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Automatic Detection & Distinction of Colored objects using Color Sorting Robotic Arm for Industrial Application

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Abstract— **The importance of process automation has been increased as the growth of any industry is directly depends on it. For precise output and accuracy of industrial process robots with sophisticated sensors are used. In this research, an idea of a robot that can classify objects according to their color is proposed. Color sorting robot is one of the useful, costless and fastest systems in industrial applications to reduce manual working time and provides less human mistakes when manual system is undertaken. The objective of this project is to design an efficient and automatic, micro controller based system that pick up right color of objects and put it down at right place same color to optimize the productivity, minimizing the cost of the products and decreasing human mistakes. In the proposed system color sorting system is developed with image processing technique. Image processing technique senses the objects captured in real-time by a webcam and then identifies color and information out of it. This information is processed by image processing technique for pick-and-place mechanism. The controller used is an Arduino Microcontroller having high speed performance, low cost. Designed system can pick**

objects of 1KG weight and arm can rotate up to 360^0, and it is quite flexible as the software can be changed according to specific requirements of the user. This makes the proposed present paper relates to an apparatus and method for classify in and sorting small-sized objects, using electronic systems and advanced sensors operating on the basis of a physical and geometric characterization of each element. The sensor handling systems which will drive the pick and place robot to pick up the object and place it into its designated place can. There are two main steps in sensing part, objects detection and recognition. The system may successfully perform handling station task, namely pick and place mechanism with help of sensor. Thus a cost effective system can be designed using the simplest concepts. The most common technology used is image processing. Due to the advent of powerful cameras, computers, controllers for controlling the machines and sophisticated tools image processing has become the most powerful emerging technology. The techniques developed for object recognition, MATLAB has the most powerful tool box for image improving, enhancing and categorizing different images using different features such as color, dimensions and texture of the object. Generally signal processing is used in the analysis of the color of an object. The arduino 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.

system to be an automatic, economical, portable and a low maintenance solution for industrial applications.

Keywords— Robotic arm, Micro controller, Camera, Motor, Image processing

1. INTRODUCTION

In today‘s industrial environment, a robot or rather a robotic arm to be precise is not something hard to find. These robots and robotic arms provide mechanical assistance for human workers in factories. Mainly the colour sorters are used in agricultural machineries like rice sorter, beans sorter, peanut sorter etc. Colour sorters are used in other industrial applications also like quartz sand sorter, plastic granule sorting of coloured nuts and bolts etc. . . . It reduces the human effort, labour and cost. Image processing in today‘s world grabs massive attentions as it leads to possibilities of broaden application in many fields of high technology. The real challenge is how to improve existing sorting system. The

2. SYSTEM DESCRIPTION

Pick and place robotic system for sorting mainly consists of following parts. It is presenting that the automatic sorting based on color is processed in advanced material handling system which is controlled by microcontroller assembly. The other main part of this technique is sensor which is camera in this case for high resolution and color identification. The sensor perform the well job of identifying objects as well as it

helps for turning of robotic arm to next object sorting. Microcontroller process so much of data at a time. MATLAB software processing the images given by camera. Thus, the processing of the image will be done by the processor inside the PC. A GUI is developed in MATLAB to communicate with the microcontroller. The hardware consists of a machine with two motors one attached to the base to provide 90 degrees rotation and other is attached to the gripper for picking and dropping the objects detected. USB to Serial cable is used in between MAX 232 and the PC for the flow of data.

To drive the two DC motors the motor driver IC L293D is used. The block diagram of system is shown in figure 1.

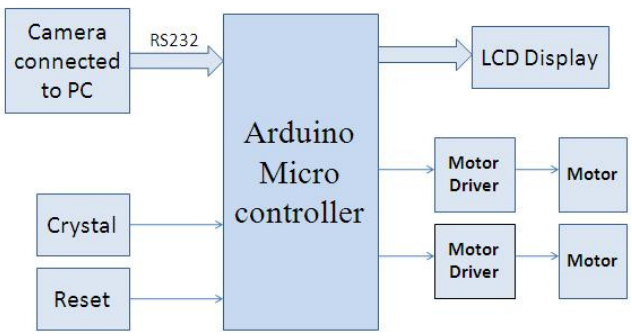


Figure 1.Block Diagram

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 Atmega 328. The microcontroller in turn will control the servomotors by PWM signals. These servomotors will control the movement of robotic arm, by controlling their angular movement. Thus the robotic arm will be fully controlled by servomotors. The gripper of Robotic arm will pick the object and place it depending on its size.

