International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Efficient Movement of Robotic Arm to Enhance Object Handling and Sorting Operation

Vikas Gulia [1], Venkanna Mood[2]

[1]Student, Department of ECE, St. Martin's Engineering College, Dhullapally, Hyderabad

[2]Associate Professor, Department of ECE, St. Martin's Engineering College, Dhullapally, Hyderabad

Abstract: ***In robotics, for accomplishing simple and complex tasks, manipulation is a very important aspect. Manipulation is achieved by different movement of the robotic arm. Here we are trying to design a Robotic Arm based on robotics arm concept to perform heavy task and lift weight using less power and efficient handling. In this abstract we are implementing some technique to automatically sense the object and perform relevant task on it. Some of the input technique used in this paper are object sensing based on color and shape using sensors. Robotic arm movement is achieved using DC geared motors attached in different directions and angle. Each geared DC motor act as joint and helps in providing various movements to different directions. . Microprocessor controls the movement of the robotic arm by sensing the position and location of the object in the 3d space with the help of IR sensor and color sensor (object color detection, identification and interpretation). Knowing the location of the object we can then easily orient the arm to pick the object. The robotic arm picks the object and place it elsewhere in the vicinity of the arm. Thus, enabling the robotic arm capable of picking and placing the objects in the sequence based on the input and object sensed. The robotic arm is independent and can be integrated with other modules. We are using geared DC motor rather than servo motor to increase the angular rotation of the arm. DC motor are easy to interface and maintain as compared to servo motors. This whole setup consume less power and provide efficient working by using various modes.***

Keyword: Robotic Arm,Microprocessor, Color sensing and recognition, IR sensor, L293D Motor Driver

1. Introduction

The Project deals with an independently automated material handling and sorting system. It relates to an apparatus and method to sense the presence of object, identify process and sort it. Our paper basically propose a multi-sensorial architecture for analysis and process. Our apparatus sense the object approaching the Arm over conveyer belt setup and accordingly synchronizes the movement of robotic arm to pick and place it The apparatus basically deals with the classification and sorting of different colored object by picking and placing them in its respective place as pre-allocated in the code. Thereby eliminating the monotonous work done by human, achieving accuracy and speed in the work.

Based on the object detection and color recognition of the object, the processor sends signal to motor driver circuit which drives the 3 motors setup of the robotic arm to grip the object and place it in the pre-allocated location, releases the object and comes back to the original position. The object is sensed using an IR obstacle sensor. The optical sensor is the combination of an infrared sensor & a photo-transistor. When the object cuts the infrared lights passed to the photo-transistor we get a square wave output signal on the output stage of sensor the digital signal is then applied to the processor [1]. The microprocessor reads the data and gives the proportional signal received from the process and displayed in the LCD. The basic firmware for the processor is written in Embedded C language. The system also uses comparator circuit to compare and detect the obstacle and alerts through buzzer alarm system. The system uses DC motor for the movement of conveyer belt and for picking the objects of same color at one place with a particular angle.

The Project circuitry consists of ARM 11 32-bit RISC microprocessor [11] [13], color identifier sensor, LCD, IR obstacle sensor, regulated power supply circuit. The system also uses DC motor to operate the conveyer belt. It alerts the user when the object is detected using IR obstacle sensor. Using the color identifier sensor, the system can detect the color of the object and identifies the color. The processor is used to calculate the no of objects, which is programmed & stored in `C` language. The number of objects are counted by the microprocessor is displayed on the LCD display.

2. System architecture and Module Interface

The fig.1 below shows the module interface and system architecture of the apparatus. The main aim of this paper is to demonstrate a method to sense then pick and place as designated place by identifying the object coming on conveyer belt.

