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# PLC BASED PNEUMATIC PICK AND PLACE SYSTEM

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## ABSTRACT

Automation is the process of controlling & operating various machineries, networks, switches, etc using automatic control, reducing human labour. The project aims to design an automatic system which picks the products or objects from one location and places it to another.There are a wide variety of power sources available for displacing objects. These include hydraulic system, pneumatic system, servo motors. There are some basic mechanisms like piston-cylinder motion, mechanical arm movement, etc. This project is based on pneumatic system. The entire design is operated using Programmable Logic controllers (PLC). Generally this design is used in industries to do repetitive tasks, which reduces human effort and saves time .The basic mechanism includes gripping, lifting, moving, placing & releasing the objects to desired locations.

**KEYWORDS:** Automation, Pneumatics, PLC, Gripper

## I. INTRODUCTION

The process of Automation is the use of Control System and Programmable controllers to reduce the need for human work in production of goods and services which are needed in factories and industries. Basically, a set of pre-defined jobs, executed sequentially and systematically with the help of hardware and software. Nowadays, automation is employed in every small and large industry. Manual control is quite hectic, as an operator periodically has to read the process and adjust the input accordingly. Whereas, an automatic control is quite convenient, as measurements and adjustments are done automatically on a continuous basis.

Industrial automation has offered higher levels of Efficiency, Productivity and maintaining quality of the processes in the industry. In most Industries, increased automation process and control has developed the path towards increased productivity. Automating using pneumatic systems has increased productivity, efficiency and quality control. During the operation of a process, pneumatic arms can be controlled to accommodate more work, and even operate beyond working hours. With the advent of pneumatics, laborious and time consuming work in automated factories and industrial plant have made ease for workers to complete the operation. There are few workers assigned to control these arms instead of requiring them to carry the task by themselves. Programmable Logic Controller (PLC) has made the control easy. To automatically control every aspect of the operation without human intervention, PLC is now used in every modern production processes.

Pick & Place system is widely used in automation industries to transfer the products from one location to other. It is based on Pneumatics i.e. system powered by compressed air/inert gas. Pneumatic System can be controlled manually or by automated solenoid valves. The entire process of gripping and lifting the objects is controlled by PLC, which is programmed by ladder logic. The design consists of a long conveyor belt on which objects are to be fed. It is controlled by a DC motor, whose movement brings the object from one end to another. At the end, there is a proximity sensor, whose active face detects presence of any object coming in front. There lies Programmable Logic Controller, which receives the electrical signals from sensor output. Also consists of Directional control valve which controls entire operation of pneumatic cylinders. There are two pneumatic cylinders i.e. horizontal & vertical. At the end of vertical pneumatic cylinder there lies a Gripper, whose jaws open & close based on the motor of gripper.

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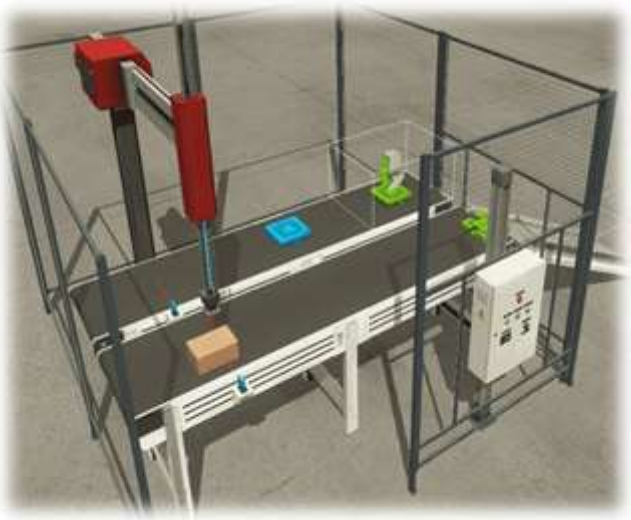

