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# OBJECT SORTING SYSTEM USING ROBOTIC ARM

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**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 sorting process is based on a 2 phase operative methodology defined 1) a self-learning step where the apparatus learns to identify objects ; 2) an operative selection process where objects are detected, classified using a decisional algorithm and selected in real time. 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 [1] [2].

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

## 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 relates to an apparatus and method for classify in and sorting small-sized objects, using elect ronic systems and advanced sensors operating on the basis of a physical and geometric characterization of each element. Recent advances in electronics and printed circuit board technology open new perspectives for industrial application in this field. The proposed selection process is based on a multisensorial characterization, and more specifically on crossed optical and impedimetric analysis of the objects to be sorted. Parallel guides, also called channels, are created on a slanted plant support. The objects to be sorted are immersed 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 movement of robotic arm to pick the objects moving on a conveyor belt. It aims in classifying the coloured objects 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 involves colour sensors that senses the object's colour 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 colour detected, the robotic arm moves to the specified location, releases the object and comes back to the original position [1][2].

## II.SYSTEM MODEL AND ASSUMPTIONS

The fig. shows block diagram of a system. The basic theme of this project is object flowing on conveyor are sensed, selected and sorted depending on their colour 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 colour processing. In PC matlab is used for processing on colour, 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

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will be fully controlled by servomotors. 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. The microcontroller used here is with the support of Arduino kit. The Arduino is good platform for robotics application. It is the software and hardware also, using both the above system is developed. Thus the real time, continuous object sorting can be done.

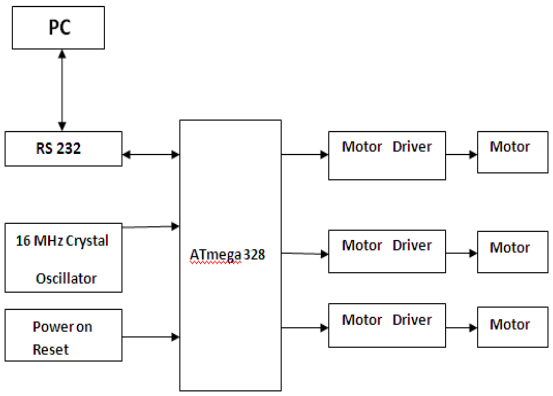


Fig. 1 Block Diagram

*A. Microcontroller*

The ATmega328 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the Atmega 328 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers 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 resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers. The Atmega 328 provides the following 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. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, USART, 2-wire Serial Interface, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next interrupt or hardware reset. In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low power consumption.The 16 MHz Crystal Oscillator module is designed to handle off-chip crystals that have a frequency of 16 MHz. The crystal oscillator output is fed to the System. As an alternative to using a crystal, you can use an externally generated 16 MHz clock source as input tothe on-chip 16 MHz oscillator.

*B. Camera*

The camera used in this case will be overhead camera, it will take the snapshot of the object for colour sensing purpuse. 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 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

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• Hi-Speed USB 2.0 certified (recommended)
• Universal clip fits laptops, LCD or CRT monitors

Fig. 2 Camera

*C. 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. The software package has been commercially available since 1984 and is now considered as a standard tool at most universities and industries worldwide. 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. Specie applications are collected in packages referred to as toolbox. There are tool boxes for signal processing, symbolic computation, control theory, simulation, optimization, and several otherof applied science and engineering [17]. 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. 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.

*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 physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can be communicating with software running on your computer (e.g. Flash, Processing, MaxMSP.) The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free. The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment. An Arduino board consists of an 8-bit Atmel AVR microcontroller with complementary components to facilitate programming and incorporation into other circuits. An important aspect of the Arduino is the standard way that connectors are exposed, allowing the CPU board to be connected to a variety of interchangeable add-on modules (known as shields). Most boards include a 5 volt linear regulator and a 16 MHz crystal oscillator. The Arduino board exposes most of the microcontroller's I/O pins for use by other circuits. It provides 14 digital I/O pins, six of which can produce PWM signals, and six analog inputs. These pins are on the top of the board, via female 0.1 inch headers. Several plug-in application "shields" are also commercially available [13]. There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handy board, and many others offer similar functionality. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems:

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- Inexpensive -The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than $50
- Cross-platform - The Arduino software runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.
- Simple, clear programming.
- Open source and extensible software- The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries.
- Open source and extensible hardware - The Arduino is based on Atmel's ATMEGA8 and ATMEGA168 microcontrollers.

The Arduino Nano, and Arduino-compatible Bare Bones Board and arduino boards may provide male header pins on the underside of the board to be plugged into solder less breadboards. The Arduino IDE is a cross-platform application written in Java, and is derived from the IDE for the Processing programming language and the Wiring project. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. There is typically no need to edit makefiles or run programs on a command-line interface. Although building on command-line is possible if required with some third-party tools such as Ino. There are a great many Arduino-compatible and Arduino-derived boards.

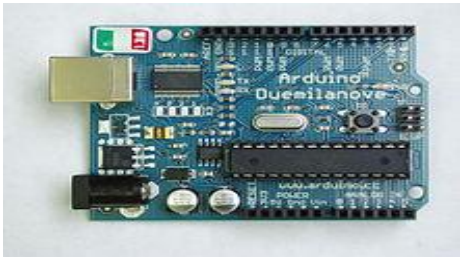


Fig. 3 Arduino Kit

Some are functionally equivalent to an Arduino and may be used interchangeably. Many are the basic 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 equivalent but change the form factor, sometimes permitting the continued use of Shields, sometimes not. Some variants even use completely different processors, with varying levels of compatibility.

