

Sorting System Using Robotic ARM

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ABSTRACT

Color and shape are the most common feature to distinguish between objects, sorting, recognizing and tracking. Generally camera is mounted on the gripper of robotic arm to detect the object. This technology can be used in material handling in sorting and packaging industry where the objects can be separated using a color and shape detecting robot. In this paper the 'Object recognition' algorithm is written in MATLAB for performing the operation. The 'Object recognition' algorithm is executed to identify the object and send the appropriate commands to the microcontroller using serial communication for the robotic arm to perform the sorting operation .

Keywords—Industrial sorting, image acquisition, image processing, serial communication coding compiling and burning.

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I. INTRODUCTION

Industrial automation and robotics are at a high demand in the industry as both of them directly affect the growth of the industry. Quality and flexibility of the product is the important criteria of the industry. Use of industrial robots is leading automation industry to another transition. In 1980's robots were used for general tasks such as machine tending, material transfer, painting, welding which does not require high accuracy. In 1990 market analysts predicted that industrial robots will become increasingly vital in applications which require high precision and accuracy. Autonomous robots with sophisticated sensors are used in such industries with accurate and précised work output which directly results in the growth of the industry. In automation Industrial robots are programmed for a single task using the sensory information. A vision system is considered to be the most sophisticated sensor in the present automation industry. The most common technology used at present in the industry 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. Image processing is basically improving and enhancing the images taken in daily life using cameras considered as vision sensors for various applications. In the last few decades different techniques have been developed for detecting the objects using vision systems. Colour

histograms were first proposed by Swain and Ballard [1] as a first approach for object recognition. Other features such as orientation, gradient magnitude were added to the histograms by Schiele and Crowley [2]. These inventions helped in changing the rotation, direction and deformation but did not help in object recognition. Schneiderman and Kanade [3] were first to introduce categorization of objects in natural scenes using wavelet transform coefficients. Wavelet transforms decomposes the image into a group of salient features wavelet transforms by reducing the redundancy of the pixels. When relationship between the parts of the object is considered rather than just the appearance, the most complex methods are used. Part based representation of objects detected in gray images was developed by Agarwal et al. [4]. Keeping in view 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 colour, dimensions and texture of the object. Generally signal processing is used in the analysis of the color of an object. In this paper the detection of different colors and shapes are done through image processing technique using MATLAB. The goal of the project is to develop Eye-Bot. Eye-bot is a typical model used to pick and place the desired color and shape objects from one location to another. This robot is used in sorting the objects in a mixture of different color and shape objects. The project consists of a MATLAB based robotic arm and a controller

for controlling the mechanical movements. An „Object recognition“ algorithm was developed in MATLAB to recognize the color and shape send command to the controller using serial communication. The controller, using the incoming signal controls the movements of the robotic arm. The robotic arm consist of three DC servo motors, one for the base, elbow and another for the gripper. The controller that was used is ATMEGA 16. CP2102 communication was used for MATLAB to communicate with the microcontroller.

Fig 1 below shows the Eye – Bot designed in fabricated in the laboratory.

II. HARDWARE DEVELOPMENT

Large volume of data is produced when camera is used as a sensor. Other sensors give out the output in terms of 0's or 1's like position sensor, encoders, IR sensors etc.

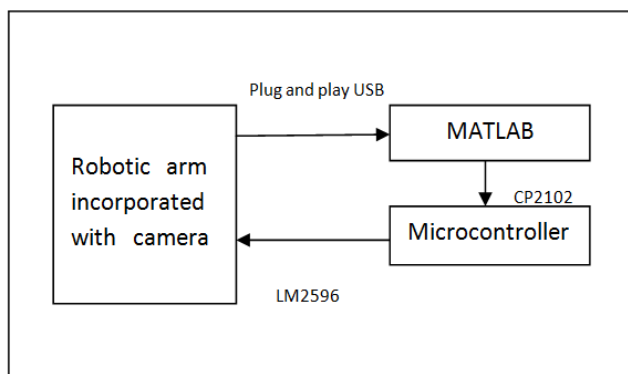


Fig1: Basic Design

For example: If each frame is of size 160X120 pixels of an RGB image then data will be produced for each colour of R, G and B representing 8 bits.

- ☐ Therefore each pixel will be 24 bits
- ☐ Total numbers of pixels would be 19200
- ☐ Which implies each frame is generating 460800 bits
- ☐ Therefore total data generated will be 57.6KB
- ☐ The amount of data generated will be approximately 1MB if 15 frames are captured per second.

So microcontroller should be able to process so much of data at a time. MATLAB being a powerful device will help in processing the images with such high volume of data. Thus, the processing of the image will be done by the processor inside the PC. The PC will send the commands to the microcontroller using serial communication [7]. The microcontroller navigates the machine. A GUI is developed in MATLAB to communicate with the microcontroller. The hardware consists of a machine with three motors one attached to the base and elbow to provide rotation and other is attached to the gripper for picking and dropping the objects detected.