**Fig-1.1: Pneumatic Pick & Place System**

## II. LITERATURE SURVEY

**M.Cianctietti, A.Arienti, B.M.Follador, B.Mazzalai, P.dario**[1] they get inspired by the Octopus to and make an interesting model in robotics due to its high dexterity, variable stiffness and very complex behavior. In this experiment they study the key features and patterns of movement of Octopus arm and these features and patterns. They conclude that the concept proposed for the mechanism at the base of the robotic arm inspired to the Octopus muscular hydrostat where successfully implemented. Ravi Kumar Mourya, Amit Shelke, Saurabh Satpuite [2], the main objective of their project is to design and implement a four DOF pick and place robotic arm. They concluded that the CAD tools like Creo1.0 and Auto CAD were used to model the desired manipulator. To determine the end effectors position and orientation, theoretical analysis of inverse kinematics were carried out. Ansys software was used for FE Analysis.

**Prof. S.N.Teli, Akshay Bhalerao, Sagar Ingole** [3], there project aims to design and fabricate the pneumatic arm for pick and place of cylindrical objects. They conclude that arm is controlled by manually flaw control and direction control valve. Arm rotation and movement is done by pneumatic cylinder using helical slot mechanism. Total arm weight is 25 kg. The model is expected to lift at least 10 kg weight. S.Premkumar, K.Surya Varman, R.Ballamurgan [4], Experimental aim is to collaborate the gripper mechanism and vacuum sucker mechanism working in single pick and place robotic arm. These robot can perform tasks like gripping, sucking, lifting, placing, releasing, in a single robotic arm. It will reduced the cycle time, Ideal time, cost of operation, space consumption. It is user friendly and effectively used in glass handling system.

**S.C.Gutierrez, R.Zotovic, M.D.Navarra, M.D.Meseguer** [5], their purpose of work is to manufacture a light weight robot arm with a low cost budget. They conclude that to avoid negative influence on the total weight of the arm, the plastic material reinforced with fiber is used and vacuum infusion man process is used for manufacturing. Local reinforced elements must be included during construction of arm shell. The mast light gear reducer, harmonic drive types are used but because of lack of alignment causes disassembly of gear package to avoid these flexible couplings are required. Gabrielle J.M. Tuithaf, Just L.Harder [6], according to them, current robots are not safe for interaction with humans, especially for children; therefore safe four DOF robot arm is develop. Firstly, the joint stiffness of arm is brought to zero then the arm is supplied with pneumatic artificial muscles and their stiffness can be adjusted by open loop stiffness control.

**M.Pellicciari, G.Berselli, F.Leali, A. Verganana** [7], this paper shows the method for reducing the total energy consumption of pick and placed robotic arm. Firstly, electro mechanical models of both series and parallel manipulators are derived and then by means of constant time scaling, the energy optimal trajectories are calculated. It is seen that blowing down an operation as much as possible is not always beneficial. Energy consumption of given operation as a function of the task execution time. Future work includes improvement of the motor model, development of online programming algorithms.

**Mohd Ashiq Kamaril, Yusuff, Reza Ezucin Samin, Babul Salam, Kader Ibrahim** [8], their paper presents the development of wireless mobile robot arm. Wireless PS2 controller is used to control the pick and place operation. The development of this robot is based on Arduino Mega Platform. Analysis of speed, distance, load lifted by arm is done to know its performance. This robot expected to overcome the problem such as placing or picking object that is away from the user, pick and place hazardous object fast and easily.

**H. Hagenah, W. Bohm, T. Breitsprecher, M. Merklein, S. Wartzack [**9], this paper will show how modern materials as cellular titanium & nano crystalline aluminium can be used to build advanced light weight robot arms. It will cover the definition of the product specification, the setting of a basic design and the optimization of this by means of topology optimization. This optimization requires an intelligent modeling to be able to investigate different initial setting and boundary conditions. Different innovative light weight construction materials and the corresponding manufacturing technologies are developing and analyzed.

**Mohd Aliff, Shujiro Dohta, Tetsuya Akagi, flexible Hui Li** [10] the aim of study is to develop the and light weight actuator and applied into has flexible hose robot arm. In this paper, the Slavic Master's degree height flexible control and the trajectory control of the robot arm are proposed. This robot arm has 3DOF i.e. bending, expanding and contracting and will be applied into has device for human wrist rehabilitation. In this paper the analytical model of year has flexible hose robot arm is proposed for Slavic Master's degree height control in trajectory control.

