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DESIGN AND DEVELOPMENT OF PRODUCT SORTING CONVEYOR BELT USING PLC

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Abstract - *The production rate has expanded enormously in the present world of industrial growth and innovation. Ultimately, the industry keeps producing the same models, in height, in weight and form, with little variation. And it plays a crucial role here to categorize various products. Industries in such cases cannot categorize these products by unadorned human mistakes. Therefore, the precise sorting of these products requires low cost automation (LCA). Industrial automation focuses primarily on developing automation with low cost, low maintenance, long resilience and the usability of systems. Finally here we have advanced a Product sorting conveyor belt on the basis of nature of different product Which is governed by Programmable logic controller (PLC) and the conveyor in the machine moves the object in front of sensor and hence sorting logic is marked and sorting of different product takes place.*

Key Words: Programmable Logical Controller ,Sensor ,Actuation, Sorting ,Conveyor.

1.INTRODUCTION

In particular, research and innovation in new products are the foundation of the development of manufacturing industries. There are known to be developed countries with a higher production rate where other countries with an under-developed manufacturing rate are considered.
Generally speaking, industries continue to manufacture the same models with slightly different levels of height, colour, weight, shape, etc. Physical work for the sorting of similar products could be carried out earlier. But companies cannot afford to classify these products actually because of increased production or the reduction in labour spending or such an amateur jobs. This forced industry to tend towards automizing the categorizing process. Since the economy was a major factor for the development of the industry, Ica (low-cost automation) must evolve to categorize these products correctly.
This project is an automation system for low cost for the sorting of lightweight objects by product nature. The main objective of the project is to categorise discrete objects through the use of both the sensor-and-actuator for inductive and capacitive proximity. For pushing the part from carrier to categorised bin, pneumatic actuators are used. The arrangement is a carrier belt, which is placed before the transducer and then categorises the item like bottles, mini boxes and packages. PLC is programmed to categorise separate objects with different logic. The setup consists of sensors of the proximity used to detect objects and object types.

1.1 OBJECTIVE

The objective of this project is to develop a machine which will sort the product using PLC.
To detect the products with the help of sensors i.e inductive and capacitive proximity sensor.
The products will get sorted when they are kept on conveyor belt which is driven by motor.
Pneumatic actuators will get signals from sensors and get activated.
The system we have developed is designed to reduce the human effort and consequently the resulting errors. In addition, the system helps deal with the tedious sorting process by simply scanning the bar code for the products selected. In addition, it promotes sorting speed and reliability.

2. LITERATURE SURVEY

With the growing volume of transferred goods, fabricated products and commercialized items, arises the need for automatic fabrication, handling, processing, sorting, packaging and shipping. To achieve such a goal, certain improvements had to be made regarding the size and complexity of automatic control systems and drivers. In the industrial world, fabrication as a technological process is preferred as less "hands-on" as possible. For instance, the environment necessary for manufacturing pharmaceutical products, alimentation byproducts, metal treatment and chemical disposal services, high complexity integrated circuits and microprocessors, is either completely sterile, vacuumed, or severely poisonous. Robotics and industrial automation has always placed an vital role in the evolution of the industry. Autonomous machines have been used to improve the growth of industry as they practices sensors for accuracy and precision of products. To achieve this precision and meticulousness , robots are programmed. Recent advances in the field of electronics and mechatronics has unlocked up new outlooks for different industrial

applications in the field of automation. The type of automation is practiced where the sorting is done on root of different constraints like color ,height, nature of materials etc. The categorization is depend upon the ladders that is once the product comes to the sorting conveyor.

3.METHODOLOGY

1.In this , a conveyor belt is used to move material or part and motion is given to the conveyor by using DC powered geared motor.

2. The whole system can work on power which is provided by the PLC.

3. When part is placed on conveyor it is automatically detect by the sensor and then conveyor start moving.

4. Two sensors are placed in such a way that they can easily detect the part on the conveyor.

5. Pneumatic actuators are placed in such a way that when sensors detect the part/material then after specific r interval of time actuator start actuating.

