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Arduino based Automatic Material Sorting Machine Using Open CV and Python 2.7 IDLE

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Abstract - *Sortation is the process of identifying items on a conveyor system and diverting them to specific destinations using a variety of devices controlled by task-specific software. Sorters are applied to different applications depending upon the product type and the required rate. Sortation systems are often employed when high quantities of products need to flow to different destinations for further processing. Sortation conveyor systems generally receive mixed unit loads and discharge them to designated locations or outfeed conveyors, in response to signals from automatic control systems. The Automatic material sorting machine has been developed to sort different kind of materials based on its shape and color through image processing technique by using webcamera mounting above the conveyor belt. This proposed technique is achieved using Open CV library programmed with python 2.7 IDLE and Arduino UNO microcontroller.*

***Key Words*: Conveyor system, OpenCV, Arduino UNO microcontroller, python 2.7 IDLE, DC motor, material sorting.**

1. INTRODUCTION

Machine vision (MV) is the technology and methods used to provide imaging based automatic inspection and analysis for such applications as automatic inspection, process control, and robot guidance, usually in industry. These systems are used to perform tasks which include selecting parts that are randomly oriented from bin or conveyor and limited inspection. Those are typically reduces the cost of part and tool fixturing, and allow the robot program to test for and adapt to limited variations in the environment.[1] The Automatic material sorting machine has been developed to sort different kind of materials such as Aluminuim, Card board and Pumice stone.

1.1 OBJECTIVE

The Automatic material sorting machine has been developed,

- To sort different kind of materials such as Card board, Aluminuim and Pumice stone from the scrap materials.
- To reduce the effort in the transfer of materials from one point to other point.
- To eliminate accurately the waste in material segregation system.

2. LITERATURE SURVEY

Bankole I.Oladapo et al., (2016) has developed an automated sorting machine is able to incorporate flexibility and separate species of non-ferrous metal objects and at the same time move objects automatically to the basket as defined by the regulation of the Programmable Logic Controllers (PLC) with a capacitive proximity sensor to detect a value range of objects. The result obtained shows that plastic, wood, and steel were sorted into their respective and correct position with an average, sorting, time of 9.903 s, 14.072 s and 18.648 s respectively.

D. A. Wahab et al., (2006), this work represents the development of a prototype automated sorting system for plastic recycling to sort Polyethylene terephthalate(PET) and non-polyethylene terephthalate(PET) bottles. This prototype system was tested for speed and accuracy. The requirement for rapid industrial processes has led to the deployment of shape analysis method for the identification of meaningful objects. In this study, a non-compiled software has been developed on a standard PC. In this configuration, it is possible to perform the whole procedure from image acquisition to classification in ~150ms regardless of the number of objects in the image. The system alone would be capable of processing a minimum of 400,000 bottles in a day based on a 24-hour operating scheme. The sorting accuracy was evaluated for each pattern recognition technique, under normal laboratory lighting. Every bottle of the database was dropped on the conveyor belt dozens of times under varying lighting condition. When considering the accuracy of the final classification for each kind of bottle, all techniques provided around 95% of correct identifications, with smaller values around 80% in cases of poor lighting conditions.

Pallavi P. Saraikar et al.,(2019), in this paper, A Robot is based on openCV and designed on Raspberry Pi which is used for objectdetection and tracking depend on the object's color, size and shape. A robot can detect only one object a time. Robotic vision deals with image processing. In this project robot can detect the object and rotate as left/right direction and then moves forward and backwards depend on object's movement. They used Python coding to identify the object with Open CV and ultrasonic sensor to maintain the distance between object and robot to avoid an obstacle. Pi camera located on robot chassis is used to capture the image.

