Robotic Cutting System using Velocity Scanning of Linear Conveyor

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ABSTRACT - In order to do operations on a moving conveyor without stopping it, need to make the relative velocity between the robotic operations arm and the belt conveyor to zero, so that any operations can be done between these two process. In this project as it is a cutting process that can be applied in food manufacturing industries, Proper cutting on required positions on the product to get equal quantity of food product at any conveyor speed is the main objective. The purpose of this model is to vary the production rate according to market requirement, to reduce the damages in the model and to minimize the production cost. So in this proposed model linear speed of a conveyor can be sensed by sensing mechanism which will convert velocity into a pulse train. Number of pulses/second will define a value that is proportional to the linear velocity of the conveyor. By multiplying with some constant we can easily obtain the linear velocity. This constant is the perimeter of the disk which is attached to encoder, which is used to obtain the pulse train. A servo motor is used for cutting process. The speed of linear conveyor obtained, then converts to a suitable voltage that runs the servo motor in synchronized rpm by the help of PLC. The vertical motion for cutting is made through a pneumatic cylinder in which the end effector moves up and down will cut the product perfectly as if it would slices when not in motion. The cutting dimensions will not vary even if the conveyor speed varied. The perfect cutting on product is the result of synchronizing the velocity of robotic system and conveyor.

KEYWORDS - Automation, Conveyor, Robotic Arm, cutting Machine, Speed Synchronizing.

I.INTRODUCTION

GENERAL

The word pneuma means breathing air. With the help of compressed air the vertical motion of robotic arm are controlled. The robotic arm motions and the conveyor speed are synchronized thus the proper cutting operation can be performed. In this project as it is a cutting process that can be applied in food manufacturing industries, Proper cutting on required positions on the product to get equal quantity of food product at any conveyor speed is the main objective [4]. In process Automation linear velocity of a conveyor is required to change according to process speed. Linear speed of a conveyor can be sensed by sensing mechanism which will convert velocity into a pulse train. Number of pulses/second will define the linear acceleration of conveyor in to a frequency. Integration of robotic arm with conveyor is the task of synchronizing linear acceleration of conveyor, and linear actuator of robotic arm equals to zero.

A PLC based control system will convert frequency feedback from conveyor into frequency command of a servo operated mechanical actuator of a pick and place robotic arm system. The vertical actuator in the name of end effector is operated by a pneumatic cylinder in which the end effector moves up and down this robotic system will cut the food product perfectly as it moves across the conveyor at regulated speeds [1]. The perfect cutting on food product will be the result of velocity matching.

AIM OF PRESENT STUDY

This project aims to synchronize the velocities of two entirely different systems. Conveyor systems which are used in transporting objects in mines, airports, are used as an industrial application to carry objects at varying speeds. While taking robotic arm into consideration with the help of a servo motor, the high-speed horizontal arm of the robot can be moved with higher velocity and better precision. With the help of transducers (encoders) and other sensing systems, the speed of the conveyor is sensed and are given to the PLC as an input. The PLC gives an output pulse to the servo motor driving the robotic arm and thus synching the velocities of the two different systems and thereby making the relative velocity between them zero [3]. The main objective of the project is to develop a automatic cutting machine based on velocity control which results in the time consumption of production and also reduces the workforce [5].

To make relative velocity between the robotic high-speed arm and the belt conveyor to zero, so that any operations can be done between these two processes. Proper cutting on required positions on food product for different speeds of conveyor is the main objective of this project. The need of this model is to increase the production level, to reduce the damages in the model and to minimize the production cost. Further the service and maintenance of such a conveyor-robotic system is much easier and cheaper, also the present function (cutting) can be modified to perform various other functions such as, pick and place, stamping, position control, cut to length of other objects etc [7].

II.METHODOLOGY

In the existing system, the conveyor is rotating with the help of induction motor. The VFD is controlling the speed of conveyor and the servo motor is controlling the movement of robotic arm. VFD motor will work at continuous rotating speed so during the cutting process, the robotic arm can't able to move to the exact cutting position because there is no synchronization between the speed of servo motor and induction motor. So the movement of conveyor is stopped or the speed of conveyor is reduced and the cutting process will be performed. Currently most of the industries used the position-controlled applications which consumes more time and cannot control the speed rate of production.

A PLC based control system will convert frequency feedback from conveyor into frequency command of a servo operated mechanical actuator of a pick and place robotic arm system [9]. The end effector is operated by a pneumatic cylinder in which the end effector moves up and down this robotic system will cut the food product perfectly as it moves across the conveyor at regulated speeds.