## III. PROPOSED WORK

Pneumatic Pick and Place System is widely used in automation industries to carry out small processes, which are controlled by PLC. The whole assembly of hardware is divided into two sections. It includes :

(A) Conveyor operation and (B) Pneumatic System

Initially the conveyor operation takes place, after its completion electrical signals are send to PLC, to carry out the pneumatic process of pick and place.

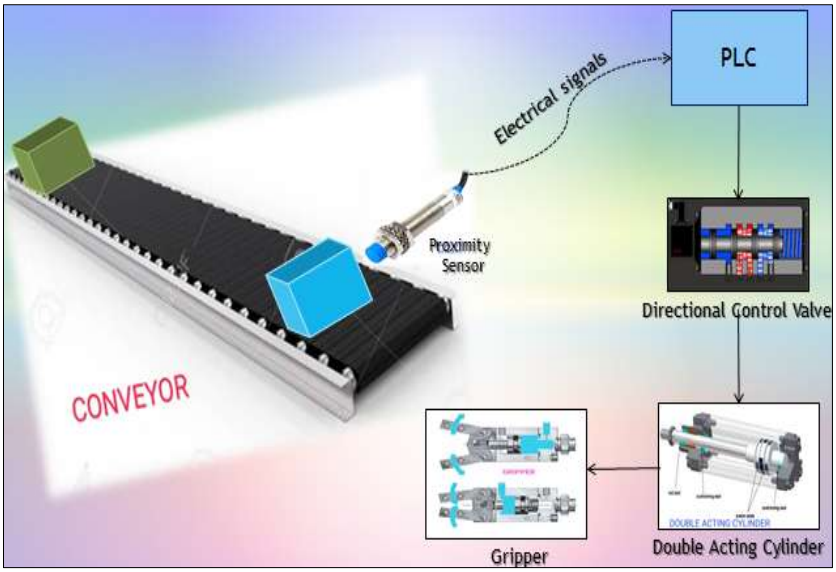


**Fig-3.1: Block Diagram**

**(A) Conveyor Operation :** The objects/products are fed on one end of conveyor belt. The conveyor motor is started for 10 sec. After 10 sec, the object reaches the other end of the conveyor due to the movement of belt. Proximity sensor detects the presence of the object and sends electrical signal to PLC.

**(B) Pneumatic System :** The electrical signals are received by PLC, which is then send to Directional control Valve. This leads the inlet of pneumatic pressure from Directional Control Valve to Double Acting cylinders. There are two pneumatic cylinders i.e. horizontal and vertical. The horizontal cylinder move

back and forth, whereas, the vertical cylinder move up and down. Gripper is located at the end of vertical cylinder for gripping object in jaws.

## IV. HARDWARE IMPLEMENTATION

The hardware design consists of conveyor and the pneumatic operation. The major components of the design consist of Conveyor belt, DC motor, Capacitive Proximity Sensor, PLC (Semantic), Directional Control Valve, Double Acting Cylinder. Motorized Gripper.

**(A) Conveyor :** It is a material handling system that uses the continuous belts to convey products/material.


**Fig-4.1: Conveyor Belt**

Roller material is made of PVC. Belt material is made up of Stripped rubber. 12 V dc Johnson motor is used to move the belt.

**(B) Capacitive Proximity Sensor :** It is a non-contact device that detects the presence or absence of object regardless of material. The object around the active face of the sensor causes change in electrical field leading to change in the capacitance. Its Range includes 1mm-10mm and the Operating Voltage is 9V-12V DC.


**Fig-4.2: Proximity Sensor**

**(C) Directional Control Valve :** It is the fundamental part of pneumatic system. Allows the fluid to flow into different paths. It has Inlet from Compressor and Outlet to cylinders. It's of Type-5/2. The Electromechanical coil is lying inside it. The Operating Voltage is 12V-24V DC.

