Object Sorting Robotic Arm based on Colour and Shape Sensing

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Abstract— Object sorting systems is one of the useful systems in today's Industrial world. Previously, man power was utilized for this purpose but the process is time consuming when it comes to sort large number of objects in industries as human brain takes time to process images. Replacement of human sorting operations with robotic implementation would reduce efforts and also yield better results with comparatively lesser time. The detection of the particular colour is done by a light intensity to frequency converter method and shape is detected by image processing. The robotic arm is controlled by a microcontroller based system, which controls DC servo motors. Robotic arm is a kind of programmable mechanical arm, similar to human arm. They are programmed to faithfully carry out repetitive actions with a high degree of accuracy.

Key words: Object Sorting Robo-Arm, Image Processing, Colour Sensing, Shape Sensing, Atmega328, Arduino, MATLAB

I. INTRODUCTION

Most of us already see robot theme movies are often amazed with the power that those robots has. In the real life, the facts that robotic arm are having such power is not questionable. Robotic arms are widely used in various fields that require power, precision and also life risking.

Object sorting Robot is one of the useful, costless and fastest systems in Industrial applications to reduce manual working time and provides less human mistake when manual system is undertaken. The objective of this project is to design an efficient, microcontroller based system that pick up right coloured and shaped objects and put it down at right place to optimize the productivity, minimizing the cost of the products and decreasing human mistakes.

II. LITERATURE REVIEW

A. Design and Implementation of A Robotic Arm Based on Haptic Technology [1]:

According to Abidhusain Syed, H, Agasbal and Zamrrud Taj, this paper deals with designing a haptic robotic arm, which can be used to pick and place the objects. In this paper, a robotic arm with four degrees of freedom is designed and is able to pick the objects with a specific weight and place them in a desired location. To facilitate the lifting of the objects, Servomotors with a torque of 11 kg are used. The programming is done on ATMEGA-328 Microcontroller using Arduino programming. The Microcontroller along with input pins is soldered on a PCB board.

B. Object Sorting Robotic Arm Based on Colour Sensing [3]:

In this paper Mr.Aji Joy, proposed to separate the objects from a set according to their colour. This can be useful to categorize the objects which move on a conveyer belt. The proposed method of categorization is based on colour of the object. In this paper the system categorize balls of three different colours. The detection of the particular colour is done by a light intensity to frequency converter method. The robotic arm is controlled by a microcontroller based system which controls DC servo motors.

C. Automation of Object Sorting Using an Industrial Robo arm and MATLAB Based Image Processing [7]:

According to Prof. D. B. Rane and Gunjal Sagar S, in recent years 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 modern era application of image processing in many industrial processes has proven its prevalence and dominance. This paper present color based object sorting system which uses the machine vision and the operations in image processing. The proposed work is to develop compact, easy and accurate objects sorting machine using real time color image processing method to continuously evaluate and inspect the color deformity using camera based machine vision. After the evaluation of quality the object is sorted into predefined quality groups with the help of pick and place roboarm. If the inspected object fails to follow quality norms it is rejected out by the system. The proposed system will have broad areas of applications in many fields where continuously evaluation of the quality is required.

III. DESIGN OVERVIEW

The block diagram depicts the total blue print of the project:

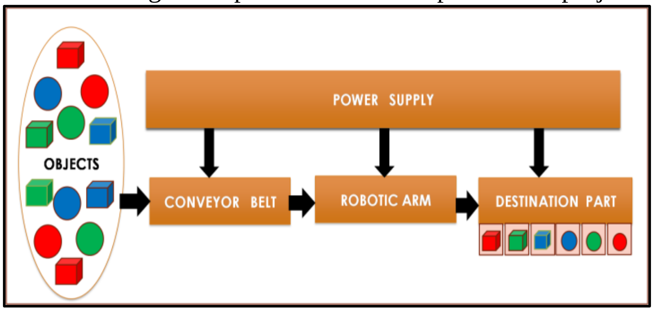

Fig. 1: Simplified Block Diagram of Robotic Arm Based Object Sorting System

In this project, colour sensing is achieved through light intensity to frequency converter method by using TCS3200 colour sensor and shape sensing is achieved by using real time MATLAB image prossing technique. This real time images are captured through camera based machine vision. Finally the outputs of TCS3200 colour sensor and MATLAB software are synchronized by the microcontroller. Here we use ATmega328p microcontroller which will drive the dc servo motors in accordance with the synchronized data. Hence the objects are sorted according to their colour and shape.

