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COLOR/METAL SENSING SORTING SYSTEM

Pankaj Agarwal, Ratnesh Kumar tiwari, Samardeep Banyal, Santosh Kanigicherla, Shivang Chaudhary
Department of Electronics and communication,
SRM Institute of Management & Technology,
SRM University, NCR Campus

Abstract —
This research paper is a work on automated material handling system. This paper aims at the problem we are attempting to solve is to create an autonomous robot that can identify objects when placed on the conveyor belt based on colour sensing and then sort by relocating them to a specific location. It synchronizes the movement of robotic arm to pick the objects moving on a conveyor belt. Also this system will use metal sensor, so that robotic system perform multi sorting and differentiate between metal/non-metal.

Keywords— Micro-controller; Robotic arm; Conveyor belt; Material handling system, DC-Motor; Sensors; Rejection counter.

I. INTRODUCTION

A robot can be defined as a programmable, self-controlled device consisting of electronic, electrical, or mechanical units. Robot is an integral part in automating the flexible manufacturing system that one greatly in demand these days. Robots are now more than a machine, as robots have become the solution of the future as cost labour wages and customers demand. Robot and automation is employed in order to replace human to perform those tasks that are routine, dangerous, complex and in hazardous area.[6] This article is based on the research project which is a fully automated material handling system to be use in industry. The most apparent reasons that are associated in installing of robotic systems in industry are;

1) Saving of manpower.
2) Improved quality & efficiency.
3) Increased consistency & flexibility.

Even though the cost of acquiring robotic system is quite expensive but as today's rapid development and a very high demand in quality with International Standard Organization (ISO) standards, human are no longer capable of such demands [14]. Research and development—of future robots is moving at a very rapid pace due to the constantly improving and upgrading of the quality standards of products.

This paper aims at fully automated material handling system. This can be done by using sensors interfaced with Micro Controller Unit. 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. This robot involves colour sensors that senses the object's colour and sends the signal to the microcontroller.

The microcontroller sends signal to eight relay 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.

II. METHODOLOGY

The pick and place robotic arm with conveyor belt is a system that detects the object on the conveyor belt, picks that object from source location and places at desired location based on colour identified or metal/non-metal. For detection of object, firstly infrared sensors are used which detect presence of object as the transmitter to receiver path for infrared sensor is interrupted by placed object. Also the colour of the object is detected by the colour sensor. Its metallic nature is detected by the metal detector. Now As soon as robotic arm receives the signal from the controller, it picks with end effectors and places it on the respective destination depending on the respective colour of the object that is red, green or blue. If another object causes interrupt, it again does the same job. The system uses AT89S52 Micro Controller Unit as its controller for performing different operations by the robot.

Also if the object does not meet required condition then it is rejected and put away from the conveyor belt.

Rejection conditions are:

1. Either fourth color is spotted.
2. Either object is not a metal.
3. Either object is RGB and metal both.

III. RESEARCH OBJECTIVES

The main objective for this study was:

a) To increase the manufacturing capacity for industries.
b) To increase the labour productivity by the redistribution of labourers in the industries.
c) Reducing the cost factor and handling time of a product.
d) To eliminate the manual based tasks and operations.

IV. INSTALLATION AND TECHNIQUES

1. Microcontroller

A micro controller is an inexpensive single chip computer. Single chip computer means that the entire computer system lies within the confines of the integrated circuit chip. The micro controller on the encapsulated sliver of silicon has features similar to those of our standard personal computer. Primarily, the micro controller is capable of storing and running a program. The micro controller contains a CPU , RAM, ROM , I/O lines, serial and parallel ports, timers and sometimes other built in peripherals as A/D (analog to digital) and D/A (digital to analog) converters[6].

