Controlling and Monitoring of Traffic Light Control Using Schneider PLC

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Abstract - Controlling and monitoring of traffic light control using schneider PLC is a modern and effective way to control traffic and prevent congestion and accidents. In this system the PLC is operated through a start and off switch and the traffic lights are given different priorities with the help of timers. The system controls a two-way traffic signal which controls the congestion according to their timings. The lights [red, yellow, green] execute according to the logic diagram. In the work that has been implemented a master circuit using the start and the stop pb with memory latching has been used. That memory latch has been used as the input along with timers to create the different light signals at the required interval of time. In general, the traffic light system is being controlled for each light based on traffic flow using proximity sensors that detect the presence of vehicles that are in the intersection of the roads. In the project the first red light keeps on for three time periods and the second lights keeps on blinking at the required time interval. The output is taken from common branches and implemented in the end. In real life the ladder logic diagram implemented is precise and easy to understand and use. It will help in preventing congestion and minimize accidents on roads.

***Key Words*:** Schneider PLC Automation, Programmable Logic Controller (PLC), Smart Traffic Signal Control, PLC-based Traffic Management

1.INTRODUCTION

Automation has been one of the most essential technologies of the modern word [1]. It is the advent and alertness of technology to provide and deliver goods and services with minimal manual support. Over the years automation has undergone various changes. Earlier there was only one form of control in traffic light systems i.e. it was controlled manually but with the coming of advanced plc the control of traffic light signal has gone through various innovations and advancements. Electrical control using relays has changed the way we could control traffic forever. There have been advancements and the system has become a lot more accurate than ever before. Nowadays with a lot of research traffic lights have been implemented with plc with sensors connected to measure the traffic density of a lane. Timers and counters have taken over the traditional approach of controlling and monitoring traffic lights and it has reduced a lot of accidents on the street [2]. In the industry plc has the following advantages over relays such as, traditional mechanical relays wear out much faster than the electronics in a solid-state relay. Every time a mechanical relay opens and closes, the contacts will arc slightly. The arcing can sooner or later smash the contact. This is virtually now no longer the case with the solid-kingdom kind relays observed in our PLC systems. Another advantage of a PLC system is that the problem in the plc can be addressed easily. In a PLC system, an engineer can read through the programming and usually find out the anomaly in the system. In a relay System, there could be numerous extra wires plus the relays and probably other components that are not needed in a PLC. This makes finding problems much harder. The first PLC was introduced in the market in the late 1960s.A programmable logic controller is an industrial computer which is designed to control manufacturing processes using electrical relays. The first industry to arrange PLCs into its operations was the automobile industry. They aimed to replace the hardwired relays and timers with programmable and flexible controllers. After that, PLCs have been universally accepted as the standard automation control system in discrete manufacturing industries. In the year 1968 the first commercially usable PLC was incorporated. A device known as the Modular Digital Controller was introduced by Richard E Morley who worked for Bedford Associates. General Motors, tested the modular controller, it showed a 60 percent time efficiency and brought a new wave of change in the automobile industry. After the success of the Modular digital controller Bedford associates changed their name to Modicon. The Irish Mathematician George Boole came

