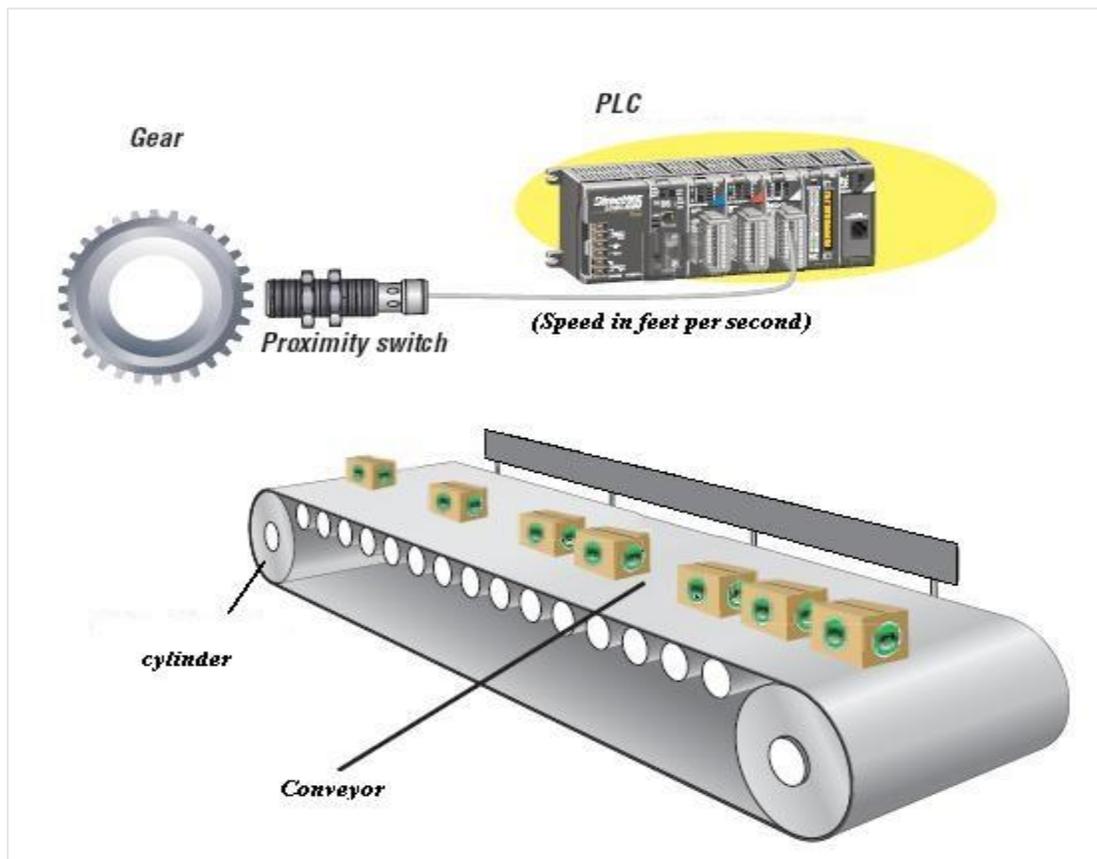


# ENGINEERING REPORT ON CONVEYOR BLOCKAGE DETECTION



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## Abstract

In order to ensure the safe and reliable operation of belt conveyor, detecting blockage and control is very necessary. The main objective of this proposal is to detect the blockage/fault occurring in the conveyor using Programmable Logic Controllers -PLC. Conveyor blockages are caused by the faults such as belt tear up faults, oil level reduction fault, fire occurrence faults in the belt conveyor are not identified properly and thus leading to serious damage to the belt conveyor. With the end goal to maintain a strategic distance from this sort of fault conditions, here we are planning to apply different kinds of sensors in their tasks utilizing PLC to give legitimate security to the belt conveyor. Manual control at present is more disadvantageous and is being the significant explanations behind continuous damages and accidents. With the end goal to reduce these accidents and damages and for expanding further improvements, computerization is utilized. All parameters will be handled, controlled, and monitored in the conveyor with help of sensors and PLC and the blockages in the conveyor can be detected.