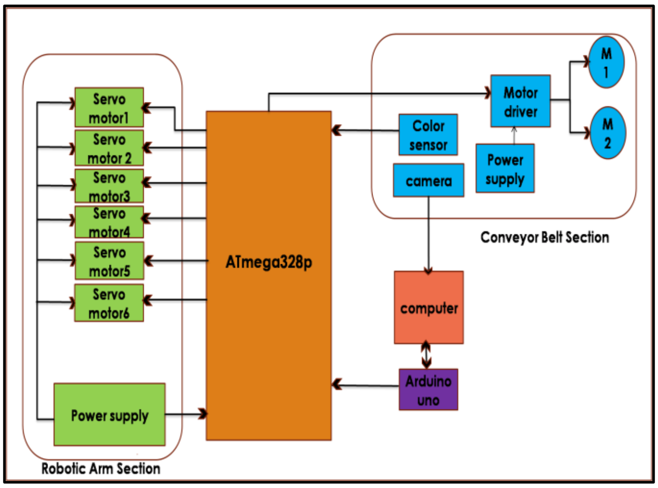

Fig. 2: Detailed Block Diagram of Robotic Arm Based Object Sorting System

A. Microcontroller

The microcontroller used here is ATmega328p. It is a high-performance Atmel pico Power 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes.

The device operates between 1.8-5.5 volts. By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed.

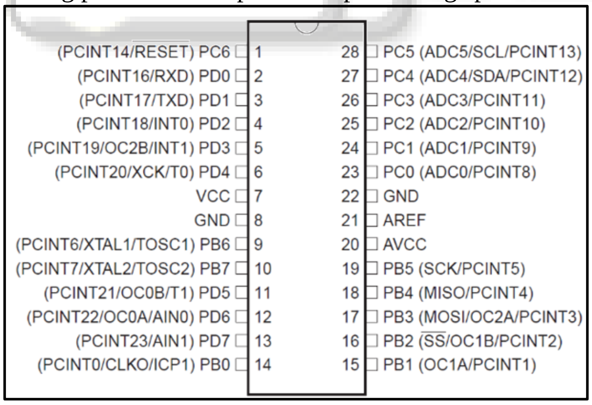

Fig 3: Pin Diagram of ATmega328p Microcontroller

B. Arduino uno Development Board

Here Arduino Uno development board act as the communication link between the computer (MATLAB) and the microcontroller through the COM port. The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

Fig. 4: Arduino uno Development Board

C. Matlab and Image Processing

MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment and fourth-generation programming language. A proprietary programming language developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, Fortran and Python.

Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing capabilities. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems. In 2004, MATLAB had around one million users across industry and academia. MATLAB users come from various backgrounds of engineering, science, and economics.

The camera used in this case will be overhead camera. It will take the picture of the object for shape sensing purpose. The image captured by the camera will be processed by image processing using matlab and a corresponding binary value is send to the microcontroller through COM port.

D. Servo Motors

As the name suggests, a servomotor is a servomechanism. More specifically, it is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is some signal, either analogue or digital, representing the position commanded for the output shaft.

The motor is paired with some type of encoder to provide position and speed feedback. In the simplest case, only the position is measured. The measured position of the output is compared to the command position, the external input to the controller. 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. Here servo motors provide rotation or movement freedom to robotic arm according to the synchronize data from microcontroller.

Fig. 5: Servo Motor

E. Colour Sensor

The colour sensor used here is TCS3200. The color sensor product family provides red, green, blue and clear (RGBC) light sensing for precise color measurement, determination, and discrimination. A SYNC input allows for greater accuracy by enabling the color sensing to be synchronized with an external event. For example, in LED solid state lighting, the SYNC input enables the color reading to be synchronized with the PWM signal and illumination of the LEDs. Color sensors are available with a built-in IR blocking filter for accurate color measurement by minimizing the effects due to unwanted IR light sources in sunlight and other light sources.