DESIGNING METHODOLOGY

The methodology of the project will be shown in figure 1.

- **Machine Designing**

  This section shows the design of entire machine. The different parts of the system, mechanical designing, electrical designing and pneumatic designing. This is doing using different software in computer.

- **Drawing of Control Panel**

  Design of the panel diagram and mention each and every connection in the system, from where a connection wire is start and where that connection end.

- **Power Supply Diagram**

  In this step, need to draw the supply diagram. What are the supplies comes in to the machine and their connections to different components.

- **Assembly of Machine Parts**

  Assemble the components to make the machine. Here based on the design of machine we need to assemble the components of machine. Mechanically requires to check for every joints and fittings of the components.

- **Wiring of Control Panel & Field Junction Box**

  According to the drawing, it explains to setup the wiring panel. The drawing of wiring panel and power supply diagram according to these diagrams need to wire the circuits. Electrical wiring is an important work. Each and every connection is needed to make perfect.

- **PLC Programming**

  Write the program for the process using PLC software. Knows the working sequence of the machine process, based on that need to write the PLC ladder program for the process. This is the starting process and this is the last process these things are need to consider while writing the program. The sequence is need to write one by one based on the working of machine. Another software used for writing the PLC program [8].

- **Verifying the process**

  Upload the program to PLC and run the program. Check the working of the machine. Here after writing the PLC program for the working of the machine that need to upload the program to the PLC memory. Then simulate the program for checking the working of the machine. Here analyze each steps of the process based on the sequence.

- **Trouble shooting**

  While simulating the program there may be some problems may occur. It requires to identify each and every mistakes in the working and then trouble shoot this mistakes. Here find out the problems occur in the machine process and solve those problems.

