with real-time emulation and embedded trace support that combines.

The microcontroller with 32 kB, 64 kB, 128 kB, 256 kB and 512 kB of embedded high speed Flash memory. Due to their tiny size and low power consumption, these microcontrollers are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. It has the High-performance RISC CPU, Up to 8K x 14 words of FLASH program memory, 35 Instructions (fixed length encoding-14-bit), 368×8 static RAM based data memory, Up to 256 x 8 bytes of EEPROM data memory, Interrupt capability (up to 14 sources), Three addressing modes (direct, indirect, relative), Power-on reset (POR) Harvard architecture memory, Power saving SLEEP mode, Wide operating voltage range: 2.0V to 5.5V, High sink / source current: 25mA, Accumulator based machine.

3 Timer/counters (programmable pre-scalars), Timer0, Timer2 are 8-bit timer/counter with 8-bit pre-scalar, Timer1 is 16-bit, can be incremented during sleep via external crystal/clock.

Two capture, compare, PWM modules, Input capture function records the Timer1 count on a pin transition, A PWM function output is a square wave with a programmable period and duty cycle, 10-bit 8 channel analog-to-digital converter, USART with 9-bit address detection. Synchronous serial port with master mode and I2C Master/Slave, 8-bit parallel slave port. 10-bit, up to 8-channel Analog-to-Digital Converter (A/D).

B. Driver IC and motor

In this system by using DC motor the movement of the robotic arm is controlled. To drive the motors or interface the DC motors with the microcontroller the driver circuit is required. Generally the L293D IC is used as the driver IC. The L293 and L293D are quadruple high-current half-H drivers. These devices are designed to drive a wide array of inductive loads such as relays, solenoids, DC and bipolar stepping motors, as well as other high-current and high-voltage loads. All inputs are TTL compatible and tolerant up to 7V. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo-Darlington source. In this project, the motors used is DC motor. A DC motor is any of a class of electrical machines that converts direct current electrical power into mechanical power. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. Most types produce rotary motion; a linear motor directly produces force and motion in a straight line. It is operated by 12V DC power supply. In any electric motor, operation is based on simple electromagnetism[3]. A current carrying conductor generates a magnetic field when this is then placed in an external magnetic field it will experience a force proportional to the current in the conductor and to the strength of external magnetic field.

C. Camera

The QHMPL PC CAMERA used in this project, it will take the snapshot of the fruit for color sensing purpose. The image captured by the camera will be processed by image processing using matlab. The camera used in this case is Logitech PN 960- 000748 .

Fig.2 Camera

D. Matlab And Image Processing

The name MATLAB stands for Matrix Laboratory. MATLAB was written originally to provide easy access to matrix software developed by the LINPACK (linear system package) and EISPACK (Eigen system package) projects. MATLAB is a high performance language for technical computing. It integrates computation, visualization, and programming environment. Furthermore, MATLAB is a modern programming language environment: it has sophisticated data structures, contains built-in editing and debugging tools, and supports object oriented programming. These factors make MATLAB an excellent tool for teaching and research. MATLAB has many advantages compared to conventional computer languages (e.g., FORTRAN) for solving technical problems. MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. It has powerful built-in routines that enable a very wide variety of computations. It also has easy to use graphics commands that make the visualization of results immediately available. Applications are collected in packages referred. to as toolbox. There are tool boxes for signal processing, symbolic computation, control theory, simulation, optimization, and several other of applied science and engineering . Image can be assumed as the visualization of what vision senses that is captured by camera. Image is considered as a two dimensional function with variables that represent the spatial coordinate[4].

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It holds information about color as well as shapes. In color image, RGB color model mixes those three prime color components, red, green and blue, to produce another color. Image capturing and processing have been used widely in diverse applications, such in medical and surveillance applications.

E. Robotic arm Controlled by DC motor

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 color detected, the robotic arm moves to the specified location, releases the object and comes back to the original position. Robotic arm is a type of mechanical arm, usually programmable,
with similar functions to a human arm. Types of robot arms depend on their range, working capability and reach.

In this project we use the 3 axis control robotic arm in which 3 motor are connect for the different operation to be performed at that part of robotic arm like Motor 1 is used for the rotation of the arm, Motor 3 is used for bending the arm just like elbow of the human arm, Motor 2 is used at the gripper. And gripper is an end-of-arm device often used in material handling applications. Generally, the gripper is a device that is capable of generating enough grip force to retain an object while the robot performs a task on the part such a pick-and-place operation. Any gripper must be capable of performing the task of opening and closing with a prescribed amount of force. The most commonly used grippers are finger grippers. These grippers generally have two opposing fingers or three fingers like a lathe chuck. Robotic arm image is shown in below.

