Automatic Material Handling System Using Pick & Place Robotic Arm & Image Processing

Mr. Deepak L RAJNOR[1] A.S Bhide[2]
[2]Professor

Abstract— The paper presents a smart approach for a real time inspection and selection of objects in continuous flow. 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 in the modular processing system which consists of four integrated stations of identification, processing, selection and sorting with a new image processing feature. Existing sorting method uses a set of inductive, capacitive and optical sensors do differentiate object color. This paper presents a mechatronics color sorting system solution with the application of image processing. Image processing procedure senses the objects in an image captured in real-time by a webcam and then identifies color and information out of it. This information is processed by image processing for pick-and-place mechanism.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. Thereby eliminating the monotonous work done by human, achieving accuracy and speed in the work. The project involve 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.

Keywords:- Camera, Conveyor belt system , Image Processing, Micro-controller, Robotic System,Servomotor.

I. INTRODUCTION

Determining real time and highly accurate characteristics of small objects in a fast flowing stream would open new directions for industrial sorting processes. The present paper relate to an apparatus and method for classify in and sorting small-sized items, using elect ronic systems and advanced sensors in use on the basis of a physical and geometric characterization of each element. Recent advance in electronics and printed circuit board technology open new perspective for industrial application in this field. The future selection process is based on a multisensorial characterization, and more particularly on crossed visual and impedimetric analysis of the objects to be sorted. Parallel guide, also called channels, are created on a one-sided fix support. The objects to be sorted are absorbed in a continuous, free-falling flow along said guides [1] [2]. By another way this project can be treated an automated material handling system & can be designed by following way. It synchronizes the progress of robotic arm to pick the objects moving on a conveyor belt. It aims in classify the coloured items which are coming on the conveyor by selection and placing the objects in its respective pre-programmed position. Thereby eliminate the repetitive work done by human, achieving accurateness and speed in the job. The scheme involve colour sensors that senses the object's colour and send the signal to the microcontroller. The microcontroller send signal to circuit which drives the a variety of motors of the robotic arm to grip the object and place it in the particular location. Based upon the colour detect, the robotic arm moves to the particular location, releases the object and comes back to the original place [1][2].

II. SYSTEM MODEL AND ASSUMPTIONS

The fig. shows block diagram of a structure. The basic idea of this project is item flow on conveyor are sensed, chosen and sorted depending on their colour and size. For this, camera is used as input sensor, camera is above your head camera which will be mount on PC, and will be coupled to PC by USB. The camera will take a spontaneous and it will feed to PC for colour processing. In PC matlab is used for processing on the colour, depending on this signal will be given to microcontroller At-mega 328. The microcontroller in turn will manage the servomotors by PWM signal. 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 select the item place it depending on its dimension. This is full automatic method.no physical support is wanted. The microcontroller used here is with the support of Arduino kit. The Arduino is good platform for robotics function. It is the software and hardware also. Using both the above method is developed. Hence the real time, continuous object sorting can be done.

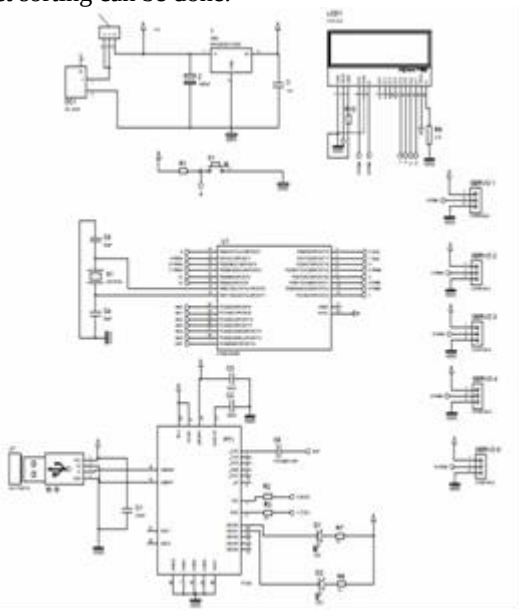

Fig. 1: Block / Circuit Diagram

A. Microcontroller

The ATmega328 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing controlling instructions in a single

clock cycle, the At-mega 328 achieves throughputs future 1 MIPS per MHz allowing the system designer to optimize power use versus processing rate. The AVR core combine a rich instruction set with 32 general purpose working registers. All the 32 register are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resultant architecture is additional system efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers. The At-mega 328 provides the next features:

- 4K/8Kbytes of In-System Programmable Flash with Read-While-Write capabilities,
- 256/512/512/1Kbytes EEPROM,
- 512/1K/1K/2Kbytes SRAM,
- 23 general purpose I/O lines,
- 32 general purpose working registers,
- three flexible Timer/Counters with compare modes,
- internal and external interrupts,
- a serial programmable USART,
- a byte-oriented 2-wire Serial Interface,
- an SPI serial port,
- a 6-channel 10-bit ADC (8 channels in TQFP and QFN/MLF packages),
- a programmable Watchdog Timer with internal Oscillator, and five software selectable power saving modes.