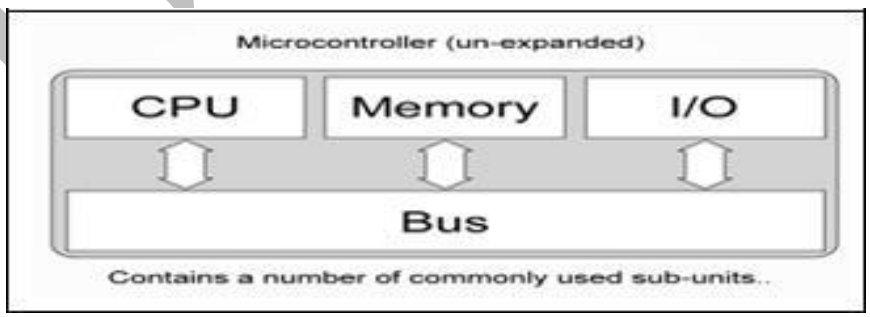

Fig - Basic Microcontroller

Most microcontrollers will also combine other devices such as;

I. A Timer module to allow the micro controller to perform tasks for certain time periods.

II. A serial I/O port to allow data to flow between the micro controller and other devices such as a PC or another micro controller.

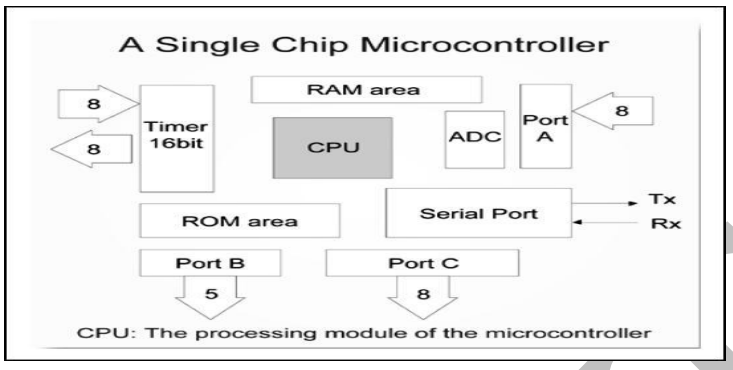

Fig - Microcontroller

The above figure illustrates a typical micro controller device and the different sub units integrated onto the micro controller.
8051 microcontroller has 128 bytes of RAM, 8K bytes of on-chip ROM, two timers, one serial port, and four ports (each 8-bits wide) all on a single chip. The 8051 is an 8-bit processor i.e. the CPU can work on only 8 bits of data at a time. The fixed amount of on-chip ROM, RAM, and number of I/O ports in microcontroller makes them ideal for many applications in which cost and space are critical [6].
Microcomputer with 8K bytes of Flash programmable and erasable read only memory (PEROM). The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional non-volatile memory programmer. By combining a versatile 8-bit The AT89S52 is a low-power, high-performance CMOS 8-bit CPU with Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcomputer, which provides a highly flexible and cost-effective solution to many embedded control applications.

Features:-
• Compatible with MCS-52™ Products
• 8K Bytes of In-System Reprogrammable Flash Memo.
• Fully Static Operation: 0 Hz to 24 MHz
• Three-level Program Memory Lock
• 128 x 8-bit Internal RAM
• 32 Programmable I/O Lines
• Two 16-bit Timer/Counters
• Six Interrupt Sources.

2. DC Motor
Direct current motor is designed to run on DC electric power. The pure DC designs are Michael Faraday's homo-polar motor (which is uncommon), and the ball bearing motor, which is so far a novelty [15]. The most common DC motor types are;

A. Brushed DC motors B. Brushless DC motors

A. Brushed DC motors: - The classic DC motor design generates an oscillating current in a wound rotor

with a split ring commutator, and either a wound or permanent magnet stator. A rotor consists of a coil wound around a rotor which is then powered by any type of battery. Many of the limitations of the classic commutator DC motor are due to the need for brushes to press against the commutator. This creates friction. At higher speeds, brushes have increasing difficulty in maintaining contact. Brushes may bounce off the irregularities in the commutator surface, creating sparks. This limits the maximum speed of the machine. The current density per unit area of the brushes limits the output of the motor. The imperfect electric contact also causes electrical noise. Brushes eventually wear out and require replacement, and the commutator itself is subject to wear and maintenance.