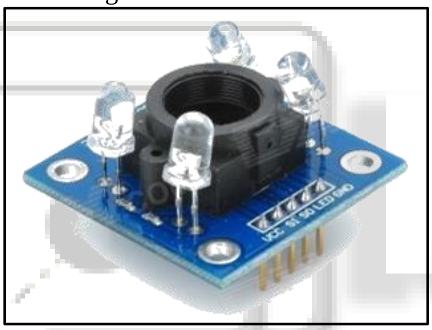

Fig. 6: Colour Sensor

F. Conveyor Belt

The conveyor belt consists of two pulleys. Both of these pulleys are powered and driven by a motor driver IC. Hence the conveyor belt and the objects on the belt are moved in forward direction. Motor driver IC used here is L293D.

L293D is a dual H-Bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.

L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.

Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.

Fig 7: Conveyor Belt

IV. Result

We can assume the objects are of red, green and blue coloured balls and cubes. The result obtained is:

Sr. No.	Object Specification	Object Supplied	Correctly Sorted
1	Red Cube	11	11
2	Green Cube	14	14
3	Blue Cube	16	16
4	Red Ball	19	19
5	Green Ball	15	15
6	Blue Ball	14	14

Table 1: Result

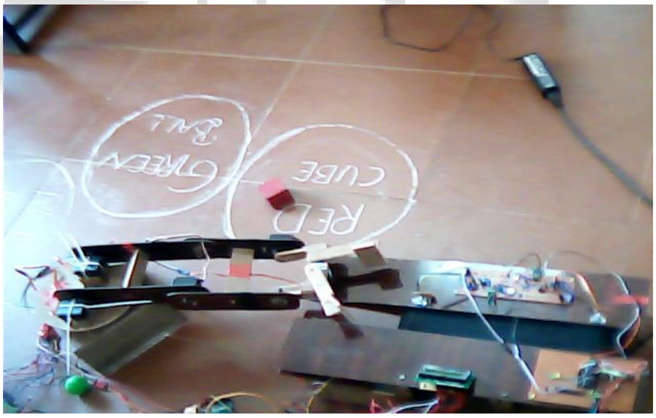

Fig. 8: Object Sorting Robotic Arm Based on Colour and Shape Sensing System

V. Conclusion

This project describes the “Object Sorting Robotic Arm Based on Colour and Shape Sensing”. It gives an easy and less expensive way to implement an object sorting system. By using this system the human intervention and manual work in production and distribution areas can be reduced. Object sorting Robot is one of the useful, costless and fastest systems in industrial applications to reduce manual working time and provides less human mistake when manual system is undertaken. Thus an efficient microcontroller based system that pick up right coloured and shaped objects and put it down at right place to optimize the productivity, minimizing the cost of the products and decreasing human mistakes.

VI. Future Scope

We can theorize a likely profile of the future robot based on the various research activities that are currently being performed. The features and capabilities of the future robot will include the following

A. *Intelligence:*

The future robot will be an intelligent robot, capable of making decisions about the task it performs based on high-level programming commands and feedback data from its environment.

B. *Sensor Capabilities:*

The robot will have a wide array of sensor capabilities including vision, tactile sensing, and others. Progress is being made in the field of feedback and tactile sensors, which allow a robot to sense their actions and adjust their behaviour accordingly. This is vital to enable robots to perform complex physical tasks that require some active control in response to the situation. Robotic manipulators can be very precise, but only when a task can be fully described.

C. *Tele Presence:*

It will possess a tele presence capability, the ability to communicate information about its environment (which may be unsafe for humans) back to a remote" safe" location where humans will be able to make judgments and decisions about actions that should be taken by the robots.

D. *Mobility and Navigation:*

Future robots will be mobile, able to move under their own power and navigation systems.

E. *Universal Gripper:*

Robot gripper design will be more sophisticated, and universal hands capable of multiple tasks will be available.

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