up with Boolean algebra and presented it in The Mathematical Analysis of Logic (1847). It is the math of ones and zeros, True and False. At its core, it includes three expressions, AND, OR and NOT. This type of logic is used by all computers. Despite the simplicity of Boolean Logic and The Genius Of George Boole, Boolean Statement applications had been ok for computer scientists but as compared to relay logic the plant engineers found them difficult to work with this new type of technology. The Engineers have been used to relay manipulate structures which hired ladder diagrams. This is because whenever relay circuits are drawn between A warm and impartial common, they resemble the rungs of a ladder. Ladder Logic is largely a photograph illustration of Boolean Logic. The engineers could locate it less difficult to apprehend and use than Boolean Logic. Introduction of the first personal computers in offices was coming at this point in time. The adoption of personal computers was now no longer relegated simply to the layout arena, however additionally the store floor. The PCs began being used to interface with PLCs directly. By this time, the PLC application turned into broadly identified because the maximum beneficial diagnostic Tool. It allowed for powerful troubleshooting, for this reason many thinking about it to be the window to machines. Nonetheless, machine diagnostics were still in their primitive stages. Nonetheless, ladder common sense stays famous because of its graphical and intuitive design. The introduction of the International Electrotechnical Commission (IEC) 61131-3 specification in 1982 is one of the most significant milestones in PLC history. It was the standard by which PLC software program being evolved become to be held against. It became posted in 1993 as IEC 1131 International Standard for Programmable Controllers. In 1990s in time engineers wanted their new equipment to include business terminals that had PLC monitoring software. Plant managers wanted their technicians doing actual troubleshooting. PLC packages at that point had been easy in design. Plant managers wanted to have machines that could tell them what was amiss. Instead of spending hours troubleshooting. This is what led to the development of the programmable human machine interface (HMI). The prototype HMIs were called the modest pushbutton replacers. However, they were thought to be Uneconomical for packages that had much less than 20 pushbuttons. Nonetheless, their reputation commenced developing as producers began finding more uses for them. Machine monitoring information was becoming more and more vital. Information such as machine Problems, time in auto, guide interventions, manufacturing counts, and more were including in the process. All that was being monitored and displayed in HMI monitors then later dispatched to the factory's central computers. The first traffic signal which was developed in London, England in 1868. The modern traffic light was invented in America. A three-color machine in 1918 which became operated manually from a tower in the middle of the street was installed in New York. Garrett Morgan in 1923 patented an electric traffic light system using a pole with a cross section on which the words STOP and GO were illuminated. First computerized indicators had been mounted in London; they trusted a timer to activate them in 1926. A breakthrough in the process was the inductive-loop device: a loop of wire was embedded in the road and connected to a box controlling lights; a current of electricity passed through the loop, and at the same time as the metal body of automobiles handed over, it produced a light activating signal. At present in some countries, site visitors are robotically routed onto constrained right of entry to dual carriageway with the aid of using the help Of pc activated steerage structures that calculate visitors volume on the intersectional lanes. Global positioning satellite systems (GPS) are installed in many cars. These systems link with a satellite and tell drivers what are the viable routes to their destination. Such structures subsequently allow the drivers to decide the nice path to a destination under prevailing traffic conditions thus optimizing time.[3] There are so many advantages of automated traffic light control such as: i) As the traffic light system controlled by plc works with minimal human support it is accurate and highly efficient than the traditional working of the traffic system. ii)Plc relays can perform the work of three to five people who were controlling traffic lights manually In Addition to financial savings at the price of labor, electricity financial savings also can be significant due to lower heating requirements in operations. So, it is saving a lot of cost for the operation. iii)With minimal human intervention traffic lights are accurate with minimum error so there is a less chance of accidents. They are accurate and precise Iv) Automated answers are primarily based totally for your specific wishes and dreams in different traffic lanes and pay for themselves quickly due to lower operating costs, reduced lead times, increased output) It is capable of surviving wear and tear and are faster, robust, and dependable. Study of PLC and its Application in a Smart Traffic Control System (Do. There has been a lot of research work already done in this domain. In one work,

Research on automated traffic light control has been done in Iop conference series materials science and engineering. In one work, an intelligent traffic control system has already been established [3] . In another work, Study of plc and its application in traffic light control systems was done in a thesis at National institute of technology Rourkela. In another type of work, Study by International Research Journal of Engineering and Technology [4] In this study various ways to implement a PLC with various levels of logic diagram has been shown. Study By Poornima College of Engineering showed an intelligent system to control traffic lights using sensor control [5]. Based on the observations in the project we implemented a simpler, precise, and easy to grasp project on controlling and monitoring traffic light signals. The Project Implemented has the following advantages over some of the already known works such as A) It is simple in design and user-friendly B) It is precise and accurate C) It has huge scope for further modifications D) Consumes very little memory E) The Software used is easily available for the general users.

