SEMI-AUTOMTIC SORTING SYSTEM

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ABSTRACT

In many industries application there is necessity of sorting. Sorting can be done by using many different ways like sorting of object according to their dimensions (height, length etc.,), according to their colours, acc. to their weight, using machine vision (image processing), etc. For E.g., Electromagnetic sorting technique is used for sorting of ferromagnetic material from coal.

Designing of a Low-Cost-Automation (LCA) system for sorting of objects based on their height have been designed in our project. Low-Cost Automation system is to be controlled using Arduino UNO. This project that we make mainly used in industries & warehouses.

The objects are sorted based on their height and weight. The conveyor is supported of two motors, object is sorted initially by the electronic system and detected with the help of laser sensor. It also includes different part which is composed of conveyor for transportation of blocks/objects, electronic system helps sorting the object and motors for driving the conveyor.

This semi-automatic sorting system is very much useful in package industry, packages & bags sorting at airports, also in separation of bricks in bricks production, etc...

Keywords: Conveyor System, Arduino, Sorting System.

I.   INTRODUCTION

It is clear that automation is being implemented in all industries who have labour-intensive work. Automation is very well discerned in the packaging industry sector. Packaging industries were built right after surging needs for packed products to be stored and transported without damage. During starting stages of evolution, packaging was accomplished by using wooden boxes, paper bags and plastic. The trends in the packaging industries keep growing rapidly, there is a necessity for automation for sorting the cartons acc. to their size, this can be accomplished by using pneumatic system, which helps in saving in the labour cost and duration to complete the specified task, thereby increasing accuracy& overall efficiencies leading to increase in productivity and profits. So, the object Sorting Machine can essentially be used in industries &warehouses and helps in reduction of errors while sorting and reduces human effort. The important advantage of this machines has high repeatability, low maintenance and robust in design.

II.   OBJECTIVE

The clear perspective is to create an object sorting/handling system that can come handy to reduce efforts of the humans/workers also to decrease duration spent on inspection of the objects and duration of its manufacturing. It also helps reducing human efforts/errors of misplacing of the object manufactured in some other workstation. The most apparent reason that is related in installation automatic system in industries is:

1. Improvement in quality and efficiency of the system
2. Higher consistency and also provides increase in flexibility of the system
3. Helps reducing human efforts (Saves Man Power)

III.   METHODOLOGY

Sorting system are used to bridge between packaging machinery & production. Sorting system are used to sort items based on various criteria so that they accordingly packed. Manual sorting consumes a lot of time and also requires sufficient efforts. Semi-Automatic sorting system allows fast and more efficient sorting of product. To demonstrate the sorting system, we develop an Arduino based sorting system. This system consists of a conveyor belt to carry product from one end to storage box. It is composed of different sensors to sense the different type of products to be sorted. The system utilizes three actuators to control their operations.

Figure 1: Work Flowchart

IV.   COMPONENTS TO USE

MECHANICAL COMPONENTS:

A) Actuators: A linear actuator that creates motion by generating momentum in a straight line. These actuator converts rotary motion into linear motion by gears or screws, from that a knob or handle is attached.

B) Ball bearing: A ball bearing is a rolling-element which is used for maintaining separation b/w the bearing race.

C) Conveyor belt: A belt type conveyor belt will be used for the movement of blocks in a mechanism. The belt is made of single or more layers/multi-layer. In general, sorting/handling system is two layered. An inner layer of material to provide linear strength and shape called a carcass and an outer layer called the cover.

ELECTRICAL COMPONENTS:

A) DC motor: It is an electrical device used to convert energy from one form to another (i.e., Electrical energy to Mechanical energy). DC Motor has a coil inside carrying current and also helps to generate electromagnetic field. By varying current inside its part, direction and magnitude of magnetic field can be controlled.

B) Arduino micro-controller: It has analog as well as digital I/O pins. By use of programming position of servo and stepper motor can be controlled. With the help of compiler that generates binary codes, Arduino programs are written.

C) Sensor: There are some systems that are capable of measuring number of blocks/objects passing over the conveyor, these systems make use of sensors for this purpose. When blocks/objects are passed over the conveyer a transmitter and receiver infrared sensors are used. With help of sensor this senses movement of the object over conveyor, but it can only sense but can not predict the weight of the object
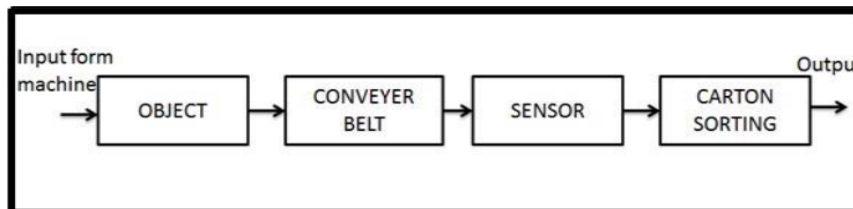
Figure 2: Sensor Based System