Fig.3 Robotic arm

III. USE OF SOFTWARE

In this system two main software's are used one is MATLAB and other one is MPLAB. MATLAB is used for the image processing purpose and MPLAB is used for the motor control. Captured image is given to the MATLAB for image processing in which the image processing is done for the finding grading and type of the fruit. MPLAB software is used for the motor controller or for the controlling of movement of the robotic arm[4]. DC motor are used for the movement of the robotic arm which are controlled by the PIC microcontroller for that the program is written in MPLAB software

IV. APPLICATIONS

This project is used to sort the fruits but we can change its application for sorting an object or any other application where has to be used for object pick and place is used. some other application like

- Industries for assembly, process automation, welding.
- In food industry to identify the rotten fruits.
- In malls and small shops sorting object.
- Grading of fruits and vegetables.

V. RESULT

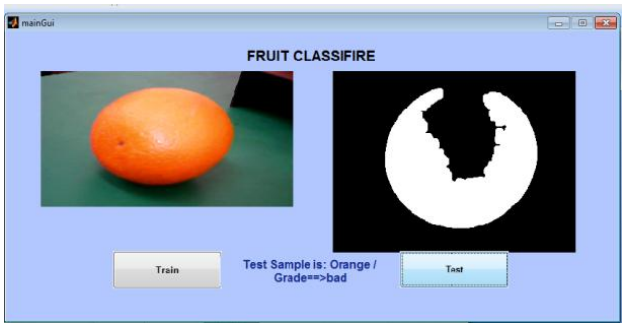

Fig. 4 MATLAB GUI

In MATLAB GUI we see the fruit type and grading shown on the screen of the GUI. It is the inbuilt function in the MATLAB which can be used for graphical interference.

Fig.5 Fuit sorting robotic arm system

In above the hole system is shown in which the main part is MATLAB which is installed on PC in which the GUI result is shown and robotic arm for pick and place of the fruit. The PIC circuitry are used for the controlling of the robotic arm.

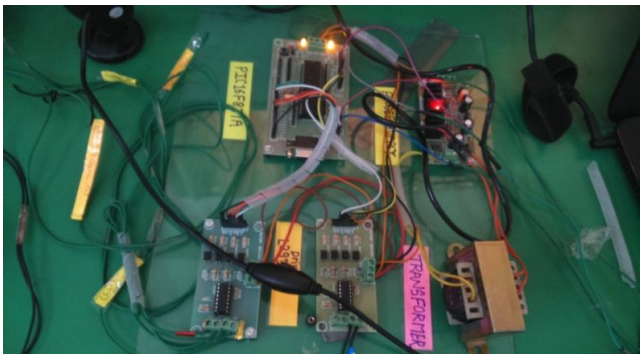

Fig.6 PIC circuitry

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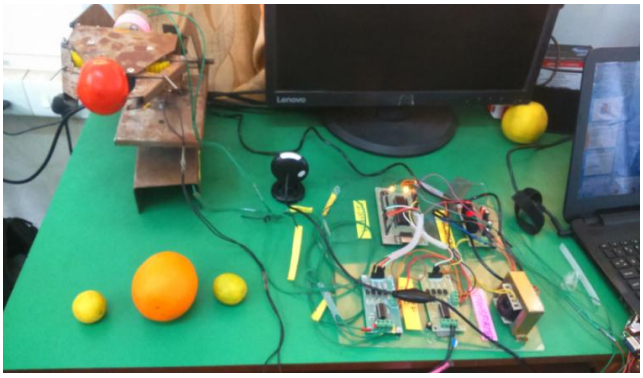

Fig.7 Robotic Arm with PIC Circuitry

VI. CONCLUSION

An image processing approach for fruit color detection, size detection, shape detection and fruit sorting has been successfully implemented. Implemented robot system gives accurate result for three colored fruit as Green or yellowish green for the lemon, orange for an orange red for tomato. With the help of some software changes this robot system can be used to sort out different color combination of basic specified color, shape, size to sort different fruits.

Due to use of image processing in MATLAB for color determination, size detection, shape detection manual efforts are reduced which produces result in improving accuracy as well as saves money and time. Due to use of the MATLAB GUI the type of fruit and the grade of the fruit can be directly displayed on MATLAB GUI there is no need of the external circuitry as a display.

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