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Design, Analysis and Fabrication of Automated Box Convey and Sorting Machine

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Abstract - As the name suggests, color sorting is simply to sort the things according to their color. It can be easily done by seeing it but when there are too many things to be sorted and it is a repetitive task then automatic color sorting machines are very useful. These machines have color sensor to sense the color of any objects and after detecting the color servo motor grab the thing and put it into respective box. They can be used in different application areas where color identification, color distinction and color sorting is important. Some of the application areas include Agriculture Industry (Grain Sorting on the basis of color), Food Industry etc. The applications are not limited to this and can be further applied to different industries.

(keywords: Colour sorting, box, sensor)

1. INTRODUCTION

Defect detection and classification are two topics that need to be treated as unique problems related to the field of artificial vision. Digital image processing problems mainly derive from specific conditions in which researchers aim to mimic or substitute human vision and decision methodologies with artificial techniques. The general purpose of mimicking human vision is to identify and classify a subject, these two goals are always strictly bonded together. Literature on artificial visual processing is usually categorized into visual processing algorithms, which consist in the recreations of the human vision, and classifiers, which are a remodeling of the human decision techniques. In this project, we address both categories, but, instead of summarizing all the visual processing methodologies, we focus on the specific solutions that are strongly related to visual processing methods and, specifically, on visual inspection techniques for objects in industrial applications. Quality control is a crucial aspect in the industrial production line. Several approaches are currently used to assess the quality of a product or the outcome of a process. Depending on the method employed to identify a defect on a surface/volume, quality control strategies can be classified as destructive or non-destructive. Non-destructive testing (NDTs) aim at monitoring a component to detect a defect without extracting samples from it, or permanently damaging it. Mostly used in the aeronautic field, NDTs are classified as: visual-based method, dye penetrant inspection, radiography, ultrasonic testing, eddy current approach, and thermography.

2. LITERATURE REVIEW

[1] "Machine parts recognition and defect detection in automated assembly systems using computer vision techniques" by P.Arjun, T.T.Mirnalinee.

In this paper, a computationally efficient 2D computer vision-based approach to recognize the machine parts and detect damaged parts in automated assembly systems has been presented. The machine part defects in the form of damage, cracks are identified by scanning the shape of the object and a feature vector is generated from the shape. The shape descriptor discussed is simple, compact, and fast one-dimensional feature vector which preserves the shape information using contour pixel coordinates of the shape.

[2] "Automatic Damage Detection of Fasteners in Overhaul Processes" by Sajjad Taheritanjani, Ralf Schoenfeld, Bernd Bruegge.

In this article we find about Automatic Damage Detection of Fasteners. This includes undoing fasteners, cleaning, checking, refitting, and tightening them. Prior to refitting the fasteners, they must be checked for damages. In this paper, we propose an automatic damage inspection of the fasteners, using computer vision and machine learning.

[3] "Detection of Micro-Defects on Metal Screw Surfaces Based on Deep Convolutional Neural Networks" by Limei Song 1, Xinyao Li 1, Yangang Yang 2, Xinjun Zhu 1 , Qinghua Guo 1,3,* and Huaidong Yang.

This paper proposes a deep convolutional neural network (CNN) -based technique for the detection of micro defects on metal screw surfaces. The defects we consider include surface damage, surface dirt, and stripped screws. Images of metal screws with different types of defects are collected using industrial cameras, which are then employed to train the designed deep CNN.

[4] "Acoustic signal-based fault detection on belt conveyor idlers using machine learning" by Xiangwei Liu, Deli Pei, Gabriel Lodewijks, Zhangyan Zhao, Jie Mei.

Belt conveyor systems are widely utilized in transportation applications. This research aims to achieve fault detection on belt conveyor idlers with an acoustic signal-based method. The presented novel method uses Mel Frequency Cepstrum Coefficients and Gradient Boost Decision Tree for feature extraction and classification. Thirteen Mel Frequency Cepstrum Coefficients are extracted from acquired sound signal as features. A Gradient Boost Decision Tree model is developed and trained. After training, the model is applied to a testing dataset. Results show that the trained model can achieve diagnosis accuracy of 94.53%, as well as recall rate up to 99.7%..

