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DEVELOPMENT OF AN AUTOMATIC COLOR SORTING MACHINE ON BELT CONVEYER

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Abstract*- For sorting object in industry optical sorting is very much convenient. Color and size are the most important features for accurate classification and sorting of product which can be done by using some optical sensors or analyzing their pictures. The color sorting machine is mainly a device that can sense the different color of the object and assert them into different belt conveyor. When object moves from one place to another with the rotation of conveyor belt, sensors as the input devices will send signal to microcontroller where microcontroller as the controller will give command to the actuator to do action. The final result was quite satisfactory. The color detecting sensors worked well and it was able to detect red or green object quite nicely and change the direction of servo on right and left side to sort the object in proper place. The belt moved from starting point to the end point through the roller without conflicting with the walls. The system performed well as programmed and detects the object according to their color.*

Key words: Color sorting, Belt conveyor, Geared DC motor, Microcontroller, Sensors.

1. INTRODUCTION

Nowadays, in the present state of intense competition, production efficiency is generally regarded as the key of success. Production efficiency includes the speed at which production equipment and production line can be lowering material and labor cost of the product, improving quality and lowering rejects, minimizing downtime of production equipment and low cost production equipment. Taking this matter under consideration the project is developed which is very useful for industries.

Main objectives of the study are studying various sorting processes, designing and fabrication of conveyor belt, designing and fabrication of automatic color sorting system of product on conveyer belt, automatic rejection of defective product from conveyer belt.

The main advantages of the system are less time required to sort the product, as the whole system is performed by machine there is less possibility of mistake, less man power required. If the industry can produce the product within the required range then the demand of the product will be increased. So the company will be benefited.

2. SCOPES AND APPLICATIONS

The scopes of this project are:

-Design a system that can identify Red and Green-color from an object [1]
-Fabricate the system using:
    Geared DC motor (12 volts)
    Microcontroller (PIC 16F73)
    Conveyor structure
-Create a program that can use to identify different (red and green) color.
-Run the programming system.
Main applications can be for:
-Sorting the product according to their color.
- Ensuring quality control in mass production [2].
-By some modification it can be used to detect any colored object
-By some modification it can be used to measure the dimension of a product.
-By increasing its sensing capacity it can be used in airport.
-It is also very useful in laboratories and workshops.

3. BASIC TERMINOLOGIES
3.1 Sorting
Sorting is any process of arranging items in some sequence and/or in different sets. It has two common distinct meanings such as ordering and categorizing. Ordering is arranging items of the same kind, class, nature, etc. in some ordered sequence while categorizing

is grouping and labeling items with similar properties together by sorts [3].

3.2 Servo motor and its parameter

A servo motor is a small device that has an output shaft. This shaft can be positioned to specific angular positions by sending the servo a coded signal. As long as the coded signal exists on the input line, the servo will maintain the angular position of the shaft. As the coded signal changes, the angular position of the shaft changes. 12Kg metal gear of the servo motor [4]:

Size: 40.4 * 19.8 * 36 mm
Weight: 48 g
Speed: 0.22 sec/60^0
Output Torque: 13 kg. cm

3.3 Microcontroller (PIC16F73)

In this project microcontroller [5] is used for motion control and object detection. A microcontroller is a single chip computer. Micro suggests that the device is small, and controller suggests that the device can be used in control applications. Another term used for microcontroller is embedded controller. The main difference is that a microprocessor requires several other components for its operation, such as program memory and data memory, I/O devices, and external clock circuit. A microcontroller on the other hand has all the support chips incorporated inside the same chip. All microcontrollers operate on a set of instructions (or the user program) stored in their memory. A microcontroller fetches the instructions from its program memory one by one, decodes these instructions, and then carries out the required operations.

4. DESIGN AND CONSTRUCTION

4.1 Necessary Equipment

The components of the project are listed below
   a) Geared DC motor (12 volt)
   b) Servo motor (12 kg)
   c) Wooden shaft and bearing
   d) Wooden Base
   e) LED (Red ,Green)
   f) LDR
   g) Electric Capacitor
   h) Voltage regulator LM 7805
   i) Resistor 1k,10k, 330Ω ,100Ω
   j) Microcontroller (16F73)
   k) Variable resistor
   l) Relay (6 volt DC)
   m) Breadboard
   n) Rexene cloth (as conveyer belt)
   o) Veroboard
   p) Fiber Glass

