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Object Sorting by Arduino Robot

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Abstract—Automation of work has become an important part of industrial manufacturing process in the recent years. Tasks that usually take large amount of labor and time can now be easily completed by using robots which can be programmed to do the said task. Tasks such as assembly and object sorting which require tasks to be repeated can be carried out by robots. The system proposed here can be used for sorting objects in the industrial manufacturing process. The system focuses on sorting objects based on their size or color or both. The system is designed using IR sensors, a TCS3200 color sensor and Arduino UNO board for controlling the different parts. The proposed system gives better accuracy and performance as compared to the methods currently used.

Keywords : Object sorting, Arduino Uno, sorting based on colour and size, IR sensors, TCS 3200 color sensor.

I. INTRODUCTION

The field of Robotics helps humans to decrease manual labor by enabling automation of processes with the use of robots. Robots are used in environments where humans have difficulties in performing various tasks or to perform tedious tasks efficiently and at a faster pace. Object sorting is an important task in the field of Robotics. In industries, where mechanical parts and products are manufactured, classification of those parts is an important task. In proposed system, the robot sorts objects based on characteristics such as the size and color of the object. Using this system objects can be sorted with a higher accuracy. The process will be beneficial in industries as it consumes less time and can work for longer duration with less maintenance.

II. METHODOLOGY

A. Explanation of Components

- Arduino UNO: Arduino is a microcontroller which is used to control different electronic devices used in a project. It makes accessing and controlling different electronic components easy and efficient. The Arduino UNO's hardware consists of an open-source board. This board is designed on Atmel AVR microcontroller. Another version of this board uses a 32-bit Atmel ARM microcontroller. The board's software comprises of a regular programming language compiler. It also consists a boot loader which is necessary for execution of tasks on the board. The Arduino UNO is an ATmega168 based microcontroller. The board consists of 14 digital input and output pins. Out of these 14 pins, 6 pins can be used as PWM outputs. The board also has a 16 MHz crystal oscillator, an ICSP header, 6 analog inputs, a reset button, a USB connection and a power jack.

  It contains everything needed to support the microcontroller. The board can be powered up by connecting it to a computer using a usb cable. We can also use an AC to DC adapter or a battery to get it started.
- IR sensors: An IR sensor is a device which can which can measure the intensity of light signals and convert them into electrical signals. It is a device which consists of a transmitter and a receiver that can emit and detect infrared radiations. In this way it can sense its surroundings. These sensors can be used as heat detectors. It can also be used to detect motion. PIR (passive infrared) sensors are a type of IR sensors that can only detect radiations. They don't have an emitter. The radiation emitted by objects is invisible to the naked eye as they usually lie in the infrared spectrum. IR sensors can detect such radiations and thus interpret it's surroundings
- Resistors: Resistors are devices used to adjust the amount of current and voltage. If a circuit requires less current and voltage than the available amount, then a resistor is used to control the flow of current to the circuit .
- TCS 3200 Color Sensor: TCS3200 chip is designed to detect the color of light incident on it. It has an array of photodiodes. These photodiodes are covered with three types of filters. Some sensors have RED filter over them, thus can measure only the component of red in the incident light. Likewise, others have GREEN filter and BLUE filters. We know that any visible color can be broken into three primary colors. So these three types of filtered sensors help to measure the weightage of each of primary color in incident light. TCS3200 converts the intensity of incident radiation into frequency. The output waveform is a 50% duty cycle square wave.
- IC 4051 Multiplexer: A multiplexer/demultiplexer is used to increase the inputs and outputs of the Arduino board. The 4051 Multiplexer can be used with the 8 inputs of the Arduino board to select just one pin at a time. The 4051 Multiplexer has 3 select pins i.e. S0,S1 and S2, these pins can be used to select one pin of our choice. The three select pins are each connected to one digital out pin of the Arduino board. Each select pin is assigned a number which represents it's value, S0=1; S1=2 and S2=4. When a select pin is set HIGH, then the number representing that pin is transmitted to the Multiplexer.