D) MICROCONTROLLER BASED SYSTEM: The microcontroller-based systems are artificially efficient as microcontroller is programmable as per the requirement of system. The microcontroller is programmed to count the boxes.
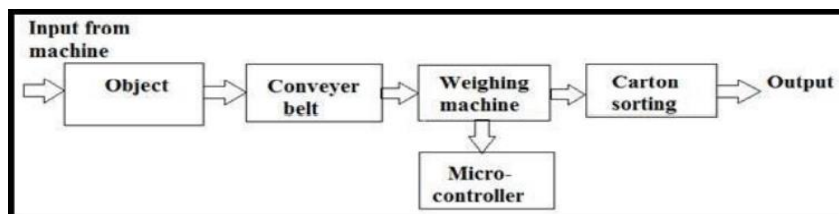
Figure 3: Microcontroller Based System

E) PNEUMATIC POWERED SYSTEM: Three double acting cylinders are used for the sorting of blocks/objects when actuated by the sensors. We use solenoid operated spring return DCV (Direction Control Valve), the design contains a belt conveyor moving at required speed (This belt conveyor is loaded with objects of three different sizes/heights).

F) SYSTEM MODELLING: The function of pre-feed conveyor is to feed with different height boxes to main conveyor. The main conveyor belt will take the objects to the height measuring station. The main conveyor is an

essential factor. Main conveyor is supplied by three phase AC induction motor. The assembly contains DC geared motor supplied by power source.

Once the object passes over the guider that is on belt conveyor, it has to pass in front of the height measuring unit. Now the Arduino is programmed such that, if the shortest object is detected in the starting, it will just start the conveyor for fixed time and the shorter objects will be allowed to pass.
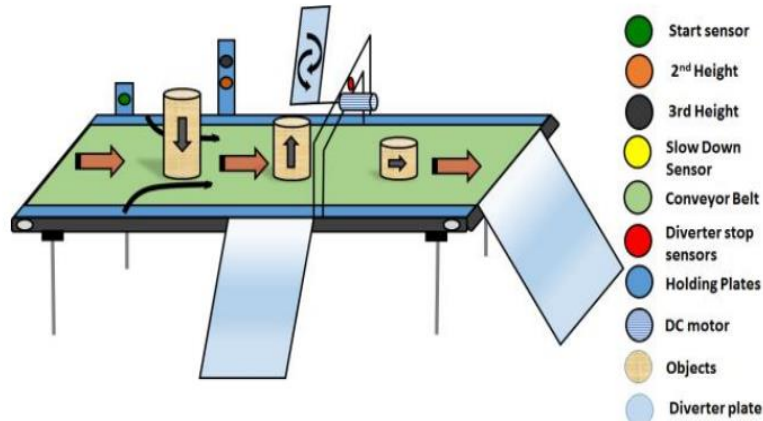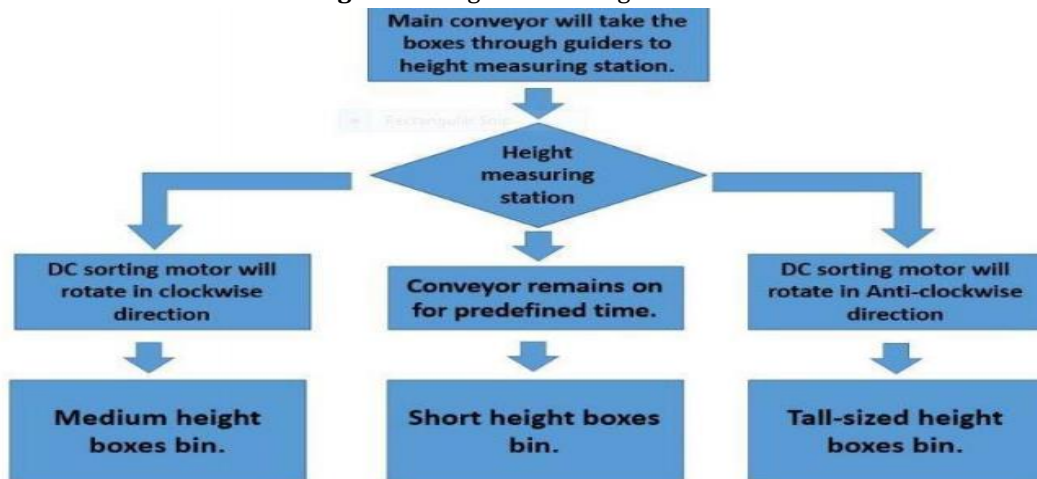

Figure 4: Height Measuring Station

Figure 5: Height Based Sorting

G) STEPPER MOTOR: step motor also called stepper motor is a brushless DC motor that divide a complete rotation in number of equal steps. DC Motor contains multiple coils that are arranged in parts called phases. By enabling this phase in sequential form, the motor rotates one step at a time.

