Automation of Product Sorting Machine by using Microcontroller

Kapil R. Pardeshi, Suyog R. Deshmukh

***Abstract*— Automation is a preferred for faster and precise operations as compare to manual operation. This paper provides a mean of simple yet effective fixed type of automation for sorting the products. Two products identical in shape and size are sorted out automatically on the basis of drilled or undrilled product. LED and photo transistor arrangement is used for hole detection. Vertical zigzag conveyor is employed instead of usual flat belt conveyor in order to utilise gravitational force as a driving force for feeding the products. 8051 Microcontroller is used for controlling the sorting mechanism by using program or coding. The cost of project is nearly negligible as it is made from the waste except electrical components used for the project. Sincere efforts are taken to set an example of a inexpensive, reliable and easy to manufacture automated machine. The Paper focuses on the aspect of sorting mechanism with microcontroller programming and the automation tasks and solutions is obtained.**

***Index Terms*— automation, zigzag conveyor, sorting machine, 8051 microcontroller.**

I. INTRODUCTION

Automation is defined as a methodology to convert manual operations into semi automatic or automatic operations by means of mechanical, computer and electronic systems, which is used for increasing efficiency of machine.

Automation systems are useful for increase the profitability of engineering services. Automation is the use of control systems and technologies to reduce the need for human work in the production of goods and services. In the scope of industrialization, automation is a step beyond mechanization. Whereas mechanization provided human operators with machinery to assist them with the muscular requirements of work, automation greatly decreases the need for human sensory and mental requirements as well. Automation plays an increasingly important role in the world economy and in daily experience.

The technology involved in automation typically includes following things:

1. Highly mechanized machine for processing.
2. Automatic material handling system.
3. Industrial robots.
4. Automatic storage system.
5. Automatic inspection and quality control system.
6. Feedback and automatic process control, etc.

There are three types of Automation systems namely Fixed automation, Programmable automation and Flexible automation. All of the three has different characteristics as tabulated below:

	Types of Automation		
	Fixed	**Programmable**	**Flexible**
Initial investments	High in custom engineered equipment	High in general purpose equipment	High in custom engineered system
Production rate	High	Low to Medium	Medium
Flexibility	Inflexible	Suitable to accommodate changes in product configuration	Flexible to accommodate product design variation
Production system	Mass manufacturing	Batch manufacturing	Continuous production of variable mixture
Tooling	Fixed tooling	Tools and fixtures as per production batch	Tool changes as per quick and efficient
Setup Time	No setup time as the type of production does not vary	Setup time varies from batch to batch	Min. setup time

II. LITERATURE REVIEW

Literature ReviewAutomation can be done in several ways based on the cost, available resources and requirement of automated system. For this particular problem two methods were considered as a solution at initial stages. One was the use of pneumatic system for sorting and other was our proposed method. Later, proposed method was found to be better and chosen as a solution to the problem

A. Pneumatic system approach:

After feeding the products and detection by the LED and photo transistor arrangement (Hole Detection System), products are sorted out on left and right side of the neutral position as shown in fig. 2.1.

The main problem with this method was to achieve these three positions using single pneumatic cylinder. Extended and retracted positions can be easily controlled by the cylinder but the position in between these two is difficult to achieve. The interfacing of hole detection system with pneumatic system was difficult to implement. Hence, this option was not chosen.

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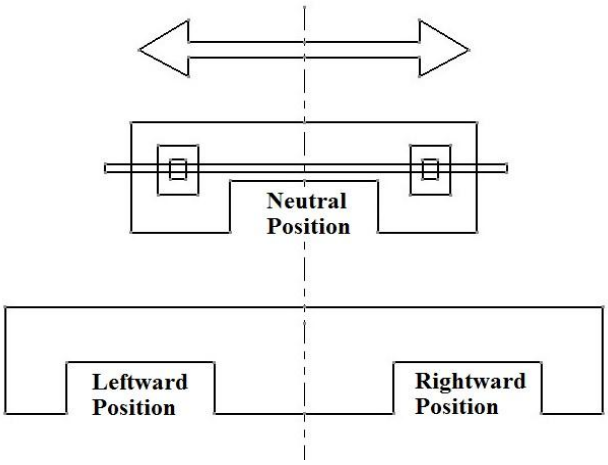


Fig. 2.1: Required Positions for Sorting of Products

B. *Proposed Method:*

In the proposed method electrical drive (DC Motor) is used for positioning of the product. Threaded rod (like lead screw in lathe) is used for converting rotary motion of DC motor to translatory motion. This rod is connected to C-collar which is an important part of slotter mechanisms with bolts fixed on it. When motor rotates, one motion is constrained as bolts are fixed. Hence the only motion left is translator motion. This to and fro motion can be achieved by rotating a DC motor in either directions. Required delay for detection and idle rotation is calculated and implemented in programming so as to achieve correct positioning of the C-collar moving along the length of the screw. The selection of the electrical drive is done on the basis of torque and RPM of motor.

