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PLC And SCADA Based Emergency Route Clearance Request for Traffic Signalling Application

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Abstract:

A route-based signal pre-emption strategy is developed to provide the most efficient and safe route for an emergency vehicle under a given network and traffic conditions. Emergency vehicles, such as ambulances, fire engines, police cars, engineering rescue vehicles, are one very important rescue resources in a city. The management and control strategy for emergency vehicle operations holds a significant position in the transportation management system, especially in a big city with complex traffic networks.

The key issue is to clear or opportunely manage the traffic on the route such that the emergency vehicle passes as soon as possible, thus ensuring that it safely and rapidly reach the destination. Based on the route-based philosophy, this project aims at developing a signal priority control strategy for emergency vehicle operation such as an ambulance in urban roads. To satisfy the safety standards set for roadway-signalling systems, PLC and SCADA based Emergency Route clearance request for traffic signalling application is designed, using formal methods on a scale road model.

Keywords:

Roadway Signalling, Emergencyvehicles, PLC, SCADA.

Introduction:

On 9 December 1868, the first non-electric, gas lit, traffic lights were installed outside the British Houses of Parliament in London to control the traffic in Bridge Street, Great George Street and Parliament Street.

They were promoted by the railway engineer J. P. Knight and constructed by the railway signal engineers of Saxby & Farmer. The design combined three semaphore arms with red and green gas lamps for night-time use, on a pillar, operated by a police constable. The gas lantern was manually turned by a traffic police officer, with a lever at its base so that the appropriate light faced traffic.The first electric traffic light was developed in 1912 by Lester Wire, an American policeman of Salt Lake City, Utah, who also used red-green lights. On 5 August 1914, the American Traffic Signal Company installed a traffic signal system on the corner of East 105th Street and Euclid Avenue in Cleveland, Ohio. It had two colours, red and green, and a buzzer, based on the design of James Hoge, to provide a warning for colour changes. The design by James Hoge allowed police and fire stations to control the signals in case of emergency. The first four-way, three-color traffic light was created by police officer William Potts in Detroit, Michigan in 1920.

Toronto, Ontario was the first city to computerize its entire traffic signal system, which it accomplished in 1963. Countdown timers on traffic lights were introduced in the 1990s. Timers are useful for pedestrians, to plan if there is enough time to attempt to cross the intersection before the end of the walk phase, and for drivers, to know amount of time before the light turns green. In the United States, timers for vehicle traffic are prohibited, and pedestrian timers are now required on new or upgraded signals on wider roadways.In the manual traffic controlling system we need more man power. As we have poor strength of traffic police we cannot control traffic manually in all area of a city or town. So we need a better solution to control the traffic. On the other side, automatic traffic controlling a traffic light uses timer for every phase.

As discussed we have problems of traffic jams that cause trouble to the emergency vehicles such as ambulances and other emergency vehicles such as fire engines, bank vehicles and other VIP vehicles, etc. to reach on time. These problems can be reduced to a significant extent if we automate the traffic signal system and implement logics for emergency vehicles. Automatic traffic light is controlled by timers and electrical sensors. In traffic light each phase a constant numerical value loaded in the timer. The lights are automatically getting ON and OFF depending on the timer value changes.

While using electrical sensors it will capture the availability of the emergency vehicle and signals on each phase, depending on the signal, the lights automatically switch ON and OFF.To make it easier for Emergency Vehicles such as ambulances, Fire Fighters to get through the traffic and thereby improve the response times, Signals are fitted with sensors which are capable of overriding the traffic signals in case of emergency, giving Emergency Vehicles priority as shown in figure 1.

This system allows Emergency vehicles to speak to the traffic light as they approach them from a distance. To satisfy the safety standards set for roadway-signalling systems, PLC and SCADA based Emergency Route clearance request for traffic signalling application is designed, using formal methods on a scale road model.

Fig 1. An Ambulance transmitting the signal to the traffic Signal

Fig 2. Led traffic light

Importance of Route Clearance for Emergency Vehicles

Statistics show that nearly half (40%) of fire-fighters killed in the line of duty die in traffic accidents enroute to the scene. In 2000, over 500 deaths occurred in accidents involving emergency vehicles. Emergency vehicles (fire trucks, police cars and ambulances) must pass rapidly through traffic intersections, using sirens and flashing lights to alert other drivers of their passage. Confusion, inattention, mobile phones, car radios, hearing impairment, distracting children, air conditioning, vehicle sound proofing, and failure to see flashing lights cause many serious accidents.