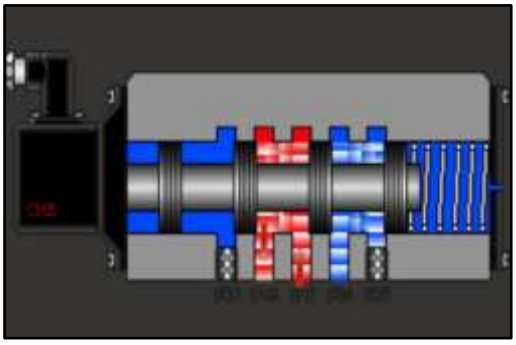

**Fig-4.3: Directional Control Valve**

**(D) Double Acting Cylinder** :It is the one in which the output force is developed in both extending & retracting directions. It acts as a hand actuator in a pneumatic system. Stroke- Cyl1 is 150mm Cyl2 is 300mm. Made of steel Material having a Mechanical Linkage.

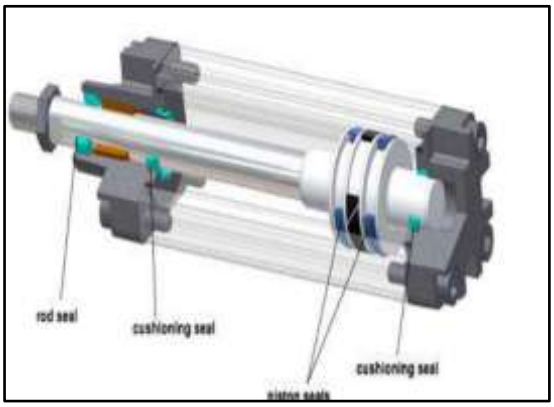


**Fig -4.4: Double Acting Cylinder**

**(E) Gripper :** It is a device which involves parallel & angular motion of surfaces. It is provided with the jaws to pick & place the objects. It is controlled by Pneumatic Valve & cylinder. It consists of 12V DC Motor with 30 RPM. Maximum Opening of gripper is 150mm.

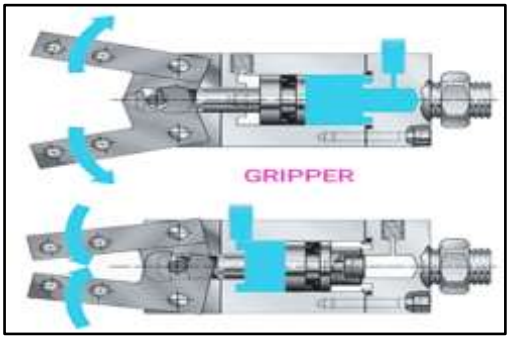


**Fig-4.5: Gripper**

## V. SYSTEM DESCRIPTION

Pick & Place system is widely used in automation industries to transfer the products from one location to other. It is based on Pneumatics i.e. system powered by compressed air/inert gas. Pneumatic System can be controlled manually or by automated solenoid valves.

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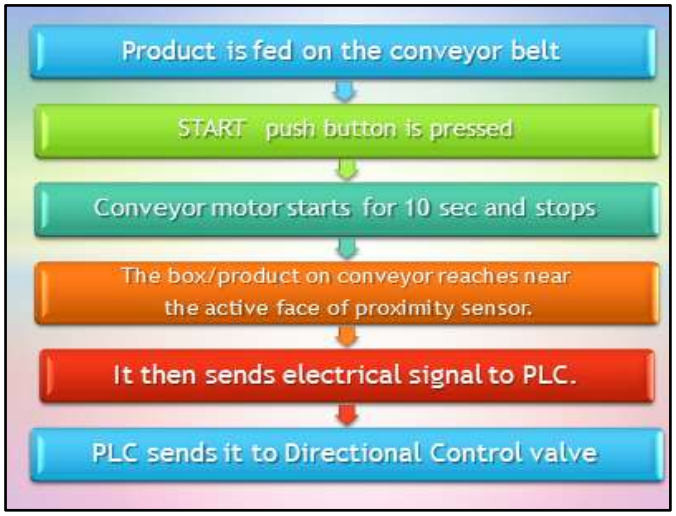


**Fig-5.1(a): System Operation**

Initially the product or object is fed on the conveyor belt. After that start push button is pressed. The conveyor motor gets on for 10 sec. Conveyor belt starts rotating and stops after 10 sec. When it stops, the object reaches in front of the sensor. The capacitive proximity sensor after detecting the object, causes the change in electrical field leading to change in the capacitance. These electrical signals are then send to Programmable Logic Controllers (PLCs).PLC then sends it to Directional control valve (DCV).


