Design of An Advanced Object Color Sorting Moving on Conveyor Belt Using Arm 7 and Mat lab

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Abstract-

The advent of new high-speed technology and the growing computer Capacity provided realistic opportunity for new robot controls and realization of new methods of control theory. This technical improvement together with the need for high performance robots created faster, more accurate and more intelligent robots using new robots control devices, new drivers and advanced control algorithms. This project describes a new economical solution of robot control systems. The paper deals with an automated material handling system. It synchronizes the movement of robotic arm to pick the objects moving on a conveyor belt. It aims in classifying the colored objects which are moving on the conveyor by picking and placing the objects in its respective pre programmed place. The main aim of the system is to sort the objects using MATLAB image processing technique interfaced with PC and it is also used to count the number of objects using IR obstacle sensor and displayed it on to the LCD. The system also uses IR obstacle sensor for object presence detection. The color sorting implementation is done using a web camera which is interfaced with computer using MATLAB image processing technique. Thereby eliminating the monotonous work done by human, achieving accuracy and speed in the work.

Index terms: Web camera; MATLAB; conveyor belt; Robotic arm; ARM microcontroller

I.INTRODUCTION

Automation has created a bigger hype in the electronics. The major reason for this hype is automation provides greater advantages like accuracy, energy conversation, reliability and more over the automated systems do not require any human attention. Any one of the requirements stated above demands for the design of an automated device. The energy conversation is very important in the current scenario and should be done to a maximum extent where ever it is possible. A robotic arm is a robot manipulator, which can perform similar functions to a human arm. Robotic arms are the vital part of almost all the industries. In industries, a robotic arm performs various different tasks such as welding, trimming, picking and placing etc. Moreover the biggest advantage of these arms is that it can work in hazardous areas and also in the areas which cannot be accessed by human. For example in NASA’s mission to Mars, the Spirit and Opportunity drone. It is also used to implement highly precise medical treatments etc. Many variants of these robots/robotic are available or designed as per the requirement and few variants are preprogrammed controlled, Keypad Controlled, Voice Control, Gesture Control, etc. However, most of the industrial robots are still programmed using the typical teaching process which is still a tedious and time-consuming task that requires technical expertise. Therefore, there is a need for new and easier ways for programming the robots.

Fig-1 Image of Object handling robot arm model

High speed pick and place robots take product from one location to another with pinpoint accuracy. Human pick and place applications can require motion
over a long duration resulting in possible ergonomic issues. High-speed pick and place robots can provide increased efficiency as well as decreased production costs and ergonomic issues. The proposed model drives the various motors of the robotic arm to grip the object and place it in the specified location. Based upon the color detected, the robotic arm moves to the specified location, picks the respective colored object and releases the object at some particular preprogrammed angle and comes back to the original position. The microcontroller reads the data and gives the proportional signal received from the process. The basic firmware for the microcontroller is written in Embedded C language. The system uses DC motor for the movement of conveyor belt and servomotor for picking the objects of same color at one place with a particular angle.

Conveyors offer a wide range of benefits, many of which are readily apparent. Before the invention and implementation of conveyors, warehouse and factory workers needed to physically travel with an object from place to place. Not only was this cumbersome for the employee, it was inefficient for the company and, essentially, a huge waste of time. The conveyor brings a project to the worker, rather than a worker having to travel to a project. Conveyors can be used to transport parts to workers or locations throughout a plant or warehouse and, eventually, to the shipping dock for delivery.

