Automatic Sorting of Monochrome Objects with a Robot
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Abstract— Repetitive tasks in production line can be executed using robotic manipulators, pick and place robots, and automated robots. Object sorting is one such task that is used to remove unwanted materials from production line with regard to removing defective end products. In certain industries, the transfer and sorting of heavy materials is carried out manually and if the transfer process is of a repetitive, the opera-tors fatigue is more. For such tasks, a pick and place robot will improve productivity and efficiency. The pick and place robotic arm is a mechatronics system that distinguishes black from white objects and after picking them, places them in selected locations. Detection is achieved through the use of two pair’s infrared sensors one for detecting the color of the object (black or white) and other pair for signaling the gripper mechanism to actuate.

Keywords — ARM Processor, IR sensors, Microcontroller (µC)

I. INTRODUCTION

Automation is the solution to the problem of relieving workers of fatigue from performing monotonous tasks. The pick and place automated sorting system is a microcontroller (µC) based mechatronics system. The concept of automated sorting is not new and has already found several applications in industrial manufacturing settings. The system used here focused on the use of a robotic arm to sort out objects by color identification. Such an arm might have distinct advantages over conventional systems such as an increased workspace or ability to place objects in a variety of different places. In addition, a modular gripper can be used to make this type of system helpful in more than one specific application. In implementing this system there were three major components to consider. One is the mechanical aspect and system hardware; it includes total hardware required to sorting system such as manipulator, conveyer belt, motors etc. The next major component was sensing. Sensing strategies will be reviewed and can be broken down into two main categories. One aspect was detecting the block on the conveyer belt. To detect the block an IR sensors are used. The next category of sensing is determining the reflective property, for this black and white color blocks are placed along the conveyer belt, it picks and places the block in one side of the conveyer when block is white and it places other side when it picks black color. The last component is software portion of the system. Use of embbeded technology makes this system efficient and reliable. µC (LPC2148) allows dynamic and faster control. Liquid crystal display (LCD) makes the system user friendly. Fig.1 shows the LPC2148 µC and it is the heart of the system as it controls all the functions.

Fig1: LPC2148 evolution working board

A geared DC motor with 100RPM is used to control the conveyer belt. Robotic free balance wheel is used to support the conveyer belt on the other end. Here we will be using picking arm using controller motor to pick the particular object from the belt and place it according to the color sensing. This machine sorter uses two regulated power supplies, one is regulated 12V for modules and other is 9v for µC (LPC2148) evolution board. 7809 and 7812 three terminal voltage regulators are used for voltage regulation. Bridge type full wave rectifier is used to rectify
the ac output of secondary of 230/18V step down transformer. The aim of this automation is to separate dark and light colored objects. A pair of IR sensors were used to transfer signals to the µC unit depending on the color of the ex-mined object. Algorithm for color recognition and object detection were developed based on the response of the IR sensors. The project is tailored to educational purposes and integrates science, technology, engineering and mathematical concepts.

II CONSTRUCTION OF THE SYSTEM

In manufacturing industries, the pick and place robot was invented to be used as hardware to solving and accomplishing most of that task that cannot be done by human being and also to be faster and pinch the product time.

A. Overview of System Hardware

The skeleton of the structure is built using pierced metal bars of 30 cm, which were properly connected using setscrews. Along with the metal construction we fixed the µC unit, a motor which sets in motion an attached conveyor belt, the IR sensors and a Geared motor, which controls the position of a manipulator (right-left). The machinery was placed on a wooden base 40x35cm, together with the regulated power supplies that provides energy for the µC (LPC2148) and the connected subsystems such as the motors. µC (LPC2148) collects the information from pair of infrared sensors and generates the control signals to gripper mechanism to actuate. A LCD display is provided to display cumulatively total number of objects sorted color wise. Pictures of the whole construction are shown in Fig.2

![Top view](image1)

B. Schematic of Sorting Machine

Automatic sorting of monochrome objects with a robotic system is built around ARM technology, which uses the LPC2148 controller is based on a 16/32 bit ARM7TDM-I-S™ CPU. By using GPIO pins of the controller, it can receive the signals getting from the IR sensor and thereby controlling the motor direction and speed by using H-Bridge. It also consists of: Obstacle sensor, Gripper Position Sensor, Conveyor belt, H-bridge Driver, DC Geared Motor, B/W sensor, Buzzer and LCD module.