Artzai Picón et al.,(2012), in this paper, they have developed a machine vision system for the material

classification process to allow the real-time sorting of the nonferrous fractions that are contained in the waste of electric and electronic equipment scrap by using hyperspectral image processing. The shredded waste of electric and electronic equipment (WEEE) mixture is automatically loaded onto a nonspecular black conveyor belt (600 mm wide) via a vibratory feeder that has been specifically designed to ensure the nonferrous materials are arranged into a thin layer prior to their arrival at the inspection line. The WEEE mixture is defined by six nonferrous materials: white copper, aluminum, stainless steel, brass, copper, and lead. The experimental results reveal that the proposed machine vision system is able to process the nonferrous shredded WEEE scrap at a rate of 2.28 m/s with a classification accuracy of 96.87%. The performance attained by our system exceeds the economic thresholds required for automatic WEEE nonferrous material sorting, and currently the developed machine vision system is fully evaluated in an industrial recycling environment.

3. DESIGN CALCULATION

3.1.DESIGN OF BELT

Length of the belt,
L = π(r1+r2)+2x+(r1+r2)^2/x
here
radius of roller, r1=r2=27.5mm
center distance between roller, x = 710mm
L = 3.14 x (55)+2(710)+(55 x 55/710)
L = 1597mm
L=1.597m

3.2.ANGLE OF CONTACT BETWEEN BELT AND PULLEY

sinα=(r1+r2)/x = (27.5+27.5)/710,
α=4.4deg,
θ=180+2α=188.8 deg
θ=188.8 x π/180
θ=3.295rad.

3.3. POWER TRANSMITTED BY A BELT

2.3log(T1/T2) = μθ
for rubber, coefficient of friction, μ=0.3
T1 = σ*b*t
here σ=2.6N/mm2,
breadth of belt, b = 95mm
thickness of belt, t = 2.5mm
T1 = 2.6 x 2.5 x 95
T1 = 617.5N
Hence 2.3log(617.5/T2) = 0.3 x 3.295
T2 = 402.28N
Velocity, v = π dn1/60
v = 3.14 x 0.055 x 60/60
v = 0.1727m/s

Power tranmitted by the belt, P = (T1-T2) v
P = (617.5-402.28)* 0.1727
P = 37.17 W.

4. DESIGN OF AUTOMATIC MATERIAL SORTING MACHINE

The model was created by using of CATIA software. The detailed view of the drawing is given in Figure 1 and Figure 2.

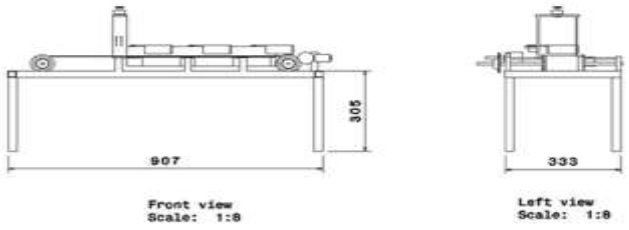

Fig -1: Assembled view of Automatic Material Sorting Machine

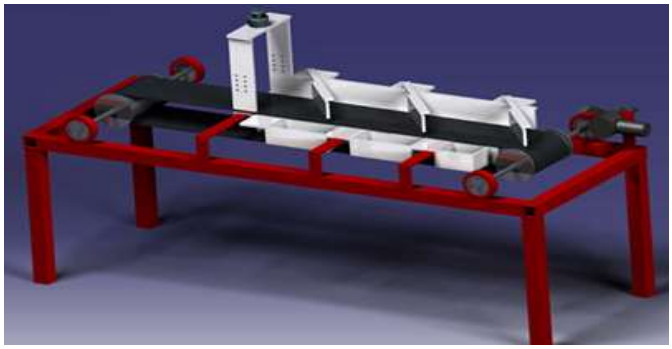

Fig -2: Isometric view of Automatic Material Sorting Machine

5. ANALYSIS ON BELT

By using the Ansys Software, mesh, total deformation and equivalent stress for the conveyor belt and frame has been analyzed. For the material selection, conveyor belt is set as Polyurethane. Force is setup at the center of the conveyor belt in vertical direction. The analysis that shown in this are 0.5N and 2.5N.