*E. Robotic Arms operated by Servomotors*

Arms are types of jointed robot manipulator that allow robots to interact with their environment. Many have onboard controllers or translators to simplify communication, though they may be controlled directly or in any number of ways. Due to this fact, standalone arms are often classified as full robots. The robot used in this project 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 reach of 23cm. It can lift the payload up to 400gms. Robotic Arm comes fully assembled and ready to use. 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)

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- 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 |

Table1. Axis Capabilities

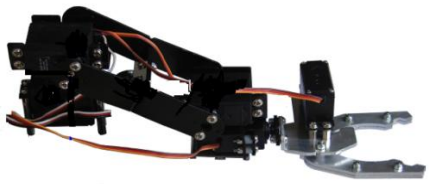

Fig. 4 Four Axis Robot

*F. Servomotor*

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. They consist of a motor coupled to a sensor for position feedback, through a reduction gearbox. They also require a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing. . 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 capableof 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 applied 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].

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Fig. 5 Servomotor Structure

This is called proportional control. 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.The very simplest servomotors use position-only sensing via a potentiometer and bang-bang control of their motor; the motor always rotates at full speed (or is stopped). This type of servomotor is not widely used in industrial motion control, but they form the basis of the simple and cheap servos used for radio-controlled models. 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 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 degrees. For example, suppose you have a servo with a transit time of 0.17sec/60 degrees at no load.

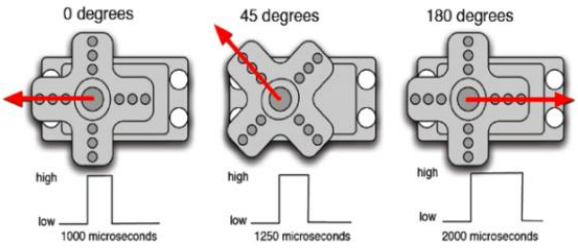


Fig.7 Servomotor Rotation

This means it would take nearly half a second to rotate an entire 180 degrees. More if the servo were under a load. This information is very important if high servo response speed is a requirement of your robot application. It is also useful for determining the maximum forward velocity of your robot if your servo is modified for full rotation. Remember, the worst case turning time is when the servo is at the minimum rotation angle and is then commanded to go to maximum rotation angle, all while under load. This can take several seconds on a very high torque servo.

*G. Conveyor Belt*

The conveyor motor receives power and signal from the central supply through rectifier and control circuit. The control circuit consisting of a potentiometer will allow the user to manually control the speed of conveyor belt by the regulatory knob. Polyester is used as a belt material. 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

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unpowered pulley is called the idler. There are two main industrial classes of belt conveyors; those in general material such as those moving boxes along inside a factory and handling such as those used to transport industrial and agricultural materials, such as grain, coal, ores, etc. generally in outdoor locations. Standard gravity conveyor frame are used overall. Conveyor frames are supplied with either butting plate (standard) or hook and bar attachments to secure each segment together. Standard frames are supplied in a hammer tone blue spray painted finish oats or conditions. Stainless steel rollers for wash-down or corrosive applications are used. Spring loaded axles slot into holes along the frame. This allows for easy replacement of damaged rollers. Heavy duty rollers are supplied with shafts. Precision or stainless steel bearings are available for frame work . Two types of standard supports are available. Both styles provide adjustment. Other support styles and complete frames are used to special support. RHS Supports are bolted to the underside of the conveyor frame via a crescent plate. This plate provides allowance for any angular misalignment. Pipe stands are also available for economy or for applications where the conveyor may be moved on a frequent basis. Normally, supports are only placed on every conveyor join 3 stands for 2frames [2].

## III. APPLICATIONS

The system has many applications in various fields, as this system provides the sorting of objects, in flow of objects by multisensing. Mainly this finds the important application in agriculture field where it can be used to sort the different agriculture products like grains, lemons, almonds, grapes, and many more. For human beings it becomes comber sum task to sort out the objects with high quality also the possibility of accuracy is less. In industry it can be used for sorting of various objects, tools, with high degree of accuracy and quality with an automation. By this way the proposed project can be used. It finds application in enormous way in agriculture, industry.

## IV. ADVANTAGES AND DISADVANTAGES

The main advantages of the proposed approach rely on the high discriminatory capacity of the object classes and on the high degree of parallelism, capable of processing large amounts of material on production lines. The use of modern electronic systems also allows high operative speed, easy calibration and flexibility (due to a programmable sorting algorithm) to the required classification features. It has high efficiency with higher quality of sorting. It has high sensitivity and ability to distinguish between the objects. It will be always better than human sorting. Some of the prominent advantages are-

- High efficiency: the sorting speed can be very high.
- High precision: the margin of error can be reduced to great extent.
- This type of sorter can be used for various objects or vegetables of different colors. Also suit to select pears, orange and other fruits of this kind.
- High degree of intelligence if used with PLC control. The machine with a high degree of intelligent , can control it.
- Good quality and low failure rate with long life.
- Reliable operation and maintenance.

## V. 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 and separates different objects using sensors. The sensor handling systems which drive the pick and place robot to pick up the object and place it into its designated place can work if accurately designed. There are two main steps in sensing part, objects detection and recognition. The system can successfully perform handling station task, namely pick and place mechanism with help of sensor. Thus a cost effective Mechatronics system can be designed using the simplest concepts and efficient result can be observed.

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**[7]** www.pdfgenicom/compacsort.com/sorters
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[**9]** www.google.com/ATMEGA 48A/PA/328/P/DATASHEET SUMMARY
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