## Project Background

In the present quick moving, profoundly focused modern world, an organization must be adaptable, financially savvy and effective to survive. Modern robotization has gained significance inferable from the consistently expanding interest for greater efficiency, better quality standard, better precision and ideal use of accessible assets and labor. With the advent of PLC, automation can be done efficiently to satisfy flexibility, reliability and efficiency of conveyor The PLC is a microcontroller based device with input/output circuitry that monitors the status of field connected sensor (inputs) and controls the attached (output) actuators (motor -starters, Solenoids, Speed drives, Valves etc.) according to a user created logic program stored in the memory. The main difference from other computers is that PLCs are armored for severe condition (dust, moisture, heat, cold, etc) and have the facility for extensive input/output (I/O) arrangements. These connect the PLC to sensors and actuators. PLCs read limit switches, analog process variables (such as temperature and pressure), and the positions of complex positioning systems.

On the other hand belt conveyors in a pharmaceutical industry gives a quality solution for handling medical equipment between processes like filling, capping and packaging. These Conveyors are ideally suited for handling powders, granules, tablets, capsules and other pharmaceutical items, vacuum pneumatic conveyors can also be designed to deliver closures and moderate-sized containers to filling lines. Pharmaceutical conveyors are used to transport or convey medical / pharma related particles, raw materials or finished products from one place to another. They consist of several pulleys which are powered by motors to move the material on the belt in the desired direction. A number of machines are equipped with the conveying

belt systems for ease of movement of materials and finished products. In this case the belt conveyor used in pill production is considered for the project.

Blockages on a pill production conveyor lead to outage and downtime of the process. Considering this fact, this project focus on an early blockage sensing system for detecting blockages by the identifying faults of belt conveyor by means of providing several types of sensors and PLC and produce an alarm. In this manner, mainly, a sensor For identifying the tear up of belt conveyor which can be occurred during overload conditions and any other causes, one sensor for identifying the oil level reduction which can be occurred when there is a decrease in oil level in the tank which is placed in low tension motor and a sensor for sensing the temperature level which can be useful in blockage detection during overheating of conveyor motor, sudden fire occurrence in the conveyor. This automated fault/blockage detection system will strongly enhance the safety, speed and control characteristics of belt conveyor in real time without requiring manpower.

## Literature Review

### Existing Methods

Several articles for our project were studied. Since the products are isolated through the conveyors, the status of the conveyor is an important factor in our project. So this is identified in the research paper “Conveyor Blockage Detection Using PLC and Sensors”, which describes that the Faults are identified using Sensors so that the safe and reliable conveyor operation be ensured. For the selection of the appropriate sensors, various studies were made and in the journal “Automatic Speed Control System by the Color Sensor for Automobiles -An Innovative Model Based Approach” where the colour sensor register items by contrast, true colour, or translucent index. Since our project is considering a fully automated industry using PLC and one of the research paper “PLC Based Industrial Crane Automation & Monitoring” helped us very well. From this research, it was found how PLC can be effectively designed for a wide variety of control tasks with the simple ladder logic to control different conveyors. When we are considering the present systems, Fire can be found in belt conveyor after happened in it. It is one of the major disadvantages in present system. Fire accidents occurs in the belt conveyor is identified only by the human working on conveyor sometimes this will lead to severe damage to the conveyor. The tear up in the conveyor is identified only by the speed variation. Speed will show variation only when the tear up is big. Thus conveyor leads to severe damage. There is no monitoring system for the oil level in the fluid coupling of LT conveyor motor. Reduction in the oil level leads to OFF the conveyor in all the conditions. These are main drawbacks in the present system.