6. All the movement of parts are controlled by using preprogramed PLC.

3.1 FLOW CHART

Whenever object/part is placed on conveyor it is detected by capacitive proximity sensor then output of sensor is given to the PLC then PLC give input to conveyor motor and motor starts the rotation. Because of rotation of motor conveyor also start the rotation. If part is detect by only capacitive proximity sensor then actuator 1 actuate. If part is detect by both capacitive as well as inductive proximity sensor then actuator 2 start actuation. And actuator rod push the part from conveyor to collecting box.

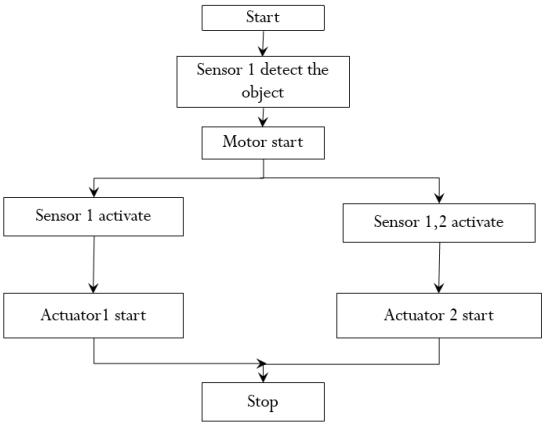

Fig -1: System flow chart

3.2 MATERIALS USED

Motor
5/2 DCV
Inductive Proximity Sensor
Capacitive Proximity Sensor
Ultrasonic sensor
Pulley
Belt
Double acting actuators
FRL unit
Pneumatic Hoses
Compressor

3.3 CALCULATIONS

Assumptions
Design Considerations: (w.r.t. Design data book)
Open flat belt drive system
Belt used is PU Belt
Power rating for this belt is 0.023kw
Length of belt=130 cm (standard)
Diameter=9 cm (standard)
Width of belt= 2---4 cm
Load correction factor (Fa)=1 (Normal load)
Arc of contact factor (Fd)=1 (Because theta=180)
Coefficient of friction=Negligible (Because coefficient of friction between belt and pulley is very low and hence can be neglected)

Numerical Calculations for the Selection of Motor
Required V of belt:
V=130/14=9.28cm/s
or 0.0928m/s 1
No. of revolution:
N =V*60/2πr
=9.28*60/2pi*4.5 .... from 1
=19.7027rpm=20rpm 2
The requirement of our project is such that conveyor belt must be able to bear travelling an approximate weight of 100 g in 10-20 seconds.
Now,
Torque(T):
T = F*r
= m*(V/t) *r
=0.1*(0.0928/14)*0.045 .....from 1
T =2.98 Nm 3
Power Rating:
Pd=0.0147*V/5.08
=0.02680kw 4

Design Power:
Pr = Pd*Fa*Fd
=0.0268*1*1 .....from 4
=0.0268kw 5
Since the values of both power rating and design power are same , this signifies that the material selection for this project is right.

Tensions:
P=(T1-T2) *V

0.0268=(T1-T2) *0.0928 ……..from 1
0.28879=T1-T2 ……6

Angle of loop for open belt drive:
θ=180-2α
α=Sin-1(D1-D2/2x)
θ=180 or 180*π/180= π radians
T1/T2 = e θ
T1/T2 =e3.1415
T1=23.138T2 ……7
0.288793=23.138T2-T2
T2=0.013045KN
or 13.045N ……from 6&7
AND
T1=0.301835KN or 30.1835N

Numerical Calculations for the Selection of Pneumatic actuator

Minimum Force required to move materials:
=0.5*9.80665
F=4.903325N ……1
Bore diameter =15 mm

Thrust exerted in forward stroke:
F1= (π *D2*p)/4 (D=0.015 and d=0.005)
= (3.14/4) *(1.5/10)2*(4*105)
F1=70.65N ……2

Thrust exerted in reverse stroke:
F2=(π*(D2-d2) *p)/4
=3.14*0.0002*4*105
F2=62.8N ……3

Remarks: It is found that value of F is lesser than F1&F2,Hence for given bore diameter the actuator would able to accomplish the task.

