Speed Control of Conveyer Belt machine using PLC by Monitoring the Product Quality

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Abstract - *Conveyer belt is the boon to the automation technology. For the manufacturing process of any product using automation, conveyer belt plays an important role. Conveyer belt are rolled with the help of the motor whose speed is controlled using traditional methods or by using a microcontroller. This paper emphasis on the monitoring and controlling the quality of the product which is being manufactured on the conveyer belt. With the help of sensors the quality parameters are monitored and fed to the programmable logic controller (PLC). PLC is composed of a microprocessor. A power supply and input l output units. As the parameters of a product are monitored and controlled during its manufacturing process, eventually the quality of the product is incremented and the quality check of a product can also be skipped.*

Key Words: **automation, monitoring, controlling, programmable logic controller (PLC).**

1. INTRODUCTION

In the early ages the speed control of the motor was attained by either changing the applied voltage or the frequency by using power electronic drives. Since technology for motion control of electric drives is available, the use of programmable logic controllers (PLCs) with power electronics in electric machine applications is used in the manufacturing and automation. This offers advantages such as lower voltage drop when turned on with near to unity power factor. PLC's in automation are used to reduce production cost and to increase quality and reliability. To develop industrial electric drive systems, it is necessary to use PLCs interfaced with power converters, personal computers, and other electric equipment.

Many applications of induction motors require besides the motor control functionality, the handling of several specific analog and digital I/O signals, to name a few: trip signals, on/off/reverse commands etc. To make electric drive system versatile PLC must be added to the system structure.

Every product has some parameters or its own specification to be maintained during its manufacturing process in order to increase the quality of the product. With the help of the sensor the parameters can be monitored and given as a feedback to the PLC so that the plc controls the variable frequency drive (VFD). Thus the speed of the motor is controlled considering the parameters of the product.

The three main pillars of this paper are mainly the Sensor Circuit, PLC and VFD. The sensor circuit reads and sense the original parameters of the product to be manufactured and gives it to the PLC as a feedback making it a closed configuration system. PLC is used as an arithmetic processing unit, it takes the feedback from the sensing unit and then it performs the operation according to the feedback value. VFD Controls the speed of the motor so as the conveyer belt to perform the required actions on the product. VFD controls the speed of the motor by changing the frequency of the motor or by changing the applied voltage to the motor.

Thus in this way the speed control of the motor of conveyer belt would surely help improve the quality of the product manufacture using the automation.

2. HARDWARE REQUIREMENTS

2.1 PLC

The PLC has its origin in the motor manufacturing industries. Manufacturing processes were partially automated by the use of rigid control circuits, electrical, hydraulic, and pneumatic. It was found that whenever change had made, the system had to be rewired or reconfigured. The use of wiring of boards on which could connections could be changed by unplugging them and changing them around followed. With the development of microcomputers it was realized that if the computer could switch things on or off and respond to a pattern of inputs, then the changes could be made by simply reprogramming the computer and so the PLC was born. PLC is an industrial computer control system that continuously monitors the state of input devices and makes decisions based upon a custom program to control the state of output devices. Almost any production line, machine function, or process can be greatly enhanced using this type of control system. However, the biggest benefit in using a PLC is the ability to change and replicate the operation or process while collecting and communicating vital information. Another advantage of a PLC system is that it is modular. That is, you can mix and match the types of Input and Output devices to best suit your application. The PLC hardware is digital electronic devices with memory can be programmed to store commands or Information and the implementation of various operations such as logical operations, arithmetic and timing. There are several companies (PLC's) devices such as Siemens who produced SIMATIC 200, SIMATIC 300, and SIMATIC 400. Allen Bradley Inc., Mitsubishi and many others. Each company has its own software, but all accomplish the required job of the (PLC's).

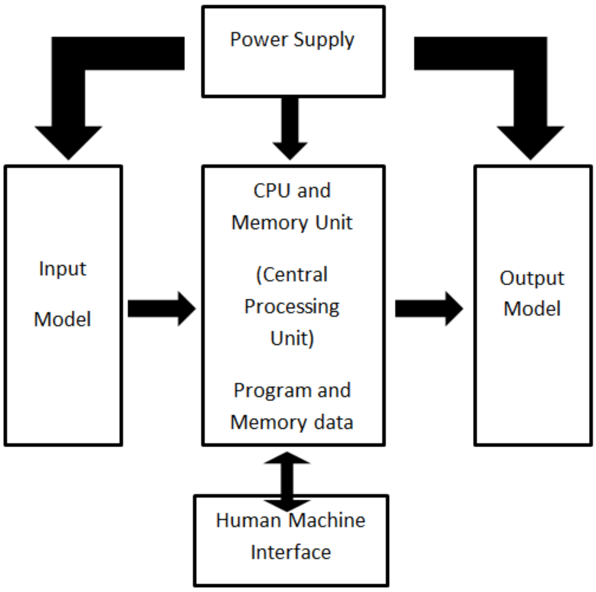

Fig -1: Block Diagram of PLC

For this Experiment we have used the SIEMEN Make 412-2DP CPU having specifications as follows:

- CPU: 6ES7412-2XG04-0AB0 Version 4.0.0
- Working Memory: 128 kb (code)
  128 kb (Data)
- Load Memory: 256kb (Itegrated)
  Up to 64 mb (Expandable FEPROM)
  Up to 64 mb (Expandable RAM)
- Timer: 2048 Range (10 ms to 9990s)
- Counters: 2048 Range (1 to 999) Preset Range(Z0 to Z7)

2.2 Variable Frequency Drive (VFD)

Induction motors operate at fixed designed speeds and are ideally suited to applications where a constant output speed is required. However motor applications have some kind of varying speed demand and this includes processes such as moving air and liquids (fans and pumps), winding reels and precision tools. Historically in applications requiring precise speed control such as paper winding reels expensive direct current (DC) motors or hydraulic couplings are used to regulate the machine speed, whereas in other applications the processes have been controlled by opening and closing dampers and valves, or changing output speeds with gears, pulleys, and similar devices whilst the motor works at constant speed.

Variable frequency drives applied to AC motors are by far the most common. Their basic design consists of four elements (Fig. 2):

- Intermediate circuit: The rectified DC supply is then conditioned in the intermediate circuit, normally by a combination of inductors and capacitors. The majority of VFDs currently in the marketplace use a fixed-voltage DC link.

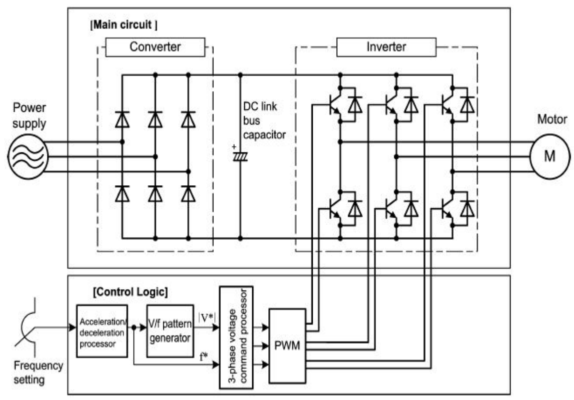

Fig -2: Block Diagram of VFD

- Converter: The working principle of rectifier is changing the incoming alternating current (AC) supply to direct current (DC). Different designs are available and these are selected according to the performance required of the variable frequency drive. The rectifier design will influence the extent to which electrical harmonics are induced on the incoming supply. It can also control the direction of power flow.

- Inverter: The inverter converts the rectified and conditioned DC back into an AC supply of variable frequency and voltage. This is normally achieved by generating a high frequency pulse width modulated signal of variable frequency and effective voltage. Semiconductor switches are used to create the output; different types are available, the most common being the Insulated Gate Bipolar Transistor (IGBT).

- Control Logic: The control unit controls the whole operation of the variable frequency drive; it monitors and controls the rectifier using PWM technique, the intermediate circuit and the inverter to deliver the correct output in response to an external control signal.

2.3 Programming Software

The SIMATIC programming languages integrated in STEP 7 are compliant with EN 61131-3. The standard package matches the graphic and object oriented operating philosophy of Windows and runs under the operating system MS Windows 2000 Professional (as of now referred to as Windows 2000) as well as MS Windows XP Professional (as of now referred to as Windows XP) an MS Windows Server 2003.

Function of the software:

- Setting up and managing projects
- Configuring and assigning parameters to hardware and communications, Managing symbols

• Creating programs, for example, for S7 programmable controllers

• Downloading programs to programmable controllers

• Testing the automation system

• Diagnosing plant failures

The programming languages Ladder Logic, Statement List, and Function Block Diagram for S7-300 and S7-400 are an integral part of the standard package.

• Ladder Logic (or LAD) is a graphic representation of the STEP 7 programming language. Its syntax for the instructions is similar to a relay ladder logic diagram: Ladder allows you to track the power flow between power rails as it passes through various contacts, complex elements, and output coils.

• Statement List (or STL) is a textual representation of the STEP 7 programming language, similar to machine code. If a program is written in Statement List, the individual instructions correspond to the steps with which the CPU executes the program. To make programming easier, Statement List has been extended to include some high-level language constructions (such as structured data access and block parameters).

• Function Block Diagram (FBD) is a graphic representation of the STEP 7 programming language and uses the logic boxes familiar from Boolean algebra to represent the logic. Complex functions (for example, math functions) can be represented directly in conjunction with the logic boxes. Other programming languages are available as optional packages.

2.4 Sensing Unit

Two synchronized cameras image the ends of the cut product (tread, sidewall). The edges are detected in the image with the aid of a special algorithm. The length of the measured tread can be determined by the length measurement system on the basis of the prior calibration of the two cameras to each other. The E+L Tread Length measurement system is used and feed as input to the PLC. The length measurement system is used at the end of the extrusion line for quality documentation and for sorting out material that is outside the tolerance limits.