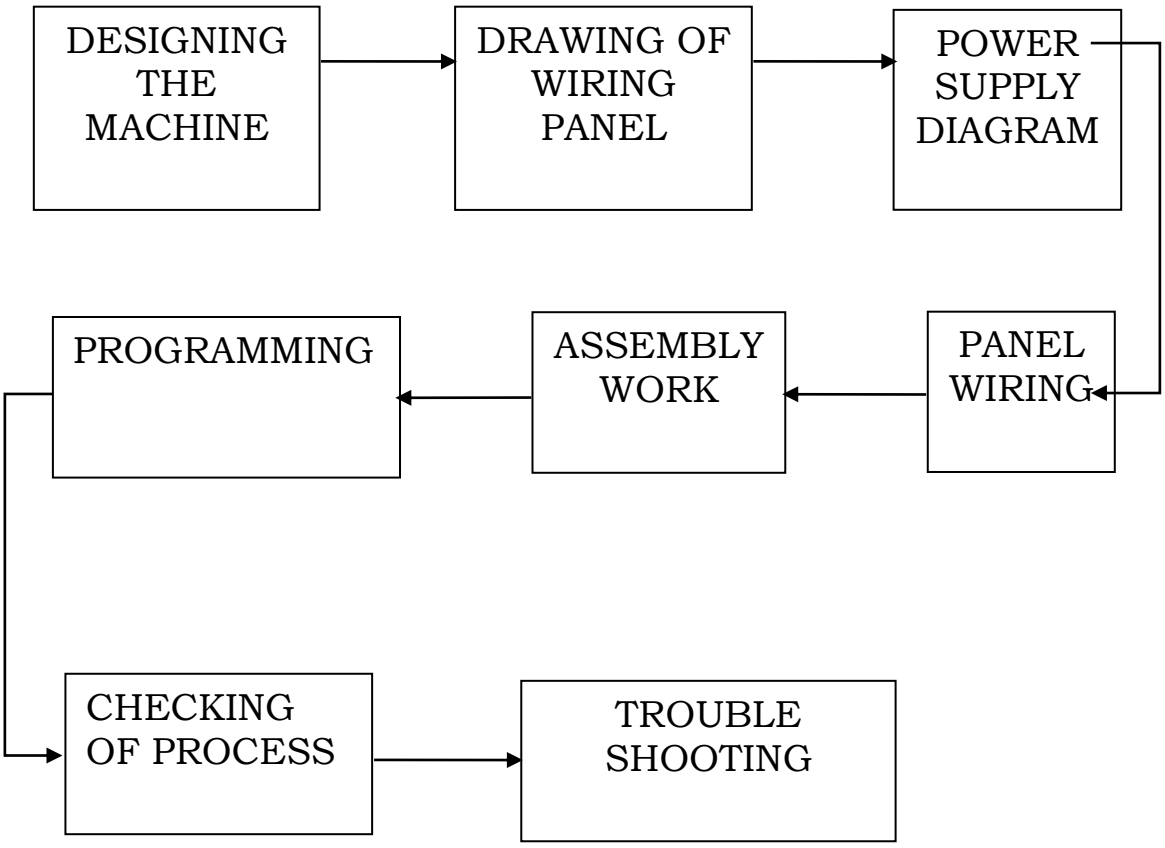

Figure 1 Flow Chart of Methodology

The major steps of methodology is shown in the flow chart in figure 1. The main steps are designing the machine, drawing of wiring panel, Power supply Diagram, Panel wiring, Assembly work, Programming, Checking Process and Trouble shooting.

WORKING

The 3 phase induction motor is used to move the conveyor belt. The conveyor belt cannot be rotated at the same speed as the motor, thus the reduction of the speed is required while transforming the power from rotary motion to linear motion. This is achieved by gear reduction with the help of a bevel gear mechanism. Thus the speed is reduced. Chain sprocket mechanisms are used to transform the power from gear to roller shaft. The rollers are fixed to the rollers are chosen. There are two rollers in the conveyor system. One is driven roller and the other one is driver roller. The driver roller is fixed to the body of the conveyor and the driven roller is attached with the tension plate adjusted by a lead screw mechanism for tightening and loosening the belt [2]. The roller shaft are attached to the frame of the conveyor with the help of roller bearing and these bearings are housed in pillow head bear housing flanged type. An encoder is fixed to the belt conveyor to sense the speed of the conveyor belt and give the feedback to the PLC [10]. According to the programme of the run in the PLC. It will provide output to the servo motor and the solenoids. The robotic arm will move with the same velocity of the conveyor with which move. When the solenoid actuate then the cylinder will make movement. Then it will cut without changing the position. The block diagram of the system is shown in the figure 2, which consists of Induction motor, Conveyor, Encoder, Opto-coupler, PLC, Servo motor, Robotic arm, piston movement, sensors and solenoids.

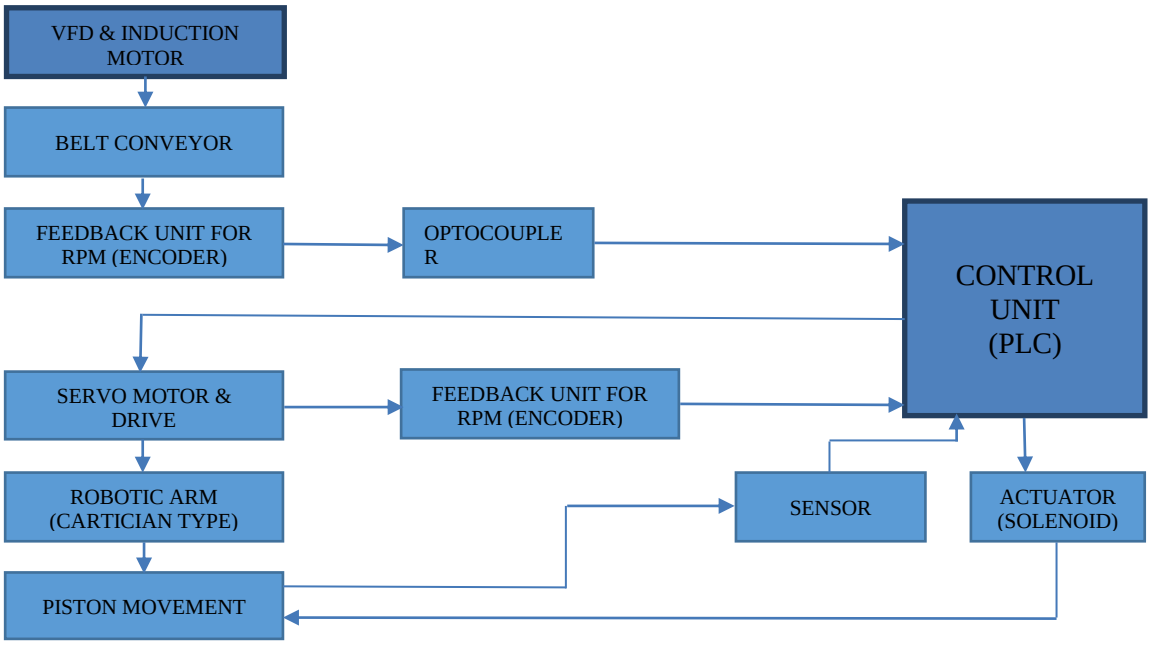

Figure 2 Block Diagram of the System

The machine drawing of the system are shown in figure 3. The conveyor system consist of a three phase induction motor, an encoder, a rubber belt mild steel body frame, roller, reduction gear, sprocket chain, tension plates, roller bearings, and a VFD. 3-Phase induction motor speed are varied by using a VFD (Variable Frequency Drive) [6]. Transverse of power are converting rotary motion in to linear motion. The working layout of the system is shown in the figure 4.