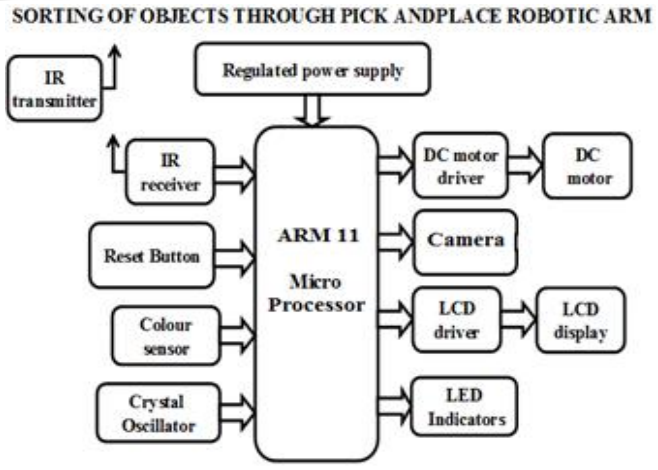

Figure 1: Overall Module Interface and System Architecture of the Robotic Arm

2.1. Regulated Power Supply

Power supply is a supply of electrical power which can be either battery power or direct AC supply. The power supply provided to the system is from 9V-12V. Generally this power is derived from AC lines by converting it into regulated low power DC lines. This regulated supply mainly used to give the power to DC Motors and conveyer belt.
The basic circuit diagram of a regulated power supply (DC O/P) with led connected as load is shown in fig2

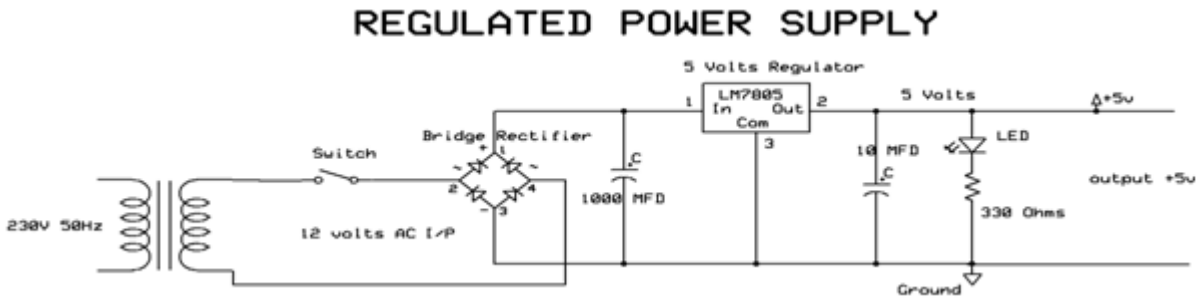

Figure 2: Circuit diagram of Regulated Power Supply with Led connection

The components mainly used in above figure are

- 230v ac mains
- Transformer (center tap step-down transformer)
- Bridge rectifier(diodes)
- Capacitor
- Voltage regulator(IC 7805)
- Resistor
- Led(light emitting diode)

2.2. Processor: Arm 11 Raspberry Pi microprocessor

The Raspberry Pi (here onward will use R-Pi) has a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZF-S 700 MHz processor (The firmware includes a number of "Turbo" modes so that the user can attempt over clocking, up to 1 GHz, without affecting the warranty), VideoCore IV GPU, and RAM size of 512 MB. It is a 32-bit RISC architecture based processor. It does not include a built-in hard disk or solid-state drive, but uses an SD card for booting and long-term storage.In addition to the familiar USB, Ethernet and HDMI ports, the R-Pi offers lower-level interfaces intended to connect more directly with chips and subsystem modules. These GPIO (general purpose I/O) signals on the 2x13 header pins include SPI, I2C, serial UART, 3V3 and 5V power. These interfaces are not "plug and play" and require care to avoid mis-wiring. The pins use a 3V3 logic level and are not tolerant of 5V levels, such as you might find, for example, on a 5V powered Arduino. CSI (camera serial interface) can be used to connect the 5 MP camera available.

2.3. Belt conveyor

A conveyor belt designed for our apparatus consists of a flat belt running over rollers. The roller are independent of each other. We are utilises the setup in order to check the efficiency and proficiency of the apparatus to sense the continuously fast coming object and is ideally suited to irregular shaped product that cannot easily be movedon other conveyor styles in big manufacturing industries. Belt conveyors provide a smooth solution for situations where one need a change in elevation— for example inter floor situations or to receive or deliver products to a mezzanine level. Besides the obvious benefits of increased efficiency, convey or scanserve to decrease the time of transport from one place to another. The use of automated production lines allows individual parts to be moved to and from automated machinery, reducing the time and hard work of worker.

2.4. Robotic Arm

Robotic arm is hardware part made up of light steel having 3 joints. A separate gripper is attached to pick the object at the third joint. The robotic arm is equipped with DC motor which give 2 dimensional translational motion of horizontal and vertical axis. DC motors which act manipulator in robotic arm is connected to motor driver IC (L293D). This IC convert the current into equivalent power and send to the respective motor. The Motors give the motion up to a distance of 15cm. (This length can varied as per requirement). The Program is the processor will choose the particular motor based on the movement.