3. PROBLEM DEFINITION

- After the manufacturing process to maintain the quality of the product, inspection of the manufactured products is necessary. But precise inspection of such high quantity products is the difficult task. So, to inspect the bulk quantity of manufactured products this project is invented.
- Image identification Automotive industries is such a complex task, for example nut and bolt industry in a day lacks of nut's and bolts are manufacture to identify the defected part by manual is a headache work.
- Requires more Number of workers.
- If worker allotment is more than off course their wages if have to provide.
- Less accuracy if done manual because of human errors.
- Time consuming.
- Requires excessive attention towards the process if done manually.

4. METHODOLOGY

Step 1: - We started the work of this project with literature survey. We gathered many research papers which are relevant to this topic. After going through these papers, we learnt about ideology.

Step2: - After that the components which are required for Smart Color Conveyor apparatus are decided.

Step 3: - analytical calculation is prepared

Step 4: - After deciding the components, the 3 D Model and drafting will be done with the help of CATIA software.

Step 5: - The components will be manufactured and then assembled together.

Step 6: - The testing will be carried out and then the result and conclusion will be drawn.

5. WORKING

As the conveyor is turned on the different colors of food product on Belt drive moves from one side to another place. In between there will be color sensor which sense the color of particular item, depending up on the color intensity of the Part which needs to continue to transfer and parts to reject based on its Code will be pared inside the Arduino to operate Separator Mechanism with Servo or stepper Motor through Drivers. Un similar color will be identified using Sensors and defect parts of food industry will be separated using the smart conveyor for Industrial segregation process. The circuit diagram for this Arduino Color Sorter is pretty easy to make and doesn't require much connections. The schematic is given below. Programing Arduino UNO is a pretty simple and requires a simple logic to simplify the steps involved in color sorting. Since the servo motor is used, so the servo library is essential part of the program. Here we are using two servo motors.

The first servo will move the colored balls from initial position to TCS3200 detector position and then move to the sorting position where the ball will be dropped. After moving to sorting position, the second servo will drop the ball using its arm to the desired color bucket beside the conveyor.

6. LIST OF COMPONENTS

Hollow Shaft or Roller: A shaft is a rotating machine element, usually circular in cross section, which is used to transmit power from one part to another, or from a machine which produces power to a machine which absorbs power.

Roller: It is a must need component for conveyor without roller there is no another option. The roller may be made of steel always in real time conveyor system also sometimes known as shaft type roller conveyor. The material always changes, depending up the load to be handled.

TCS3200 TCS230 Color Sensor Module: Color Sensor, based on TCS3200, is a complete color detector capable of detecting static color. The output of the sensor is a square wave with frequency directly proportional to incident light intensity. It also supports fill light by on board LEDs.

It includes a TAOS TCS3200 RGB sensor chip and 4 white LEDs. The TCS3200 can detect and measure a nearly limitless range of visible colors. Applications include test strip reading, sorting by color, ambient light sensing and calibration, and color matching, to name just a few.

Conveyor belt: A conveyor belt is the carrying medium of a belt conveyor system (often shortened to belt conveyor).

Arduino: The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc.

7. DESIGN & CALCULATION

Conveyor Calculation

Frame calculation.

Given values:

- Cross-sectional dimensions: 25 mm x 25 mm with a thickness of 1.5 mm.
- Frame length (span), L: 775 mm
- Frame width: 325 mm (assumed to have no effect on bending in this case)
- $Load$: $20\ kg\ (equivalent\ to\ 20 \times 9.81\ N) = 196.2\ N$

Here are the calculated results for the frame:

1. **Moment of Inertia (I):** 13030.75 mm4
2. **Bending Moment (M):** 38013.75 N·mm
3. **Maximum Bending Stress (σ):** 36.47 MPa
4. **Deflection (δ) at the center:** 0.695 mm

Conveyor belt

The approximate tension required in the belt is **9.81 N** under the given load and conditions.

