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LAYBOUY SEQUENCE OF PULP WETLAP CONTROL USING PLC

G.Balanavin[1], E.Elakhya[2], K.N.Baluprithviraj[3]

Department of Electronics and Instrumentation Engineering Kongu Engineering College, Perundurai, Erode-638060, Tamilnadu, India

Abstract —*Nowadays, automation in the industry is a global need for ease of operation, flexibility and operational safety. Automation is basically the delegation of human control functions to technical equipment aimed towards achieving higher productivity, superior quality of end product, efficient usage of energy and raw materials, improved safety in working conditions etc. In recent years programmable logic controller (PLC) has experienced an unprecedented growth as universal element in industrial automation. This research paper presents laybouy sequence for pulp sheet in wetlap process. The idea is to automate the process of pulp sheet collection in sequence operation using programmable logic controller. The purpose of this proposed method is to replace the manual system which currently used, compare the cost and maintenance time for both the existing with the proposed automated safety system. The Siemens S7 1200 series PLC is used to mechanize the system. Sensors such as proximity, limit switch and photo cell are used to provide input to the system and motors such as servo and dc motor serves as an output. Ladder diagram as a programming language is used to control the whole system between the input and output*

Keywords*-component; Wetlap machine, Retro-Reflection Sensor, Photoelectric Sensor, Proximity Sensor, Solenoid Valve*

I. INTRODUCTION

Tamilnadu Newsprint and Papers Limited (TNPL) furnish the multifunctional printing processes like sheet-fed, web offset, and digital printers based on the necessities. The paper reels have identical shape with strength properties to manage even with high speed machines. The printing and writing papers made in TNPL ranging from 50 GSM (Grams per Square Meter) to 110 GSM. TNPL offers high-quality surface sized and non-surface sized paper to outfit the desires of modern high speed printing machines. TNPL's latest technology backed by experienced professionals make certain quality products to customers. The pulp mill is the area which consists of linear formation of segment and portions carried out to manufacture the pulp sheet. In this pulp mill section, the pulp manufactured is wound over the core with the help of a wetlap machine. In this paper the laybouy sequence of pulp sheet collecting area is designed with the help of PLC.

1.1 Wetlap Machine

Pulping is the sequence of operation by which the combined within the wood structure are split either mechanically or chemically. Chemical pulps can be produced by either alkaline (i.e., sulphate or kraft) or acidic (i.e., sulphite) processes. The pulp is a chemical compositon which is produced by the sulphate method, followed by mechanical (including semi-chemical, thermomechanical and mechanical) and sulphite methods. Pulping processes differ in the yield and quality of the product, and for chemical methods, in the chemicals used and the proportion that can be recovered for reuse. The pulp is spread in the form of a fine sheet with help of a equivalent spreader while in its liquid form. It is then passed through series of presses by different weights in order to remove the moisture. Then it is send to the drier section[1].

1.2 Pulp Drier

The pulp is passed in the drier on a sheet which acts as a base for the wet pulp. The sheet is pressed by weight and the water is removed. Then the pulp sheet is removed from the base sheet and after cutting in a line from both sides it passes towards the laybouy sequence.

1.3 Pulp Collector

Pulp sheets are collected in the end of the wetlap machine with help of vacuum drum and it is stacked in a sequence called laybouy sequence. The sequence activates a palette table to hold the wooden palette, a fork table to shift the wooden palette and a stack table which collects the finished pulp sheets. The stacked pulp sheets are moved towards the packing area by energizing the rollers automatically and are packed using polythene sheets. Once the rollers are energized, the next sequence gets started[2]. In case if the rollers are not moving due to some mechanical problems, the filled stack table starts collecting the fresh pulp sheets and hit the fork table and the vaccum drum which will get damaged. So a manual command has been initiated after checking the complete removal of pulp sheets from the stack table.

II HARDWARE DESCRIPTION

2.1 Photoelectric Sensor

In automation technology, photoelectric sensors work as "artificial eyes". Photoelectric sensor will be suitable for particular applications where a reliable and non-contact detection of the exact position of objects is required. The different kind of light and technique by which the target is detected change based on the sensor. Photoelectric sensors are made up of a light source (LED), a receiver (phototransistor), a signal converter, and an amplifier. Photoelectric sensors have a much higher sensing zone than inductive sensors.