4.2 Development of the Mechanical Structure (conveyor belt)

At first a wooden block was chosen to make the structure of the conveyor .A rectangular shaped wooden block, 18 inches length and 12 inches width was selected for the base of the structure. Two pieces of wood, length 14 inches, width 0.75 inches and height 5 inches was selected for two horizontal support of the belt. The horizontal wooden block were placed parallel and 5 inches apart from each other. This two horizontally directed parallel wooden block support the roller so that they can rotate freely between them with the help of bearings. To fix the bearing properly with the horizontal wooden block, four holes in each wooden block was made, which had diameters as same as the bearing. The holes were made by drilling the block with a drilling machine. Then the bearings were tightly fitted with the wooden block by hammering. Four rollers were made by turning wood into the lathe machine. The diameter of the roller was 1 inch. The diameter of the smaller shaft of the roller which coupled with the bearing was 10 centimeters. Then the four rollers were covered with a piece of Rexene cloth, 14 inches length and 5 inches width. A geared DC motor was coupled with the front roller which is shown in the figure 1. When the roller rotated for the rotation of the motor, the belt started to move horizontally as it connected with the roller. The geared DC motor produced high torque so that the belt moved slowly but steadily.

Now a structure was made for holding the servo motor. It was made by cutting a plastic sheet. First a 'U' bend was made from the plastic sheet. The servo was placed on it. Another 'U' bend was made to cover the servo and support it. Then this two plastic bends were joined by screw. A small plastic shaft was attached with the servo, acted as like a sorting mechanism which is shown in the figure 2. The full structural view is shown in the figure 3.

Fig. 1: Geared DC Motor connected with the shaft

Fig. 2: Servo controlled sorting mechanism

Fig. 3: Total structure of the system

4.3 Development of the Electrical System (sensors and servo controlling circuit)

Electrical system is the heart of the sensing and sorting process. Two sensor circuits were made on a veroboard using mainly LED, LDR and resistor for sensing the different colored object. A servo controlling circuit was made on a breadboard using mainly microcontroller 16F73, crystal oscillator, voltage regulator LM 7805, capacitor 100μF, and one 6 volt relay variable resistor. The circuitry arrangement for sensing the object and controlling the servo motor was shown in the figure 4
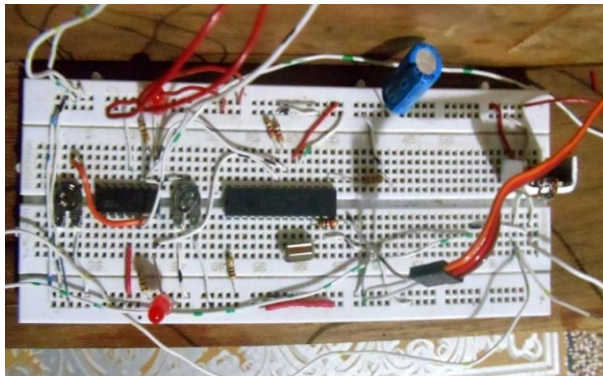

Fig.4: Circuitry arrangement for sensing the object and controlling the servo motor

5. RESULT AND DISCUSSION
5.1 Result
The final result was quite satisfactory. The color detecting sensors worked well and it was able to detect red or green object quite nicely and change the direction of servo on right and left side to sort the object in proper place. Geared DC motor was used to get increased torque for the movement of the shaft as well as the conveyor belt.

The belt moved from starting point to the end point through the roller without conflicting with the walls. The system performed well as programmed and detects the object according to their color.

5.2 Limitation
Every successful invention has its own limitations. There are a number of limitations in the project also, which are as follows:
 a) Here in case of color measurement and detection of color over a wide range which might not gave the proper result always.
 b) Here only two colored (red and green) products are asserted precisely. Other color can be asserted by preparing a good and more accurate structure and highly efficient coding of microcontroller.
 c) Sometime the belt slip [6] on the roller as gripping mechanism of belt with the roller is not good enough. Again no use of timing belt and gear also causes the faulty power transmission to the roller.

5.3 Further Development
Anyone can upgrade the system using the following instructions:
 a) Using of timing belt and gear instead of direct connection with roller and motor shaft will be more efficient. But care should be taken with the proper meshing of timing belt and gear.
 b) Some rubber gripers can be used. It increases surface resistance which helps to avoid slipping of conveyor belt.
 c) Using of TCS230 color sensor [7] can be more useful. But it is not cost effective.
 d) A pneumatic actuator [8] can be used for sorting and placing the objects in different belt.

6. CONCLUSION
Nowadays in highly competitive industrial manufacturing, the management of the integrity of supply of a product from raw material to finished product through quality manufacturing is of paramount importance. For the declaration of a product bearing high quality and dimensional accuracy is mandatory. So this project of automatic color sorting is an excellent one because of its working principle and wide implementation. By applying the idea of this project an industry can easily sort the required product according to its color. Though it has some limitations, but by having done some modification this concept can be implemented in wide range of application.

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