B. Brushless DC motors: - Some of the problems of the brushed DC motor are eliminated in the brushless design. In this motor, the mechanical "rotating switch" or commutator / brush gear assembly is replaced by an external electronic switch synchronized to the rotor's position [13]. Brushless motors are typically 85-90% efficient, whereas DC motors with brush gear are typically 75-80% efficient [13]. Midway between ordinary DC motors and stepper motors lays the realm of the brushless DC motor.

In this research project, Hosiden and Crouzet DC motors are used.

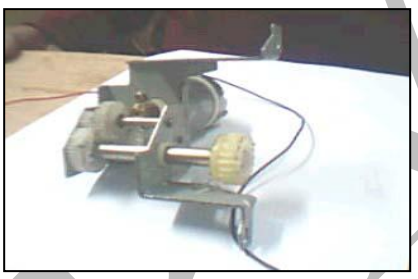

Fig - Hosiden DC motor

Fig - Crouzet DC motor

3. Conveyor Belt

The conveyor belt used here consists of two wheels which serve the function of pulleys, with a continuous loop of material—the conveyor belt—that rotates about them. One of the wheels is powered by a 75 rpm DC motor,

moving the belt and the material on the belt forward. Here, the conveyor motor receives power and signal from the central supply through rectifier and control circuit.

4. Robotic Arm

The work space of this arm is a circle in which it rotates to pick and place the job and position itself. The base of the arm is provided with a dc motor to rotate the arm; the motor rotates in both clockwise and anti clockwise directions to place the job. The motor is interfaced with the microcontroller and relay. The robotic arm movements are controlled by the DC motor of 75 rpm. Here micro controller controls the movement of the arm depending on the colour of the object (Red, Green or Blue) or metal object placed and relay drives it that is it supplies power to arm. When the job is picked up the arm moves through a particular angle to its left or right, if the colour of the job is red then the robotic arm moves towards its right with certain angle and releases the job at a particular place, if the colour of the job is blue then the robotic arm moves towards its right with an angle more than that of red and releases the job at a specified place, if the colour of the job is green then the robotic arm moves towards right by an angle fixed by limited switch, if the job is a metal object then robotic arm moves towards left by angle fixed by limited switch . Once it releases the job, the robotic arm automatically comes back into its initial position with the help of interrupter onto the conveyor to pick up another object.

5. Gripper

24.5 V, 75 rpm, DC motor is used to control the gripper movement, for opening and closing of the gripper. The DC motor receives its signal from the controller for performing gripping and dropping operations. The gripper has been specially designed in order to grip rectangular or square objects from the running conveyor and dropping them at programmed locations. An industrial robot is defined as automatically controlled, reprogrammable, multipurpose manipulator programmable required axes. The parameters such as Degree of freedom, Work Volume, Payload, accuracy, repeatability, acceleration and robot kinematics are considered before designing the robotic arm.

6. Transformer

Usually, DC voltages are required to operate various electronic equipment and these voltages are 5 V, 9 V, 12 V or 18 V. But these voltages cannot be obtained directly. Thus the A.C input available at the mains supply, i.e., 230 V is to be brought down to the required voltage level. This is done by a transformer. Thus, a step down transformer is employed to decrease the voltage to a required level.