A. HARDWARE IMPLEMENTATION

The hardware implementation deals in:

- ☐ Drawing the schematic on the plane paper according to the application
- ☐ Testing the schematic design over the proteus simulation tool if the design meets the objective
- ☐ Designing the PCB layout of the schematic tested on the simulation tool.
- ☐ Finally preparing the board and testing the designed hardware.

Hardware development of Eye-Bot shown in figure 2 is divided into two parts.

- ☐ Interfacing section
- ☐ Power supply

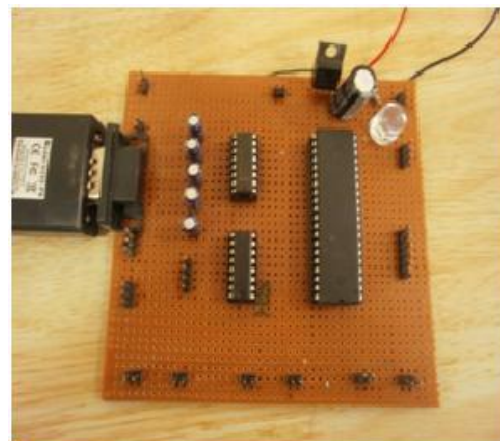


Fig 2: Hardware of eye bot

The hardware board as shown in Figure 3 consists of:

- Power supply
- ATMEGA 16
- CP2102
- LM2596 .

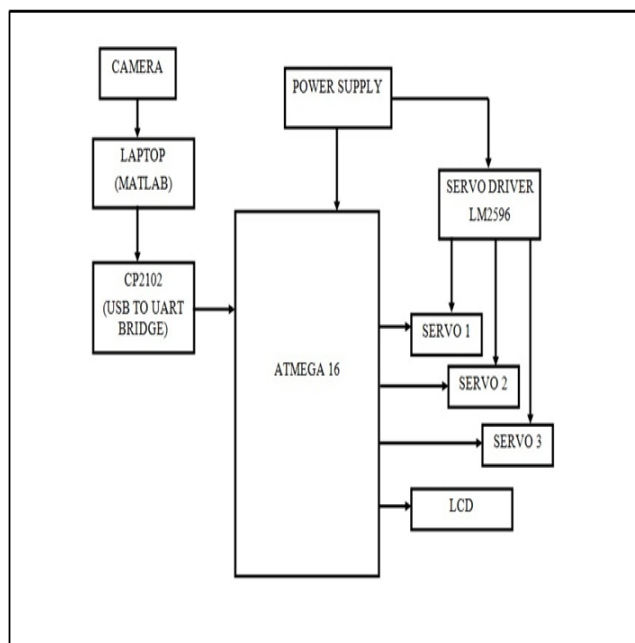


Fig 3: Block diagram of the Hardware

The power supply supplies the power of 5V to the controller to operate, which includes a bridge rectifier and a voltage regulator as shown in figure 2. ATMEGA 16 is the microcontroller which receives the commands from the MATLAB and sends the commands to the LM2596 for driving the motors. CP2102 is used for serial communication in order to communicate with the PC. To drive the two DC servo motors the IC LM2596 is used.

A webcam was mounted on the Robotic arm which was connected to the USB port of the PC. The specifications of the camera are as follows:

☐ CMOS camera with plug and play USB connection (with driver software)

☐ Video data format: 24 bit RGB

☐ 30 fps max

Active night vision with backlit LEDs

☐ Resolution 640 x 480 pixels

☐ Focus range: 3 cm to infinity

☐ Clip type mounting to clamp on any surface

☐ Integrated microphone for sound recording

Once the colour and shape is detected, the microcontroller will initiate the following actions on the robot.

☐ Gripper open

☐ Gripper close

☐ Left

☐ Right

III. DEVELOPMENT OF THE SYSTEM

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 robotic arm's movement as planned

The ideal position of the ball will be when the centre of the frame coincides with the center of the ball.

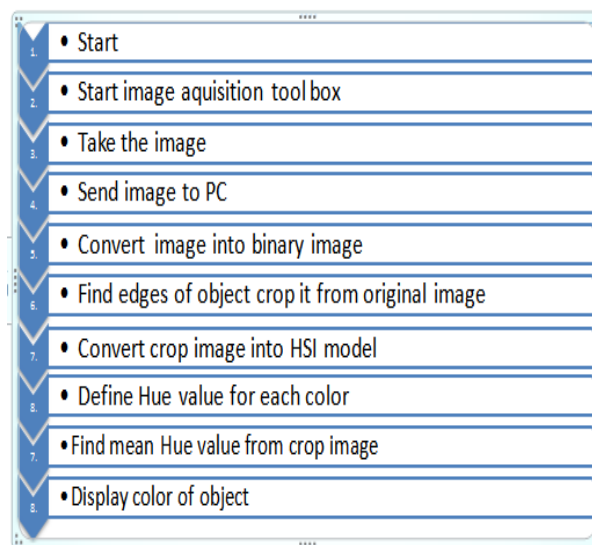
The color and shape of the ball will serve as the distinction on the basis of which we will identify it. In order to have accurate sorting, first we have to decide, whether we have sort the object according to its color or shape.

a. 'OBJECT RECOGNITION' ALGORITHM

In the algorithm's initial settings are set. The settings include starting the MATLAB, starting image acquisition tool box. Then take out the image and send it to PC for image processing to recognise color and shape of the object.