First responders arrive at the scene faster than emergency vehicle pre-emption. Shorter response times for emergency vehicles enable them to arrive at a scene in the initial moments when their key decisions are important. For a fire fighter, arriving a minute sooner may mean being able to stop the spread of a fire. In a medical emergency, saved time may be the difference between life and death, giving medics the opportunity to stabilize and treat a victim.

Emergency vehicle pre-emption increases:

1. The area that emergency vehicles can cover in required response times
2. Safety of emergency vehicle personnel and the public.
3. The speed of responders in reaching a scene.
4. The time available for making critical decisions.

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Emergency vehicle pre-emption and reduces:

1. The cost of replacing emergency vehicles damaged in crashes.
2. The damage to public and private property caused by delayed responses to fires, Chemical spills, and other hazardous events.
3. Fatalities.
4. The legal liability of public agencies when motorists are injured.

Programmable Logic Controllers(PLC):

PLCs (programmable logic controllers) are the control hubs for a wide variety of automated systems and processes. They contain multiple inputs and outputs that use transistors and other circuitry to simulate switches and relays to control equipment. They are programmable via software interfaced via standard computer interfaces and proprietary languages and network options. Available inputs for programmable logic controllers include DC, AC, analog, thermocouple, RTD, frequency or pulse, transistor, and interrupt inputs. Outputs for PLCs include DC, AC, relay, analog, frequency or pulse, transistor, and triac. Programming options for PLCs include front panel, hand held as well as computer. PLCs can also be specified with a number of computer interface options, network specifications and features. In addition to controlling output functions, programmable logic controllers are good for compiling data from many sources and uploading this data into a computer network. PLCs are generally more durable, and less expensive, than computer systems and as a result can be placed in remote or rugged industrial locations, and perform at a high level for many years.

SCADA(Supervisory Control and Data Acquisition):

SCADA stands for Supervisory Control And Data Acquisition. As the name indicates, it is not a full control system, but rather focuses on the supervisory level. As such, it is a purely software package that is positioned on top of hardware to which it is interfaced, in general via Programmable Logic Controllers (PLCs), or other commercial hardware modules. SCADA systems are used not only in industrial processes: e.g. steel making, power generation (conventional and nuclear) and distribution, chemistry, but also in some experimental facilities such as nuclear fusion.

However, SCADA systems evolve rapidly and are now penetrating the market of plants with a number of I/O channels of several 100K SCADA systems used to run on DOS, VMS and UNIX; in recent years all SCADA vendors have moved to NT and some also to Linux.

Implementation of Emergency Route Clearance System on A PLC:

Since the hardware and software requirements should besatisfied according to defined safety standards in the implementationphase, on the hardware side, fail-safe programmablelogic controllers are used. Therefore, a CoDeSys based model fail-safe programmable logic controller was used in thisstudy. In the fail-safe programming, it is allowed to use only alimited set of programmable-logic-controller commands. Userdefined data types, or other complex data types, such as REAL,ARRAY, BYTE, are also mpy allowed to be used in the fail-safeprogram. Only basic data types, such as WORD, INT, BOOL, andTIME are allowed to be used.

The fail-safe programmablelogic-controller program can be written only in ladder-diagram(LD) or function-block-diagram (FBD) languages. All of theselimitations lead to difficulty in programming. However, with allthese precautions, safe operation is guaranteed.It is easy to implement the design of emergency route clearance on the programmable logic controller using the basic logical expressions and the SCADA screens are given in the figure below.