Wiper Motor

The torque required is approximately **82.53 Nm**.

DC Motor for sorting mechanism

Motor selection for Link to separate

Motor selection on total pay load of component with belt Selection Motor

Mass of the objects placed on conveyor = 1Kg
= 9.81N =10N

Total weight on the frame = 10 = 10N

Diameter of the link hole = 10 mm

Torque = ½ Force X Diameter
= ½ X 10 X 10mm
= 50 N.mm
= 0.05 Nm.

For the same condition we have smaller servo motors but if the mass of the product increases, then servo motors will fail so, Dc Motors are used in safety cases. Above shown motor can be used to separate the parts on the conveyor up to 1 kg.

Shaft Calculation

Given Data

- $Load\ (FFF)\ =$ $1\ kg\ (converting\ to\ Newtons: 1\ kg \times 9.81\ m/s2 = 9.81\ N)$
- Shaft diameter (d) = 20 mm
- Shaft length (L) = 325 mm

Material assumed to be steel (for calculating Young's Modulus

Final result

- **Maximum Bending Stress**: 10.13 MPa
- **Deflection**: 0.00672 mm

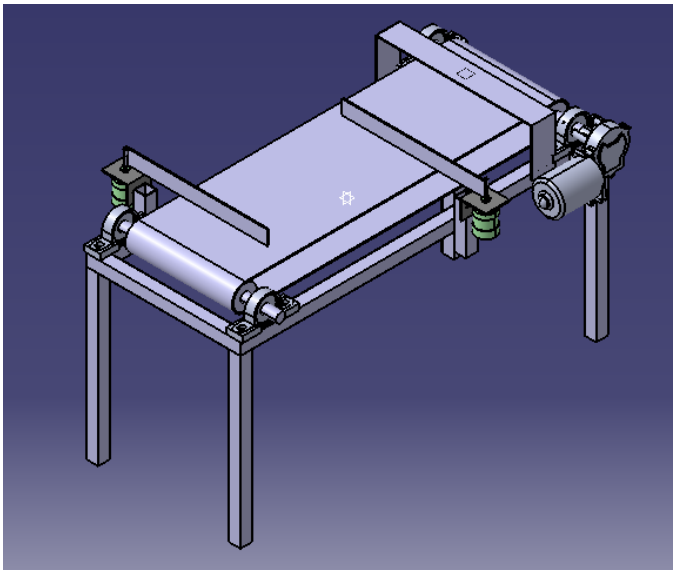

Fig 1. Figure ISO view of the Conveyor

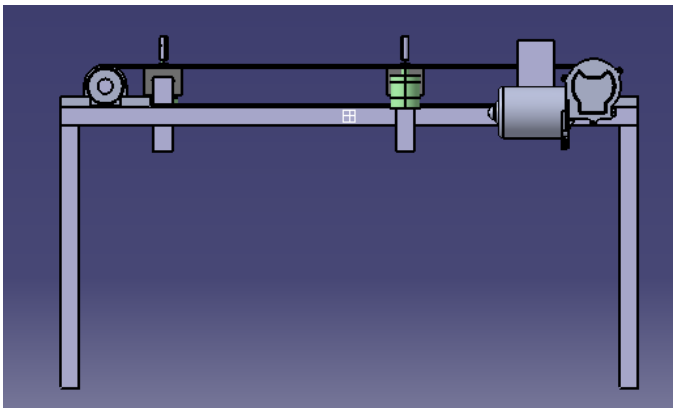

Fig 2: Figure Front View

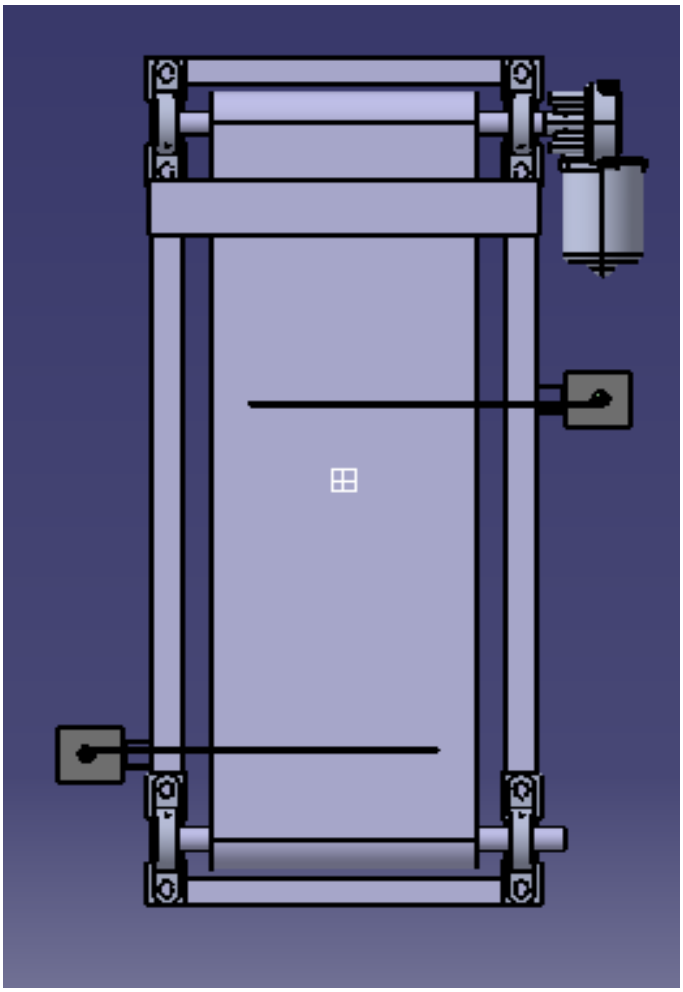

Fig 3: Figure Top View from Catia v 5 Software

8. CONCLUTION

In conclusion, the automated box convey and sorting machine represents a significant advancement in industrial automation, offering increased efficiency, accuracy, and throughput in sorting and packaging processes. By integrating conveyor systems with intelligent sorting mechanisms, the system ensures faster processing, reduced human