Technical specifications of stepper Motor are as follows:

Step angle- 1.80

Steps per revolution- 200

Current rating- 1.7A per coil

Shaft diameter- 5mm

Voltage rating- 2.8V

H) CONVEYOR BELT: It provides the platform for sequentially supplying of object. The belt is placed on the rollers and is moved by using DC motor. Its dimensions are: Length=1200mm, Width=150mm

I)CONVEYOR ROLLERS: Rollers are fitted on bearings using a shaft. It helps in moving conveyor belt. Diameter=50mm, Length=160mm

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J) BEARINGS: Bearing helps in minimizing the friction force generated between shaft and the belt conveyor.

K) USING PROXIMITY SENSORS (OPTIONAL): The material is detected by using capacitive, inductive and the photo electric sensors placed at small height then it is small sized metal.

Table no.1

Technology	Sensing Range	Applications	Target Material
Inductive Sensor	<4-40 mm	Close Range detection of ferrous material	Iron, steel, copper, Aluminum
Capacitive Sensor	<3-60 mm	Close range detection of non-ferrous material	Liquid, wood, granulates glass.
Photoelectric Sensor	<1 mm-8 cm	Long range, small and large target detection	Metal, Plastic, Rubber, Paper, Wood

L) ARDUINO BASED COLOUR DETECTOR: Color Sensor is a device that helps in the detection of colors. A color sensor emits the light (a ray/beam of white light from the LEDs) and then observes the reflected light from the block/object to determine its color. Color sensors provides accurate coloring of the object.
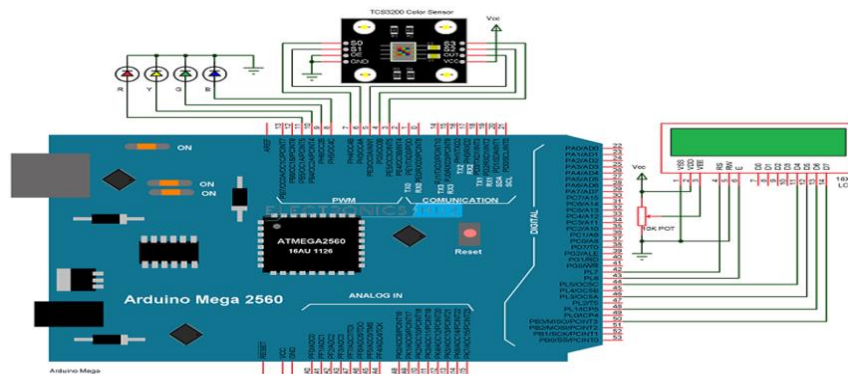

Figure 6: Arduino Based Colour Detector

The TCS-3200 color sensor, it is programmable color sensor that detects converts different colored light to various frequency. The output frequency is directly proportional to intensity of the light that gets reflected from the object. The TCS-3200 Color Sensor 4 bright white LEDs. TCS-3200 has 8x8 array of photo-diodes, there are 16 each initiated for Red, Blue, Green and Clear filters.
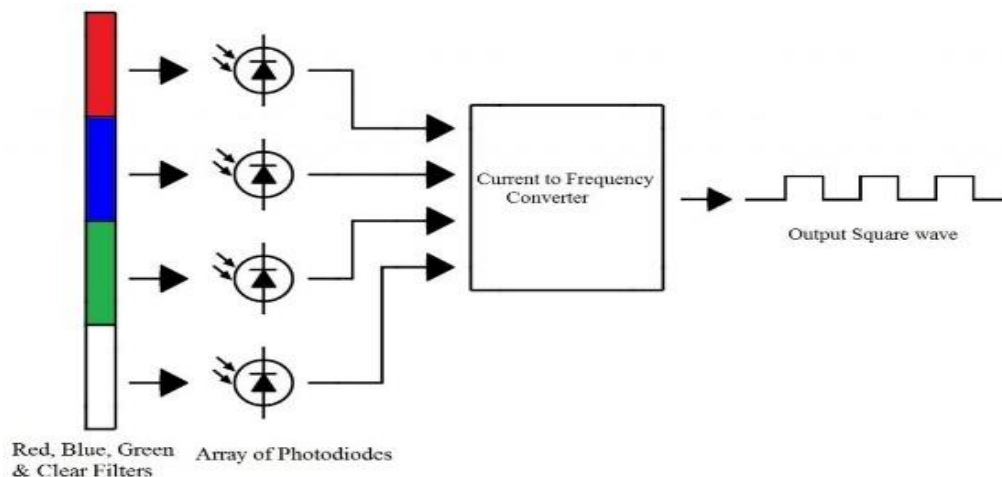

Figure 7: TCS-3200 Working

V.   CALCULATION

- Length of belt = 1200mm
- Width of belt = 150mm
- Roller diameter = 50mm
- Roller length = 160mm
- **DC motor**: 30 R.P.M., motor torque = 2 kg. cm, operating voltage = 6–18-volt, rotor R.P.M. = 10
- **Stepper motor**: step angle = 1.8, step per revolution = 200, current rating = 1.7A per coil, shaft diameter = 5mm
- **Conveyor**: belt travel length = 1200mm = 1.2m, diameter of roller = 50mm= 0.05m

Note: coefficient of friction between pulley and conveyor is very low, hence can be neglected.