Besides the obvious benefits of increased efficiency, conveyors can serve to increase quality control at a manufacturing or storage location. The use of automated production lines allows individual parts to be moved to and from automated machinery, allowing workers who were once designated to transporting parts to perform tasks that cannot as easily be automated, such as quality control or supervision/management processes. In addition, conveyors can increase the safety of a facility. Specialty conveyors are designed to transport heavy or hazardous products, keeping workers out of harm's way. The history of conveyor belts begins in the latter half of the 17th century. Since then, conveyor belts have been an inevitable part of material transportation. But it was in 1795 that conveyor belts became a popular means for conveying bulk materials. In the beginning, conveyor belts were used only for moving grain sacks to short distances. The conveyor belt system and working were quite simple in the early days. The conveyor belt system had a flat wooden bed and a belt that traveled over the wooden bed. Earlier, conveyor belts were made of leather, canvas or rubber. This primitive conveyor belt system was very popular for conveying bulky items from one place to another. In the beginning of the 20th century, the applications of conveyor belts became wider. Hymle Goddard of Logan Company was the first to receive the patent for the roller conveyor in 1908. The roller conveyor business did not prosper.

Fig-2: Figure of a conveyor belt Set up for the proposed model

II. RELATED WORK:

The objective of the proposed system is to design an colored object sorting using robotic arm. Today, due to technological advances of robotic applications in human life, it is necessary to overcome natural and virtual obstacles such as to the motion of such robots for picking and placing objects. A conveyor belt is the carrying medium of a belt conveyor system (often shortened to belt conveyor). A belt conveyor system is one of many types of conveyor systems. A belt conveyor system consists of two or more pulleys (sometimes referred to as drums), with an endless loop of carrying medium—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 pulley. There are two main industrial classes of belt conveyors; Those in general material handling such as those moving boxes along inside a factory and bulk material handling such as those used to transport large volumes of resources and agricultural materials, such as grain, salt, coal, ore, sand, overburden and more. Today there are different types of conveyor belts that have been created for conveying different kinds of material available in PVC and rubber materials. The belt consists of one or more layers of material. Many belts in general material handling have two layers. An under layer of material to provide linear strength and shape called a carcass and an over layer called the cover. The carcass is often a woven fabric having a warp & weft. The most common carcass materials are polyester, nylon and cotton. The cover is often various rubber or plastic compounds specified by use of the belt. Covers can be made from more exotic materials for unusual applications such as silicone for heat or gum rubber when traction is essential.

The object presence is sensed using an IR obstacle sensor. The optical sensor is the combination of an infrared sensor & a phototransistor. When the object cuts the infrared lights passed to the phototransistor we get a square wave output signal on the output stage of sensor the digital signal is then applied to the ARM 7 Micro controller. The ARM 7 micro controller reads the data and gives the proportional signal received from the process and displayed on to the LCD module along with the signal input is sent to the PC for MATLAB image process. The object color detection is done using MATLAB image processing and the detected color is sent as input o the ARM7 LPC2148 microcontroller for further process.

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![Block diagram of the proposed model](image)

In this paper we are presented object color sorting using web camera interfaced onto the PC using MATLAB software. MATLAB stands for matrix laboratory. MATLAB (matrix laboratory) is a numerical computing environment and fourth-generation programming language. Developed by Math Works, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran.

**SERIAL COMMUNICATION USING MATLAB:**

Serial communication is the most common low-level protocol for communicating between two or more devices. Normally, one device is a computer, while the other device can be a modem, a printer, another computer, microcontroller or a scientific instrument such as an oscilloscope or a function generator.

As the name suggests, the serial port sends and receives bytes of information in a serial fashion — one bit at a time. These bytes are transmitted using either a binary (numerical) format or a text format.

The serial port interface for connecting two devices is specified by the TIA/EIA-232C standard published by the Telecommunications Industry Association.
The original serial port interface standard was given by RS-232, which stands for Recommended Standard number 232. The term RS-232 is still in popular use, and is used in this guide when referring to a serial communication port that follows the TIA/EIA-232 standard. RS-232 defines these serial port characteristics:

- The maximum bit transfer rate and cable length
- The names, electrical characteristics, and functions of signals
- The mechanical connections and pin assignments

Primary communication is accomplished using three pins: the Transmit Data pin, the Receive Data pin, and the Ground pin. Other pins are available for data flow control, but are not required.