7. Infrared LED Sensors (IR Sensors)

An Infrared sensor is an electronic device that measures infrared (IR) light radiating from objects in its field of view. IR sensors are often used in the construction of IR-based motion detectors apparent motion is detected when an infrared source with one temperature, such as a human, passes in front of an infrared source with another temperature, such as a wall. It is the same principle in all Infra-Red proximity sensors. The basic idea is to send infra red light through IR-LEDs, which is then reflected by any object in front of the sensor. Then all one have to do is to pick-up the reflected IR light. For detecting the reflected IR light that was emitted from another led of the exact same type. This is an electrical property of Light Emitting Diodes (LEDs) which is the fact that a led produces a voltage difference across its leads when it is subjected to light. As the name implies, the sensor is always ON, meaning that the IR led is constantly emitting light. This design of the circuit is suitable for counting objects on the conveyor belt. However this design is more power consuming and is not optimized for high ranges in this design, range can be from 1 to 10 cm, depending on the ambient light conditions. As one can see the schematic is divided into 2 parts the sender and the receiver.

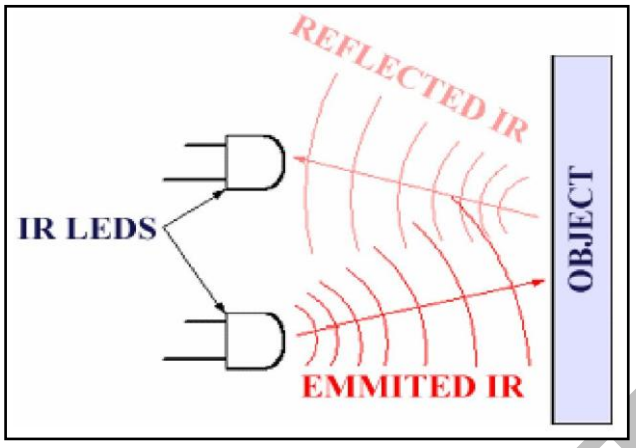

Fig - IR Sensor

IR Transmitter

TSAL6200 is a high efficiency infrared emitting diode in GaAlAs on GaAs technology, moulded in clear, blue grey tinted plastic packages [14]. In comparison with the standard GaAs on GaAs technology these emitters achieve more than 100% radiant power improvement at a similar wavelength. The forward voltages at low current and at high pulse current roughly correspond to the low values of the standard technology. Therefore these emitters are ideally suitable as high performance replacements of standard emitters.

Features

a) Extra high radiant power and radiant intensity.
b) High reliability.
c) Low forward voltage.
d) Suitable for high pulse current operation.
e) Standard T-1¾ (□5 mm) package.
f) Angle of half intensity □□= ± 17°.
g) Peak wavelength □p = 940 nm.
h) Good spectral matching to Si photo detectors.

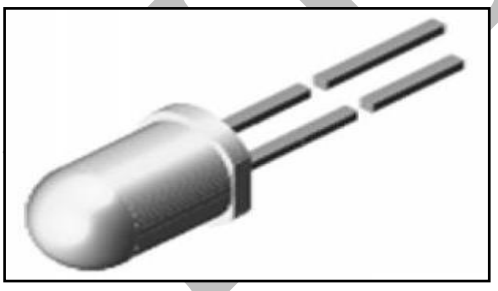

Fig. - IR Transmitter

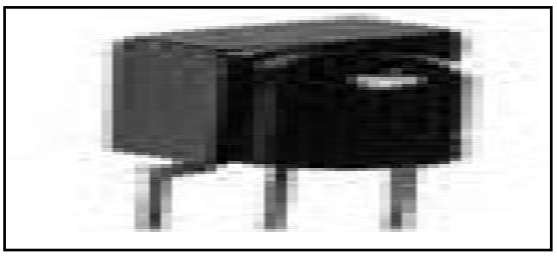

Fig. - IR Receiver

IR Receiver

The TSOP17-series are miniaturized receivers for infrared remote control systems. PIN diode and preamplifier are assembled on lead frame, the epoxy package is designed as IR filter. The demodulated output signal can directly be decoded by a microprocessor. TSOP17XX is the standard IR remote control receiver series, supporting all major transmission codes [14].

Features

a) Photo detector and preamplifier in one package.

b) Internal filter for PCM frequency.
c) Improved shielding against electrical field disturbance.
d) TTL and CMOS compatibility.
e) Output active low.
f) Low power consumption.
g) High immunity against ambient light.
h) Continuous data transmission possible (up to 2400 bps).
i) Suitable burst length 0.10 cycles/burst.