2. LEVELS OF AUTOMATION

Enterprise Resource Planning is an enterprise control software program that is employed by many business houses to upsurge their productivity and performance. It is a very influential business tool. It is used to assemble, store, manage and interpret data from many business activities like Product development, cost, Manufacturing or Service Delivery, Marketing and Sales, Inventory management, Shipping, and payment etc. Data are gadgets of information, frequently numeric, that are collected through observation. In a greater technical sense, records are a set of values of qualitative or quantitative variables approximately one or more people or objects, at the same time as a datum (singular of data) is a unmarried value of a single variable. The PLC obtains information from connected Sensors or enter devices, techniques the data, and triggers outputs based on pre-programmed parameters. ... I/O may be both analog or Digital; enter gadgets would possibly consist of sensors, switches, and meters, at the same time as outputs may consist of relays, lights, valves, and drives. Integration of the control system into a process system, effectively reduces the labour involved in the process of complex equipment and provides reliable, consistent presentation. Today the programmable logic controller is the brain of the control system [6].

3. IMPLEMENTATION IN TRAFFIC LIGHT SYSTEM

Traffic lights are one of the most vital and important facilities which play an important role to the public. Traffic lights are implemented to control the movement of vehicles and passengers so that passengers and cars can move safely around the road and any chances of accidents are minimal. The growth of the implementation of traffic light signal roadways ascertains its effectiveness in directing the traffic flow and reducing congestion in roads and preventing accidents. In the conventional traffic light system, which were operated manually it caused congestion especially in the metropolitan areas of the country. Occasionally the roads became crowded and it resulted in a traffic jam, conventional traffic light systems failed to give priority to heavy traffic lanes. but now with the coming of automated traffic light system the functionality has become accurate and precise [7].

Figure-1: Level of Automation

4.PROPOSED SCHEME

A programmable logic controller (PLC) or programmable controller is an industrial digital computer which has been resistant to wear and tear and modified for the control of manufacturing processes, such as assembly lines, or robot devices, or any interest that calls for excessive reliability, ease of programming and process fault diagnosis. The range of the plc from small Modular devices with tens of inputs and outputs (I/O), in a housing vital with of I/O, and which are often networked to other PLC and SCADA systems. For PLC systems there are two types of

mechanical designs. A single box, or brick is A small programmable controller that suits all devices and interfaces into one Compact casing, although, typically, extra growth modules for inputs and outputs are available. layout kind second – a modular PLC – has a chassis (also known as a rack) that offers area for modules with exclusive functions, such as power supply, processor, selection of I/O modules and communication interfaces – which all may be custom designed for the precise application. Several racks can be Administered with the aid of using an unmarried processor and might have hundreds of inputs and Outputs. Either a unique high-velocity serial I/O hyperlink or similar communication technique is used in order that racks may be dispensed far from the processor, reducing the wiring costs for large plants. Options are also available to mount I/O factors immediately to the device and make use of short disconnecting cables to sensors and valves, saving time for wiring and replacing components. The intention of the engineers working with plcs are to be used by engineers without a programming background. A graphical programming language called Ladder Diagram (LD, LAD) was first developed for this reason. Built with electromechanical relays it resembles the schematic diagram of a system and was followed by way of means of many producers and later standardized withinside the IEC 61131-3 control systems programming standard. As of 2015, it is still widely used, thanks to its simplicity. The majority of PLC systems as of 2015 adhere to the IEC 61131-three well known that defines 2 textual programming languages: Structured Text (ST; just like Pascal) and Instruction List (IL); in addition to three graphical languages: Ladder Diagram, Function Block Diagram (FBD) and Sequential Function Chart (SFC).Instruction List (IL) was deprecated in the third edition of the standard[Modern PLCs can be programmed in a variety of ways, from the relay derived Ladder common sense to programming languages which include mainly tailored dialects of BASIC and C.While the fundamental concepts of PLC programming are not unusual place to all manufacturers, variations in I/O addressing, memory Organization, and coaching units imply that PLC packages are in no way perfectly interchangeable between different makers. Even in the equal product line of an unmarried manufacturer, exceptional fashions won't be immediately compatible. [Citation: 7. Basile,F.,Chiacchio, P., & Gerbasio, D. (2012). On the implementation of industrial automation systems based on PLC. IEEE Transactions on Automation Science and Engineering, 10(4), 990-1003.]