3.4 PROJECT MODEL

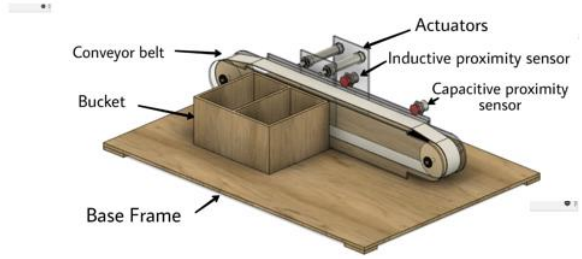

Fig -2: Conceptual design

The design of prototype is created using fusion 360 software. The dimensions for the project assembly are 670mm*970mm respectively. The capacity of motor is 12V and the RPM is 20. At 12V. the motor produces a torque of 0.00298 Nm at 20RPM. The above ratings help in achieving the appropriate motion of the conveyor belt which ultimately results in smooth operation of the entire setup i.e. sorting .

3.5 LADDER DIAGRAM

Every PLC has associated with programming software that allows the user to enter a program into the PLC .Before a PLC can perform any control task, it must be programmed to do so .The controllers offers two programming languages such as:

1-Ladder Diagram i.e implemented.

2-Function Block Diagram(FBD).

3-Sequential Flow Chart(SFC).

4-Structured Text Language (STL).

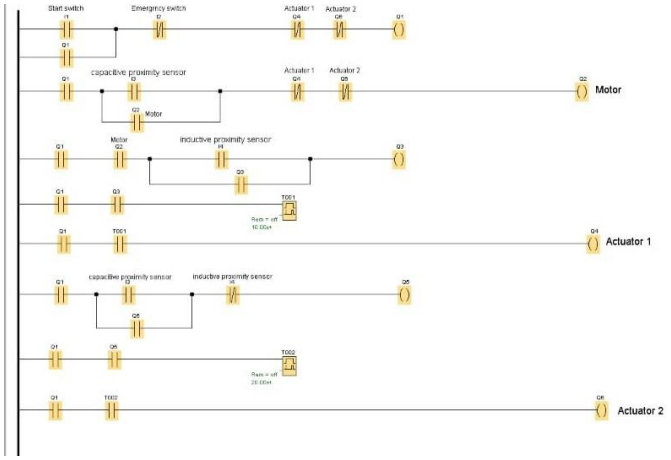

Fig -3: Ladder diagram

4. FUTURE SCOPES

The system speed can be increased to the production speed.
By adding more sensors, the system can be used as a quality controller.
Depending on the product type, the sensor can be changed.
The entire system can be used for surface inspection by the addition of ultrasonic sensors.
To measure the weight of the product, load cells can be used.

5. CONCLUSION

Only two types of parts / material were intended to be sorted by the prototype that was planned and built. By making minor adjustments to the carrier structure, the same method can be used to sort a variety of items. The Automatic Sorting Machine simplifies, improves, and ensures the accuracy and reliability of the sorting operation. Other areas where sorting is used extensively include airports, seaports, small-scale factories, supermarkets, and so on. All of these used the traditional sorting process, which is labor-intensive, time-consuming, and prone to errors. However, due to the

limited scope of automation in sorting in these industries, the idea of automated sorting in these fields should be given serious consideration.