Other standards such as RS-485 define additional functionality such as higher bit transfer rates, longer cable lengths, and connections to as many as 256 devices.

The MATLAB serial port interface provides direct access to peripheral devices such as modems, printers, and scientific instruments that you connect to your computer's serial port. This interface is established through a serial port object. The serial port object supports functions and properties that allow you to

- Configure serial port communications
- Use serial port control pins
- Write and read data
- Use events and callbacks
- Record information to disk

Instrument Control Toolbox™ software provides additional serial port functionality. In addition to command-line access, this toolbox has a graphical tool called the Test & Measurement Tool, which allows you to communicate with, configure, and transfer data with your serial device without writing code. The Test & Measurement Tool generates MATLAB code for your serial device that you can later reuse to communicate with your device or to develop GUI-based applications. The toolbox includes additional serial I/O utility functions that facilitate object creation and configuration, instrument communication, and so on. With the toolbox you can communicate with GPIB- or VISA-compatible instruments. Using MATALAB we can select COMPORT, BAUDRATE, START BIT, STOP BIT, PARITY BIT and DATA BIT for serial communication.

- Create a serial port object:

Obj=serial('port','propertyname',propertyvalue)

Example: s = serial('COM1','BaudRate',9600);

To specify properties during object creation

s = serial
('COM2','BaudRate',9600,'DataBits',8);

Obj = serial('port') creates a serial port object associated with the serial port specified by port. If port does not exist, or if it is in use, you will not be able to connect the serial port object to the device.

Rgb2ycbcr converts RGB color, grayscale, or bi-level TIFF images to YCbCr images by transforming and sampling pixel data. If multiple files are specified on the command line each source file is converted to a separate directory in the destination file.

By default, chrominance samples are created by sampling 2 by 2 blocks of

0luminance values; this can be changed with the –h and –v options. Output data are compressed with the Pack Bits compression scheme, by default; an alternate scheme can be selected with the –c option. By default, output data are compressed in strips with the number of rows in each strip selected so that the size of a strip is never more than 8 kilobytes; the –r option can be used to explicitly set the number of rows per strip.
Convert RGB color values to YCbCr color space

**Syntax**

\[
\text{Ycbcrmap} = \text{rgb2ycbcr} \text{ (map)}
\]

\[
\text{YCBCR} = \text{rgb2ycbcr} \text{ (RGB)}
\]

`Ycbcrmap = rgb2ycbcr (map)` converts the RGB values in map to the YCbCr color space. `map` must be an `M` by `3` array. `ycbcrmap` is an `M` by `3` matrix that contains the YCbCr luminance (`Y`) and chrominance (`Cb` and `Cr`) color values as columns. Each row in `ycbcrmap` represents the equivalent color to the corresponding row in the RGB colormap, `map`.

\[
\text{YCBCR} = \text{rgb2ycbcr} \text{ (RGB)}
\]

converts the truecolor image RGB to the equivalent image in the YCbCr color space. RGB must be a `M` by `N` by `3` array. If the input is a double, `YCBCR` is double, where `Y` is in the range [16  235], and `Cb` and `Cr` are in the range [16  240]. If the input is a double, `Y` is in the range [16/255 235/255] and `Cb` and `Cr` are in the range [16/255 240/255]. If the input is `uint16`, `Y` is in the range [4112 60395] and `Cb` and `Cr` are in the range [4112 61680].

### III. HARDWARE DESIGN OF PROPOSED SYSTEM

In this paper we presented a color object sorting on conveyor belt using DC motors and robotic arm. The controlling device of the whole system is an ARM 7 LPC2148 MICROCONTROLLER to which PC is interfaced using USB to TTL converter along with USB web camera; DC motors of robot are interfaced through a DC motor driver. Whenever the appropriate colored based objects were detected using PC MATLAB, then those objects are sorted using robotic arm for picking and placing operations using DC or servo motors along with drivers. The Microcontroller checks the data with the program embedded in it and performs appropriate actions on the DC motors of the conveyor belt and also robotic arm.