**Fig-5.1(b): System Operation**

The signals sent to Directional Control Valve leads to the inlet of pneumatic pressure from DCV to Double Acting Cylinders (DAC).Due to this, the horizontal cylinder move forward i.e. left to right and vertical cylinder lowers down i.e. up to down. The gripper motor then starts and locks the object in its jaw. The vertical cylinder then moves up. Subsequently, the horizontal cylinder moves back. The vertical cylinder again lowers down. The gripper jaw opens placing the object to another location. The entire process repeats.

## VI. IMPLEMENTATION & RESULTS

### 6.1: Ladder Programming (CodeSys)

```
PROGRAM PLC_PRG
VAR
        psensor1: BOOL;
        conv_motor: BOOL;
        timer_UD: BOOL;
        T1: TON;
        a: TIME;
        psensor2: BOOL;
        T2: TON;
        b: TIME;
        T3: TON;
        c: TIME;
        pv1_HLR: BOOL;
        pv2_VUD: BOOL;
        psensor3: BOOL;
        gripper_motor: BOOL;
        pv1_HRL: BOOL;
        T4: TON;
        d: TIME;
        timer_DU: BOOL;
        pv2_VDU: BOOL;
        T5: TON;
        e: TIME;
END_VAR
VAR_INPUT
        start: BOOL;
        stop: BOOL;
END_VAR
VAR_OUTPUT
        p_stop: BOOL;
END_VAR
```

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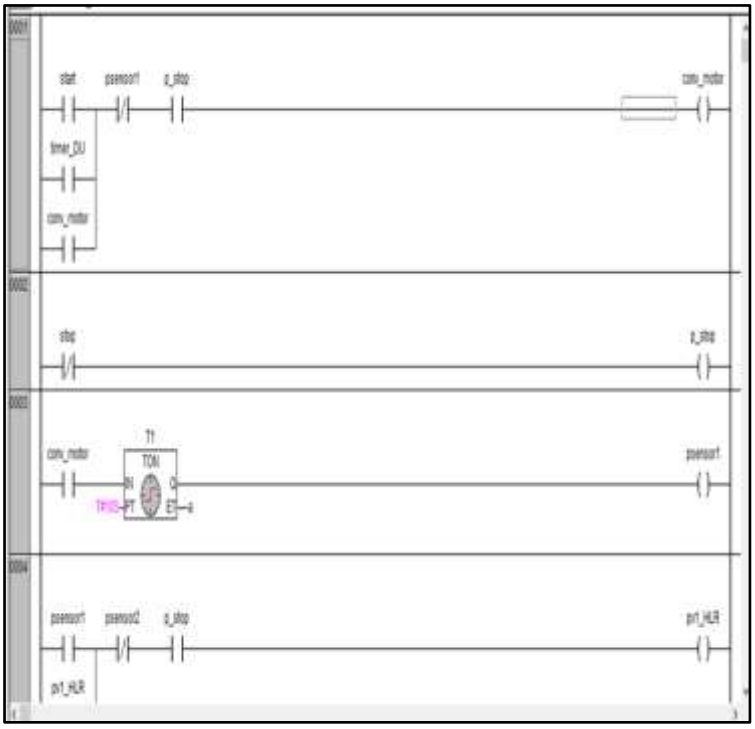