Figure 2.2 shows CATIA model of the project. It is made in V5R20 version. Efforts are taken to include every detail in software model. All major components like feeding mechanism, slotting mechanism and hole detection system are included in model to provide complete understanding of the project.

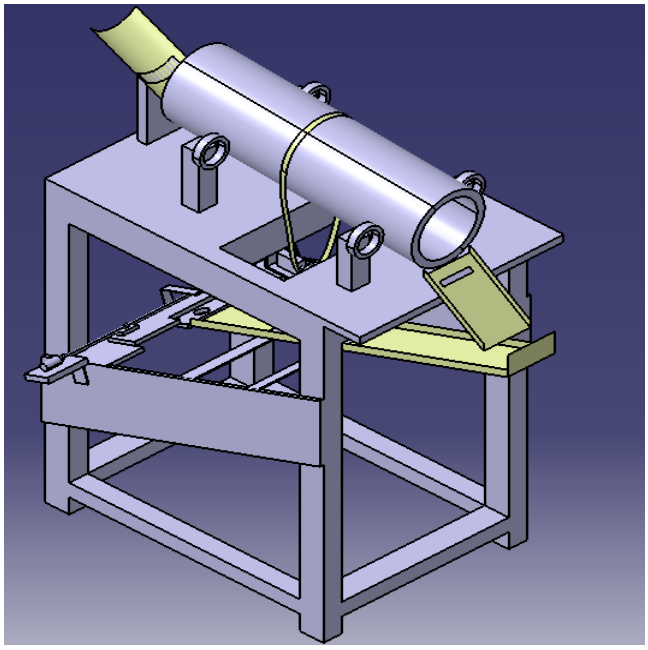


Fig. 2.2: Project Model (CATIA Software)

III. Methodology

Project was conceptualized as shown in block diagram 3.1. The basic aim was to make a machine with both mechanical and electronics systems with minimum cost and effective design in order to achieve an unconventional automation system.

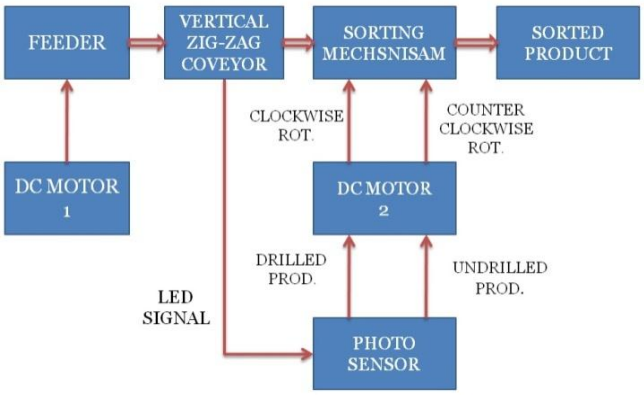


Fig. 3.1: Block diagram of project

The products are to be fed through the sheet metal feeder to a vertical zigzag conveyor. Dc motor 1 is used for feeding system so as to provide smooth flow of products. Once products are passed through conveyor they are collected in a C-collar where hole detection system is placed to check for drilled or undrilled product. Corresponding signal was transmitted to 8051 microcontroller from where it was further transferred to L293D DC motor driver according to programming dumped in microcontroller. Motor driver drives the DC motor 2 in clockwise or counter clockwise direction and product is sorted accordingly.

Vertical zigzag conveyor helps in fluent flow of the products and continues submission of products to whole detection system

IV. Slotting Mechanism

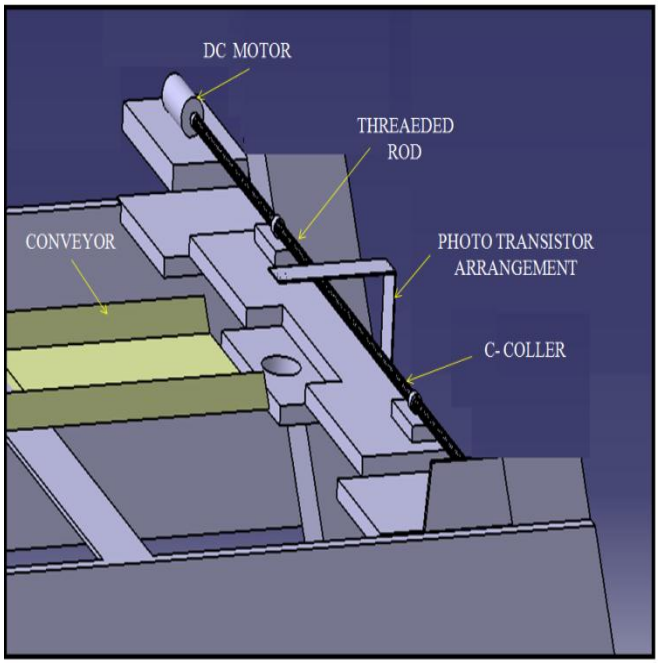


Fig. 4.1: Slotting mechanism

Slotting mechanism was the backbone of this project. The sorting operation is completely dependent on this system. Basically screw arrangement with fixed bolts was used to insure to and fro motion. C-collar is gas welded to bolts and screw is allowed to rotate freely. DC motor of 1000RPM, 12V is coupled with the screw to achieve required speed and torque. Because of the welding, C- collar slides along the length of the screw.