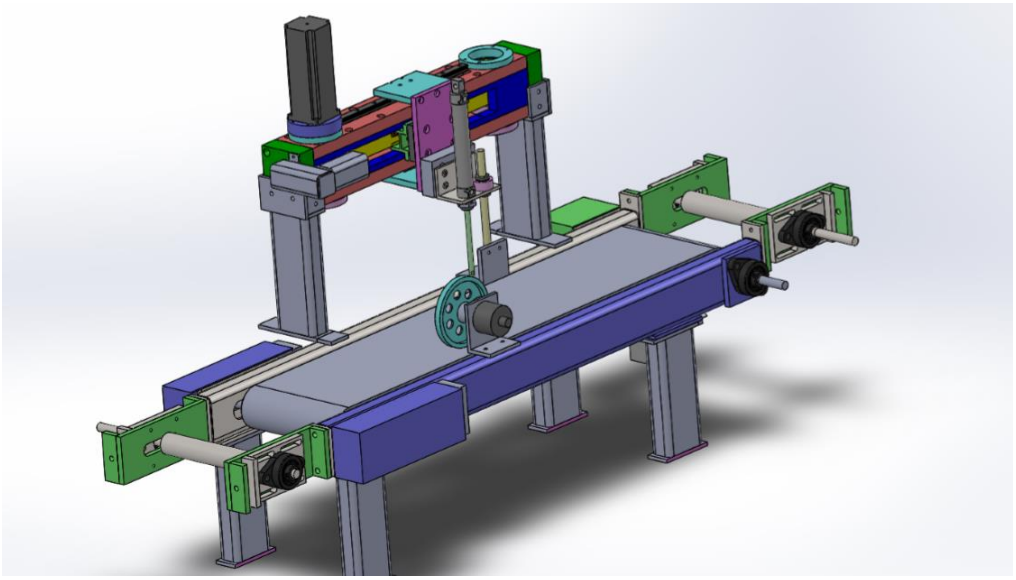

Figure 3 Machine Drawing of the System

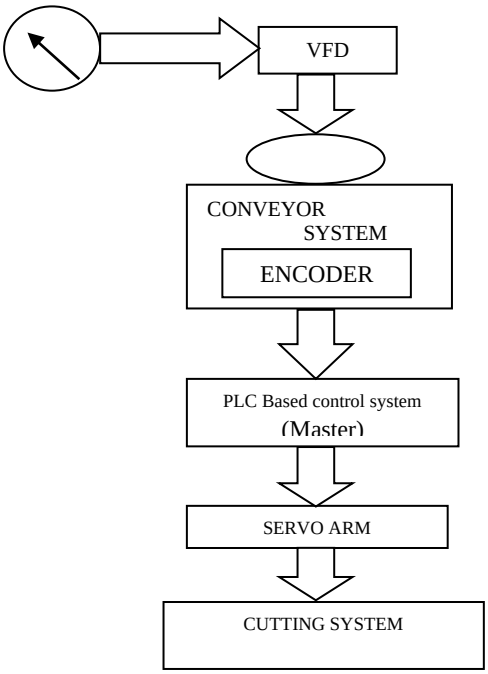

Figure 4 Working layout

SCOPE OF PROJECT

Velocity controlled machines are used as an industrial application to carry objects at varying speeds. While taking the robotic arm into consideration with the help if a servo motor, the high speed horizontal arm of the robot can be moved with higher velocity and better precision. With the help of transducers (encoders) and the sensing systems and thereby making the relative velocity between them zero. To make the relative velocity between the robotic high speed arm and the belt conveyor to zero so that any operations can be done between these two process. The need of this model is to increase the production level, to reduce the damages in the model and to minimize the production cost.

Further the service and maintenance of such a conveyor-robotic system is much easier and cheaper, also the present function (cutting) can be modified to perform various other functions such as, pick and place, stamping, position control, cut to length of other materials etc. Here we are synchronizing the velocities of two entirely different systems. Conveyor systems which are used in transporting objects in mines, airport.