2.2 Retro-Reflective Sensors

The transmitter and receiver are integrated into one housing in retro-reflective sensor. By means of a reflector the transmitted light is returned to the receiver. Retro-reflective sensors without polarisation filter operate in the infrared area, systems with polarisation filter with visible red light figure 2.1 shows the Retro-Reflective Sensor. Figure 2.2 depicts the internal picture of photoelectric sensor.

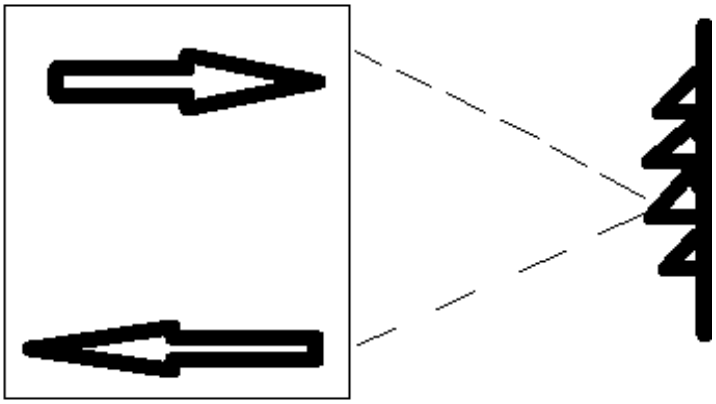

Figure 2.1 Retro – Reflective Sensor

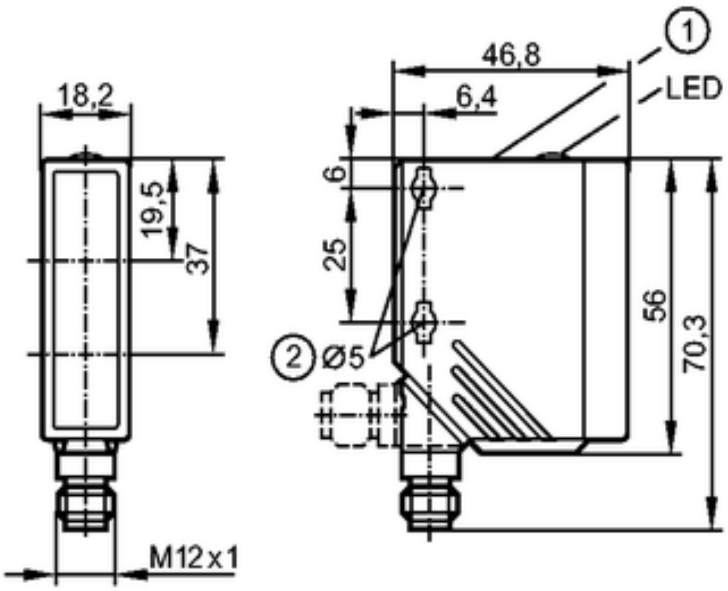

Figure 2.2 Photoelectric Sensor

The safe functioning of the sensor is checked and in dark–on switching units the output is switched or the yellow LED is lit when no object is detected, In Light–on switching units, the output is switched or the yellow LED is lit when an object is detected.

2.3 Proximity Sensor

Proximity Sensor includes all sensors that perform non-contact detection in comparison to sensors, such as limit switches, that detect objects by physically contacting them. Proximity Sensors convert information on the movement or presence of an object into an electrical signal. There are three types of detection systems that do this conversion, systems that use the eddy currents that are generated in metallic sensing objects by electromagnetic induction, systems that detect changes in electrical capacity when approaching the sensing object, and systems that use magnets and reed switches. The maximum distance that this sensor can detect is defined "nominal range". Some sensors have adjustments of the nominal range or means to report a graduated detection distance. Proximity sensors can have a high reliability and long functional life because of the absence of mechanical parts and lack of physical contact between sensor and the sensed object. A clear description of the proximity sensor is shown in Figure 2.3.