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- Pin y2 is selected if S1 is HIGH and S0 and S2 are low i.e. 0+2+0=2.
- Pin y4 is selected if S2 is HIGH and S0 and S1 are low i.e. 0+0+4=4.

We cannot read or write to more than one pin at a time of the 4051 as only one pin can be selected at a time.

This is not a problem as there is no delay between selecting pins and thus we can read and write to the pins quite fast.

B. Working principle

In proposed system, the objective is to sort the object on the basis of 2 parameters –

- Size
- Color

To do this task, a step-by-step approach is implemented to judge the appearance of the object. In all there are 2 chambers or blocks present in this System, each chamber contributes to the final decision to be made by the Arduino Diecimila microcontroller.

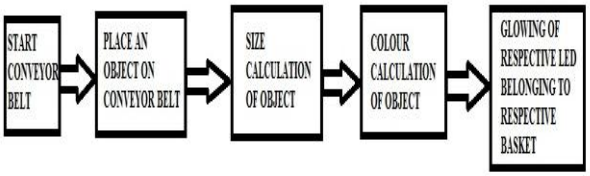
Object will be moved through all these chambers with the help of a conveyor belt .Conveyor belt will keep rotating with the help of dc motor. When the object appears at the first chamber, its size (area) is calculated with the help of array of IR Sensors. The scan line detector detects the reference lines on the conveyor belt. Whenever a reference line is scanned, it gives signal to Arduino Board. Arduino Board instructs array of IR Sensors to start sensing. The IR Sensors starts transmitting IR rays and received value is forwarded to Arduino. Arduino determines the size of the object based on returned value from IR Sensors and by invoking the sorting algorithm. Then the object is moved to 2 nd Chamber with the help of rotating conveyor belt.

The true color of the object will be determined on the basis of red, green, blue Colors' Contribution.

2nd chamber consists of color sensor. Object detector detects that the object is approaching and gives signal to Arduino Board. Arduino board instructs the color sensor TCS3200 to start sensing the object. It incidents light on the object. It receives reflected signal and depending upon the color of the object, information contained in the signal varies. It then forwards this sensed value to Arduino Board. It calculates intensities of red, green and blue color present in the object from the received signal. Based upon combination of RGB intensities, it computes the true color of the object.

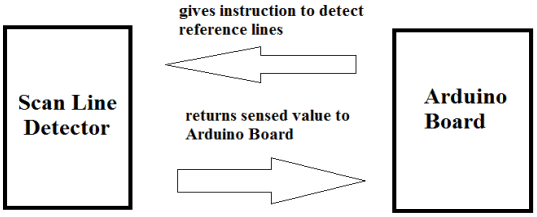
Size and color information of the object is gathered and depending upon these parameters, what kind of object it is and where it is to be placed can be judged accurately.

When object passes through all these chambers, Arduino Board computes the final result by invoking the object sorting algorithm. Based on the final result given by the Arduino board, respective LED glows, to which the object belongs. Following diagrams briefly describe the above explanation.



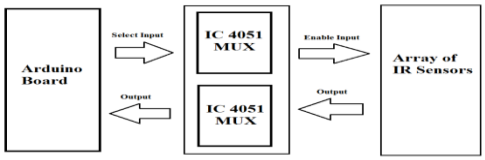
C. IMPLEMENTATION

- Scan line detector:



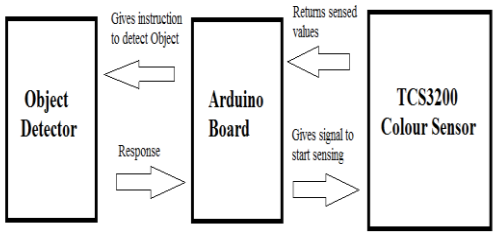
The scan line detector scans the reference lines present on the conveyor belt. The purpose of scan line detector and reference lines on conveyor belt is to reduce the consumption of IR Sensors. The scan line detector is connected to the A2 pin which is one of the analog pins on the Arduino board. This scan line detector continuously sends the sensed value to Arduino at pin A2. If the value read at pin A2 is more than 500, the Arduino Board interprets that reference line is detected and instructs IR Sensor arrays to start sensing the object. Computation of size of object is described in next subsection.