**Fig-6.1: Ladder Program for Conveyor Movement**

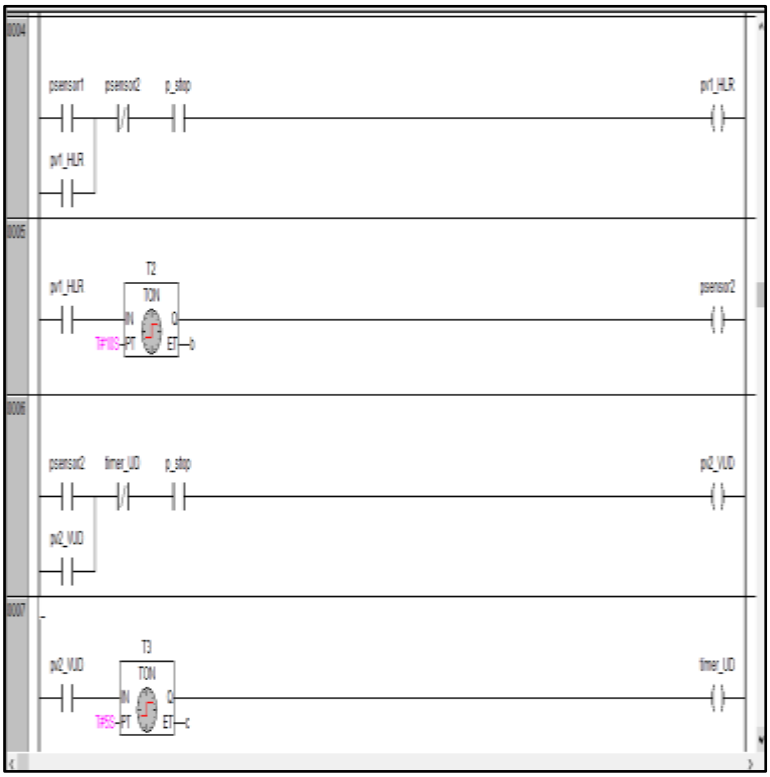


**Fig-6.2: Ladder Program for Object Detection by Proximity Sensor**

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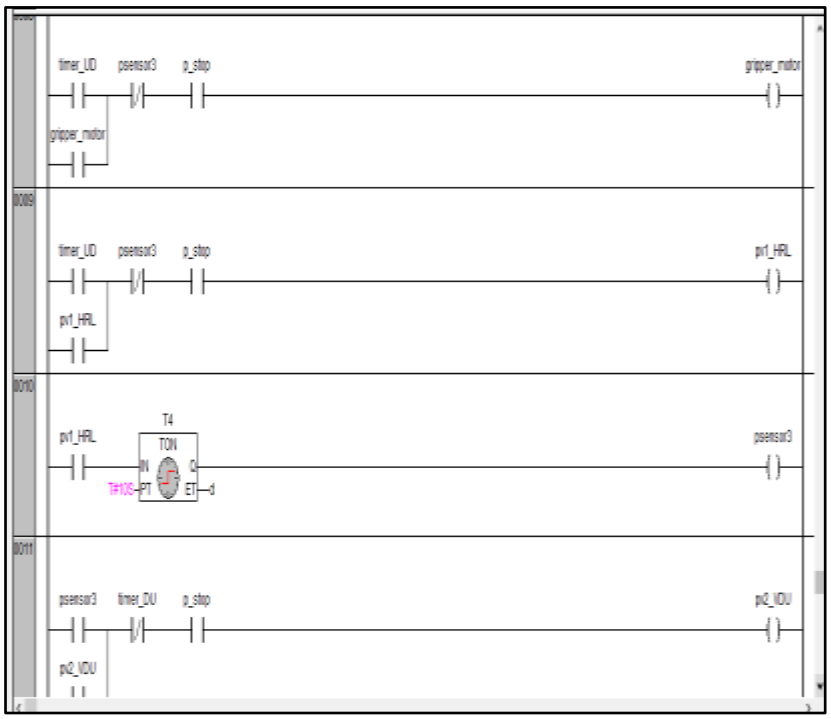