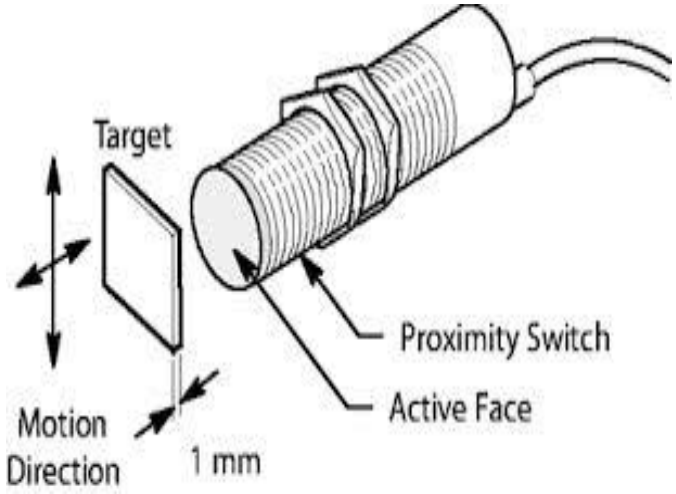

Figure 2.3 Proximity Sensor

2.4 Solenoid Valve

The solenoid valve is energized by applying the voltage supply and changing of port occurs (i.e.) the output port 2 is active under no supply is given to the solenoid, and the output port 4 is active under the supply to solenoid coil. A manual override is used to change the port manual without supply to the solenoid coil. An LED will glow, by applying supply to the solenoid valve.

2.5 Limit Switches

A limit switch is a switch operated by the action of a machine part or occurrence of an object. Machinery are controlled by a limit switches as branch of a control system, as safety interlocks, or to count objects passing a point. A limit switch consists of an actuator which is mechanically linked to a set of contacts and act as an electromechanical switch. The device operates the contacts to make or break an electrical connection, when an object is in link with the actuator. Variety of applications and environments are used by limit switches because of their roughness, ease of mechanism, and consistency of operation. This limit switches can determine the presence or absence, passing, positioning, and end of travel of an object. Industrial control components are made by standardized limit switches which are manufactured with a variety of operator types, including lever, roller plunger, and whisker type. Mechanically limit switches are directly operated by the motion of the operating lever. A reed switch are required to represent the proximity of a magnet escalate on some moving part. By the disturbance of an electromagnetic field the proximity switches work by disturbance of an electromagnetic field and also other method of enabling by capacitance, or by sensing a magnetic field.

III PROGRAMMABLE LOGIC CONTROLLERS

A Programmable Logic Controller (PLC) is a small, self –enclosed, hardy computer designed in an industrial automation atmosphere to control processes and events. In earlier days relay logic controllers are done in the process automation. PLC directly connected to switches, sensors and other input devices through wires. To drive the output, each PLC has been programmed with a microprocessor. PLC program is frequently developed on the separate programmer by particular software make available by the PLC manufacturer. Once the program has been written, it is downloaded into the PLC. The basic function of a PLC is to provide output commands based on some combination of a set of input provision to that machine or process. The PLC is extended capabilities which are similar to the familiar relay logic panel.

IV PLC HARDWARE OVERVIEW

PLC is basically a programmed interface between the field-input element like limit switches, sensor, transducer, push-button, etc. and the final control elements like actuators, solenoid valves, dampers, drives, LED's, etc.
Programmable Logic Controller consists of the following:

1. Input Modules
2. CPU with processor and program memory
3. Output Modules
4. Bus system
5. Power supply

PLC Hardware Architecture is shown in figure 4.1

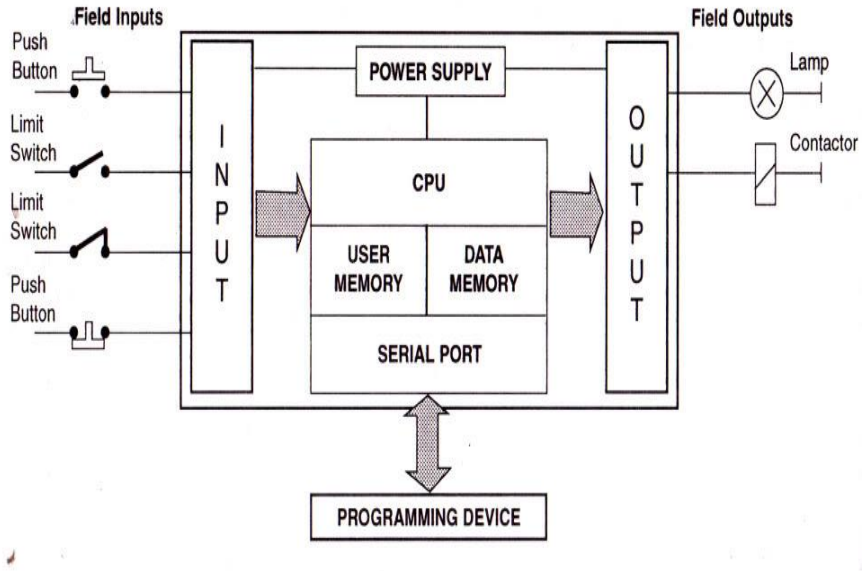

Figure 4.1 PLC Hardware Architecture

4.1 Input Module

The input module acts as an interface between the field control inputs and the CPU. The voltage or current signals generated by the sensors, transducers, limit switches, push buttons etc. are applied to the terminals of the input module.
The input module helps in the following way:

1. It converts the field signal into a standard control signal, for processing by the PLC. The standard control signal delivered by input module could be 5V or 9V whereas the field signal received by it could be 24V DC or 230V AC.
2. If required, it isolates the field signal from the CPU.
3. It sends one input at a time to CPU by multiplexing action thus helping in serial communication.

4.2 Output Module

The output module acts as a link between the CPU and the output devices located in the field. The field devices could be relay, contactors, motorized potentiometers, actuators, solenoid valves, dampers etc. These devices actually control the process.

The output module converts the output signal delivered by CPU into an appropriate voltage level suitable for the output field device. The voltage signal provided by CPU could be 5V or 9V, but the output module converts this voltage level into 24V DC, or 120V AC or 230V AC. Thus the output module on receiving signal from the processor, switches voltage to the respective output terminals. This makes the actuators (i.e. contactors, relays etc.) or indicating lights connected to the terminal, to turn ON or OFF.

4.3 Central Processing Unit

The Central Processing Unit or CPU consists of the following blocks.

1. Arithmetic Logic Unit (ALU)
2. Program memory
3. Process image memory (i.e. internal memory of CPU)
4. Internal timers and counters
5. Flags

