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Development of a traffic light system controlling and monitoring through PLC and SCADA

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ABSTRACT

This project is divided into two parts hardware as well as software. The hardware part for this project is a model of four way junction of a traffic light. Each lane has two limits switch (input) functions a sensor. Three indicator lamps with different colours (Red, Yellow and Green) are installed at each lane for representing as traffic light signal. This limiting switches and indicator lamps are connected to PLC of Allen Bradley micrologix 1000. The software part operated in RSLogix, RSLinx and RSLogix Emulate. With using these softwares, the ladder logic diagram is programmed to control the traffic light. At the end of this project, the traffic light successfully control by PLC. Supervisory control and data acquisition (SCADA) is a control system architecture that uses computers, networked data communications and graphical user interfaces for high-level process supervisory management, but here in this project we use other peripheral devices such as programmable logic controllers. Supervisory and Data Acquisition System is used for both for controlling and monitoring purpuses.
Keywords: Traffic light control, Rockwell software, SCADA, and, controlling and monitoring

I. INTRODUCTION

Ever since Roman times, society has tried to control traffic on road. Even the fabled Roman road system created a conflict between pedestrian as well as equine travelers. However, a practical solution was not developed until 1850s when J. P. Knight, a railway signaling engineer, created the first traffic light signal, which was installed near Westminster Abbey in London, England in 1868. Unluckily, the device exploded, killing a police officer, and its use was discontinued after being in operation for only a short time.

The modern traffic light was invented in the United State of America. New York had a three colour system in 1918 which was normally operated manually from a tower in the middle of the street. Other cities soon adopted the idea of having someone on the scene to control the lights. Garrett Morgan who invented the gas mask, also developed traffic signaling devices. Having witnessed an accident between a car and a carriage, Morgan felt compelled to devise a system to obviate such collisions at intersections of street.

In 1923 he patented an electric traffic light system using a pole with a cross section on which the words STOP and GO were marked on it. These basic designs were soon improved.

In 1926 the first automatic signals were installed in London; they usually depended on a timer to activate them. In the 1930s vehicle activated lights were created in which cars rolled over half-buried rubber tubes.

Air in the tubes was displaced by the weight of the car rolling over them, and the increased pressure operated an electric contact which activating the lights. But these tubes wore out quickly.

A better idea was the inductive-loop device: a loop of wire was imbedded itself in the road and connected to a box controlling the lights; a current of electricity passed through the loop, and when the steel body of a car passed overhead, it normally produced a signal that activated the light.

Today, traffic jam on road is automatically routed onto limited access highways courtesy of a computer activated guidance system that determines traffic volume on the highway. Nowadays due to advancement of technology Global positioning satellite systems (GPS) are installed in many cars. These systems connect with a satellite and use to guide drivers about his current location and possible routes to their destination.

Such systems will ultimately enable a drive to determine the best route to a destination given prevailing traffic conditions. Problems occur in the monitoring and control of city traffic light is becoming a prominent problem in many developed countries of the world.

The increasing number of vehicles and the lower phase of highways developments have led to traffic congestion problem especially in major cities. As a result of traffic congestions, travel time, environment quality, life quality, and road safety are all adversely affected.

In addition, delays due to traffic congestions also indirectly affect productivity, efficiency, as well as energy losses. There are many factors that lead to traffic congestion such as the density of vehicles on the roads, human habits, social behaviour, traffic light system and so on. One major factor is due to the traffic lights system that controls the traffic at junction.

Traffic policeman are deployed at traffic intersection every day in order to overcome these congestion during peak hour of the day, but one of the roots of such problem is due to ineffective traffic lights controllers. With effective control the intersection, it is believed that the overall capacity and performance of urban traffic network could be resolve.

There are several types of conventional methods of traffic light control; however they fail to deal effectively with complex and time varying. Currently, two types of traffic light control are basically installed in many parts of the world: the pre-set cycle time (PCT) and vehicle actuated (VA).

Due the deployment of a large number of traffic police in the city during peak hours, it is evident that these types of traffic lights controllers are not enough in number. There is a need to research on new types of effective practical traffic light controllers.

In this paper, a new development of a traffic light control system controlled by PLC and SCADA. This system will decreased the traffic jam at traffic light by extend the time for the green signal if traffic density at that lane are high and give the priority to who first arrive at the junction.

The monitoring and control of city traffic light is becoming a major problem in many countries. The increasing number of vehicles and the lower phase of highways developments have led to traffic congestion problem especially in major cities mainly developed ones. Due to traffic congestions productivity, efficiency, and energy losses are also affected indirectly.

There are many factors that lead to traffic issues such as the density of vehicles on the roads, human habits, social behaviour, and traffic light system. One major factor is due to the traffic lights system that controls the traffic at junction. One of the main roots of the problem is due to ineffective traffic lights controllers.

