Magnetic And Non-Magnetic Material Sorting Machine By Using PLC

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***Abstract*: In our project, the development of a LCA (Low Cost Automation) system to sort objects according to their height has been designed. This LCA system is controlled by Programmable Logic Controller (PLC). This project consists of two parts, first consisting of software which contains ladder logic programming which is used to program PLC that controls the whole process of the project step by step according to input data sequence. Second is the hardware part which consists of conveyors used to transport the objects, sensors used to sense the height . In many industrial applications there is need of sorting. Sorting can be done by using many ways like sorting of object according to their dimensions (height, length etc.), according to their colours, according to their weight, using machine vision (image processing), according to the material of an object etc. For example in Thermal Power Station electromagnetic sorting technique is used to sort ferromagnetic materials from coal.**

Keywords: Material sorting, Magnetic,Non- Magnetic,PLC

I. INTRODUCTION

In our project we are propose the concept of "Metal & Non-metal Sorting Using Metal Detector". This system of sorting products is optimized to differentiate between metal & non-metals product, which is done with the help of a metal detector. A continuous conveyor belt carries the different products, and with the help of a control motor it separates metal from non-metal.

In a nutshell, this system consists of a metal sensor. When the conveyor belt carries the products, it goes through a metal detector, if it's a metal product the control motor separates it with the help of a bar and the skipped product goes further to another container for non-metal. GSM technique is also introduced for mobiles messaging. The counter displays the metal count.

This project is useful in automobile industries, steel plants and industry for separation of metal and non-metal element in the industry on a large basis. It can also be used for waste management so also beneficial for the environment.

Around the world, waste generation rates are rising. So many companies are involved in designing systems that can be able to sort and classify solid waste and scrap into different types to facilitate the process of recycling and then achieve the maximum price of each material from the scrap.

Sorting is the first step of a waste management process. It should be sorted according to the type of material.so the main idea of our project is to design and implement a machine that sorts, and classifies three different types of materias which are iron, aluminum, and plastic. Then guide materials to different carts to prepare for the material recycling process.

II. ABOUT

Problem statement:

The problem statement for the project is to create the electronic material handling system which can be used to reduce the effort of the workers as well as to reduce the time spent in the inspection of the components, uring their manufacturing .it also reduces the effort in transferring the component manufactured to another workstation. The most apparent reason that is associated in installing of automatic system in industries is;

Saving man power ,Improved quality and efficiency.

III. THEORY

DC Motor

DC motor is used to drive the conveyor along with the rollers. The DC motor is interfaced with the PLC through a relay so as to fulfill the requirements of the motor (i.e. Voltage and Current ratings).

DC motor voltage : 12V
Motor torque : 2 kg-cm
Motor RPM : 100 RPM , 10RPM

Fig: Dc Motor

Pusher

A Pusher is used to move the object from one conveyor to another conveyor.

Operating Voltage : 12VDC
Voltage : 5VDC

DPDT

DPDT relay stands for double pole double throw relay.Relay is electromagnetic device used to separate two circuit electrically and connect them magnetically,which works at low voltage 12V or 24V.

Relay

A Relay is used to operate DC Motors, LDR's output, operation of CD Drive.

Operating voltage : 12VDC and 24 VDC
Type : Electromagnetic PCB relay
Max. Current : 7A
Max. Voltage : 250V

Laser

A Laser is used to supply light to the LDR when the object is to be detected.

Voltage : 5VDC
Wavelength : 630-680mm
Diameter of laser case : 15mm
Class II laser

Conveyor Rollers

Rollers are fitted on bearings using a shaft. It helps in moving conveyor belt.

Diameter : 50mm
Length : 160mm

Bearings

Bearings are used to minimize the friction between shaft and conveyor belt. It is fitted inside the wooden socket.