PLC CPU Architecture is shown in figure 4.2

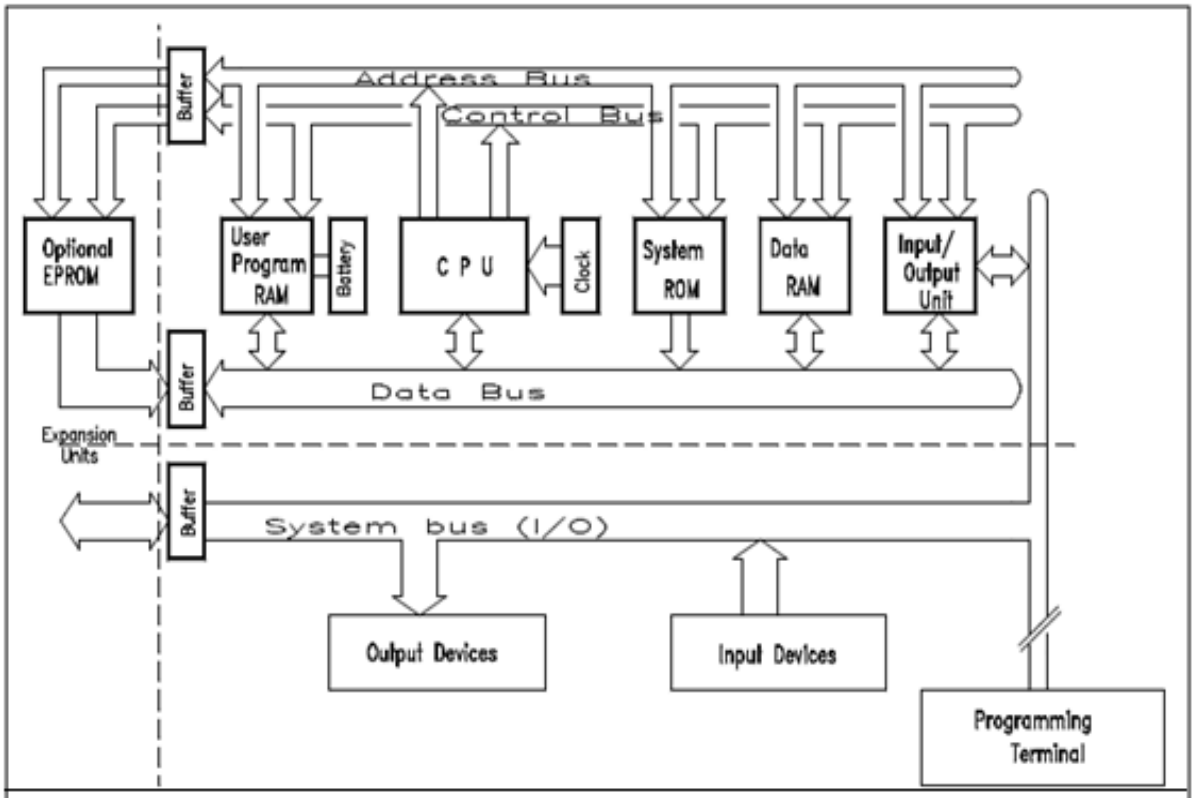

Figure 4.2 PLC CPU Architecture

4.4 Power Supply

The power supply module generates the voltages required for the electronic modules of the PLC from the main supply. Typically single phase, 230V AC supply is converted into 24V DC supply by power supply module. It should be noted that CPU needs 24V DC input, and the CPU generates the other voltage required by the PLC hardware such as 5V DC.

4.5 Bus System

Bus system is a path for the transmission of signals. In PLC, it is responsible for the signal exchange between processor and input/ output modules. The bus comprises of several signal lines.

There are three buses in PLC named,

1. Address bus which enables the selection of memory location or a module
2. Control bus, which transfers control and timing signals for the synchronization of the CPU's activities within the programmable controller
3. Data bus, which helps to transfer data from input/output device to the central processing unit

4.6 Power Supply PLC Programming using Simatic Software

For a specific application of a process the PLC programs are normally downloaded in a computer by a direct-connection cable or over a network to the PLC. The program is stored either in battery-backed-up RAM or some other non-volatile flash memory in the PLC. Thousands of relays are often replaced by programming a single PLC. Under the IEC 61131-3 standard, PLC's can be programmed from the standard - based programming languages. Ladder Diagram (LD) also known as Ladder Logic are the most commonly used programming language. It uses Contact-Coil logic to make programs like an electrical control diagram. A graphical programming detail which is also called as Sequential Function Charts is offered on certain programmable controllers.

4.7 Simatic Manager

The SIMATIC Manager handles all the data that fit in to an automation project − regardless of programmable control system (S7).The tools needed to edit the selected data are started automatically by the SIMATIC Manager. The SIMATIC Manager is the basic application for configuring and programming. A typical SIMATIC Manager will be as shown in Figure 4.3.

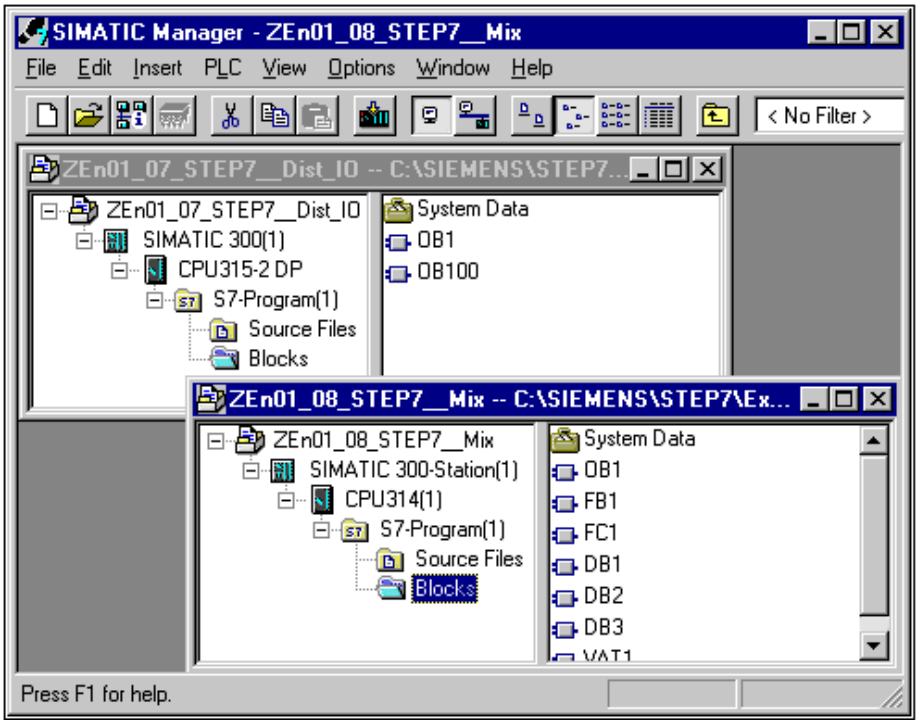

Figure 4.3 Simatic Manager

SIMATIC Manager can perform the following functions:

1. Set up projects
2. Configure and assign parameters to hardware
3. Configure hardware networks
4. Program blocks
5. Debug and commission the programs

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 well as MS Windows XP Professional and MS Windows Server 2003.

V LAYBOUY SEQUENCE USING PLC

This chapter deals with existing methods of pulp sheet collection by laybouy sequence at Tamilnadu News Print and Papers Limited. Also, it addresses the algorithm framed to bring out the PLC program.

5.1 ALGORITHM OF LAYBOUY SEQUENCE

STEP 1: Sequence start
STEP 2: Pallete table Rises
STEP 3: Pallete top high level sensor detects
STEP 4: Lock cylinder holds the pallete
STEP 5: Pallete table lowered to restore the next wooden pallete
STEP 6: Pallete low level switch detects
STEP 7: Fork forward holds the wooden pallete when the lock cylinder releases
STEP 8: Stack table move upwards by manual command to hold the wooden pallete
STEP 9: Stack top level sensor detects starts collecting pulp sheets
STEP 10: Pulp stacking operation takes place
STEP 11: Stack low level sensor detects roller starts
STEP 12: Wooden pallete moves to handling area
STEP 13: Next sequence starts step1 repeats

5.2 Existing Method

The Laybouy Sequence of Wetlap machine that is already available at Tamilnadu Newsprint and Paper Limited contains manual operations to be performed during the loading of the palette and stack tables. A Pictorial representation of the laybouy sequence is shown in Figure 5.1.

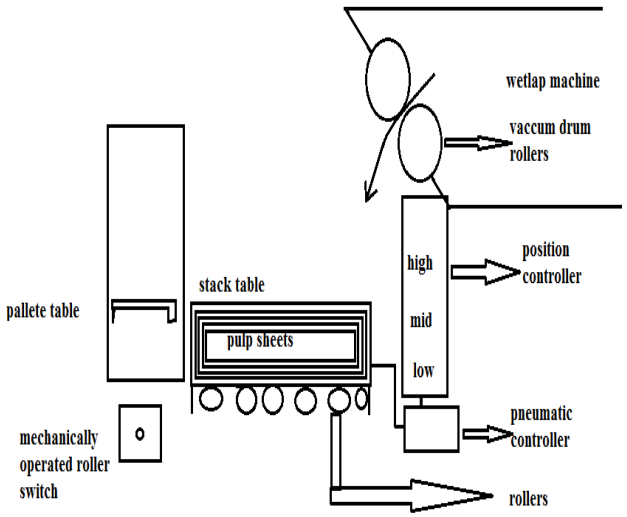

Figure 5.1 Pictorial representation of laybouy sequence

5.3 Proposed Method

The Laybouy Sequence of Wetlap machine that is available at Tamilnadu Newsprint and Paper Limited is automated with the help of Siemens S7 1200 series PLC. Sensors such as proximity, limit switch and photo cell are used to provide input to the system and motors such as servo and dc motor serves as an output. The whole system between the input and output are controlled by the ladder diagram as a programming language.

Advantages:

- Increased plant efficiency
- Reduced repair time
- Prevention of unscheduled outages

Figure 5.2 depicts the manually operated parts in the Laybouy sequence that is being automated using PLC in this project.