II. METHODS AND MATERIAL

A. PLC software

A programmable logic controller (PLC) is an industrial computer used to control and automate complex systems. PLCs are a relatively recent development in process control technology. It is designed for use in an industrial environment, which uses a programmable memory for the integral storage of user-oriented instructions for implementing specific functions such as logic, sequencing, timing, counting, and arithmetic to control through digital or analog inputs and outputs, various types of machines or processes.

PLCs are used throughout industry to control and monitor a wide range of machines, other movable components and systems. PLC is used to monitor input signals from a variety of input points (input sensors) which report events and conditions occurring in a controlled process.

Programmable logic controllers are typically found in factory type settings. PLCs are used to control robots, assembly lines and various other applications that require a large amount of data monitoring and control.

Typical PLC controller employs a backplane to serve as the communications bus for interconnecting the PLC processor with the array of individual input/output devices with which the processor interacts in terms of receiving input data for use in executing the control program and transmitting control data for controlling the targeted objects.

A PLC includes a rack into which a plurality of input/output cards may be placed. A rack includes several slots into which these input/output cards are placed.

Each input/output card has a plurality of I/O points. The I/O modules are typically pluggable into respective slots located on a backplane board in the hardware of PLC. An I/O bus couples the cards in the slots back to the processor of the programmable logic controller. The slots are coupled together by a main bus which couples any I/O modules plugged into the slots to a central processing unit (CPU).

The CPU itself can be placed on a card which is pluggable into a dedicated slot on the backplane of the PLC. The particular processor used in a PLC together with the particular choice of input and output cards installed in the PLC rack are often referred to as the hardware configuration of the programmable logic controller.

The hardware configuration also includes the particular addresses for the I/O cards. Each option module typically has a plurality of input/output points.

The option modules are coupled through an interface bus to a main controller having a microprocessor executing a user program. Option modules may include a microprocessor and a memory containing separate user programs and data directed to a particular operation of the PLC system.

During the execution of a stored control program, the PLC's read inputs from the controlled process and provide outputs to the controlled process as per the logic of the control program. The outputs typically provide analog or binary voltages or "contacts" implemented by solid state switching devices.

PLC's are normally constructed in modular fashion to allow them to be easily reconfigured to meet the demands of the particular process being controlled.

There are some common components present in each of the PLCs. These components are as below:

Power Supply: This module can be built into the PLC processor module or be an external unit. Common voltage levels required for an operation of the PLC are 5V dc, 24V dc or 220V ac. The voltage lends are stabilized and often the monitors its own health.

Processor: This is the main computing module where ladder logic and other application programs are stored and processed.

Input/Output (I/O): A number of input/output modules must be provided so that the PLC can monitor the process and initiate control actions which specified in the application control programs. Depending on the size of the PLC systems the input-output subsystem can either span across several cards or even be integrated on the processor module. Some of there input/output cards generates/accept TTL level, clean signals. Output 'modules' provide necessary power to the signals. Input 'modules' converts voltage levels, cleans up RF noise and isolates it from common mode voltages. I/O modules may also prevent over voltages to reach the CPU or low level TTL.

Indicator lights: These indicate the status of the PLC including power on, program running, a fault and etc. These are essential when diagnosing problems.

Rack, Slot, Backplane: These parts of the PLC physically house and connect the electronic components used in PLC.

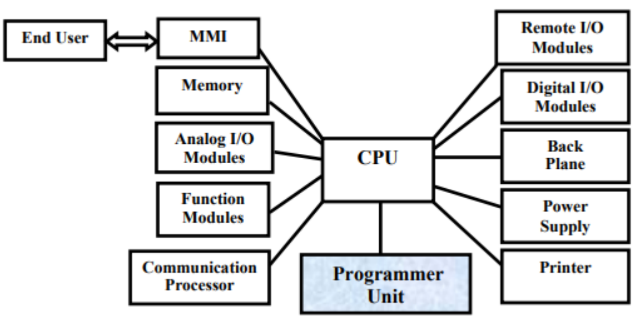

Figure 1. Typical Subsystems for a PLC system

In this project MicroLogix 1000 programmable controller is used. This employs a packaged controller containing a power supply, input circuits, output circuits, and a processor. The controller is available in 10 I/O, 16 I/O and 32 I/O configurations, as well as an analog version with 20 discrete I/O and 5 analog I/O.

B. SCADA software: Wonderware InTouch.

Supervisory control and data acquisition (**SCADA**) is a control system architecture that uses computers, networked data communications and graphical user interfaces for high-level process supervisory management, but use of other peripheral devices such as programmable logic controllers and discrete PID controllers to interface to the process plant or machinery.

SCADA can be defined as a collection of equipment that will provide an operator at remote location with enough information to determine the status of a particular piece of an equipment or entire substation and cause actions to take place regarding the equipment or network.