## Project Aim

The aim of the project, is to design and build blockage sensing system for detecting blockages by the identifying faults of belt conveyor by means of providing several types of sensors and PLC and produce an alarm. In this manner, mainly, a sensor For identifying the tear up of belt conveyor which can be occurred during overload conditions and any other causes, one sensor for identifying the oil level reduction which can be occurred when there is a decrease in oil level in the tank which is placed in low tension motor and a sensor for sensing the temperature level which can be useful in blockage detection during overheating of conveyor motor, sudden fire occurrence in the conveyor. This automated fault/blockage detection system will strongly enhance the safety, speed and control characteristics of belt conveyor in real time without requiring manpower.

# Implementation of the project

Time Plan for Implementation of the project

Gantt Chart



2	Research & Literature Review	15 Days	1	Internet, Journals, Books, Research Papers
3	Interim Report	10 Days	1,2	Internet, Journals, Books, Research Papers
4	Hardware Implementation	25 Days	3	Internet, Journals, Books, Research Papers
5	PLC programming	20 Days	3	Internet, Journals, Books, Research Papers
6	Testing the system	5 Days	4,5	
7	Submission & Presentation	1 Days	6	

## Hardware description of the Proposed System

This proposed system gives the efficient way of automating the belt conveyor monitoring using plc along with sensors for high reliability, and fast operation without delay. It consists of hardware and software modules (which will be discussed in detail in the upcoming sections) to identify the belt conveyor faults/blockages in a pill production and create an alarm.

### Proposed system architecture

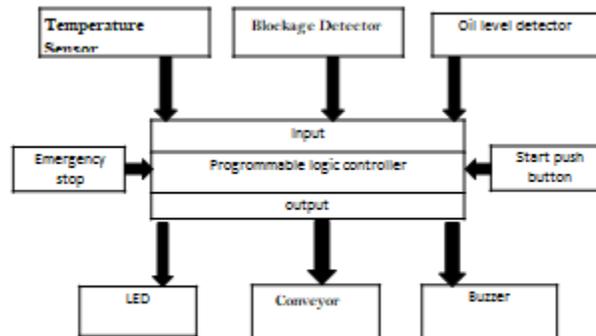


Figure 1 the proposed system architecture

### Components of Proposed System

#### A. PLC system

Programmable logic controller (PLC) is the control system for the intended application. The PLC controller gets the readings from the sensors and according to the preprogrammed ladder logic it will control the

### **B. Temperature Sensors (LM35)**

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 $\mu$ A from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a -55° to +150°C temperature range. Once it reaches the specified temperature range, which is meant for fire accident, the belt conveyor will give indication and stopped immediately and fire is extinguished, thus protecting fire accidents without time delay.

### **C. Blockage Detectors – (Photoeye)**

The blockage detector detects blockages on the conveyor system by detecting material passing against the sensor. The motor (which moves the conveyor) when the object (which is desired to be transported) is detected by photoeye1. Likewise, the motor and light are kept turned on when photoeye2 detects the box in the second line of code. When the desired object passes by photoeye1, and if it does not pass by photoeye2 in 30 seconds (the timer counts in milliseconds), the motor and light are shut off. This is the indication of the blockage of the conveyor. The switch upon activation informs the control system of the occurrence of a level limit being reached or blockage as the case may be. The speed sensors may be mounted to the conveyor frame so as to maintain contact with the return belt to thereby determine belt speed as a wheel on the speed sensor rides on the upper surface on the return belt.

### **D. Oil level detector**

In industry, liquids such as water, chemicals, and solvents are used for many processes. The amount of such liquid stored can be found by measuring level of the liquid in a container or vessel. In this project, capacitive type of level sensor is used. The principle of capacitive level measurement is based on change of capacitance. An insulated electrode acts as one plate of capacitor and the tank wall (or reference electrode in a non-metallic vessel) acts as the other plate. The capacitance depends on the fluid level. An empty tank has a lower capacitance while a filled tank has a higher capacitance.

### **E. Start push button**

To start a belt conveyor the operator presses the Start button. This provides power momentarily to a relay coil. As the relay coil is energized, it closes its normally-open contact so that power is provided through the normally-open relay contact to both the relay coil and the conveyor. Coal conveyor is the electrical that uses electricity. As long as the relay is energized, the circuit is complete and power is provided to the conveyor. This button is must for safe and reliable operation of belt conveyor.