This is full automatic process no manual support is needed. The Arduino microcontroller is good platform for robotics application. The microcontroller used here is with the support of Arduino kit. It is the software and hardware also, using both the above system is developed. Thus the real time, continuous object sorting can be done. The camera used in this case will be overhead camera, it will take the snapshot of the object for color processed sensing purpose. The image captured by the camera will be by image processing using MATLAB.

Robotic Arm and Servomotors

The robotic arm with three servo-motors are mounted as one servo for the basis rotation of 360 degrees, one servo for the elbow and, finally, one servo for opening and closing the gripper at the wrist. The servos assure accurate and repetitive movements, the links are very light and the bearings minimize the friction. The servos are driven by the controller and the driving code is on-purpose implemented. The robot used is 4 Axis Robotic Arm. 4 Axis Robotic Arm is designed for small mobile robots. It can grip objects with the size up to 60mm with the force up to 250gms. Arm has reached of 23cm. It can lift the payload up to 400gms. First two axis of the arm are made up of NRS-995 dual bearing heavy duty metal gear motors and remaining 2 axis and gripper uses NRS-585 dual bearing plastic gear servo motors. Axis 2 and 3 enables gripper to maintain its angle constant with the surface while moving up and down. Robotic arm can do Left-Right, up-Down while keeping gripper parallel to surface, Twist motions and Gripping action. Robotic Arm will require current up to 5Amps. Make sure that your robot can supply that much

amount of current for proper operation of the arm. The robotic arm has following specifications.

Number of Axis: 4 + Gripper Gripping force: 250gms (Maximum) Gripping jaw length: 43mm Gripping jaw width: 60mm

Weight: 541gms (Including 2 NRS-995 and 3 NRS-585 servo motors)

Operating voltage: 5V to 6V

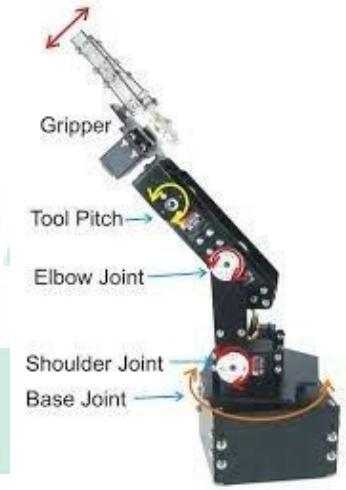


Figure 2.Four Axis Robot Arm

Servos are DC motors with built in gearing and feedback control loop circuitry and no motor drivers required. A servomotor is a rotary actuator that allows for precise control of angular position. The servo motor has some control circuits and a potentiometer (a variable resistor) that is connected to the output shaft. This pot allows the control circuitry to monitor the current angle of the servo motor. If the shaft is at the correct angle, then the motor shuts off. If the circuit finds that the angle is not correct, it will turn the motor the correct direction until the angle is correct. The output shaft of the servo is capable of traveling somewhere around 180 degrees. Usually, it's somewhere in the 210 degree range, but it varies by manufacturer. A normal servo is used to control an angular motion of between 0 and 180 degrees. If the output position differs from that required, an error signal is generated which then causes the motor to rotate in either direction, as needed to bring the output shaft to the appropriate position. As the positions approach, the error signal reduces to zero and the motor stops. Servomotors measure both the position and also the speed of the output shaft. They may also control the speed of their motor, rather than always running at full speed. Both of these enhancements, usually in combination with a PID control algorithm, allow the servomotor to be brought to its commanded position more quickly and more precisely, with less overshooting. The servo turn rate, or transit time, is used for determining servo rotational velocity. This is the amount of time it takes for the servo to move a set amount, usually 60 degees. The servomotor rotation is shown in figure 4.Forose you have a servo with a transit time of 0.17sec/60 degrees at no load, this means it would take nearly half a second to rotate an entire 180 degrees.

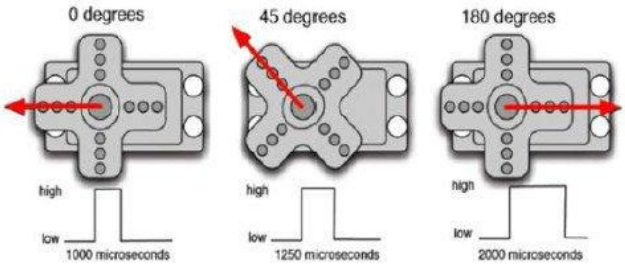


Figure 3.Servomotor Rotation

Color image processing using MATLAB

A simple approach for developing object reorganization system is shown below:

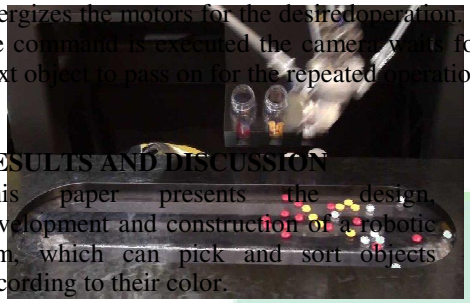
Decide the ideal position of the object with respect to the camera

The distinguishing feature of the object to be picked is to be figured out.