Requirement of conveyor is to sustain travelling with 10kg in 8sec

- Required speed of belt conveyor $= \frac{\text{Distance}}{\text{Time}} = \frac{1.2}{8} = 0.15$ m/sec = 15 cm/sec
- Required R.P.M. $= \frac{15 \times 60}{2 \times 3.14 \times 0.25} = 572.9$ R.P.M.
- Load torque required for running a belt conveyor,

Torque (T) = F x r $= \frac{m \times v \times 0.05}{t} = \frac{10 \times 0.15 \times 0.05}{0.5} = 0.15$ Nm

- Hence, motor with 0.19 Nm is sufficient for the allowable range of weight on conveyor belt. Therefore, a motor of rated torque of 0.19 Nm is chosen.
- **Capacity of belt type conveyor**:

$Q = CVb^2 = CV (0.09B-0.05)^2$ (m³/sec)

Where, C = Surcharge factor, B = Width of the belt (m)

b = Width of material storage on belt, Q = Volume capacity of conveyor (m^3/sec)

M = Mass flow rate of conveyor (kg/sec), V = Belt speed (m/sec)

- **Length of pulley:** L = B + 2 s

Where, L = Length of pulley (mm), B = Width of belt (mm), S = Side margin (Generally 60 to 75 mm)

- **Actuator**: 12V solenoid 0.5kg push linear actuator motor
1) Initial force (0mm travel): 5N
2) Keeping force (10mm travel) =4.905N
- Consider a mass to be push as 1kg.

Force = 1 x 9.81 = 9.81 N

P = Air pressure = 101325 N/m² or Pa

As, F = PA, Therefore, bore size area (A) $= \frac{\text{Force}}{\text{Pressure (air)}} = \frac{9.81}{101325} = $ Pi x d²/4

$d = 0.011m = 11mm$ (Bore diameter of piston)

VI.   CONSTRUCTIONAL DETAILS

Pulleys are installed on the shaft and is to be insert on opposite sides of frame. The shaft of the motor is inserted in any one pulley. The belt conveyor is supported on the pulley and Ultrasonic sensor is mounted at the center of the belt at specific distance away from the belt. Arduino is placed along with L293Dat the bottom of the belt. The sensor senses the object based on its height which is feed into the system and if the object/block has height greater compared to specified height, the conveyor belt moves towards one side and if the object/block has a height smaller compared to specified height. Also, by use of timing circuit and Geneva mechanism object can be delivered at different intervals at various stations (note: use of timing circuit is optional, since we use Arduino here instead of PLC, we may not use timing circuit to perform this task but can be considered based on future use sense). As the range of sensors used is 2-25 centimeters, the object is to be placed on the conveyor belt at a distance of more than 2 centimeters. The object is placed manually, but in the industries the object can be placed using pick and place robot or using any other means so the object will automatically get placed at a mentioned distance of greater than 2 centimeters in case basic sensors are used. The Color Sensor with Arduino is made in this project. This unit senses the colors present in the object. TCS-3200 Sensor contains Red, Blue, Green and Clear filters. The frequency obtained by TCS-3200 determines its

intensity too. After getting detected by the sensor the rest is followed by height measuring station and passed through actuator and obtain the best suited object with very minimum defects. Various proximity sensors are also used if need for improvising e.g., detection sensor for detecting material category like, wood, plastic or metal (optional).

VII.   CONCLUSION

Here we tried to create a setup that reduces involvement of human efforts and help to achieve accuracy to certain extent by the use of LCA (Low-Cost Automation) to avoid risk, increasing production speed/rate and reduce dependency and cycle time. This work functions efficiently for multi-sorting of different objects (like, wood, plastic, metal) in different sizes (like, small, medium and large) material. Limitations will be because of difficulties in programming according to the availability of the required materials and components. This setup can be furthermore improved to a sorting system that sorts the items based on various considerations (like, installment of electronic pickup system, etc..). This can be achieved using the various sensors and other necessary requirements. In industry this helps in the sorting of various objects, tools, etc. in very diverse manner with very high accuracy and quality with the assistance of automation.

ACKNOWLEDGEMENTS

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