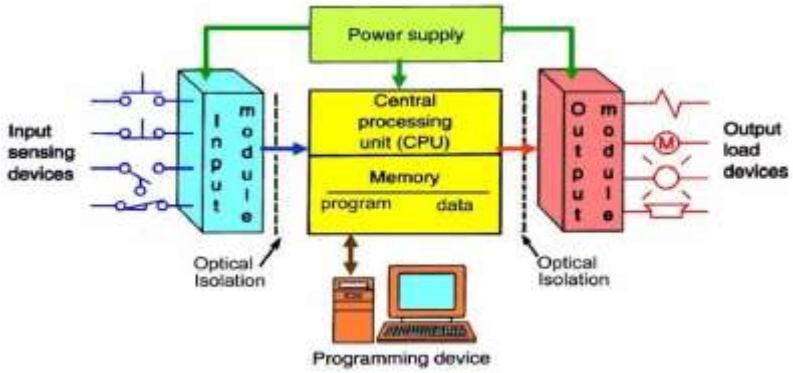
Base board

It is made up of wooden material. It provides the basement to whole assembly. All hardware components like motors, rollers and conveyor belts, etc. are mounted on the base board.

PLC Programming

A central control system from which one can operate and program functions of several independent or dependent systems. The PLC consists of a user interface, central processor, links to subsidiary system controls, and an electrical control interface. See

Figure The PLC-type that will be used is DELTA- DVP16ES2 that has 8 inputs and 8 outputs. We chose Delta PLC because of its good quality, it is easy to be programmed, has accepted the price and meet the required purpose



Event	Description
Input Scan	The status of input modules is read and the Input Image table is updated with this new data.
Processor Scan	The ladder program is executed. The input image table is evaluated, ladder rungs are solved, and the output image table is updated using this new results. This information is not yet transferred to the output modules.
Output Scan	The output image table contents are transferred to the output modules. The
Communications	Communication with programming devices and other network devices take place in this section of PLC scan cycle.
Processor Overload	Processor internal housekeeping functions are carried out in this section of PLC scan cycle. These actions include performing program pre-scan and updating the internal time base and the status files.

Program& Data Organization Inside the PLC

A lot of information is stored in PLC memory. The PLC memory is divided into two main files:

Program file
Data file

Processor stores system and configuration information along with user developed ladder programs in the part of memory called "Program Memory". Processor stores the data used by the processor in conjunction with input image files and output image files in part of memory called "Data Memory". Data files contain the information, or data used in conjunction with input and output image tables. Along with that there are many internal data storage files.

File 0, Output status file

File 0 is the default output status file. There can be only one output status file per processor. The output status file is made of single bits grouped into 16 bit words. Each bit represents the ON or OFF status of the output points. There is a one bit in the output status file for each output module point in your PLC system. The first row in Table 2.2, lists the output module address. ON state means 1 of the output status file.

Table 2.2: Output Status Table

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Address
0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	O:0.0

File 1, Input status file

File 1 is the default input status file. There can be only one input status file per processor. The input status file is made of single bits grouped into 16 bit words. Each bit represents the ON or OFF status of the input points. There is a one bit in the input status file for each input module point in your PLC system. The first row of Table 2.3, lists the input module address.

ON state means 1 of the input status file.

Table 2.3: Input Status Table

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Address
0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	I:0.0

File 2, Processor status file

File 2 is the default processor status file. There can be only one processor status file per processor. The processor status file contains extensive amount of data regarding the processor and its operation. Status file consist of following list.

Operating system information
Monitoring of hardware and software faults
Clearing of hardware and software faults
Monitoring of arithmetic flags
Average scan time information
Communication bits
I/O error

File 3, Bit file

File 3 is the default bit file. A bit file is used to store signal bits in a 16-bit words format. There can be many bit files for a single processor files. Each bit file will have 256 16-bit words. One 16-bit file word is one element. Table 2.4 lists the bits 0 through 15 across the top row from right to left. The row on the right of the table 2.4 lists the bit file element. Each 1 or 0 in the file is a single bit.

Table 2.4: Bit Table

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Address
0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	B3:0
0	1	0	1	0	1	0	1	0	0	0	1	1	0	0	0	B3:1

File 4, Timer file

File 4 is the default timer file. A timer file is used to store timer data. Each timer is comprised of three 16-bit words, called “Timer Element”. There can be up to 256 timer elements in each timer file. If more than those timer elements are required then we can make one more timer file whose address is greater than 10.

File 5, Counter file

File 5 is the default counter file. A counter file is used to store counter data. Each counter comprises of three 16-bit words, called “Counter Element”. There can be up to 256 counters in each counter file. If more than that counter elements are required then we can make one more counter file whose address is greater than 10.

