PLC Operated Colour Based Product Sorting machine

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Abstract. Manual sorting requires excessive effort and takes time, while automated sorting makes it possible to sort items quickly and efficiently. Production and packaging systems widely use the sorting method of product lines as a bridge. Industries have been sorting processes to arrange the materials of their items according to the requirements to decrease labour and increase overall accuracy. We have developed a S71200 PLC-based sorting system to demonstrate this sorting system, where we use electro-magnetic actuators with TCS2300 colour sensor to automate the whole system. The system consists of a conveyor belt to carry items and a colour sensor to sense the product's colour form, and the system will then use 2 electromagnetic actuators to actuate and drive the product at its respective collection station. To identify the colour of the object moving on the conveyor belt, a colour sensor was used. The colour sensor transmits a particular signal to the PLC as soon as the appropriate colour is detected, which, in turn, operates the corresponding electromagnetic actuator to force the product out of the respective station. We can completely automate the sorting system in this way. In parallel processing industries, the sorting of these goods is very difficult. A consistency issue is created by continuous manual sorting. For controlling the overall operation, PLC is used as a master controller and Arduino as a slave controller. The colour identification method is based on the frequency analysis of the colour sensor's output. This will fulfill the requirements of higher output and accurate performance in the field of automation.

1. Introduction

Automatic sorting system is the fast and efficient system for sorting of products, whereas manual sorting is an effort intensive process. Industries use sorting systems to sort products/raw materials as per nominal criteria to improve accuracy and minimize the human effort. Manual arranging is a period extreme and exertion serious procedure. Programmed arranging frameworks consider snappy and proficient arranging of items. Our endeavour incorporates decreasing the cutting-edge cost used in the foundation and working of different vehicle line structures in different ventures, it is a fundamental negligible exertion automation system used for masterminding.

Several systems are proposed with automatic sorting of products in industries. In "Automatic Sorting in Process Industries using PLC". by P. Thirumurugan has proposed a system which sorts an object based on the height. But this system is implemented for only small ranges of height which cannot be used in large scale sectors [1]. Mohd Aleem Uddin implemented “Automatic Industrial Sorting Machine by the different Sensors for Automation-An Innovative Model-Based Approach”. As per his examination, PLC can be viably intended for a wide assortment of control assignments with the simple
ladder logic to control the whole framework. Be that as it may, this framework has detriment i.e., there is no visual investigation and moving of article and setting in just specific areas happen [2].

In “Design of an object sorting using PLC” the author proposed a structured framework that is completely mechanized utilizing PLC and automated DVD Drives additionally. The principle inconvenience utilizing of DVD drives is space occupation and they are costly contrasted with actuators and output activities fluctuated [3]. In Object sorting and stacking automation using PLC a design that would count and segregate the works into the box, and then stack those things dynamically was proposed using Infrared sensors. Infrared sensors have disadvantages such as requiring line of sight, restricted range, and sluggish climatic conditions such as dust & fog which in reality might affect the sensors and data signal strength, therefore it might not be a sophisticated device [4].

In “PLC Based Object Sorting Automation” a setup that would significantly accomplish to a limited extent by using the low cost automation system (LAC) to avoid risk, improve repeatability, ramp up production speed also reducing the cycle time was developed. In industry, it can be used for sorting different objects, tools with a high degree of accuracy and automation quality [5]. The author Saurin Sheth proposed “Automatic sorting machine using machine vision” in which an arranging framework that can check the flawed parts and put them in the reusing compartment. In this work, the imperfect items are distinguished and are set in the reusing receptacles and the costs of these machines are generally high so it is hard to use in little ventures and partnerships [6].

In “Automatic Sorting Machine Using Conveyor Belt” an ongoing application that helps in objects arranging with the use of PLC was developed. A few sensors are utilized to screen the parameters, for example, shape, tallness, weight, shading, and so on [7]. A sorting system using PLC and HMI system was developed with automatic conveyer system with in-process sorting mechanism. The automatic conveyer and HMI systems can be used in wide range. But this system has many disadvantages. It is costly for small industries and it requires frequent monitoring and the PLC devices are proprietary [8].

In “Development of a Prototype Automated Sorting System for Plastic Recycling” an automatic sorting system for recycling of plastics was developed. The refinement of the routines in pattern recognition involves artificial intelligence techniques also in edge detection useful for high speed conveyer belts which can blur the acquired images was developed [9]. “A proposed hierarchical control model for automated manufacturing systems”, describing the five layer hierarchical production control model was proposed to manage factories. The hierarchical structures need frequent changes and can lead to communication barriers [10].

The author Pourdarbani proposed a “Study on an automatic sorting system for Date fruits” in a journal of the Saudi Society of Agricultural Sciences. This system is developed based on Machine vision to sort the date fruits in food packaging industry. Main disadvantage of using this method can vary in the presence of outlier [11].