5.CLASSIFICATION OF PLC ACCORDING TO MANUFACTURER'S MANUFACTURER OF PLC ARE: •

5.1 SCHNEIDER ELECTRIC: A European multinational company Schneider Electric delivers energy and automation digital solutions for proficiency and sustainability. It majorly works in homes, buildings, data centers, Infrastructure, and industries, via means of combining power technologies, real-time automation, software, and services.

5.2 SIEMENS: A German multinational multi-national company Siemens sg founded in Munich and the biggest commercial production enterprise in Europe with branch offices overseas. The fundamental divisions of the corporation are Industry, Energy, Healthcare, and Infrastructure & Cities, which denote the main actions of the company

5.3 ALLEN-BRADLEY: Allen-Bradley is the brand-call of a line of factory automation apparatus, today possessed by Rockwell Automation. The company manufactures programmable logic controllers (PLC), human-machine interfaces, Sensors, protection additives and systems, software, drives and force systems, Contactors, motor manipulate centers, and structures of such products

5.4 MITSUBISHI: Founded by Iwasaki Yatarō in 1870, the Mitsubishi Group historically descended from the Mitsubishi zaibatsu, a unified company which existed from 1870 to 1946. The products from MELCO encompass elevators and escalators, high-quit domestic appliances, factory Automation systems, education systems, semiconductors, digital signage, and satellites.

6.COMPONENTS OF PLC

A plc consists of the following components such as central processing unit (CPU), memory, power supply, rail/rack, input modules, output modules, redundancy, communication media and protocols [8].

6.1 Power supply: The power supply converts facility electrical distribution Voltage, which includes 230 VAC, a hundred and twenty VAC or a hundred twenty-five VDC to sign stage voltage used by the plc processor and other modules.

6.2 Processor: The processor module contains the microprocessor that manages capabilities and

computations, in addition to the memory required to store the program.

6.3 Input/Output (I/O): These modules offer the method of connecting the processor to the field devices. Examples of these modules are Analog Input Module, Analog output module, Digital input module, Digital output module etc. These are used to attach gadgets between % and discipline gadgets like waft transmitters, stress transmitters, control Valves, analyzers', substation feeders for motor manipulation etc.

6.4 Communication: Communications modules are available for a wide variety of industry- widespread conversation community connections. These permit virtual information switch among PLCs and to different structures inside the Facility. Most generally used modules are Modbus communication cards or Serial communication. Some PLCs have communications functionality integrated to the processor, as opposed to the use of separate modules.

6.5 Communication Media and Protocols: The most common communique media used are copper-wire, coaxial, fiber-optics, and Wireless. The maximum common "open" conversation protocols are Ethernet, Ethernet/IP, and Device Net. "Open" systems generally Provide "plug and play" capabilities wherein the gadget software mechanically acknowledges and communicates to any well-matched device that is connected to it. Other widely accepted open protocols are Modbus, Profibus, and ControlNet.

6.6 Redundancy: Many PLCs are able to be configured for Redundant operation wherein one processor backs up another. This association frequently calls for the addition of a redundancy module, which offers repute affirmation and manage announcement among the Processors. In addition, sign wiring to redundant racks is an option.

7.ARCHITECTURE OF PLC

The plc shown in the figure has three major units/sections they are

A)I/O(Input/Output)Modules')
B)CPU(CentralProcessingUnits).
C)Programmer/Monitor.

The enter segment converts the sector alerts provided through enter Devices/sensors to logic-stage indicators that the percent CPU can read. The Processor Section reads those inputs, approaches the signal, and prepares the output signals. The output section converts the common-sense stage output alerts coming from the processor segment to excessive stage indicators and used to actuate diverse output discipline devices. The Programmer/reveal is used to go into the user's software into memory and to monitor the execution of the program [9].