File 6, Control file

File 6 is the default control file. A control file is used to store status information for bit shift, first in first out (FIFO) stack, last in first out (LIFO) stack, sequence instructions and certain ASCII instructions.

File 7, Integer file

File 7 is the default integer file. An integer file element is a 16 bit word representing one whole number. The integer file is used to store integers that include whole numbers. Any whole number e.g. 100, 251 or 32767. Each integer file contains 256 integer elements. Each element can store a number ranging from -32768 to 32767. Data stored in integer file can be addressed as an integer word or at the bit level.

File 8, Floating-point file

File 8 is the default floating- point file. A floating point data is comprised of two parts, an integer and an exponent. Floating point data is stored in two words element. One word is used to store the integer. The other is used to store the exponent.

IV. DESIGN OF EXPERIMENTAL SETUP

Table represents the main mechanical properties of the conveyor belt and some mechanical coefficients:

Belts and other similar elastic or flexible machine elements are used in conveying systems and in the transmission of power over comparatively long distances. Because of its inherent advantage that it can absorb a good amount of shock and vibration. It can take care of some degree of misalignment between the driven and the driver machines. Figure shows a flat belt geometry.

Properties	**Value**
Steel density	8000 Kg/m^3
Belt density	1200 Kg/m^3
Belt thickness	0.005 m
Belt width	0.2 m
The diameter of the pulley	0.058 m
Friction coefficient μ	0.35

$$\theta_d = \pi - 2\sin^{-1}\frac{D-d}{2C}$$

$$= \pi$$

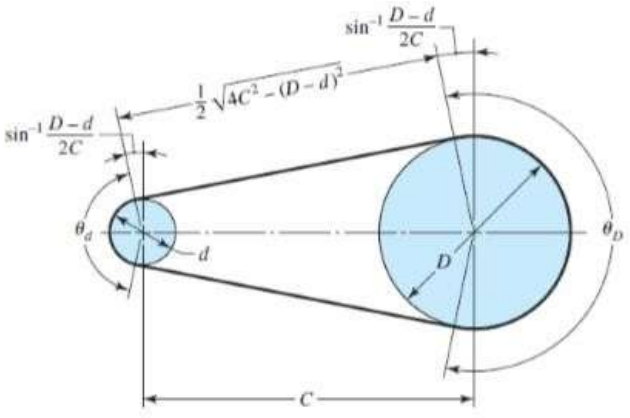
$$\theta_D = \pi - 2\sin^{-1}\frac{D-d}{2C}$$

$$= \pi$$

$$L = \sqrt{4C^2 - (D-d)^2} + 0.5(D\theta_D + d\theta_d)$$

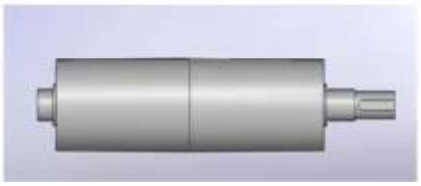
$$= \sqrt{41^2 - (0.058 - 0.58)^2} + 0.5(0.058 * \pi + 0.058 * \pi)$$

$$= 2.18 \text{ m}$$



The angle of contact in the driven and driver roller:

The length of the belt is found by summing the two arc lengths with twice the distance between the beginning and end of the contact. The result is



Where:
D: diameter of the large pulley d: diameter of the small pulley C: center distance
Θ: angle of contact
L: total length of the conveyor belt (m) The area of the belt = L × W

= 2.18×0.2

= 0.436 m2

The Volume of the belt = thickness × Area

=0.005 × 0.436

Fig: Driving pulley. Fig: Driven pulley

$= 2.18 \times 10^{-3}$ m3

The Mass of the belt $= \rho \times V$

$= 1200 \times 2.18 \times 10^{-3}$

=2.616 kg

We suppose that the belt will carry ten pieces of steel with following dimensions (0.05, 0.05, and 0.05) m