- Determination of size of object:



IC 4051 consists of 3 select lines namely S0, S1 and S2. One pin of the 4051 multiplexer can be selected for read/write using these three select pins. S0, S1 and S2 are each connected to a digital out pin of the Arduino board. S0, S1 and S2 are connected to digital pins 8, 9 and 10 of the Arduino board. The Arduino board selects the input by setting the values of S0, S1 and S2 as either LOW or HIGH. Initially S0, S1 and S2, all are set to LOW. Therefore the pin of IC 4051 from which value will be read is pin number 13 representing input y0 (0+0+0=0). IR Sensor senses the object and returns back sensed value to IC 4051. IC 4051 contains the received sensed value at pin number 3, which is the output pin of IC 4051. The analog pin A0 is connected to pin number 3 where the analog output is transmitted. The same procedure is repeated for the rest of the IR sensors by changing values of select lines S0, S1 and S2 at each instance and reading from different pins of IC 4051. Sensed values are forwarded to Arduino A0 and A1 analog pins. Based on output received at analog pin A0 and A1, the size of the object is computed.

- Determination of color of object:



Arduino Board instructs object detector to detect the object. The sensed value from object detector is given to analog pin A5 of the Arduino. Arduino receives this sensed value and if value received at pin A5 is greater than 800, Arduino Board interprets that the object is approaching. It then instructs Colour Sensor to start sensing the object. Purpose of object detector is to reduce the consumption of colour sensor.

The TCS3200 colour sensor is a light to frequency converter which is used to detect the colour of an object . It consists of silicon photodiodes which are configurable and a current to frequency converter. It is a programmable colour sensor implemented on a CMOS integrated circuit. The sensor generates a square wave as output whose frequency is directly proportional to the light intensity. It consists of an 8 x 8 array of photodiodes. The value of this array is read by the light to frequency converter. The TCS3200 consists of 16 photodiodes of blue filters, green filtes and red filters each. In addition to this it also consists of 16 photodiodes which are clear with no filters.

To select which group of photodiodes i.e. red, green, blue or clear, will be active, the S2 and S3 select pins of TCS3200 are used. If S2 and S3 are LOW, it indicates photodiodes with red filters are active and corresponding output frequency scaling is computed from S0 and S1 select pins at pin number 1 and 2.

The final output frequency is computed and returned back to Arduino from pin number 6 Output pin. The Arduino Board receives this sensed value at digital pin 2. The final step involves invoking object sorting algorithm and computing where the object belongs and glowing the respective Led.

III. RESULT

The objects to be sorted are placed on the conveyor belt of the system. The object detector detects if an object is present on the belt and informs the Arduino microcontroller.

After the object is detected, it passes through the first chamber.

- In this chamber the object's size is calculated.
- The object passes through the array of IR sensors.
- The scan line detector keeps track of the scan lines occupied by the object.
- The array of sensors and scan line detector send their results as input to the Arduino controller.
- The controller then calculates the size of the object using these values.

After this the object is passed through the second chamber where the objects color is determined.

- The TCS3200 color sensor detects the color of the object.
- The object's color is determined by the amount of Red, Blue and Green (RGB) colors detected by the color sensor.

The system is programmed to categorize the objects into small, medium and large objects based on their size and the color sensor categorizes the objects into Red, Blue and Green based on their color.

IV. CONCLUSION

Automatic sorting of objects in large industries is necessary to increase throughput and efficiency in sorting the objects. "Object Sorting by Arduino Robot" system is implemented using Arduino technology which is very cost-effective and provides 16KB flash memory and 16MHz clock frequency. Arduino programming IDE is an open source IDE which runs on all platforms, reducing overhead on users in switching to different platform.

The system provides 100% accuracy in sorting objects on the basis of color and acceptable 80% accuracy on the basis of size. This system can be used in industries where flat and monochromatic objects are manufactured and ae to be sorted. So, the system is efficient in Object Sorting based on size and color parameters without facing perplexity or ambiguity conditions.

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