1. COLOR RECOGNITION:

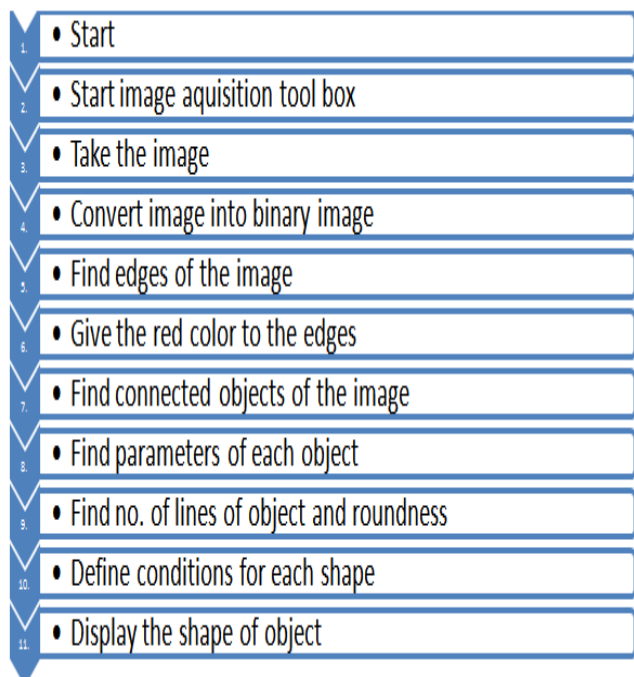
In this algorithm, first convert the image into binary image. Find out edges of the image and crop object from original image. Then convert crop image into HSI model and find out mean of Hue, Saturation and Intensity. Set maximum value for saturation and intensity as '1' and minimum value for those as '0.1'. Then giving threshold values of Hue for different color, different color can be recognized.



2. SHAPE RECOGNITION:

Similar to color recognition algorithm, in this algorithm find edges of the image. Then using hough transform line

detection method, find the no of edges of the object and recognized the shape of the object.



Matlab sends this information to microcontroller through serial communication. As soon as microcontroller receives this information, it energizes DC servo motor for desired operation.

This process goes on continuously. If there is no object there would be no robot movement. Closing commands such as close infinite loop, close the serial port are executed at the end in order to stop the operation

IV. SOFTWARE DEVELOPMENT

The coding is done in AVR Studio4 in embedded C". The actions performed by the robot are written in ATMEGA16 microcontroller. The following steps are involved in the software development:

- ☐ Coding/debugging
- ☐ Compiling
- ☐ Burning

a. CODING/DEBUGGING

High level languages such as C, Java or assembly language are used for coding and debugging. For this model the coding is done in AVR studio4 using embedded C language as shown in figure 7. The code is written to move the motors of the robot according to the image acquired.

b. COMPILING

A compiler for a high level language helps to reduce production time. To program the microcontroller WinAvr was used. Although inline assembly was possible, the

programming was done in strictly in C. A source code for USART has also been included. The compilation converts C program into machine level language as shown in figure 8. The microcontroller understands only the machine level language

c. BURNING

Burning the machine language file into the micro controller's program memory is achieved with the dedicated programmer, which is attached to the PC peripheral. PC's serial port has been used for this purpose. Here Robokits Programmer has been used as shown in figure 9

V. MATLAB GUI DEVELOPMENT WINDOW FOR EYE- BOT

A graphical user interface (GUI) is a graphical display that contains devices, or components, that enable a user to perform interactive tasks [5][8][9]. To perform these tasks, the user of the GUI does not have to create a script or type commands at the command line. Often, the user does not have to know the details of the task at hand. The GUI components can be menus, toolbars, push buttons, radio buttons, list boxes, and sliders, etc. just to name a

VI. RESULT

Robot has been successfully developed and testing was done in the dummy industrial environment developed in the laboratory. The objective is met by sorting the objects based on the color feature from a group of objects. A GUI in MATLAB was successfully created in order to display the video of the incoming object and displaying the color of the object to the user. The user has to select the COM Port. After the Connection is made the camera detects the RED object and using serial communication the robot picks the object and places in the desired location. The robot gets the signal about the position of the object in the workspace through the serial communication. Once the color of the object is known the Eye – Bot picks the object as shown in figure 13. Then robot reaches the desired location to place the object in the appropriate position, according to the microcontroller commands. The desired operation is met and the robot gets back to the home position in order to fetch the other object, once the current operation is performed.

VII. CONCLUSION AND FUTURE SCOPE

The developed Eye-Bot is able to detect the colour of the object and place it in the desired location. The colour detection capability can be increased to blue and green along with red which can sort out wide range of objects. There is a wired communication between the robot and the PC this can be improved by creating a wireless communication. The robot can be controlled wireless in industries with hazardous environment. Colour detection along with pattern recognition and Speech recognition will

play a vital role in many industries and also will increase the accuracy of the task in logistic and packaging industry.

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