## **F. Emergency stop**

Emergency stop (E-Stop) buttons are an important safety component of many electrical circuits, especially those that control hazardous equipment such as gas pumps, moving machinery, saws, mills, and cutting tools, conveyor belts, and many other types of equipment. They are designed to allow an operator or bystander to stop the equipment in a hurry should anything go wrong. Pressing the E-Stop button breaks the circuit and removes power from the holding relay that keeps the circuit energized and allowing the relay to return to its normally closed position.

## **G. Belt conveyor**

Conveyors are durable and reliable components used in automated distribution and warehousing. In combination with computer controlled pallet handling equipment this allows for more efficient retail wholesale and manufacturing distribution. It is considered a labor saving system that allows large volumes to move rapidly through a process, allowing companies to ship or receive higher volumes with smaller storage space and with less labor expense. These are the synthetic rubber belts which move on metallic rollers called idlers and are used for shifting of coal from one place to other places. Coal helps fuel stoves and other devices around the world. Once it's extracted from underneath the ground, there are various options available when it comes to transporting it to where it needs to go. After it's arrived at the processing facility or other commercial/industrial area, it's time to unload it onto a conveyor belt. You can either shovel it out on your own or dump it out of the vehicle it was transported in before it reaches its next destination. Conveyor belts are also used to transport material into processing equipment and back out again. These belts optimize productivity.

## [Software Implementation Programming the PLCs](#)

The PLC software is manufacturer dependent and even when the manufacturer is the same, it may vary for the different models of the same brand. In this project the renowned PLC programming software, 'GX Developer' is used for program the PLCs.

### **A. Concept of conveyor blockage detection**

This whole system is operated by proximity sensor, motor and PLC in our project we use capacitive type of proximities sensor to sense the material at which position and it gives the signal towards the PLC .The PLC of our project depends on the number of input output module and analog signal. The blockage detector detects blockages on the conveyor system by detecting absence of material passing against the sensor. The motor (which moves the conveyor) Is turned on when the object (which is desired to be transported) is detected by photoeye1. Likewise, the motor and light are kept turned on when photoeye2 detects the box in the second line of code. When the desired object passes by photoeye1,

and if it does not pass by photoeye2 in 5 seconds (the timer counts in milliseconds), the motor and light are shut off. This is the indication of the blockage of the conveyor. The switch upon activation informs the control system of the occurrence of a level limit being reached or blockage as the case may be. The speed sensors may be mounted to the conveyor frame so as to maintain contact with the return belt to thereby determine belt speed as a wheel on the speed sensor rides on the upper surface on the return belt. And also when a block is detected an alarm will be turned on to alert the user about this situation.

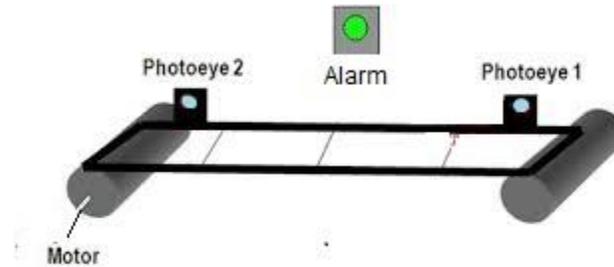


Figure 2 Block Diagram of our proposed conveyor blockage detection

In order to have more accuracy it is better to use 4 proximity sensors in both sides. An approximated block diagram of our blockage detection system is shown below.

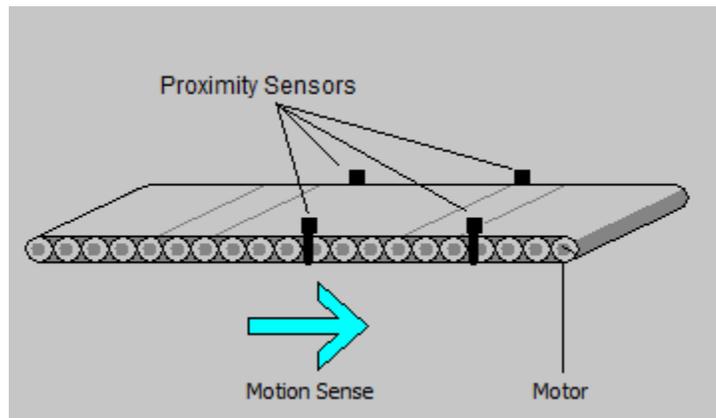


Figure 3 Block Diagram for more better conveyor blockage detection system

## B. The Ladder Logic

Table 2 lists each rung of the ladder diagram along with its function.