So, a novel automatic sorting system using actuators with a colour sensor which are controlled by PLC is developed. The sorting system consists of a conveyer belt to carry products from one end to the collection bins. This is designed with a proximity sensor and a colour sensor attached to the conveyer belt setup wherein which the proximity sensor distinguishes if the placed product is a metal or a non-metal and the colour sensor is for colour assortment.

2. Methodology
The main objective is to plan and build up a PLC worked colour-based object sorting machine, which is utilized to sort metals and non-metals followed by colour assortment. The output from TCS 2300 is less than required, which is only about 10% to 15% of the frequency. Due to this the information required cannot be processed from low output directly, for in which an Arduino is used to process the information and to obtain the output which is to be understood by the PLC controller.

The system utilizes three electromagnetic actuators to regulate operations. One actuator is used for metal/non-metal sorting and the other two actuators are used to sort two colours and for an already sorted product. The whole system is controlled by a PLC to regulate the sorting process. Three
assortment bins are used to retain the products sorted by the actuators mounted parallel to it. The PLC communicate with sensors and actuators to attain the specified functionality and control total automated product sorting system.

For the most part, enterprises deliver similar models with almost no variation in dimensions, weight, shape and in this way arranging of items assumes a significant job here. In the days of yore, it was feasible to execute physical work for arranging comparable items. In any case, these days to limit the work use for such untalented errands, ventures can't manage the cost of human mistakes for arranging these items. This constrained enterprises to tend towards auto missing the arranging procedure. As the economy has consistently been an extensive factor in the creating business, in this way it got important to grow minimal effort computerization for precisely arranging these items.

2.1 Process flow & Block Diagram

2.2 Working of PLC based sorting system

The system that we have come up with aims to reduce human efforts by replacing manual sorting of things with automation and for fast and efficient sorting of products. This system is designed to sort two types of products. The products are placed on the conveyor belt, which moves it forward, the conveyor
line is driven by 100 rpm motor of the DC type. The objects are moved forward for sensing. The DC motor is used to move the continuous movement of the conveyor belt. A relay, an electrically operated switch, used for the process of switching. Initially, the objects that are to be assorted are placed on the conveyor. The conveyor is started, and the object will start to move on the conveyor, then the object will pass through the sensor.

![Flow Chart](image)

**Figure 2.3 Flow Chart**

The Proximity sensor senses the object coming parallel to it thus segregates metals and non-metals. It utilizes the inductive effect of the detection of metals. If the object is failed to sense near the Proximity sensor, then the product further moves on the conveyor belt and is sensed by the colour sensor. The colour sensor is placed to sense the objects with colour and then collected in the sorting bins. If the
colour of the object is identified by the sensor then the object goes to sorting procedures as per requirement by going through the whole process and get sorted into waste bins.

The sorted bins are placed to collect the products after they are been sensed by the sensors. For this purpose, the Electromagnetic actuators are placed to push the products into the sorting bins. We have two actuators for this purpose. One of the actuators is used for pushing the products that are sensed by the proximity sensor. And the other actuator is used to push the products that are sensed by the colour sensor. This way various products are differentiated and categorized accordingly.

2.3 Flow chart description

➢ The packages are placed on conveyor belt line initially. The belt on the conveyor starts moving as a DC motor is connected to it.
➢ As soon as the object reaches to a position such that it is parallel to the proximity sensor, it is detected for its metallic/non-metallic nature. The response generated is sent to the PLC.
➢ After the sorting based on this characteristic the objects are then passed by parallel to the COLOUR sensor and used to sense the products of particular COLOUR if it matches it is sorted using actuators it goes to waste bins.
➢ In this way the objects are passed by the sensors and detected or sorted based on the requirements that we give in the ladder logic.

![Figure 2.4 HMI screen with tags](image)

3. Results and Discussions
We made an ease programmed arranging framework utilizing the Programmable Logic Controller (PLC). We have attempted to arrange that will diminish human exertion and prevailing to a degree by utilizing the minimal effort robotization framework (LAC) to stay away from hazard, improve exactness,
and speed up creation. The arranging framework is utilized to sort the items dependent on their metals/non-metal attributes and shading put together qualities which are going with respect to the transport framework utilizing electromagnetic actuators. Further a few upgrades should be possible in our work by actualizing it in enormous scope areas. The arranging procedure should be possible from multiple points of view by arranging dependent on the different measures of the item, by size of the article or by dependent on the material by which it has been made. The procedure can be additionally improved by executing various kinds of arranging framework in an equivalent arranging procedure and it very well may be made with different sorts of arranging framework. Additionally, this can be additionally improved to an arranging framework that sorts the things dependent on the other physical thought. What is more, this can be accomplished utilizing the different sensors. In industry it tends to be utilized for arranging of different items, with high level of exactness and quality with a robotization.
When red colour sensor output is null, em_actuator_3 will be in off condition only.

When red colour sensor output is enabled after 0.5 sec, em_actuator_3 will be enabled.