This allows very fast start-up combined with low power use. The 16 MHz Crystal Oscillator module is planned to handle off-chip crystals that have a frequency of 16 MHz. The crystal oscillator output is feed to the structure. As an selection by using a crystal, you can use an outwardly generate 16 MHz clock resource as input to the on-chip 16 MHz oscillator.

B. Camera

The camera used in this case will be overhead camera, it will take the picture of the item for colour sensing purpuse. The image capture by the camera will be processed by image processing using matlab.

The camera used in this case is Logitech PN 960-000748 whose technical specifications are:

- Video calling (640 x 480 pixels)
- Video capture: Up to 1024 x 768 pixels
- Fluid Crystal Technology
- Photos: Up to 1.3 megapixels (software enhanced)
- Built-in mic with noise reduction
- Hi-Speed USB 2.0 certified (recommended)
- Universal clip fits laptops, LCD or CRT monitors

C. Matlab and Image Processing

The name MATLAB stands for Matrix Laboratory. MATLAB was written initially to give 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 compute. It integrates computation idea, and programming environment. in addition MATLAB is a modern programming language surroundings: it has complicated data structures, contains built-in editing and debugging tool, & supports object-oriented programming. These factors make MATLAB an brilliant tool for teaching and research. MATLAB has many advantages compared to usual computer languages (e.g., FORTRAN) to solve technical problems. MATLAB is an interactive system whose essential data element is an selection that does not require dimensioning. It has powerful built-in routine that allow a very wide selection of computation. It also has easy to use graphics instructions that make the image of results instantly available. Applications are collected in packages referred to as tool box. There are tool box for signal processing, symbolic calculation, control theory, reproduction, optimization, and several other of applied science and engineering [17]. Image can be assumed as the image of what vision senses that is capture by camera. Image is measured as a two dimensional function with variables that represent the spatial organize. It holds information about color as well as shape. In color picture, RGB color model mixes those three main color components, red, green and blue, to produce another color. Image capturing and processing have been used widely in diverse application, such in medical and observation applications.

D. Arduino

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source material computing stage based on a simple microcontroller board, and a development surroundings for writing software for the panel. Arduino can be used to develop interactive items, taking inputs from a selection of switch or sensors, and controlling a selection of lights, motors, and other material outputs. Arduino projects can be separate, or they can be communicating with software running on your computer (e.g. Flash, Processing, Max MSP.) The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free of charge. The Arduino programming language is an achievement of Wiring, a similar physical compute platform, which is based on the Processing multimedia programming surroundings. An Arduino board consists of an 8-bit At-mel AVR microcontroller with complementary components to facilitate programming and incorporation into other circuit. An important aspect of the Arduino is the normal way that connectors are showing, allow the CPU board to be connected to a variety of interchangeable add-on modules (known as shields). Most board include a 5 volt linear regulator and a 16 MHz crystal oscillator. The Ar-duino board represent the most of the microcontroller's I/O pin for use by other circuits. There are many other microcontrollers and microcontroller platforms available for physical computing. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateur over other systems:

- Inexpensive -The least expensive version of the Arduino module can be assembled by hand.
- Cross-platform - The Arduino software runs on Windows, Macintosh OSX, & Linux operating systems.
- Simple, clear programming.
- Open source and extensible software- The Arduino software is published as open source tools, available for extension by experienced programmer.

– Open source and extensible hardware - The Arduino is based on Atmel's ATMEGA8 and ATMEGA168 microcontrollers.

There are a great many Arduino-compatible and Arduino-derived boards. Some are functionally equal to an Arduino and may be used interchangeably. Many are the fundamental Arduino with the addition of commonplace output drivers, often for use in school-level education to simplify the construction of buggies and small robots. Others are electrically equal but change the form factor, occasionally permitting the continued use of Shields, occasionally not. Some variants even use completely dissimilar processors, with varying levels of compatibility.

Robotic Arms & Servomotors Arms are types of jointed robot manipulator that allow robots to interact with their surroundings. Many have on the project controllers or translators to simplify announcement, though they may be controlled directly or in any number of way. Due to this fact, standalone arms are often classified as full robots. The robot use in this project is 4 Axis Robotic Arm. 4 Axis Robotic Arm is planned for small movable robots. It can grip objects with the size up to 60mm with the force up to 250gms. Arm has reach of 23cm. It can lift the load up to 400gms. Robotic Arm comes completely assembled and ready to use. First dual 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 behaviour plastic gear servo motors. Axis 2 and 3 allows 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 plane, Twist motions and Gripping action. Robotic Arm will need current up to 5Amps. Make assured that your robot can supply that much amount of current for proper procedure 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
– Reach: 23cm

Axis Capabilities: Mechanical Assembly Maximum Angle(º) Speed (Degree/sec)

Waist	180º	0-27º
First Arm	180º	0-27º
Second Arm	180º	0-27º
Third Arm	180º	0-27º
Forth Arm	180º	0-27º