**Fig-6.3: Ladder Program for Pneumatic Cylinder Movement**

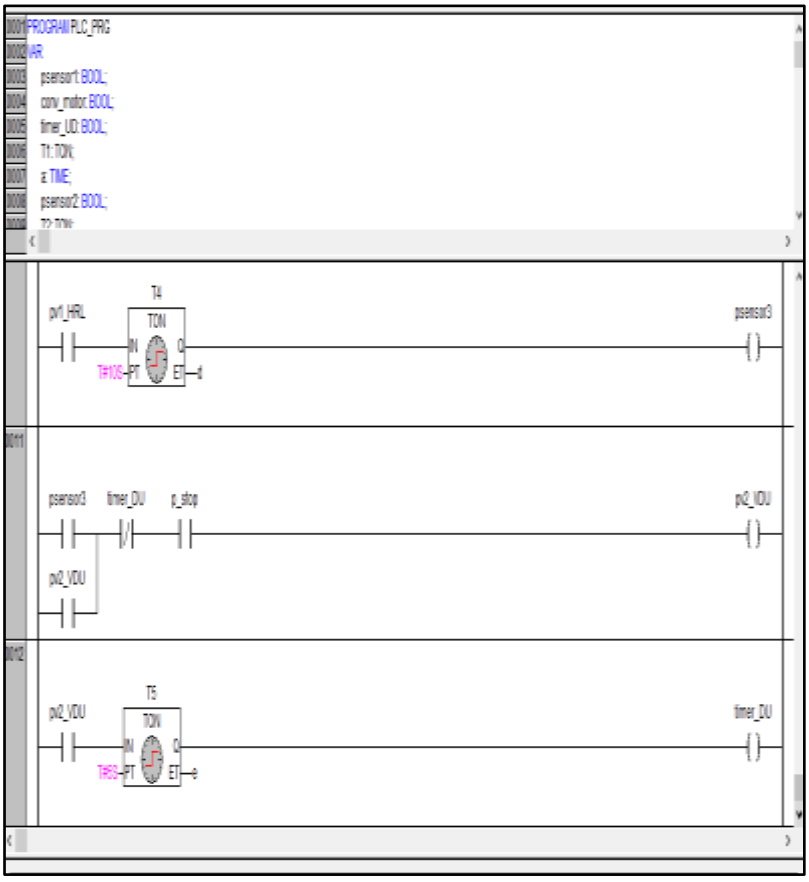


**Fig-6.4: Ladder Program for Object Gripping, Lifting & Placing**

### 6.2: SCADA Visualization (InTouch)

SCADA visualization of the project gives the demonstration in an animated form. It shows movement of blocks based on switches pressed. It works by writing the script for object movement & by changing properties.