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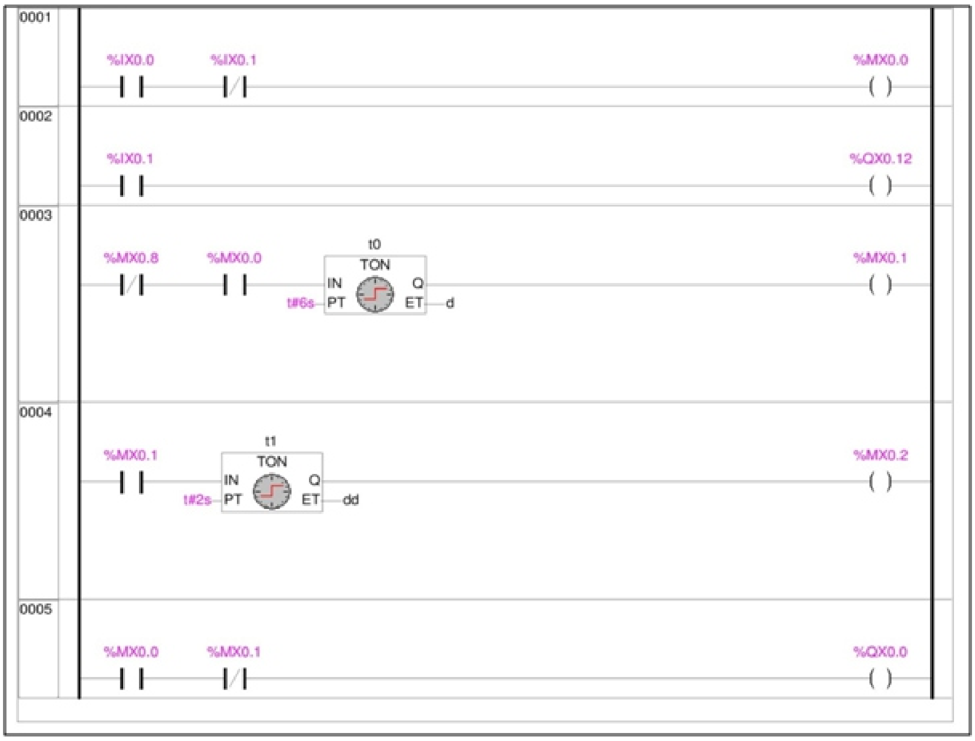