2.5. Sensor

The sensor network implemented to get the movement of the robotic consist of mainly IR sensor for object(known as obstacle) detection and camera sensor for detection of the color of the object. The IR sensor detects the presence of the object and color sensor detects the object color based on RGB spectrum. This criteria sets the classification of choosing the specific object from the arrived object on the conveyer belt. The trajectory for the robotic arm is set by the IR sensor and camera [5]

3. Working Algorithm

The algorithm to handle the movement of the robotic is very simple. At any instant no two motor will run, there will be only one motor which will run. This reduce the code complexity and processor overhead. In Code, it can be shown as:

```
If (vertical_movement) {
Motor1=ON;
Motor2=OFF; }
Elseif (horizontal_movement) {
Motor1=OFF;
Motor2=ON; }
Else {
Motor1=OFF;
Motor2=OFF; }
```

Since Processor give us the ability of multi-tasking, so we are using 3 three process i.e. continuously monitoring the incoming object if any, managing robotic arm movement, processing the object received from different sensor. The processor GPIOs will manage the sensor data and convert it readable form. This way the whole process work parallel increasing the efficiency.

The algorithm allow the use two motor for movement. The robotic arm reach to object based on this vertical and horizontal movement. The object is then pick by the gripper which is handled by separate dedicated motor. The gripper is handled as per the sensor data received by the processor. If the object is in the vicinity of the gripper. As per the sensor data, then the gripper will pick else it will wait for the object to come in the vicinity. The gripper is designed such that it can hold any type of object. The gripper can open maximum upto 7cm. The gripper is made up of plastic with zig-zag teeth structure in the mouth to get better grip on the object. The robotic arm is light in size and oriented such that it will cover a circular segment of 250° in the horizontal plane. The 2 degree of freedom handled by the motor gives the movement is restrict the movement of the robotic arm upto 120° in the vertical plane. Here the conveyer belt is so sync that the object arrived on it will be properly in the vicinity of the robotic arm. The robotic arm will move on predefined trajectory as the program.

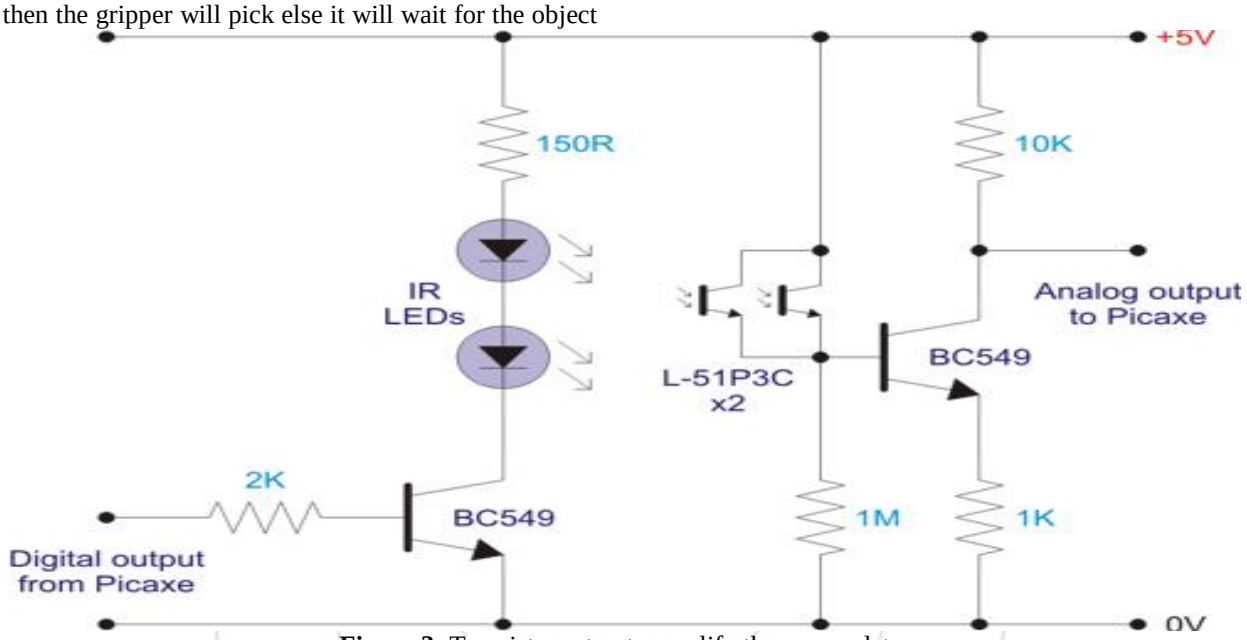

Figure 3: Transistor setup to amplify the sensor data

3.1. Sensors:

3.1.1. IR Sensor

This sensor is a short range obstacle detector with no dead zone. It has a reasonably narrow detection area which can be increased using the dual version. Range can also be increased by increasing the power to the IR LEDs or adding more IR LEDs.