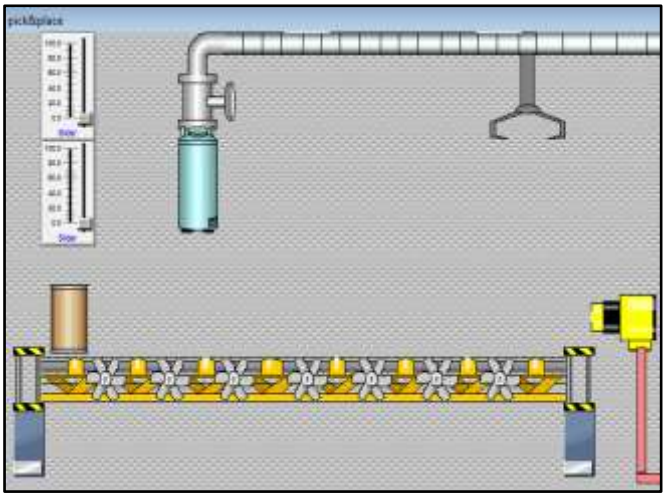

**Fig-6.5 : Object Placed on Conveyor Belt**

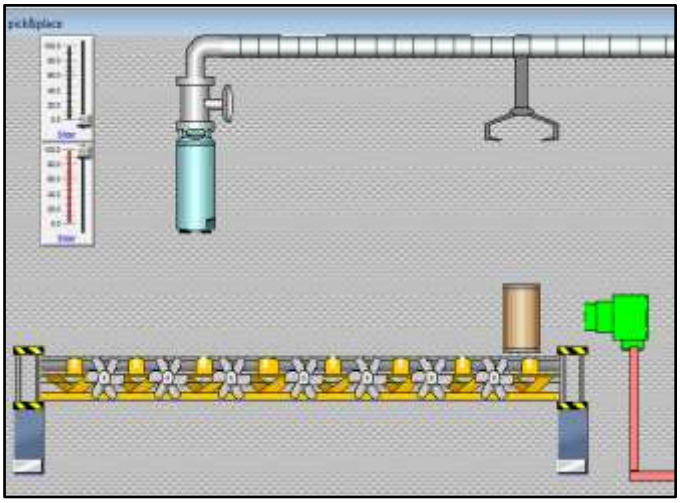

**Fig-6.6 : Object in Front of Proximity Sensor**

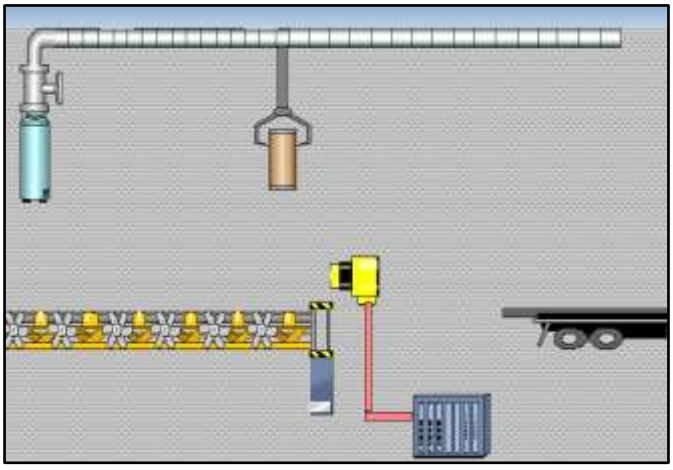

**Fig-6.7: Object Gripped & Lifted**

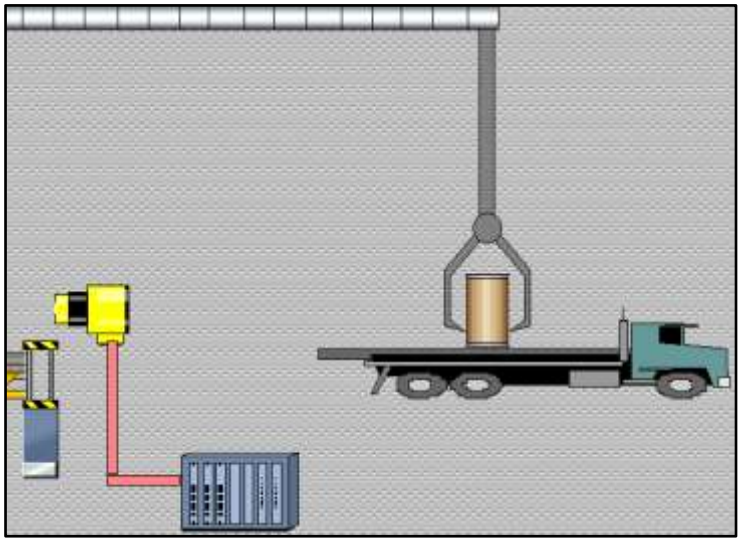

**Fig-6.8: Object Placed at Other Location**

## VII. CONCLUSION

The proto-type of pneumatic pick and place system utilizes sensor technology, programmable logic controller and pneumatic system. Pneumatic consists of Directional control valve, Double Acting Cylinder and Gripper. The design consists of Conveyor movement and cylinder movement. The whole assembly of hardware is controlled by PLC, which is programmed using ladder logic. Ladder programming is the primary programming language used to execute the motion sequence of the pneumatic pick and place system.

This automated process has reduced human efforts, saved time and increased rate of process completion. It requires minimal work area due to less wiring. Nowadays, automation is employed in every small and large industry. Manual control is quite hectic, as an operator periodically has to read the process and adjust the input accordingly. Whereas, an automatic control is quite convenient, as measurements and adjustments are done automatically on a continuous basis.

## VIII. REFERENCES

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