8. Colour sensor:

TCS3200 Colour Sensor is a complete colour detector, including a TAOS TCS3200 RGB sensor chip and 4 white LEDs. The TCS3200 can detect and measure a nearly limitless range of visible colours. Applications include test strip reading, sorting by colour, ambient light sensing and calibration, and colour matching, to name just a few.

The TCS3200 has an array of photo detectors, each with either a red, green, or blue filter, or no filter (clear). The filters of each colour are distributed evenly throughout the array to eliminate location bias among the colours. Internal to the device is an oscillator which produces a square-wave output whose frequency is proportional to the intensity of the chosen colour.

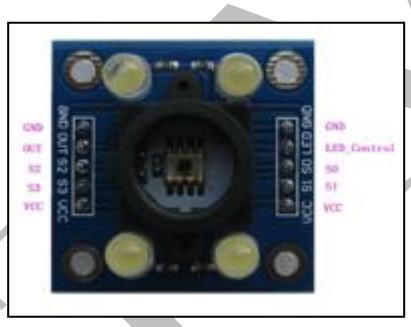

Fig. - Colour Sensor

Specification:

- baby size: 3 CM * 2.7 CM (length-width).
- Interface definition: VCC GND power supply.
- SO - S3 E0 OUT communication interface.
- Plate load TCS3200 colour sensor.

support 3 v - 5 v voltage input;

- chip pin all have eduction, pin for the standard 100 mil (2.54 mm), convenient for lattice board
- Module testing all sorts of colour has certain off colour; to the colour test requirements are high please careful consideration to buy

- TCS3200 and to test the best object distance is about 1 cm.

9. Metal Sensor:-

Metal sensor uses a detecting circuit in which EMF is produced if the passing object is a metal and no EMF produced in case of non-metal. The metal detecting circuit used here is of vegakit.

10. Relays:-

A relay is an **electrically operated switch**. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are **double throw** (**changeover**) switches.

Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.
The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the popular 555 timer IC is 200mA so these devices can supply relay coils directly without amplification. ULN 2003 circuit board is used in this research project.