The calculation is done as explained below.

$$M_t = W\tan(\alpha+\phi)D_m/2$$

Where,
M_t = Torque required to move the thread against the load
W = Applied load
α = Helix angle of screw
ϕ = Friction angle = tanμ ,
μ is coefficient of friction
D_m= Mean diameter of screw thread

Mean diameter was calculated by averaging major and minor diameter of screw. This formula gives a torque required to move the single thread against the load. Considering the number of threads total torque can be calculated as

$$M_t = n.\ W \tan(\alpha+\phi)\ D_m/2$$

Where,
n = Number of threads.

With the increase in torque, RPM decreases. According to availability of motors, optimised option was chosen. In this way torque selection for the DC motor is done and appropriate motor is used for the service.

V. Circuit Diagram

Fig. 5.1 shows the circuit diagram of 8051 microcontroller with electronic drives. The components details are as follows:

1. *Microcontroller:* P89V51RD2 microcontroller of 8051 family was connected to the motor driver to drive the motors.
2. *Motor Driver:* Single motor driver was used to drive both the motors with single assembly C program dumped into microcontroller. L293D type of driver was used for this purpose. Once started, DC motor 1 (12V, 500RPM) rotates continuously which was used in feeding mechanism and DC motor 2 (12V, 1000RPM) was rotated in either directions as per the signals coming from the hole detection system. All these components are shown in pin diagram.
3. *Photo Transistor with LED:* Photo transistor (FFH300) with 3W high power LED. This system was used a Hole Detection system. If signal passes through drilled component, DC motor 2 rotates in one direction. LED light could not fall on photo transistor if undrilled component was fed. In such cases, motor rotates in opposite direction.

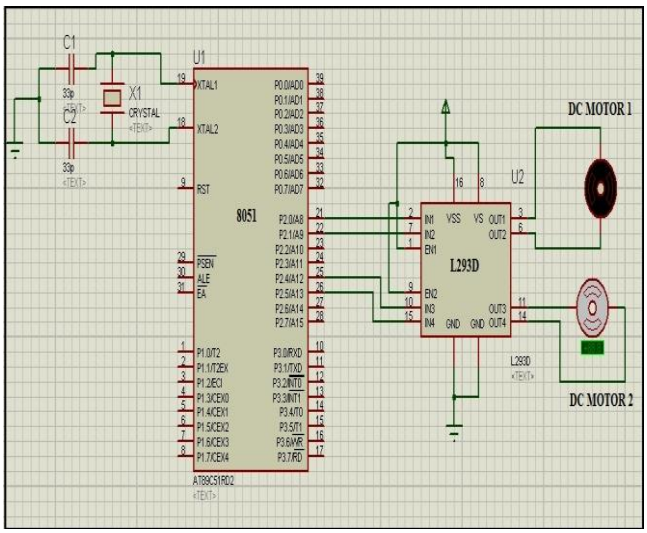
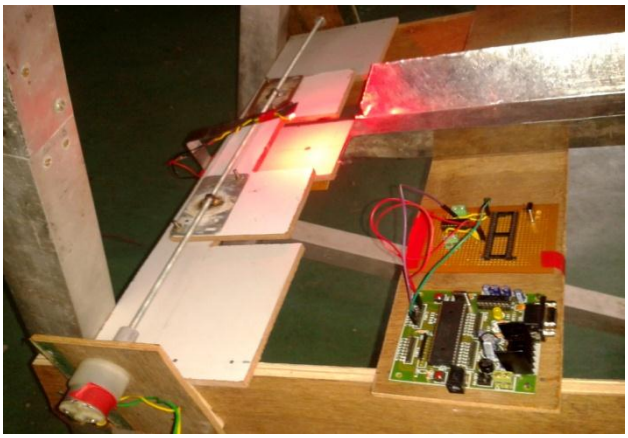


Fig. 5.1: Circuit Diagram of 8051 Microcontroller with Electronic Drives

VI. Conclusion

The project was successfully completed and aim of low cost, effective automation machine was achieved. It was observed that Sorting was smooth and accurate. The mechanical systems were fine and manufactured considering all the requirements. Sheet metal was used whenever possible to make project lighter and portable. Reverse engineering approach was used for design calculation and motor selection. This was the prototype of the machine, however it was concluded that practical large scale execution was possible with the same approach. Final project is shown below.



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