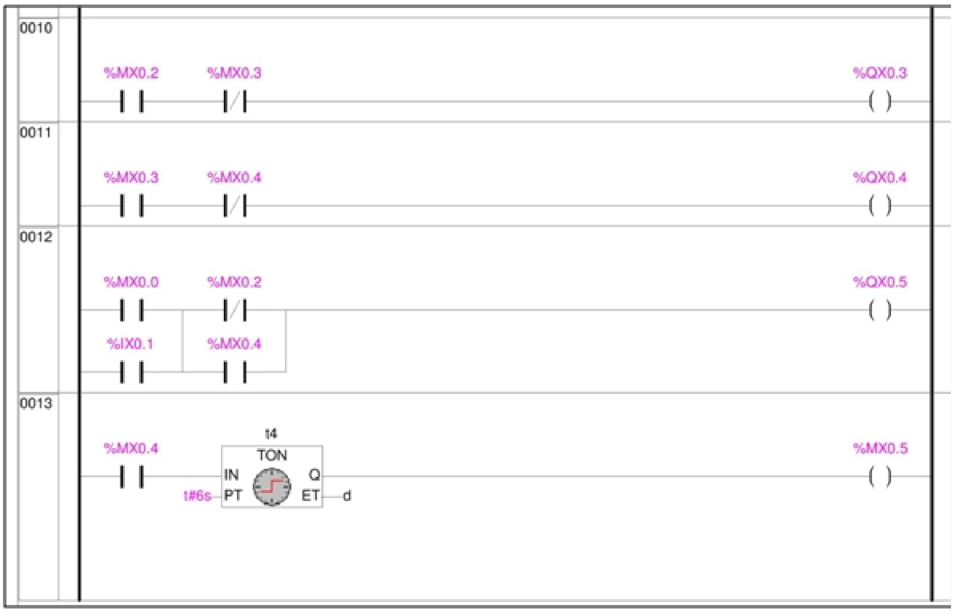

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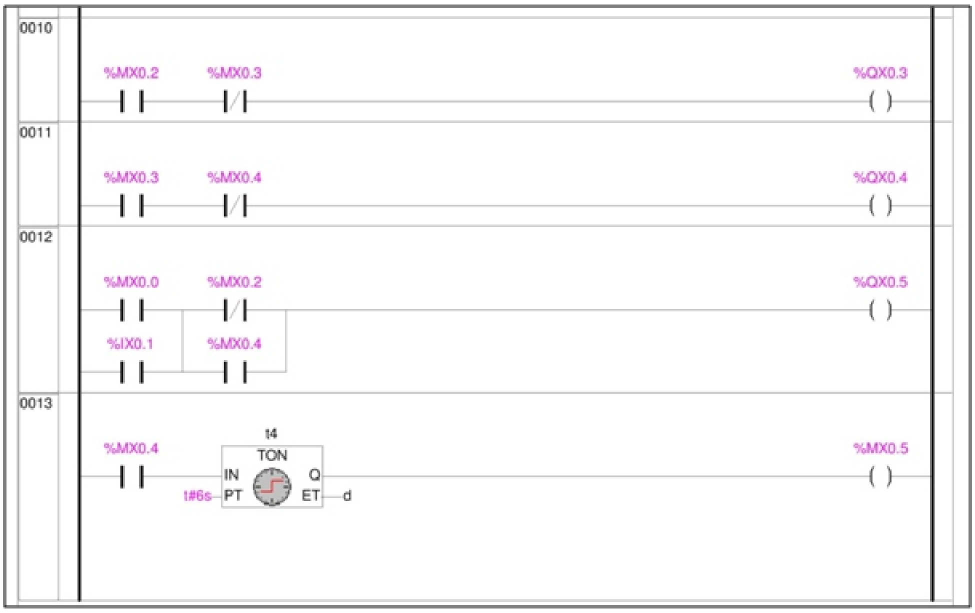