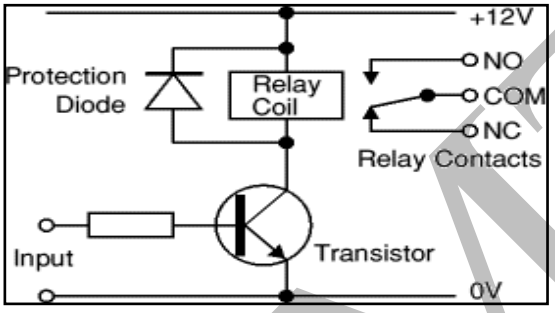

Fig. - Relay

11. Rejection unit:-

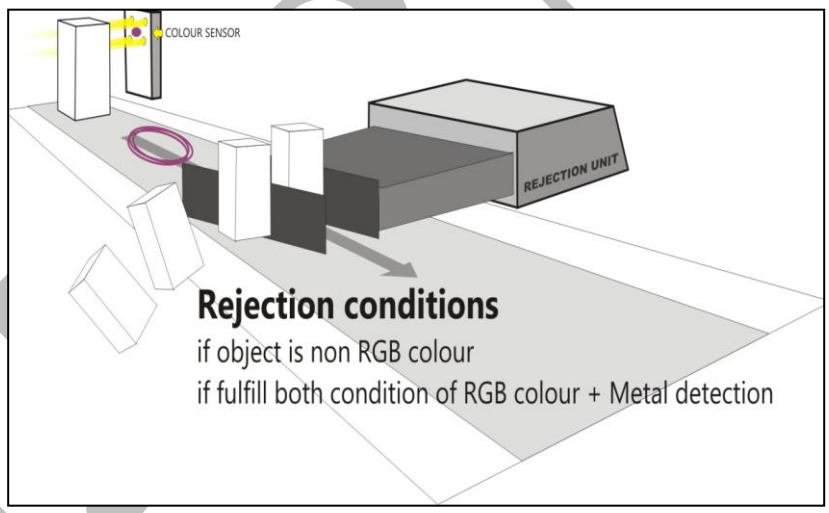

Fig. - Rejection Unit

This layout tell about the rejection conditions that are to be considered by the rejection unit before reaching the robotic arm.
Conditions are :
1. Either fourth color is spotted.
2. Either object is not a metal.
3. Either object is RGB and metal both.

There is an IR sensor present infront of rejection unit gives an low signal whenever object passes through rejection unit,due to this there is a requirement of IR amplification circuit to amplify the signal.

V. BLOCK DIAGRAM

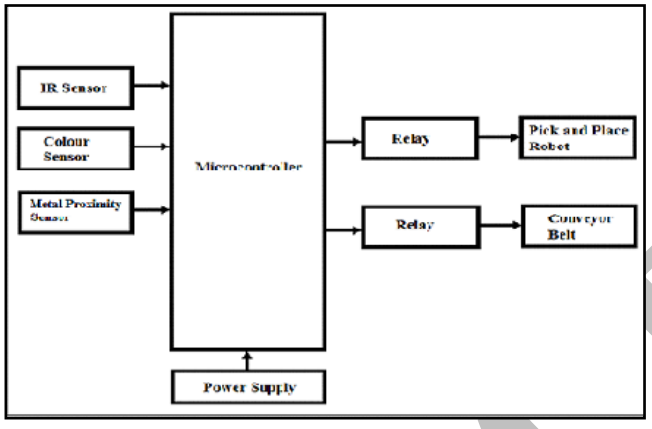

Fig - Block Diagram

VI. MODEL AND DESIGN

1) Layouts of Project:

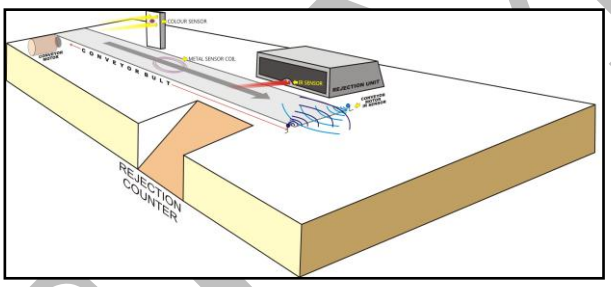

Fig - Basic layout of Project

This figure just shows the basic idea of the project. Here, it shows the conveyor belt.Along with that the position of the color sensor which will detect the color of the object. Also there is a metal sensing coil after the color sensor for the detection of metal / non-metal. Also there is an IR sensor for the detection of object . Also there is a rejection unit which will reject the non- metal and any unwanted color.

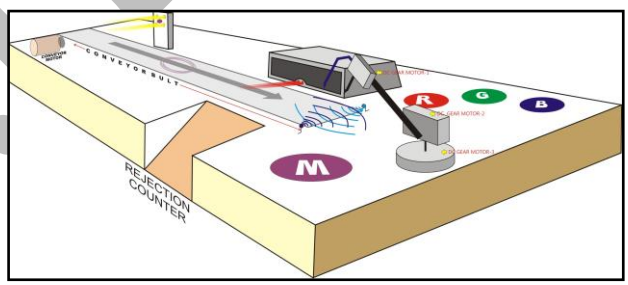

Fig - Full layout of Project

This diagram is the Full layout of the model of project . This layout contains the position of the robotic arm at one of the edge of conveyor belt. This layout also shows the position os the pre defined places for placing the objects according to the differenr sensed colors and also the its nature whether metallic / non-metallic.