Table 1 Rung of the ladder diagram along with its function

Rung	Function
0	If ready button becomes unlatched, move the value 0 to the motor_started tag and unlatch motor output and stop conveyor.
1	If ready button is true, 5 second timer has not timed out, and motor output (Start) is true, then move the value 1 to the Motor Minute tag, and illuminate the Motor_Running_Indicator.
2	If ready switch is true, and the part is in front of sensor 1, jump to the start motor subroutine.
3	If the ready switch is true and the motor has been started, then start the 5 second timer.
4	If the ready switch is true and the motor has been started, start the 1 minute timer.
5	If the 5 second timer has not timed out and the part reaches sensor 2, jump to the Sensor_2_Reached subroutine.
6	If the 5 second timer times out before the part reaches sensor 2, stop the conveyor and on the alarm. Once the situation OK button has been pressed, reset the 10 second timer.

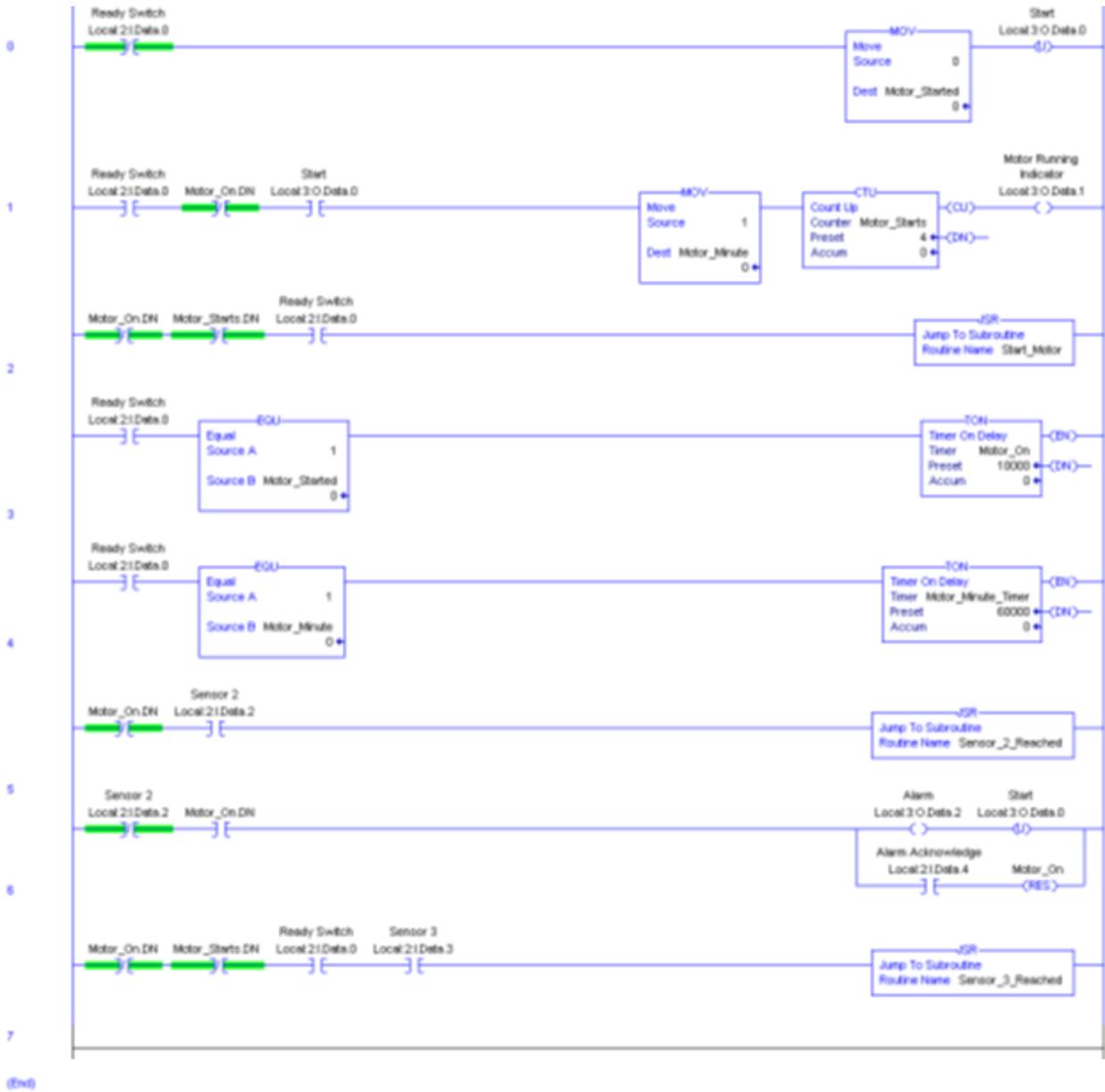


Figure 4 screenshot of the Ladder Logic of our proposed system

The Figure 4 shows the program for the conveyor in our proposed system. The first line of code turns on the motor (which moves the conveyor) and the light when the object (which is desired to be transported) is detected by photoeye1. Likewise, the motor and light are kept turned on when photoeye2 detects the box in the second line of code. The third line begins a timer when the desired object passes by photoeye1, and if it does not pass by photoeye2 in 5 seconds (the timer counts in milliseconds), the motor and light are shut off by line 4. This is the indication of the blockage of the conveyor.

The switch which is to be kept ON always in order to give a continuous supply for the sensors to sense the faults in the belt conveyor. The temperature sensor and oil level detector are taken as analogue signal. The belt conveyor gets ON only if three conditions are satisfied that is (a) whether the ultrasonic sensor is sensing continuously, (b) whether the forward and reverse direction of the belt conveyor is satisfied, (c) whether the oil level in the tank which is kept in a desired level, if all these conditions are satisfied the motor will start to run. The temperature at normal level will not show any detection and the belt conveyer runs normally, when the temperature reached 45<sup>0</sup> C, the LED showed low fire and the motor stopped running. The temperature till 60<sup>0</sup> C the buzzer indicates a medium fire and if exceeded shows high fire.

## PLC Implementation

The PLC implementation was performed on an Wecon 60 I/O PLC : LX3VM-3624MT [5]. The parts list is shown in the following Table and the schematic is shown in Figure 5. The core functional requirements were specified below for the PLC design.

- If a 5-second timer times out before the part reaches the second sensor, the conveyor is stopped and an alarm is ON. The alarm will stop and program will only continue after the 'situation OK' button is pressed.