A simple Test setup can be made with enhanced power and more range to cover the detection of object. To do so,some IR LED's (dark blue) acting as a light source and two photo-transistors in parallel for the receiver, must be used. You could use one of each but I wanted to spread them out to cover a wider area. It output range of about 10-15cm (4-6 inches) with my hand as the object being detected.

From the left, two IR LEDs are connected with a resistor and transistor in series. The transistor act as switch for the processor to turn the LEDs on or off. This is necessary in order to tell the difference between the ambient IR from daylight and indoor lighting and the reflected light from the LEDs that indicates the presence of an object. The two photo-transistors in parallel are then connected with a 1MΩ resistor in series. Because of this, even a small increase in current will create a reasonable increase in voltage across the 1MΩ resistor. Unfortunately the low input impedance of many AD converters will act like a small resistor in parallel with the 1MΩ resistor and dramatically reduce the output to the processor. The solution to this problem is BC549 transistor as shown in fig. 3BC549 transistor will amplifies the signal and send it to the processor. BC549 transistor had an hfe of 490 when measured with a multimeter. (NOTE: You should probably have an hfe of at least 200-300.)

3.1.2. Color Identification Sensor

The RGB color model is an additivecolor model in which red, green, and blue light are added together in various ways to reproduce a broad array of colors. RGB is a *device-dependent* color model: different devices detect or reproduce a given RGB value differently, An RGB LED have one each of red, green, and blue LED element crammed in one package. These three LEDs share the same positive (anode) terminal. To control each color, simply connect its cathode pin to ground (usually through a resistor), and it will light up.

The color sensing circuit of the project contains three different colored LED emitter and three separate receivers. The light is reflected off of the target and returns to the sensor. The receivers are tuned to look for a specific wave length of light working out its RGB values [3].The sensor then compares these values to the settings on the Processor to determine the necessary action. In this process, LDRs helps in checking the presence of light. The LDR act as high

resistance device in the absence of light. This prevents current from flowing to the base of the transistors. Consequently the LED does not light. When light shines onto the LDR its resistance falls and current flows into the base of the first transistor and then the second transistor [2] [4].

The object whose color is required to be detected should be placed in front of the system. When reflected light rays from the object fall on the gadget, the colored filter glass plates determine which of the LDRs would get triggered.

3.2. D.C. Motor

A dc motor uses electrical energy to produce mechanical energy, very typically through the interaction of magnetic fields and current-carrying conductors. The input of a DC motor is current/voltage and its output is torque (speed).

DC Motor Driver

The L293 and L293D are half H bridge quadruple IC capable of providing high-current. We used the L293Ddriver IC as shown in fig 4to drive the DC motor which is designed to provide bidirectional movement. It can drive currents of up to 600-mA at voltages from 4.5 V to 36 V. All inputs of L293D are TTL compatible. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo-Darlington source. The interface sample is shown in fig.5.When the enable input pin of the IC is low, those drivers are disabled and their outputs are off and in the high-impedance state. With the proper current –voltage combination at inputs, each pair of drivers forms a full-H (or bridge) reversible drive(in both direction) suitable for solenoid or motor applications. A Vcc1 terminal, separate from Vcc2, is provided for the logic inputs to minimize device power dissipation. The L293D are characterized for operation from 0°C to 70°C.