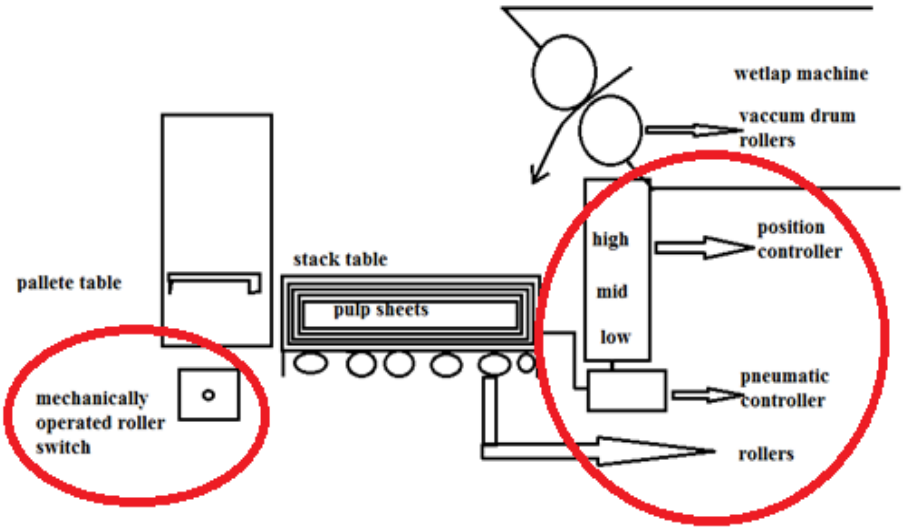

Figure 5.2 manually operated parts in the Laybouy sequence

5.5 WETLAP MACHINE OUTPUT

The Wetlap machines have certain target values of production every day. Table 5.1 depicts the output details of Wetlap Machine in TNPL.

Table 5.1 Output details of Wetlap Machine

Contents	Details
Wetlap Machine	3 machines
Palettes filled per day	70
One palette of pulp sheets	800 Kg
Total production in Wetlap Machine 2	5.6 Tonnes

VI RESULTS AND DISCUSSION

In Tamilnadu Newsprint and Papers Limited, this proposed method is implemented using PLC to ensure the continuous productivity. With the automation for all operations in pulp sheet manufacturing, the laybouy sequence in wetlap machine is made very comfortable to increase in production rate. Frequent shut down in paper making section of the plant is drastically eliminated due to implementation of this method. In future, this system can be updated for the other wetlap machines with the same program and it may be possible to implement using the same PLC without any interruptions and with high efficiency.The Ladder Diagram of Laybouy Sequence of Wetlap Machine is depicted in Figure 6.1. Relay connections of Laybouy Sequence in Wetlap Machine is shown in Figure 6.2. Hardware Setup of Laybouy Sequence in Wetlap Machine is shown in figure 6.3.