The Microcontrollers used in the project are programmed using Embedded C language. The proposed working model of the system uses PC with MATLAB image processing for color object detection through web camera and the respective objects placed on the conveyor belt and separates them using robotic arm interfaced with DC motors. This style of conveying is ideal in warehouse order picking applications or where cartooned product is being transported through a manufacturing process. It provides minimum pressure accumulation, quiet operation and easy installation. Line shaft conveyors are suitable for transportation of products within warehouse or manufacturing operations where lighter weight cartons, tote bins and other products need to be moved, allowing for a variety of situations requiring directional changes. Limited, minimal pressure accumulation of product can be obtained with this style of conveyor.

**Fig-4: Figure of the hardware implementation of the proposed model along with conveyor belt**

Microcontroller will receive signal and rotate the DC motors in forward direction. In the similar manner the appropriate actions of the robotic arm is predefined in the micro controller program and the robot performs the relevant operations like making robot movement forward, backward, left, right, up, down, open close directions. We are using H-bridge as a DC motor driver. And for each and every DC motor one enable pin of the IC should be connected to the ARM 7 LPC2148 microcontroller. Here we are using 2 DC motors connected to H-Bridge motor driver board.
Robotic arm is connected using servo motor interfaced with the gripper for pick and place of the selected objects. The unique feature of the design is that the conveyor belt and also the robotic arm controlling are efficiently made using ARM 7 microcontroller.

In the proposed object color sorting we used the ARM-7 microcontroller is RISC microprocessor architecture from Advanced RISC Machines Ltd. The ARM7 architecture is made up of a core CPU plus a range of system peripherals which can be added to a CPU core to give a complete system on a chip. It offers several architectural extensions which address specific market needs, encompassing fast multiply and innovative embedded ICE support.

Objects using robotic arm and acts accordingly on the DC motors equipped with Robotic arm.

MOVEMENT 1: To open the Gripper Mouth so that it can place / drop the object (DC motor)

MOVEMENT 2: To close the Gripper Mouth so that it can pick the object (DC motor)

MOVEMENT 3: To move the robotic arm to either left/right (Servo motor)

Robotic arms are becoming increasingly popular in several fields such as industrial automation, medical applications such as remote key-hole surgeries and military applications because of its preciseness and accuracy. In certain critical applications such as performing surgeries or diffusing a bomb, robotic arms could be of tremendous use to save lives. In such applications, controlling the robotic arm precisely is of utmost importance. Currently, such robotic arms are typically controlled using a joystick that is wired to the robotic arm. To demonstrate pick-and-place functionality, we fixed a gripper at the end of the frame.

IV. CONCLUSION

An existing object sorting on conveyor belt “DESIGN OF AN ADVANCED OBJECT COLOR SORTING MOVING ON CONVEYOR BELT USING ARM 7 AND MATLAB” was designed such that the robotic arm can be operated automatically for sorting of...
objects depending on object color detection using PC with MATLAB. The controlling device of the whole system is an ARM 7 LPC2148 Microcontroller. Using IR obstacle sensor to the robot, the system displays the counting details about the objects moved on the conveyor belt. The Microcontroller checks the data mentioned predefined in the program depending on color of the objects and performs appropriate actions on the robot. The robot can also be extended by connecting wireless camera to the robot, and then we can view the object height, length, and breadth from our personal computer only by using GPRS and GPS. We can use this robot at so many fields like in bottle filling industries and we can use to handle so many situations and send it to anywhere i.e. like to user mobile phone in the form of SMS messages, PC wireless data transmission for data base. It can also be extended by connecting temperature, gas, smoke sensors to the robot we can get the temperature, leakage of any gases, smoke of dangerous zones in industries and it gives information to the micro controller and micro controller gives the information to the transceiver from that we can get the data at pc side.

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