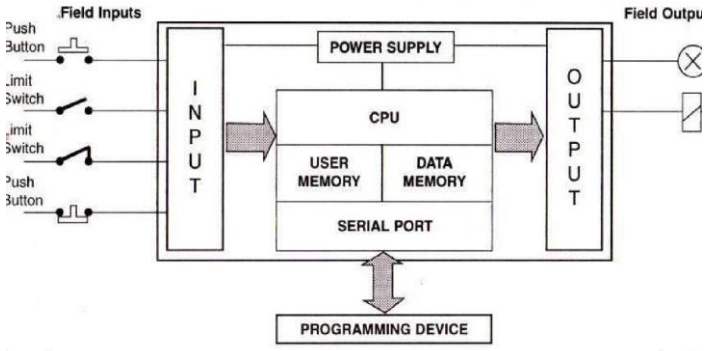


Figure 2: Architecture of PLC

8.SOFTWARE USED

For building and running this project on controlling and monitoring of traffic light signals through schneider plc Zeliosoft 2 version 5.3.1 has been used.it is one of the very few free and user-friendly simulators available in the internet. ZelioSoft software for Zelio Logic smart relays (SR2/ SR3). It Contains programming software, self-training module, application library, and methodological instructions.

Other simulators that we could have used are:

1. Simatic manager

2. Logixpro 500

3. Delta.

8.1 Advantages of using Zeliosoft are:

● It is easy to understand.

● It is an open-source software so the general people can access it.

● It consumes very low memory and it has a lot of library packages and instruction packages.

9. METHODOLOGY AND PROCESS DIAGRAM

9.1 DESIGN METHODOLOGY OF THE TRAFFIC LIGHT SYSTEM

At the beginning of the proposed work R1 was on and R2 was on for five minutes each. Then R2 switched off and Y2 became on but R1 continued in the ON state, next G2 was ON but R1 continued. After that, R1 switched off and Y1 became ON for five minutes and simultaneously R2 was on. Finally, G1 was on for ten minutes with R2. After this cycle the process repeated itself.

SEQUENCE	NORTH SIDE SIGNAL	STATUS	TIME(SEC)	EAST SIDE SIGNAL	STATUS	TIME(SEC)
1	R1	OK	5	R2	OK	5
2	R1	OK	5	Y2	OK	5
3	R1	OK	10	G2	OK	10
4	G1	OK	5	R2	OK	5
5	Y1	OK	10	R2	OK	10

Table-1: Input for Traffic Light stimulation.

9.2 PROCESS DIAGRAM

There are two roads respectively in the north and east direction. The north side road has signals R1,G1,Y1 and the east direction road are R2,G2,Y2. At the first instant the red signal on the north side road glows for five minutes and the red signal on the east side road glows for five minutes. After that, the red signal on the north side road continues to glow whereas the east side signal turns to yellow. Next, the red signal on the north side continue to glow but the east side road changes its signal to green but after this point the north side road changes its signal to yellow and red signal glows on the east side road, this continues for five seconds and at last, north side signal becomes green whereas, the east side continue to be red for another ten seconds. After completing this cycle the entire process repeats itself. This function enables you to up count or down count pulses, until a value pre-set in the parameter setting window has been reached. The block function Counter consists of a depend input (CC) (on every occasion the coil is energized, the counter is Incremented or decremented with the aid of using 1 relying on the selected counter direction), a Reset input (RC), a counter direction input (DC) (the block down counts if this enter is activated) and a C output that permits you to recognize what degree is controlled by the counter. When the pre-set value has been reached, this output is going to one till it's miles zeroed or the counting route changes. The counting value and the pre-set value can be visualized.