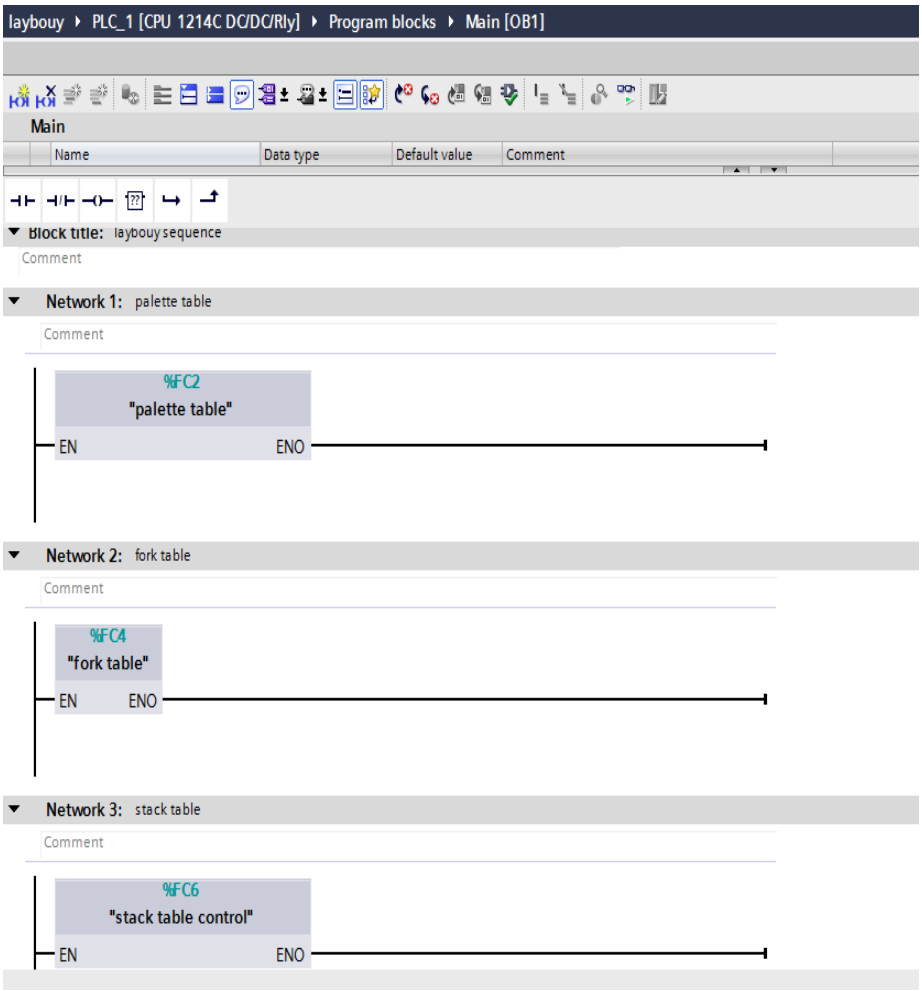

Figure 6.1 Ladder Diagram of Laybouy Sequence of Wetlap Machine

Figure 6.2 Hardware Setup of Laybouy Sequence in Wetlap Machine

Figure 6.2 Relay connections of Laybouy Sequence in Wetlap Machine

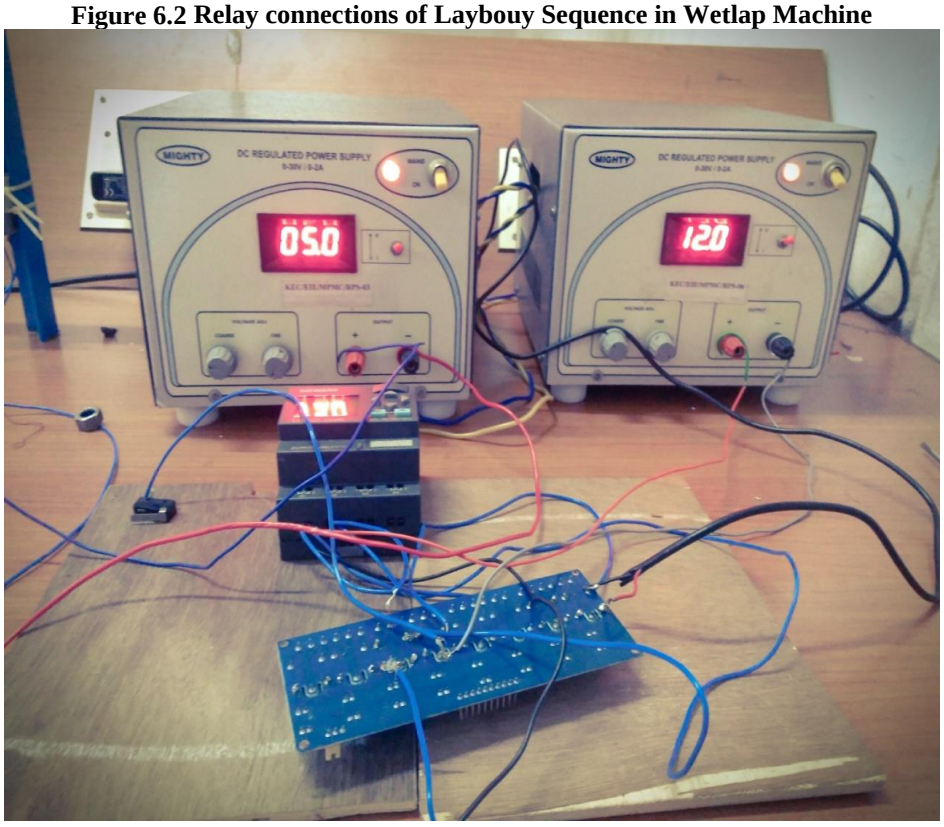

Figure 6.3 Hardware Setup of Laybouy Sequence in Wetlap Machine

VII CONCLUSION

This paper is about an Laybouy Sequence of Pulp Wetlap Control using PLC which uses automated technquies to control the process in wetlap machine. The proposed method is to automate the process of pulp sheet collection in sequence operation using programmable logic controller. This method is to replace the manual system which currently used, compare the cost and maintenance time for both the existing with the proposed automated safety system.

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