Fig -3: Properties of Polyurethane(PU) flexible material

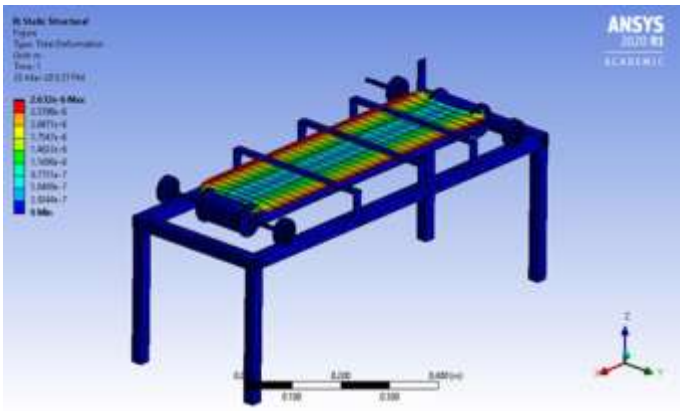

Fig-4: Total deformation for 0.5N

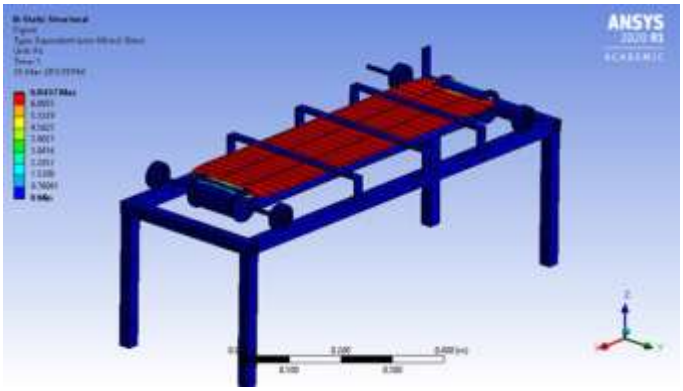

Fig-5: Equivalent (von-Mises) stress for 0.5N

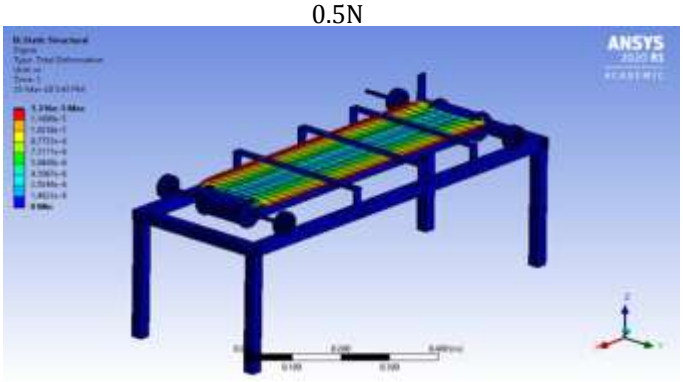

Fig-6: Total deformation for 2.5N

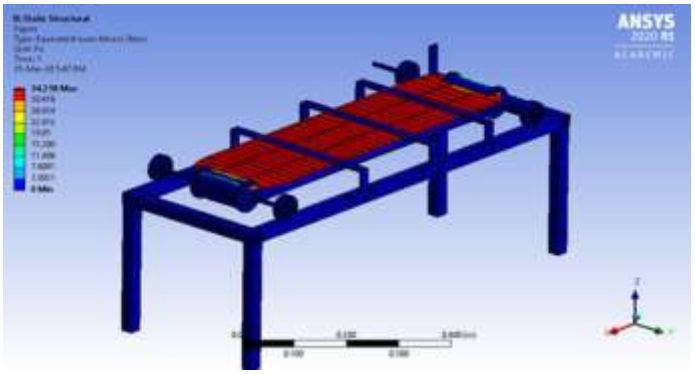

Fig-7: Equivalent (von-Mises) stress for 2.5N

6. DETAILED WORKING PROCEDURE OF AUTOMATIC MATERIAL SORTING MACHINE

A mild steel bar of 2mx2.5cmx2.5cm, has been used as a frame for automatic material sorting machine. The deflectors are made up of acrylic sheet of 5mm thickness and it is deflected by means of DC motor of 12V controlled by Arduino UNO microcontroller. A DC motor of 60RPM, 24V has been used for rotating the conveyor belt. The USB camera of 12MP is mounted above the conveyor belt for the material recognizition to take place. The materials to be sorted has been place on the conveyor belt below the camera for recognizition. The camera is used to capture the three different kind of materials such as Aluminium, Pumice stone and Card board. Once the materials get recognized with the help of Open-CV library and python 2.7 IDLE. It sends the signal to the Arduino UNO microcontroller for starting the conveyor belt through relay of 5V. The deflectors are used to sort the three different kind of materials into their respective bins. After the delay time period, the conveyor gets stopped. This process occurs in a repetitive cycle for sortation of materials.