Deciding the robots movement as planned

The ideal position of the object will be when the centre of the frame coincides with the centre of the object. The color of the object will serve as the distinction on the basis of which we will identify it. In order to have accurate color detection a few live images of the object must be captured and the pixel values for different colors should be noted. Taking a mean of the pixel values obtained through various images would be fair and justifiable. This threshold range will then be used to mark all pixels containing the object as 1 and all other pixels as 0. In the algorithms initial settings are set. The settings include starting the MATLAB, starting image acquisition tool box, setting up the settings. After starting the video the serial port must be opened and image processing toolbox must calculate the total number of pixels captured. Initially the DC motor of the robot is off and the infinite while loop is started for continuously capturing the video through camera. After starting the infinite loop the image of the object is captured and is displayed to the operator. The image is converted into Ycbcr format. This format separates the intensities in each color then size of the image is calculated. The image is then captured and all the pixel values for different colors are noted. The mean of the pixel values available are noted. A binary matrix is created in which pixel values of the object will be 1 having the color (of the desired color) and all other pixels which do not belong to the object (no color detected) are marked 0. Then

centre of the object is initialized and the colored pixels are determined. After determining the red pixels, centre of the object is calculated. MATLAB sends commands to the development board in terms of characters using serial communication. As soon as the microcontroller receives the commands it energizes the motors for the desiredoperation. After the command is executed the camera waits for the next object to pass on for the repeated operation.



RESULTS AND DISCUSSION

This paper presents the design, development and construction of a robotic arm, which can pick and sort objects according to their color.

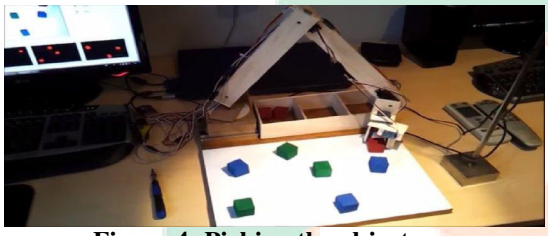


Figure 4: Picking the object

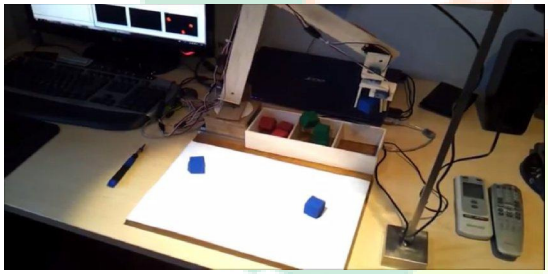


Figure 5: Placing the object

APPLICATIONS

Agricultural Industry: Color sorting roboarm can be used in agricultural industries to sort the fruits and vegetables depending upon their color.

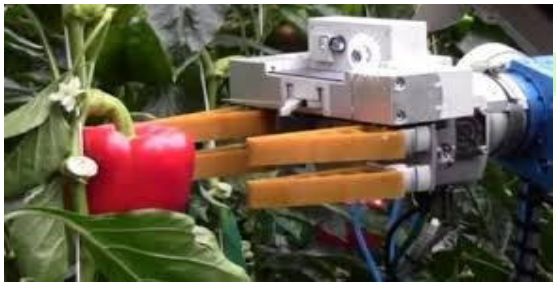


Figure 6: Color sorting robot in agriculture

Pharmaceutical industry: To separate different medicines color sorting robots are used in pharmaceutics.

Figure 7: In pharmaceutical industry

Food and Beverages: In beverages industry to separate different juice bottles color sorting robot is helpful.

CONCLUSION

The color sorting machine sorts the objects depending upon the colors of the objects successfully with the help of the roboarm and MATLAB program in image processing. The system designed has the capability to rotate 3600 and handle the required task. The USB webcam serves as an eye of the system which captures the real time image of the objects. The servomotors used in the roboarm plays important role as control movement of the roboarm totally depends upon control signal given to servo motor.

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