This project will not only solve the issue of errors made by humans for the sorting i.e conventional way but also increases the efficiency and outcome of process/production which will lead to benefits for the company growth. Limitations will be there due to the practical difficulties in programming of the project according the availability of the materials and components. The setup can be further enhanced in the area where by implementing different logics and sensors depend upon the requirements or other physical considerations. In this project, the aim is to create an arrangement to reduce human effort and to an extent successful by using the low cost automation system (LAR) as a means of avoiding risk, improving precision, increasing production speed and reducing cycle time..

REFERENCES

[1] Prof. Nilima Bargal, Aditya Deshpande, Rucha Kulkarni, Rucha Moghe ,"PLC Based Object Sorting Automation"International Research Journal of Engineering and Technology (IRJET) IISN:2395-0056, Volume: 03, Issue: 07 July-2016 .

[2] Kunhimohammed C. K, Muhammed Saifudeen K. K, Sahna S, Gokul M. S and Shaeez Usman Abdulla, "Automatic Color Sorting Machine Using TCS230 Color Sensor And PIC Microcontroller" International Journal of Research and Innovations in Science and Technology ,IISN 2394-3858, Volume 2 Issue 2 : 2015

[3] Simran,Aditi Diwan,Dr.Sangeeta kamboj, "Development of automatic sorting conveyor belt using PLC"International Journal of Mechanical Engineering and Technology (IJMET) ISSN:0976 -6359, Volume 10 Issue 8,August 2019.

[4] Kadiyam Sasidhar , Shaik Faiz Hussain , Syed Ali Safdar, Mohd Aleem Uddin, "Design and Development of a PLC Based Automatic Object Sorting ", International Journal of Research and Scientific Innovation (IJRSI), Volume IV, Issue XII, December 2017

[5] Ali, M. H. and N. Mir-Nasiri (2017). Design of an Automated Pepper Sorting Machine. 2017 3rd International Conference on Control, Automation and Robotics (ICCAR).

[6] Wenchang Zhang , Jiangping Mei , Yabin Ding (2012). "Design and Development of a High-Speed Sorting System Based on Machine Vision Guiding." Physics Procedia 25: 1955-1965.

[7] George Alexandru Smeu (2013). Automatic conveyor belt driving and sorting using SIEMENS step 7-200 programmable logic controller. 2013 8TH International Symposium on Advanced Topics In Electrical Engineering. (ATEE).

[8] M.Kutila, J. Viitanen, A .Vattulainen (2005). Scrap Metal Sorting with Colour Vision and Inductive Sensor Array. International Conference on Computational Intelligence for Modelling, Control and Automation and International Conference on Intelligent Agents, Web Technologies and Internet Commerce (CIMCA-IAWTIC'06).

[9] Jiu Huang, Thomas Pretz, Zhengfu Bian (2010). Intelligent solid waste processing using optical sensor-based sorting technology. 2010 3rd International Congress on Image and Signal Processing.

[10] Amrutha Chandramohan , Joyal Mendoca, Nikhil Ravi Shankar, Nikhil U Baheti, M.S.Suma, Nitin Kumar Krishnan (2014). Automated Waste Segregator. 2014 Texas Instruments India Educators' Conference (TIIEC).

[11] Mohammed Rafeeq,Ateequr Rahman, Sanjar Alam,Mikdad (2016). Automation of plastic, metal and glass waste materials segregation using Arduino in scrap industry. 2016 International Conference on Communication and Electronics Systems (ICCES)

[12] Saurin Sheth,Rahul Kher, Rushabh Shah, Parth Dudhat, Pratyush Jani "Automatic Sorting System Using Machine vision", DOI: 10.13140/2.1.1432.144 Conference: Multi Disciplinary International Symposium on Control, Automation & Robotics, At DDIT, Nadiad, Volume: 1

[13] D. A. Wahab, A. Hussain, E. Scavino, M.M. Mustafa and H. Basri "Development of a Prototype Automated Sorting System for Plastic Recycling" American Journal of Applied Sciences 3 (7): 1924-1928, 2006 ISSN 1546-9239 © 2006 Science Publications