COMPONENTS	DESCRIPTION
USB Camera	12MP, Resolution (640*480)
DC Motor	60RPM, 24V
Relay Circuit	5V RELAY
SMPS	24V, 6.5A
Conveyor Belt	Polyurethane(PU) (2.5mm thickness)
Capacitor	1000µF, 100V
L293 DRIVER	4.5-25V, 600mA
Arduino UNO	16 MHz, Flash Memory 32 KB

Table-1: Components of Automatic Material Sorting Machine

Fig-8: Top view of Automatic Material Sorting Machine

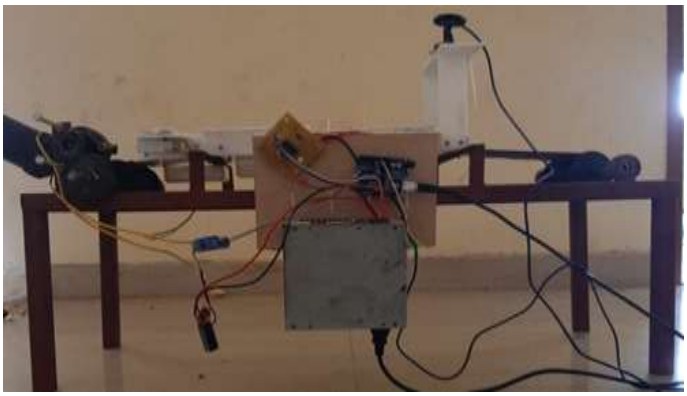

Fig-9: Front view of Automatic Material Sorting Machine

7. RESULTS AND DISCUSSION

The Automatic material sorting machine has been tested successfully with three different kind of materials such as card board, aluminum and pumice stone in a random order. The response time taken from recognition of materials till sortation has been recorded and displayed in the chart[1].

Fig-10: Sorting of Aluminium by Automatic Material Sorting Machine

Fig-11: Sorting of Card board by Automatic Material Sorting Machine

Fig-12: Sorting of Pumice stone by Automatic Material Sorting Machine

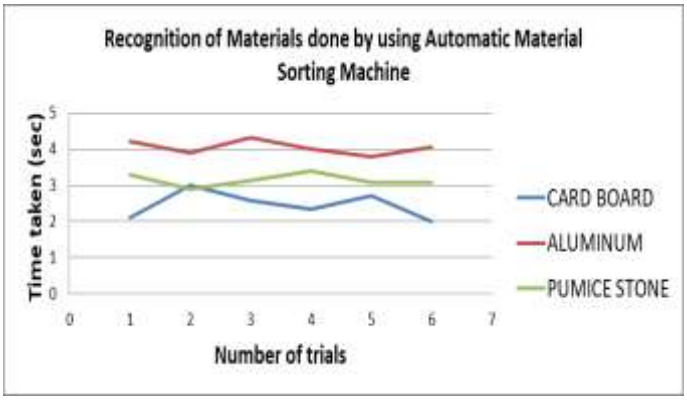

Chart -1: Time taken vs Number of trials

8. CONCLUSION

Material sorting system based on the shape and color has been implemented in this work. This work uses Python IDE along with Open CV library for Image Acquisition and processing. Arduino Uno has been used for controlling DC motors and actuators. Algorithms have been tested and performed well for various shapes. Refined routines could involve the use of color and brightness as a further tool for pattern recognition. The suggested framework will be a demo rendition which gives expense effective, taking less time and technically the easiest way for differentiating objects. This version can be stretched out to ongoing programs in waste recycling ventures and bundling corporations as an open source customizable material sorting assembly line.

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