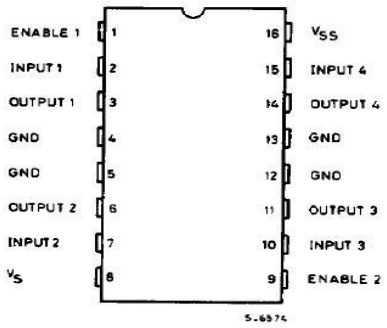

Figure 4: L293D pin configuration

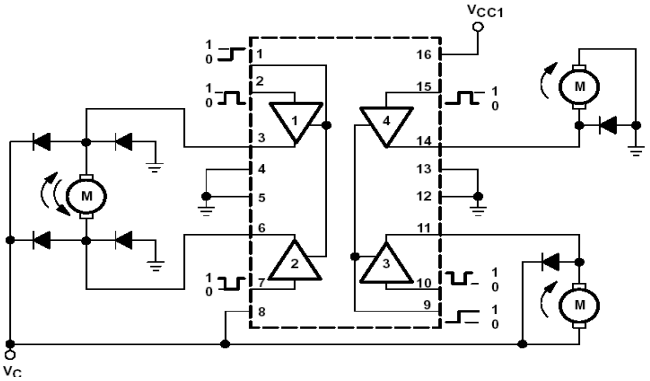

Figure 5: L293D motor interface

4. Application

This prototype finds it application mainly in the manufacturing and packaging industries where odd/not relevant product must be removed from main line of packaging. 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. This prototype is not only limited to any particular industry, it can used in other type of manufacturing and development facilities can find better usage [6].

5. Conclusion

The system has been successfully designed and it has the capability to rotate 230° and detect, identify and recognize and lift and place the required task. It can take specific colored object, hold it and put it to a pre-designated place using RGB color sensor. Color sensing section performed two main tasks; object's detection and color identification and recognition. System is fully automated and can pick objects of 250 gm weight without and instability. The cost effective system was designed to perform the continuous and reliable tasks without human errors using the simplest concepts. The robotic sorting systems are useful in industries and different household activities. Since this system is mainly controlled and processed by the ARM 11 microprocessor the results obtained are more reliable and faster.

Reference

[1] Vishnu R. Kale, V. A. Kulkarni - "*Object Sorting System Using Robotic Arm*", pp-3400, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE) Vol. 2, Issue 7, July 2013;

[2] Uzma Amin, Ghulam Ahmad, NudratLiaqat, Manzar Ahmed, SumbalZahoor - "*Detection & Distinction of Colors using Color Sorting Robotic Arm in a Pick & Place Mechanism*", pp- 1164, International Journal of Science and Research (IJSR), Volume 3 Issue 6, June 2014;

[3] Carlos Astua, Ramon Barber, Jonathan Crespo and Alberto Jardon - "*Object Detection Techniques Applied on Mobile Robot Semantic Navigation*", pp-6734-6757, Sensors Magazine 2014, 14;

[4] M.Z.A Rashid, H.N.M Shah, H.I Jaafar, M.S.M Arasand S.K.S Nordin - "*Sorting and Retrieval Robotic System Controlled via Programmable Logic Controller for Library Usage*" pp.19-30, International Journal of u- and e-Service, Science and Technology (IJUESST) Vol.7, No.4 (2014);

[5] ManojSabnis, Vinita Thakur, RujutaThorat, GayatriYeole and Chirag Tank - "*Object Sorting In Manufacturing Industries Using Image Processing*"- pp-119, International Journal of Computer Engineering and Applications (IJCEA), Volume IX, Issue V, May 2015

[6] Pankaj Agarwal, Ratnesh Kumar tiwari, SamardeepBanyal,Santosh Kanigicherla, Shivang Chaudhary – "*Color/Metal Sensing Sorting System*"-pp-168 International Journal Of Engineering Research & Management Technology(IJERMT), March 2014 Volume 1, Issue 2
[7] Andren, Gerald B., "*Robot Design Handbook*", SRI International,Mitsubishi Electric Company, 1988.
[8] Maloney, Timothy, "*Industrial Electronics*", 7th edition, TintPrinting, Health Company, 1995.
[9] Montecastro, Anna Marie N., "*Info Net Magazine*", 2nd quarterissue, Vol. 8, 2000
[10] Rehg, James, "*Introduction to Robotics*", Prentice Hall, Inc.,Englewood Cliffs, New Jersey, 1988.
[11] https://www.raspberrypi.org/
[12] https://www.raspberrypi.org/learning/demo-programs/
[13] https://www.raspberrypi.org/wp-content/uploads/2012/02/BCM2835-ARM-Peripherals.pdf
[14] http://www.wikipedia.com/raspberry-pi

Author Profile

Vikas Gulia (2013-15): pursuing his M.tech in Embedded System Design form St. Martin's Engineering College affiliated to Jawaharlal Nehru Technical University (JNTU) Hyderabad. He completed his BTech in electronics and communication from VTU Belgaum.

Venkanna Mood: pursuing his Ph.D in Embedded Systems from Osmania University. He completed his M. Tech and B. Tech from Jawaharlal Nehru Technical University (JNTU) Hyderabad in 2003 and 2008 respectively. He is associate professor in St. Martin Engineering College and has a teaching experience of 10 yrs. He published in many international journals.