Camera Specification and function:

- Slip-free length measurement for cut treads and side walls
- Precise edge recording with matrix cameras with a wide range of vision
- Visualization of the edge recording and the measuring results
- Automatic pre-positioning of the upper matrix camera to the required profile length
- Quality assurance to avoid overlaps or the creation of gaps in the subsequent production process.
- Measuring Interval : 1000 / 1500 / 2000 / 2500 (mm)
- Web Speed: Max 100 m/min
- Number of Cameras: 02
- Resolution: 0.1mm
- Field of view matrix camera: 60 x 60 (mm)

3. WORKING AND METHODOLOGY

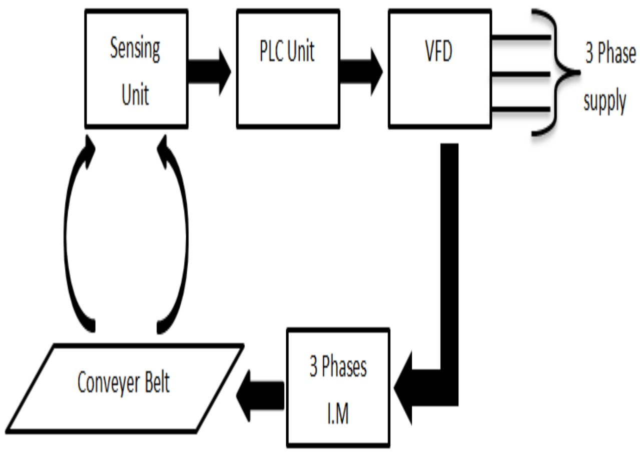

Fig -3: Block Diagram

A 3 phase induction motor governed by VFD is used to roll the conveyer belt. Sensing unit comprising of The E+L Tread Length measurement system is used to check the parameters of the product on the conveyer belt. This unit is a camera set up used to check the length of the tread on the conveyer belt. This sensed signal is given as an input to the PLC. PLC interprets the signals. On the detection of the error in the signal PLC sends an output signal to the VFD (variable Frequency Drive) the VFD with respect to the error signal changes the speed of the 3 Phase Induction Motor. So with this change in the speed the conveyer belt speed is also changed and thus we can recover the specifications of the product with respect to the change in the product dimensions.

4. SOFTWARE PROGRAM

SIMATIC software is used with a SIEMEN, PLC for the programming purpose. A ladder diagram method is used for the programming of the PLC for this experiment. The program flow chart is as shown in the Fig 3. According to the flow chart it is seen that, Firstly initialize everything. After that the parameters of the product are set in the PLC. PLC then performs the operations on the values obtained from the sensing unit. After the arithmetic operation of the values the appropriate signal is calculated by the PLC. Then the VFD drives the Motor according to it. Till the products of required specifications are not attained the final output is not completed. After the final evaluation the final product is then made ready.

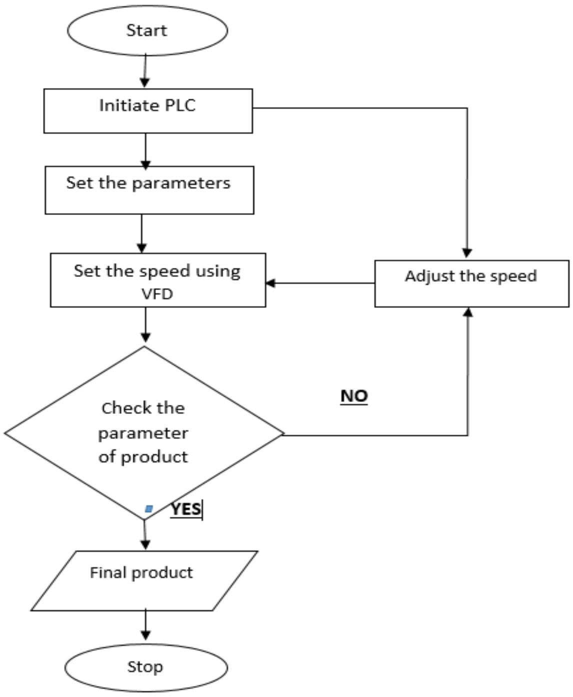

Fig -4: Flow Chart

5. Conclusion

After the completion of the experiment is can be concluded that the final quality of the product is increased and following conclusions can be made

1. It is a cost effective project as the initial cost is high but has a very low maintenance cost.

2. As the quality increases the profit of the firm also increases

3. As the parameters can be changed in the programming, the system is a versatile system and t can be later used for the other products also.

4. As it is completely automatic it can used in the hazardous environment.

5. The system is completely Human friendly.

Hence a system can be used in the industries having a high turnover and are also those industries who have to maintain the high precision in their final products.

6. RFERENCES

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