Volume of one piece = length × width × height

=0.05 × 0.05 × 0.05

$=1.25 \times 10^{-3}$ m3

Mass of object = 10 × ρ of steel × Volume of one piece

$= 10 \times 8000 \times 1.25 \times 10^{-3}$

=10 kg

The total mass (M)= Mass of the belt + Mass object

= 2.616 + 10

=12.616 kg

The force produce from this mass F= M × g

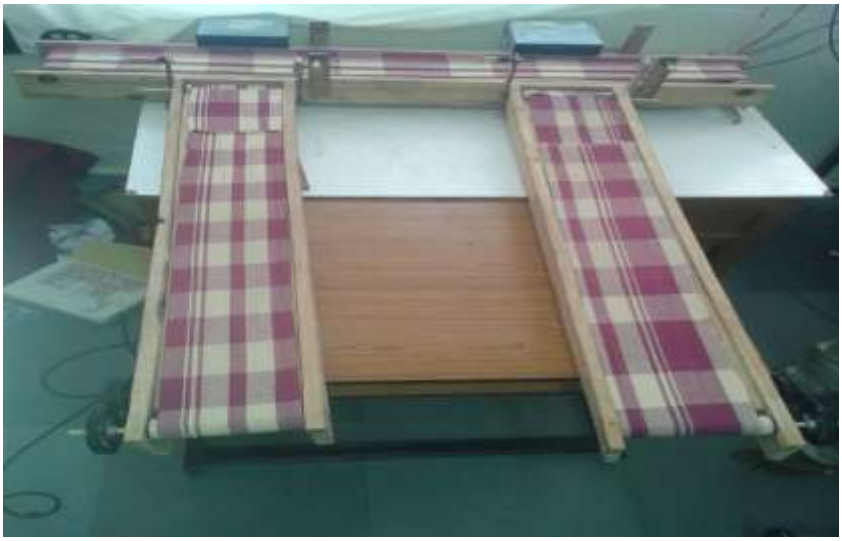
= 12.616 × 9.81

= 123.76 N

The friction force Ff= □ × μ

= 123.76 x 0.35

43.32 N



V. WORKING PRINCIPLE

Working principle:

1. The pieces are entered by hand in the hopper.
2. In the hopper, the pieces move on an inclined surface, using vibrator motor.
3. The pieces are inserted into the conveyor belt, by a first DC motor which connected to the inclinedsurface, In the retraction mode, the piece is allowed to enter to the conveyor, In the extension mode, pieces are blocked to entering to the conveyor belt.
4. After entering the object into the conveyor belt, the piece is checked through sensors in a sequential manner.
5. If the magnetic sensor activated, that means this piece is iron, the second DC Motor will push the piece into the iron box, otherwise, the pieces complete their path on the conveyor belt.
6. If the magnetic sensor and the inductive sensor deactivate, that means this piece is plastic, then continue to plastic box at the end of the conveyor.

VI. RESULT AND CONCLUSION

Results

The operation of the system has been accomplished and have obtained the sorting results as follows.

- When LDR1 is activated then Pusher1 is operated with start of Conveyor 2.
- When LDR3 is activated then Pusher2 is operated with start of Conveyor 3.

Conclusion

The proposed method is a solution to the current waste management problem which will effectively segregate metal, glass and plastic. This system can be effectively deployed in industries for material segregation, scrap shops and urban households. The waste separated material can be used to produce the desired products thus helps in saving economy and resources.

Future Development

Following developments can be done in the system to increase the production rate as well as to minimize cost. 1. Using high quality sensor like Laser sensor we can increase the speed of the process. 2 . Objects are sorted; we can distinguish it easily by improving extra circuitry. It is also economical. 3. This system can be used to sort more than one Object in one cycle by suitably altering the hardware and software of the system.

Applications

1. Manual sorting of any object consumes a lot of time and labour. Hence, PLC object sorting system finds wide application in the following industries.
2. Brick Manufacturing Process:
3. In Brick manufacturing Process the quality of bricks considering their height as a parameter can be checked. If the height is more or less from the original size then the defective bricks can be sorted out.
4. Luggage sorting at Airports:
5. The parcels at airport which has to loaded in cargo planes can be sorted accordingly to reduced the load of the plane.
6. Quality Checking of Solid Objects:
7. If the height of the solid material is taken as a criteria in quality check of that object then this system can be used effectively.
8. In Food Processing Industries:
9. The food packing of the food stuffs of different sizes can be sorted in such type of industries where various quantities of packed food are running on a single line.

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