error, and lower operational costs. It is particularly valuable in industries such as logistics, e-commerce, and manufacturing, where rapid and accurate handling of packages is crucial. With its ability to handle a high volume of boxes, its scalability, and the potential for further integration with other automated systems, this machine can greatly optimize supply chain operations and improve overall productivity. Ultimately, the implementation of such technology is key to maintaining competitive advantage in an increasingly fast-paced market.

9. FUTURE SCOPE

- Ultrasonic sensor may be added to count the parts entering the conveyor
- Cameras may help in defining the part in accuracy.
- No mis-judgement in segregating and operating of system without any aid of labors or manual specific work.
- Reduction in wages for workers.
- Less-Time consumption
- Easy to operate (fully automation)

10. REFERENCES

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[4] "Acoustic signal-based fault detection on belt conveyor idlers using machine learning" by Xiangwei Liu, Deli Pei, Gabriel Lodewijks, Zhangyan Zhao, Jie Mei.

[5] "Fault Diagnosis of Belt Conveyor Based on Support Vector Machine and Grey Wolf Optimization" by Xiangong Li, Yu Li, Yuzhi Zhang, Feng Liu, and Yu Fang.

[6] "Automatic Metallic Surface Defect Detection and Recognition with Convolutional Neural Networks" by Xian Tao 1, Dapeng Zhang, Wenzhi Ma, Xilong Liu and De Xu

[7] "Research Progress of Visual Inspection Technology of Steel Products" by Xiaohong Sun, Jinan Gu, Shixi Tang and Jing Li.