Fig 3.1: Ladder Logic Output

HMI screen when conveyor is in on condition.

HMI screen 5 sec after proximity_in is enabled.

HMI screen 5 sec after blue_sensor_in is enabled.

HMI screen 5 sec after red_sensor_in is enabled.

Fig 3.2: HMI Screen Output
4. Conclusions
An easily reprogrammable framework utilizing the Programmable Logic Controller (PLC) was developed. An attempt was done to diminish human exertion and prevailing to a degree by utilizing the minimal effort computerization framework (LAC) to keep away from chance, improve precision, and speed up creation. The arranging framework is utilized to sort the articles dependent on their metals/non-metal qualities and shading put together attributes which are going with respect to the transport framework utilizing electromagnetic actuators. Further, a few upgrades should be possible in our work by executing it in huge scope segments. The arranging procedure should be possible from multiple points of view by arranging dependent on the different physical parameters of the object like degree of size of or dependent on the type of material it is built. Furthermore, sorting can be accomplished utilizing the different sensors. In parallel process industry tends to be utilized for arranging of different items, with high level of precision and quality with a mechanization.

By developing this PLC operated colour-based object sorting system, sorting the objects based on their metal/ non-metal characteristics and based on their colour assortment was done. This sort technique will be exceptionally helpful in parallel processing industries where different objects are processed simultaneously. This differentiating procedure is a unique procedure by which we can sort n number of objects passing through conveyor in a single stretch without any errors. The sorting procedure additionally decreases the manpower requirement in numerous enterprises.

5. Future scope
Programmed arranging machine upgrades proficiency, common sense, and security of administrators. It guarantees wonderful preparing limit just as flawless execution including shading discovery. Of course, we have to include stepper motors or high precision motors and sensors with considerable reaction to accelerate the framework for mechanical sorting process. The present prototype can be developed further by rolling out certain improvements in the program and segments. A few proposals for developing this same work have been listed below.

- We can add other parameters in the sorting process by using different sensors which can make sorting process more efficient like weight, height and type of material of the object.
- By using DC motor, increases operation and maintenance cost due to presence of commutator and brush gear. So using stepper motor can make it more efficient.
- We can also track how many objects are being sorted by developing automatic counter which can count number of objects being sorted.
- Sensors with high precision and accuracy can be used to sort the object based on the colour assortment more accurately
- Usage of quality sensors make sorting more efficient and need not to be checked or replaced more often.

References
[1] "Automatic Sorting in Process Industries using PLC" by P. Thirumurugan GRD Journals- Global Research and Development Journal for Engineering | Volume 3 | Issue 3 | February 2018
[2] Mohd Aleem Uddin “Postal Automation System for Mail Sorting” International Journal of Emerging Technology and Advanced Engineering, Volume 5, Issue 3 December 2017.
[3] 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.
[4] Dhaval Tailor, Vivek Kamani, Ankit Ghetiya, Naresh Bhatiya, “Object Sorting and Stacking Automation with PLC”, International Journal of Engineering and Technology (IJET) DOI: 10.21817/ijet/2017/v9i3/170903S031 Vol 9 No 3S July 2017.
[5] Prof. Nilima Bargal1, Aditya Deshpande2, Rucha Kulkarni3, Rucha Moghe4, “PLC Based Object
Sorting Automation” International Research Journal of Engineering and Technology (IRJET) Volume: 03 Issue: 07 | July-2016

[6] Saurin Sheth, Rahul Kher, Rushabh Shah, Parth Dudhat, Pratyush Jani “Automatic Sorting System Using Machine vision”, DOI: 10.13140/2.1.1432.1448 Conference: Multi Disciplinary International Symposium on Control, Automation & Robotics, At DDIT, Nadiad, Volume:1.

[7] Y V Aruna, Beena S “Automatic convey or System with In–Process Sorting Mechanism using PLC and HMI System”, Int. Journal of Engineering Research and Applications ISSN: 2248-9622, Vol. 5, Issue 11, (Part -3) November 2015, pp.37-42

[8] S.V. Rautu, “sorting of objects based on colour, weight, and type on a conveyor line using PLC, "IOSR Journal of mechanical and civil engineering (IOSR-JMCE), ISSN2278-1684.

[9] Darshil; Sagar; Rajiv; Satyajit A. Pangaokar; V.K. Sharma " Development of a PLC Based Elevator System with Colour Sensing Capabilities for Material Handling in Industrial Plant" Published in: 2008 Joint International Conference on Power System Technology and IEEE Power India Conference.

[10] 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.

[11] Albert T. Jones, Charles R. McLean, ”A proposed hierarchical control model for automated manufacturing systems”, National Bureau of Standards, Gaithersburg, Maryland, USA

[12] Pourdarbani, R., et al., Study on an automatic sorting system for Date fruits. Journal of the Saudi Society of Agricultural Sciences, 2015. 14(1): p. 8