Figure-3 below shows the overall schematic sorting system

![Schematic](image2)

C. The IR Sensors

The IR sensor mostly consists of an infrared light sensor and an infrared LED. It functions by illuminating a surface with infrared light; the sensor then picks up the reflected infrared radiation and, based on its intensity, determines the reflectivity of the surface. Lightly colored surfaces will reflect more light than dark surfaces; therefore, lightly colored surfaces will appear brighter to the sensor.

![Side view](image3)

**Fig2**: Top view and Side view of an automatic object sorting system
1. **IR TX & RX schematic for color identification**

   ![Fig.4 Schematic for color identification](image)

   In fig.4 IR RX output is connected to P0.10 of μC (LPC2148). When signal on this pin is high, it recognize object as white and increase the white count. When voltage on this pin is low, it recognize object as black and increase the black count.

2. **IR Transmitter and Receiver for object detection and for arm postion**

   ![Fig.5 IR TX & RX for object detection](image)

   In this 36 kHz 555 Timer designed to drive IR transmitter LED continuously over the TSOP17xx IR receiver. The active low output of TSOP1736 connected to port pin P0.11 of μC (LPC2148).

**D. The H-BRIDGE**

L293D is a dual H-Bridge motor driver, so with one IC we can interface two DC motors. L293D has output current of 600mA and peak output current of 1.2A per channel. Moreover for protection of circuit from back EMF output diodes are included within the IC. The output supply (VCC2) has a wide range from 4.5V to 36V, which has made L293D a best choice for DC motor driver. The ports P0.1 to P0.2 is shorted to H-Bridge L293d input pins In1 and In2 and port P0.3 and p0.4 to In3 and In4. The output ports Out1 to Out4 are connected to two pins of Geared DC motors each. L293D is used to drive the Geared DC motor in different directions.

A simple schematic for interfacing a Geared DC motor using L293D is shown Fig.6

**E. Interfacing Relay**

**Part no:** HFD27/005-S  
**Rating:** 2A, 30V, DC  
1A, 125V, AC

Relays are devices which allow low power circuits to switch a relatively high Current/Voltage ON/OFF. A relay circuit is typically a smaller switch or device which drives (opens/closes) an electric switch that is capable of carrying much larger current amounts. Fig.7 shows how to interface the relay to μC (LPC2148). There are 2 input channels. Each input is connected to the triggering coil of the respective relay. There are 2 output channels that each correspond to an input. When the input is energized, the relay turns on and the ‘+’ output is connected to +12v. When the relay is off, the ‘+’ output is connected to Ground. The ‘-’ output is permanently wired to Ground.

![Fig7: Interfacing the relay to μC (LPC2148)](image)
F. Interfacing schematic of LCD with LPC2148

Fig. 8 LCD interfacing
It consists of 2 Rows with 16 characters on each. It has a 16 pin Interface. Operates on 5V and has LED backlight. Works in 2 Modes: 1) **Instruction Mode**: Used for initializing and configuring LCD before we can use it & during operation. 2) **Data Mode**: Displays the respective characters for codes supplied to it via Data Pins. Now let’s see some of the important pins bef-ore we actually start writing programs for LCD: Contrast Voltage (VEE); **RS** – short for Register select (Control Pin): Used to switch been Instruction and Data Mode. RS = High for Instruction Mode and RS = Low for Data mode. **R/W** – Read or Write (Control Pin): R/W = High for Read Mode and R/W = Low for Write. Since we are going to use Write Mode only. **Enable** (Control Pin): This is similar to a trigger pin. Each Data/Instruction is executed by the LCD module only when a pulse is applied to enable pin.

III. THE PROGRAM

After having examined the hardware invol-ved in the design of this robotic sorter in previous section. This section gives the algorithm for the software that controls hardware. Fig 9 show the flowchart of the program used to sense, pi-ck up, and sort the blocks.

![Flowchart](image_url)

IV. RESULTS
Color of block = black; Size of block= 24mgr
- Throughput of robotic arm: Average count is 4.38 black objects per minute
• Color of object: White; block Size = 26mgr
• Throughput of robotic arm: Average count is 4.30 white objects per minute

V. CONCLUSION

This automatic object sorting system works successfully and separates mo-no-chrome objects using infrared sensors. The IR sensor result was converted chiefly to the command that drive the han-dling systems which drive the pick and place robot to pick up the object and place it into its designed place according to mono-chrome color. There are two main steps in sensing part, color identification and object detection. The system has successfully performed handling station task, namely pick and place mechanism with help of infrared sensor.

Thus a cost effective mechatronics system was designed using the simplest concepts and efficient result was being observed. This system is a depicting the prototype of sorting systems which are used in industries.

VI. REFERENCES:

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