PROBLEM STATEMENT

Now a days, companies are looking forward to fully automatic machines. By the help of this type of machines companies can increase the productivity. Automated machines can help to reduce the manpower. The requirement of cutting machine is very important, for all the activities have machines but for the cutting purpose the availability is very low. In this situation the automated cutting machine is very useful to do the needful. Increasing the speed of the conveyor or decreasing its speed of the conveyor can be controlled manually. According to the requirements the productivity of the system can be changed by varying the speed of the conveyor. The material on the conveyor will be cut by cutter. Hence the system can increase the productivity of unit and reduce the manpower.

III. RESULTS AND DISCUSSION

RESULT

The final result was quite satisfactory. The belt moved from starting point to the end point through the roller without conflicting with the frames. The system performed well as programmed and detects the object. The Field Junction Box for the pneumatic section are also completed. The Direction Control Valves (DCV) and the Solenoids for the pneumatic section is placed in the Field Junction Box. The assembly of Robotic arm for cutting machine, conveyor frame and roller is completed. The PLC programming and the setting of the servo drive also done. Panel wiring is completed properly, and we can understand easily. Which are wired with the help of wiring diagrams. The Machine is working properly. The Robotic Arm is moving forward and reverse by using Induction motor. The speed of the motor is varied by using

Variable Frequency Drive. The vertical actuator in the name of end effector is operated by a pneumatic cylinder in which the end effector moves up and down this robotic system will cut the food product perfectly as it moves across the conveyor at regulated speeds. The actual machine is shown in figure 5.

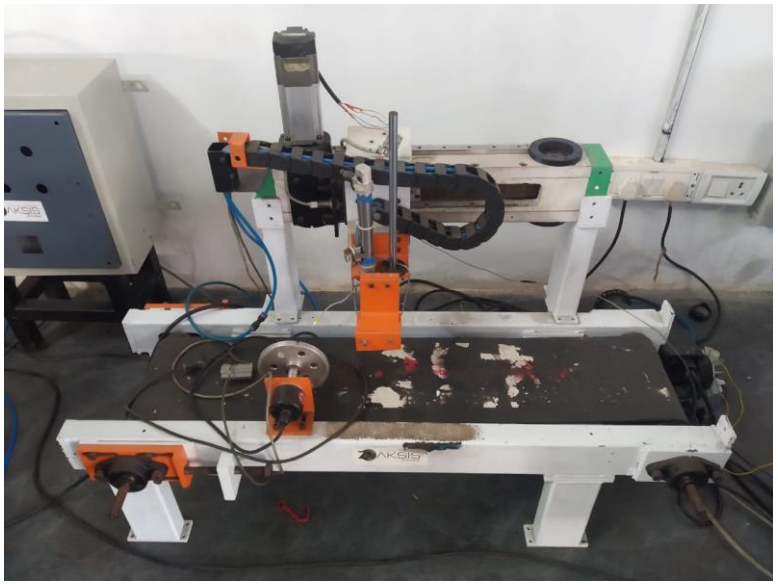

Figure 5 Actual Machine

DISCUSSION

This technology can apply in every field where cutting occurs. Further the service and maintenance of such a conveyor-robotic system is much easier and cheaper, also the present function (cutting) can be modified to perform various other functions such as, pick and place, stamping, position control, cut to length of other objects etc. The productivity can be increased by increasing the speed of the conveyor. Also possible to add another robotic arm to pick and place the products for another type of productions. So that can easily adoptable in cargos sections in airports and ships. A PLC based control system will convert frequency feedback from conveyor into frequency command of a servo operated mechanical actuator of a pick and place robotic arm system. The cutting dimensions will not vary even if the conveyor speed varied. The perfect cutting on food product will be the result of velocity matching of robotic system and conveyor.

IV.CONCLUSION

Nowadays major challenge in industries are regarding with the workforce like their operational cost, allowances, managing issues etc. By the development of Industry 4.0 made a revolution in industrial sector. So the main objective of this project is to make an automated cutting machine with velocity controlled. In this project, developed a computer based velocity controlled automated robotic system which reduces the workforce for operations.

Robotic cutting system using velocity scanning of linear conveyor is an automatic machine. The FRL, pressure regulator, flow and directional control valves, cylinders are used in the pneumatic side and PLC or other controllers like Raspberry pi, FPGA etc, Relay channel, various sensors like proximity, magnetic and encoders in the electrical side. This velocity controlled robotic system controls the production unit that depends on market needs.

ACKNOWLEDGMENT

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