VII. CIRCUIT DIAGRAMS

a) Main Controlling Circuit

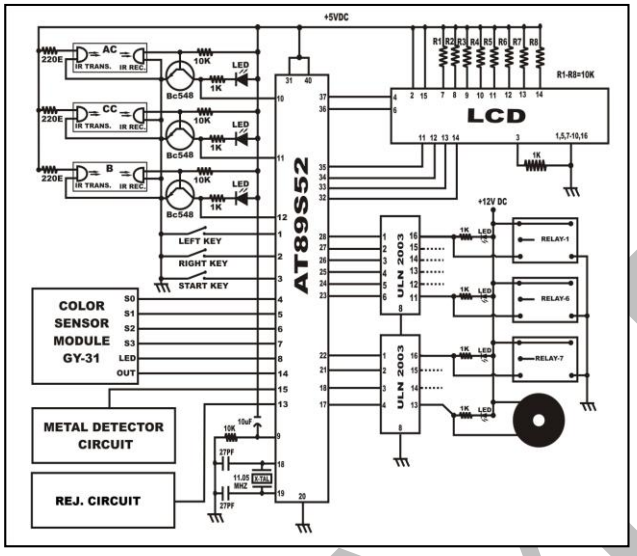

Fig - Controlling Circuit

b) Metal Detector Circuit

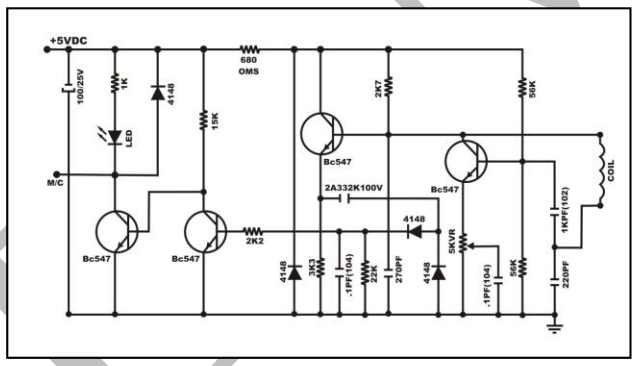

Fig - Metal Detector Circuit

c) IR Amplifier Circuit at Rejection Unit

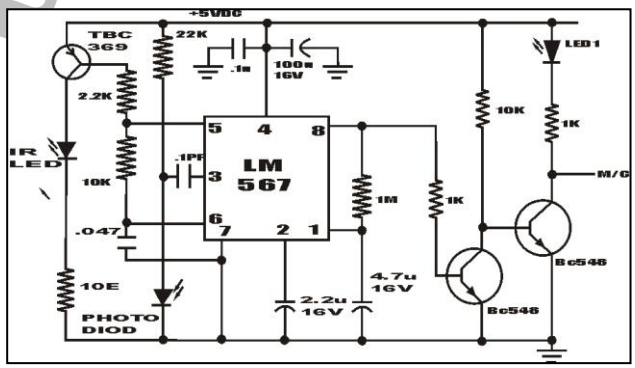

Fig - IR Amplifier Circuit at Rejection Unit

VIII. RESULTS

This project involves sorting of objects through colour sensors and metal sensor in addition. The research project successfully carry out the task of identifying the colour of object and whether it is metal or non-metal and place those at the pre programmed places and rejects if the conditions are not met. This method is verified to be highly beneficial for automated industries. The sensor is key component of project which aides in distinguishing the objects. Failing of which may result in wrong material handling. Thus it becomes vital that the sensor had a very high sense of sensitivity and ability to distinguish between colours.

IX. APPLICATIONS

1. Used in Packaging Industry.
2. For handling of biomedical waste bags.
3. At Airports and metro stations.

X. FUTURE IMPLEMENTATIONS

This project involves the sorting of objects through colour sensors the future cements can be done by increasing the efficiency of the colour sensor.

Another area of improvement is that it is designed to follow voice commands or gesture control.

Other improvement can be done by using camera and Digital Image Processing (DIP). MATLAB is the software environment for research and automation using DIP. This will give an extra edge to by processing in the real time.

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