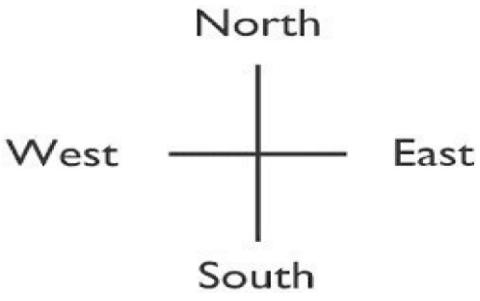


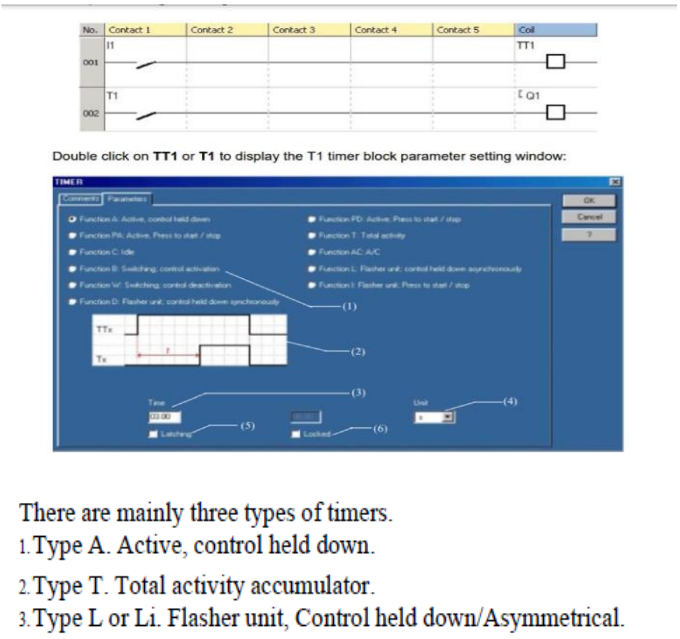
Figure 3: Traffic signal and Directions

10. RESULTS AND DISCUSSION

The topmost circuit acts as the master circuit in the figure. It can be used to start and stop the traffic light mechanism. The memory bit that is latched in the first circuit acts as the input in the second circuit. The timer t5 (NC) is fed parallel and t1 (NC) is used in the input with the memory bit M2. The second rail uses the same method and t2(NC)is used with M3. The third rail uses the same method and it connects timer t3 with M4 and output of TT3 in parallel to it. The fourth rail uses t4(NC) with m5 and the fifth rail uses t5(NC) with m6. The previous timer is used as the input (Normally open contact) in the next ladder of the circuit. In the memory bit M2,M3,M4 R1 is common so M2,M3,M4 in parallel in connected to the output Q1.In the memory bit M2,M5,M6 R2 is common so they are in parallel to each other connected to the output Q2.The memory bit M6 is connected to Q5(Y1).The memory bit M5 is connected to Q3(G1).The memory bit M4 is connected to Q6(Y2).The memory bit M3 is connected to Q4(G2).

10.1 TIMERS

The Timer function block is used to delay, prolong and control actions during a set period of time.



There are mainly three types of timers.

1. Type A. Active, control held down.
2. Type T. Total activity accumulator.
3. Type L or Li. Flasher unit, Control held down/Asymmetrical.

Figure -4: Timer Diagram

10.2 COUNTER

This function enables you to up count or down count pulses, until a value pre-set in the parameter setting window has been reached. The block function Counter contains a count input (CC) (each time the coil is energized, the counter is incremented or decremented by 1 depending on the chosen counter direction), a Reset input (RC), a counter direction input (DC) (the block down counts if this input is activated) and a C output that enables you to know what level is controlled by the counter. When the pre-set value has been reached, this output goes to 1 until it is zeroed or the counting direction changes. The counting value and the pre-set value can be visualized.

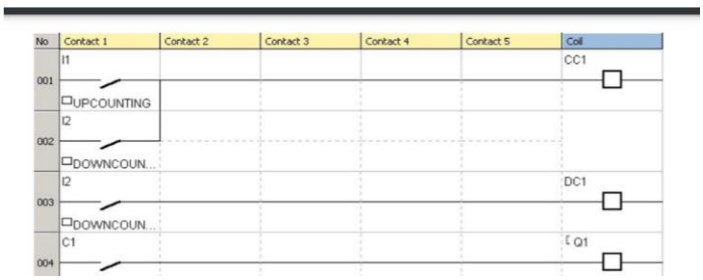


Figure-5: Diagram of Counter

The parameter window is as follows:

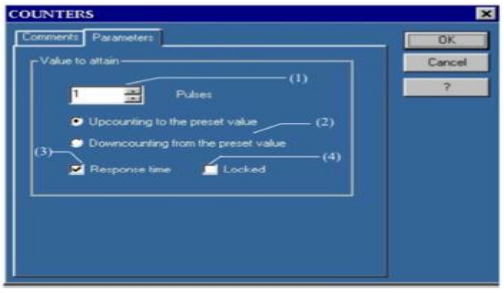


Figure-6: The Parameter window

With Timers, counters and memory bits in change, the system you have read about produces full cycles of traffic signal operation for both the east and north roads. The outcomes are summarized as follows: operation of traffic signals where the north and east road's traffic lights follow a coordinated cycle. The north road begins with a red light and remains that way while the east road alternates between red, yellow, and green. The east route remains red and the north road turns yellow and green. East road: when the north road changes its lights, the east road's light changes from red to yellow to green to red again. Utilizing counters and timers, the timers regulate how long each light (Red, Yellow, Green) remains on. After the predetermined amount of time, the counters assist in transitioning the signal from one state to another by counting the cycles or pulses. The mechanism of control is the master circuit makes sure that everything is coordinated and that the lights change in the right order. The memory bits M2, M3, etc. function in tandem with timers to guarantee proper signal switching by storing the current states of each signal. Memory bits and timers that correspond to each signal R1, G1 and Y1 for the north and R2, G2, and Y2 for the east govern its operation. At the end Repeat Cycles follow the completion of the entire signal sequence with the north and east moving through their corresponding red, yellow and green lights, the system-controlled cycle repeats again and again.

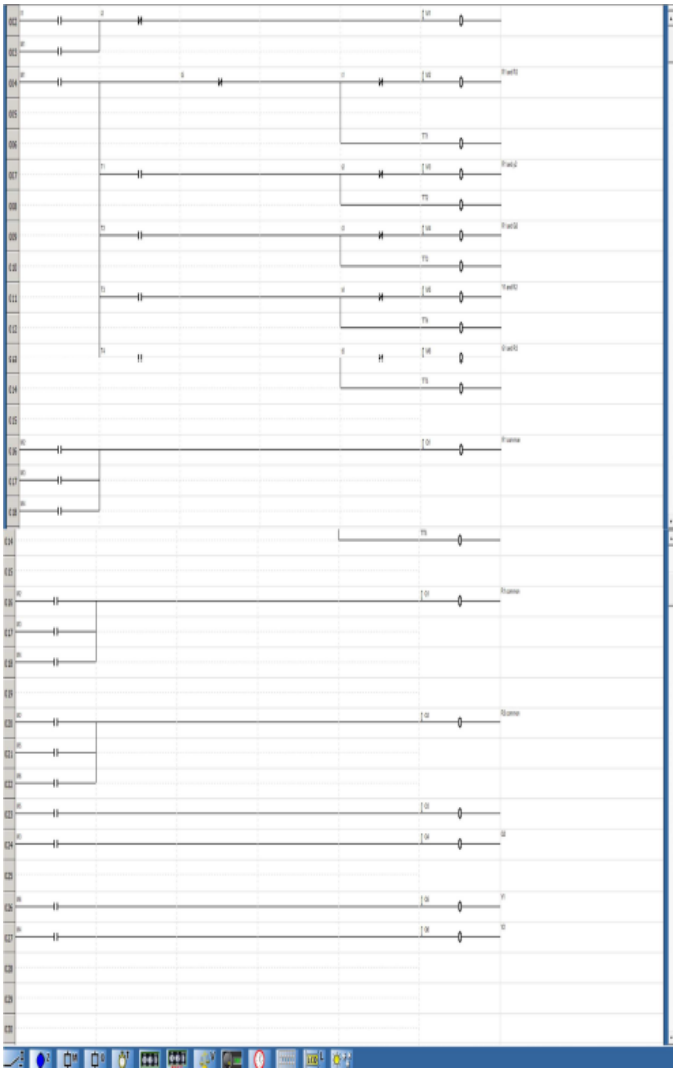


Figure 7: Figure of the ladder logic diagram

11. CONCLUSIONS

Automation has become one of the most essential and required technologies in the modern world. In today's competitive world, accuracy in production and delivery has become very important to stay in profit. The complex operations which cost a lot of manual labor can be achieved by using electromechanical relays. In this project we have used the concept of using electromechanical relays as Dol starters and further implemented it to achieve a parallel output at various time inputs. Timers and counters were implemented which made the project according to the requirement of a practical situation. In this proposed work, experimental results and graphical representation have proved with easy to understand, flexibility, less memory consumption and portability which have been claimed earlier. In future work, the proposed work can be further extended to achieve more accuracy and efficient control using SCADA based implementation with proximity sensors.

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