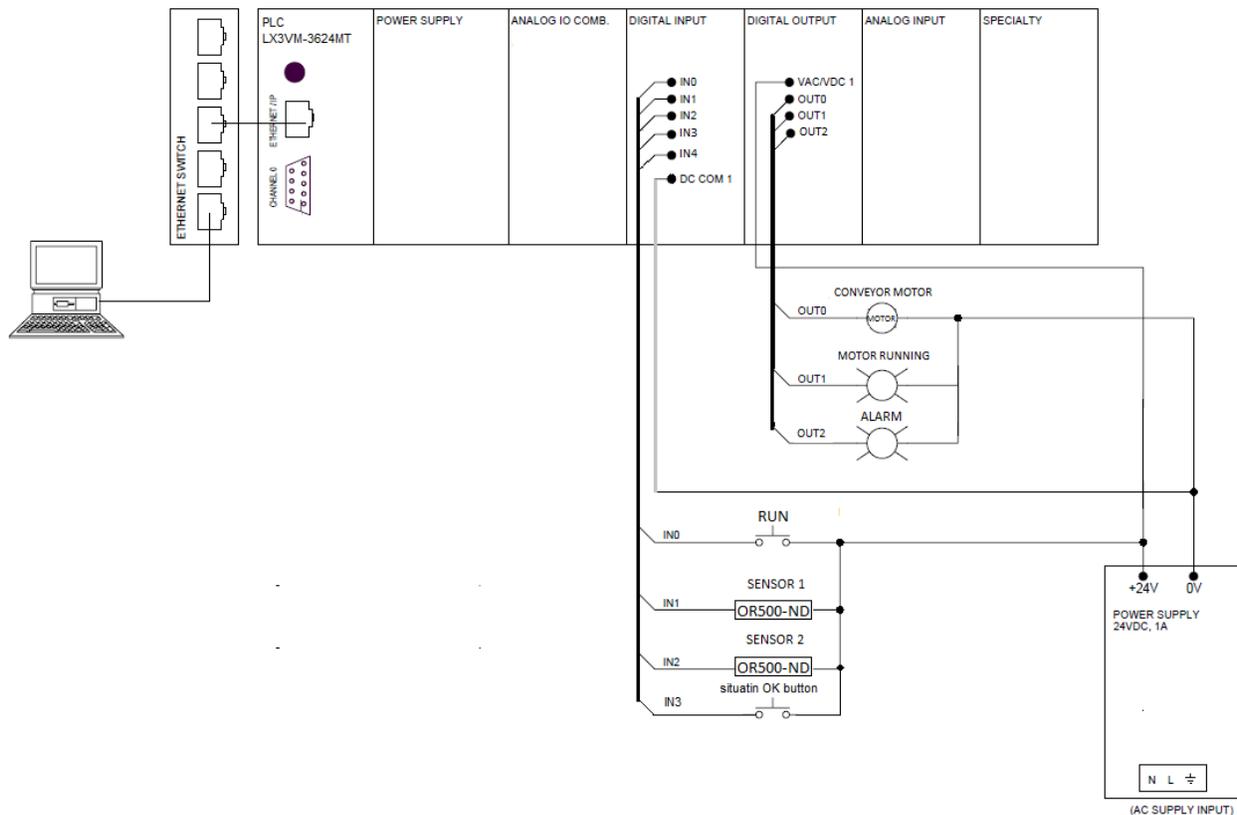


Figure 5 PLC Schematic

Table 2 Parts List for PLC Implementation

Parts	Model	Pricing
PLC	LX3VM-3624MT	140\$
Power Supply	LX3VM-3624MT	
Digital Input	LX3VM-3624MT	
Digital Output	LX3VM-3624MT	
2 NC Push Buttons	Run, situation OK	4\$/piece
1 DC Motor	Motor	30\$
1 or more Alarm	Alarm	96\$/piece
1 Lights	Motor Running	2\$/piece
2 IR Proximity Sensors	SD-3020A	5\$/piece
2+ Temperature Sensors	LM-35	10\$/piece
1 Oil level Detector	ULS01	50\$

## Conclusion

PLCs are capable of perform a broad range of automation tasks. These are typically useful in industrial processes in manufacturing where the cost of developing and maintaining the automation system is high relative to the total cost of the automation, and where changes to the system would be expected during its operational life. After the implementation of the proposed system, the blockages were identified precisely and in the instance which it occurs. That means it was able to achieve our project objective.

From this proposed system, Belt conveyors not only in pharmaceutical industry, but also in industrial/ manufacturing processes and Power Plants etc. will be controlled using Programmable Logic Controller, sensors and photo detectors etc. and the blockages can be identified precisely and in the instance which it occurs. This would be most efficient in the point of view of reducing human errors. PLCs are important part to design with more reliable and less power consumption for conveyor monitoring operations. This project would give better accuracy, reliable operation in Real-time. This project is automatic blockage detector in the conveyor. Thus the monitoring process is done to ensure the uninterrupted operation of the conveyor.

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