Wonderware InTouch is used in this project which is the world's number one Human Machine Interface (HMI) for over more than couple of decades and offers legendary ease of use, market leading innovation, unequalled investment protection, brilliant graphics, unsurpassed connectivity, the industry's best support and the broadest partner ecosystem.

The award-winning HMI software is an open and extensible Supervisory HMI and SCADA solution that enables the rapid creation of standardized, reusable visualization applications and deployment across an entire enterprise without having to leave the office. Used in over one-third of the world's industrial facilities, InTouch software continues to deliver business value in engineering simplicity, operational agility and real-time performance mastery. This helps drive maximum performance, increased agility, lowered costs, additional security and reduced risk.

WonderwareInTouch delivers truly transformational value. By improving real-time visibility into your processes, InTouch greatly improves operator effectiveness and increases control of your processes to simplify and enforce standardization and change management.

InTouch delivers a breakthrough in advanced engineering tools, delivering faster time to value, more effective HMI design, better trouble shooting, ease of application maintenance and many more.

InTouch includes numerous new visual enhancements to improve the ability to identify and address abnormal situations before they impact operations.

The powerful tools in InTouch go beyond the simplistic graphics provided by other vendors and enable application builders to focus on creating valuable content and to easily assemble effective HMI applications for simplicity, agility and performance.

While InTouch gives you the most powerful graphics tool available in any HMI, InTouch also makes it unbelievably easy to implement and encourage best practices to bring clarity, consistency and meaning to integrated data.
With Wonderware InTouch, both experienced and entry-level operators are more easily able to identify, understand, react to and resolve an abnormal situation,

This also provides a unique solution to the industry wide challenge of a retuning workforce. The world's favourite HMI is also fully mobile - casual and remote web HMI and Mobile SCADA users can now view and control real-time plant floor operations data using a secure web browser from just about any "Smart" device such as tablets and smartphones.

The unique features of Wonderware InTouch deliver highly contextualized and interpretive visual content and the most effective HMI applications and user interfaces for standardization, consistency, situational awareness and abnormal situation management. InTouch supports Microsoft integrated security, Active Directory and Smart Card technology. Within regulated and validated industries

III. RESULTS AND DISCUSSION

The four ways junction is developed to display simulation of development of the new traffic light control system. Figure 2 show the design of traffic light model.

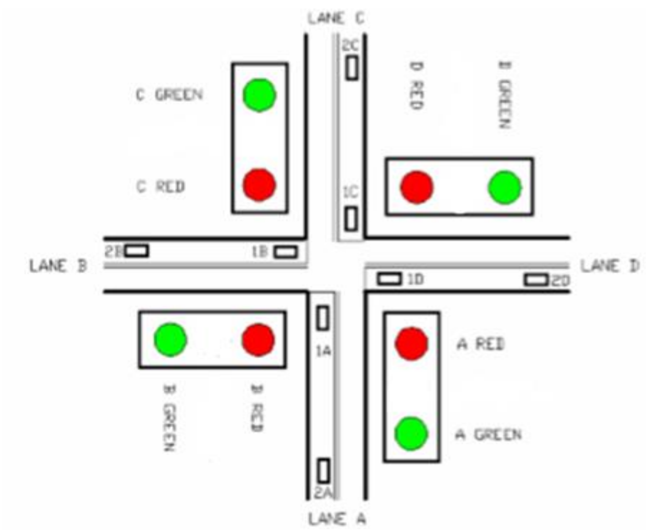

Figure 2. Four way junction

Every lane and traffic light signals have been labelled with alphabet A, B, C and D to separate each land traffic light. Each traffic light lane has their set of traffic light signal "Red and Green". This traffic light signal operates similar like common traffic light signal.

It changes from red to green and then yellow and after that back to red signal. The suitable sensor for design a real traffic light system is type of linear sensor or electromagnetic sensor.

The four ways traffic light model is constructed to display how this traffic light control system is running. This traffic light model has a complete set of traffic light signal which are red, yellow and green as a traffic signal for each lane.

Each lane also has two limiting switches represent as a sensor on the road. The first sensor placed in front of the lane to detect the presence of a car at the junction. And the second sensor placed at certain length from first sensor to determine the volume of car at that lane.

The right connection between PLC and traffic light model is vital because it can avoid problem or conflict when the program is transferred to PLC.

A ladder logic diagram programming is used to control the traffic light and Continuous monitoring as well as frequent acquisition of data can be got through SCADA system. Combine the software part and the hardware part to simulate a traffic light system.

IV.CONCLUSION

This method will help reduce congestion on roads and would help in coping with accidents as the heavy vehicles and light vehicles will be in different lanes. Resultantly, a solution to a much critical problem of traffic congestion and fatal accidents is possible using this system. Thus a given system would make our roads a safer place to travel.

In this method main focus is to reduce the heavy traffic and congestion on the road by using PLC and SCADA based traffic diversion system. This would work on weight sensing using sensors whose output will be fed to a PLC, which will control the traffic diversion.

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