Servos are DC motors with built in gearing and feedback control loop circuitry. And no motor drivers essential. A servomotor is a rotary actuator that allow for accurate control of angular position. They consist of a motor attached to a sensor for position feedback, through a reduction gearbox. It also require a relatively sophisticated controller, frequently a dedicated module designed specifically for apply by servomotors. Servomotors are used in applications such as robotics, CNC machinery or automatic manufacturing. The servo motor has a few control circuits and a potentiometer (a variable resistor) that is connected to the output shaft. This pot allows the control circuitry to observe the present angle of the servo motor. If the shaft is at the correct angle, then the motor shut 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, its 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. A normal servo is mechanically not capable of turning any farther due to a mechanical stop built on to the main output gear. The amount of power useful to the motor is proportional to the distance it needs to travel. So, if the shaft needs to turn a large distance, the motor will run at full speed. If it needs to turn only a small amount, the motor will run at a slower speed [14] [15] [16].

Fig. 2: Four Axis Robot

The motor is paired with some type of encoder to provide position and speed response. In the simplest case, only the position is calculated. The measured position of the output is compared to the command position, the external contribution to the controller. If the output position differ from that necessary, an error signal is generated which then causes the motor to rotate in either direction, as needed to bring the output shaft to the proper position. As the positions approach, the error signal reduce to zero and the motor stops. More sophisticated 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 enhancement, usually in combination with a PID control algorithm, allow the servomotor to be bring to its commanded position more quickly and more accurately, 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 progress a set amount, usually 60 degrees. For example, suppose you have a servo with a transportation time of 0.17sec/60 degrees at no load, this means it would take nearly half a second to rotate an complete 180 degrees

Table I. Axis Capabilities

Axis Capabilities: Mechanical Assembly	Maximum Angle(º)	Speed (Degree/sec)
Waist	180º	0-27º
First Arm	180º	0-27º
Second Arm	180º	0-27º
Third Arm	180º	0-27º
Forth Arm	180º	0-27º

E. Conveyor Belt

The conveyor motor receives power from battery. A conveyor belt consists of two or more pulleys, with a continuous loop of material - the conveyor belt - that rotates about them. One or both of the pulleys are powered, moving the belt and the material on the belt forward. The powered pulley is called the drive pulley while the unpowered pulley

is called the idler. Conveyor frames are supplied with either butting plate (standard) or hook and bar attachments to secure each segment together. Heavy duty rollers are supplied with shafts.

Fig. 3: Conveyor Belt

III. RESULT

We can assume objects in circular, rectangular shape in different colours so the result is

Table II. Result

Sr. No	colour	No. of object	Result	
			Sorted	Not Sorted
1	Red	15	12	3
2	BLUE	8	5	3
3	GREEN	5	3	1
4	Orange	5	2	3
5	Navy Blue	3	2	1

IV. CONCLUSION

Fully functional sorter machine can be implemented by using a structure of parallel and independent channels in order to increase the overall throughput which results with a forecasted performance. The project can work successfully. There are two main steps in sensing part, objects detection and identification. The system can successfully perform handling station task, that is pick and place mechanism with facilitate of sensor. Thus a cost effective Mechatronics system can be designed using the simplest concepts and efficient result can be observed.

REFERENCES

[1] Alessandro Golfarelli, Rossano Codeluppi and Marco Tartagni, " A Self-Learning Multi-Sensing Selection Process: Measuring Objects One by One",ARCES – LYRAS LAB University of Bologna, Campus of Forlì, 1-4244-1262-5/07/$25.00 ©2007 IEEE, IEEE SENSORS 2007 Conference.
[2] Sahu, S., Lenka, P.; Kumari, S.; Sahu, K.B.; Mallick, B.; "Design a colour sensor: Application to robot handling radiation work", Vol. 56, No. 10, pp. 365- 368, 2007, Industrial. Engineering.
[3] www.google.com/microepsilon.com/catcolorsensor—e
[4] www.shortcourse.com/www.sensors.com/optical/images ensors
[5] wwgoogle.com/wisegeek.com/whatisoptical sensors.htm
[6] www.google.com/osa.org/sensors
[7] www.pdfgenicom/compacsort.com/sorters
[8] www.pdfgenicom/indiamart.com/sorting machine
[9] Www.Google.Com/Atmega 48a/Pa/328/P/ Datasheet Summary
[10] www.google.com/zimbio.com/clip-base cam
[11] www.google.com/pdfsb.com/smps
[12] www.google.com/pdfgeni.com/vermnlstweb.nl
[13] www.google.com/arduino.cc/main/software
[14] www.google.com/eyantra.org/home/project
[15] Project on" Pick n Place Robot", made by Bharat Jain and Dinesh Rajput, under guidance of Prof. KaviArya, IIT Mumbai,2010.
[16] www.pdfgeni.com/servo-tutorial
[17] www.pdfgeni.com/matlab- mathematical lab/pdf