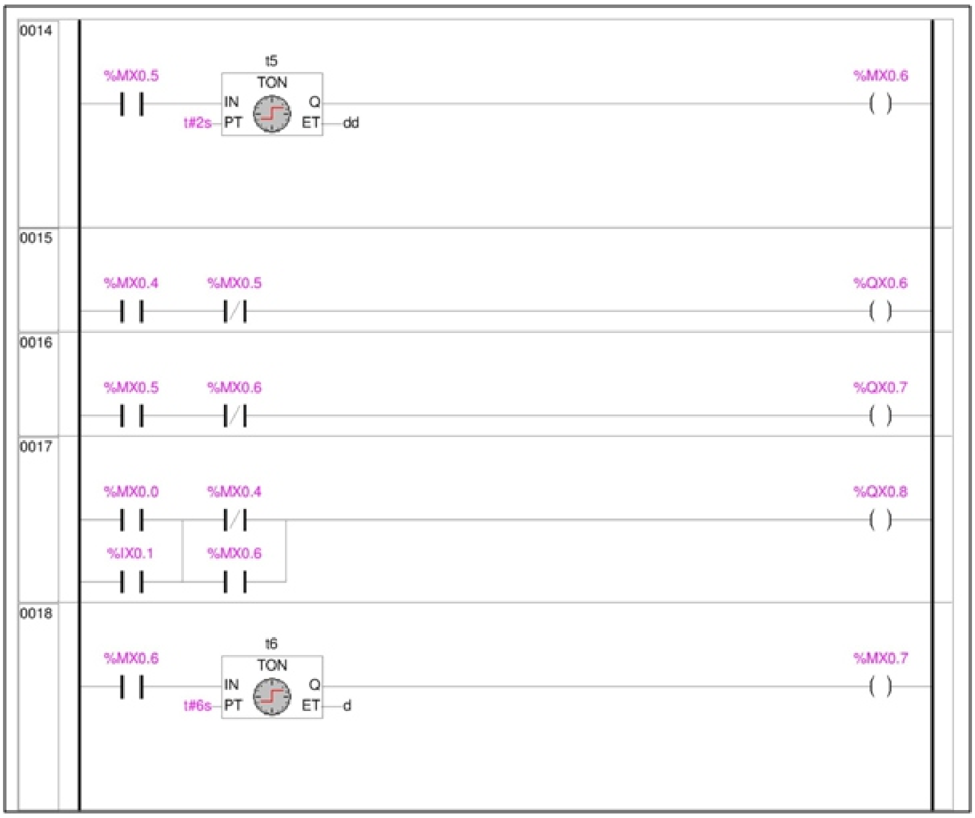

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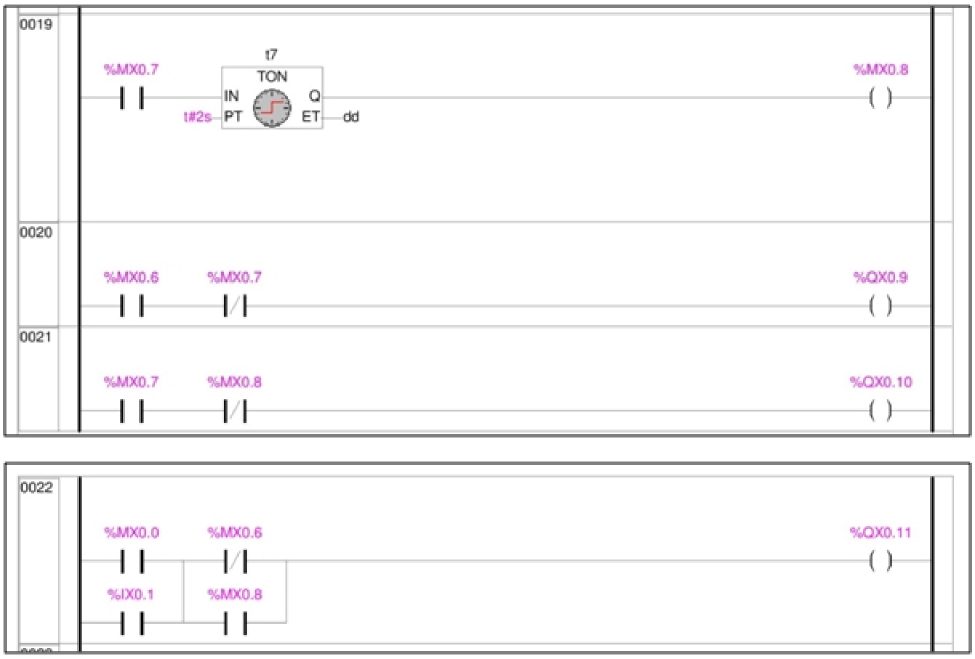
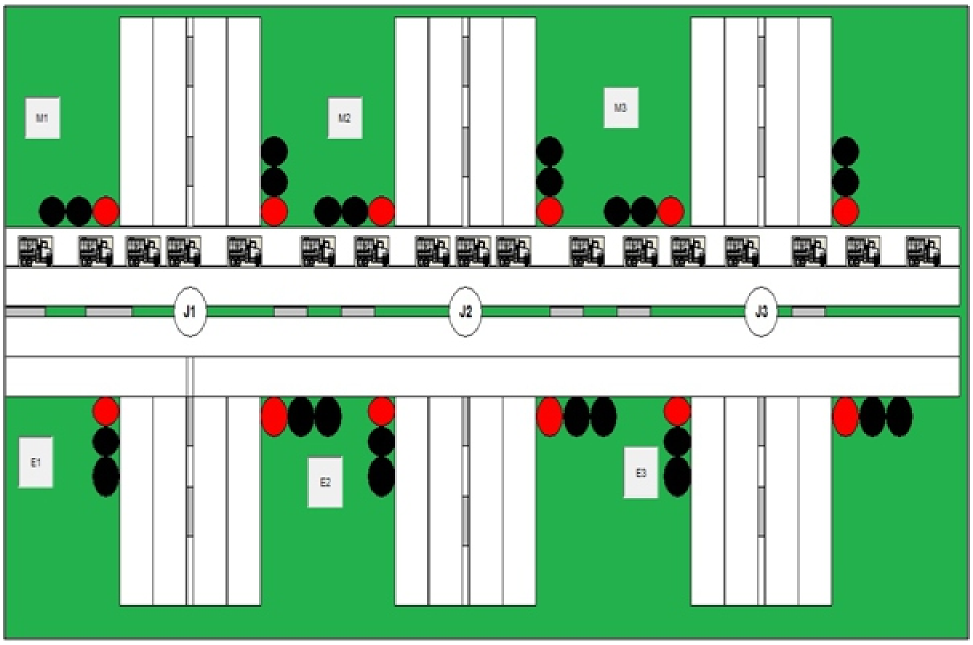


PLC Coding in CoDeSys Software



SCADA Screen in CoDeSys Software

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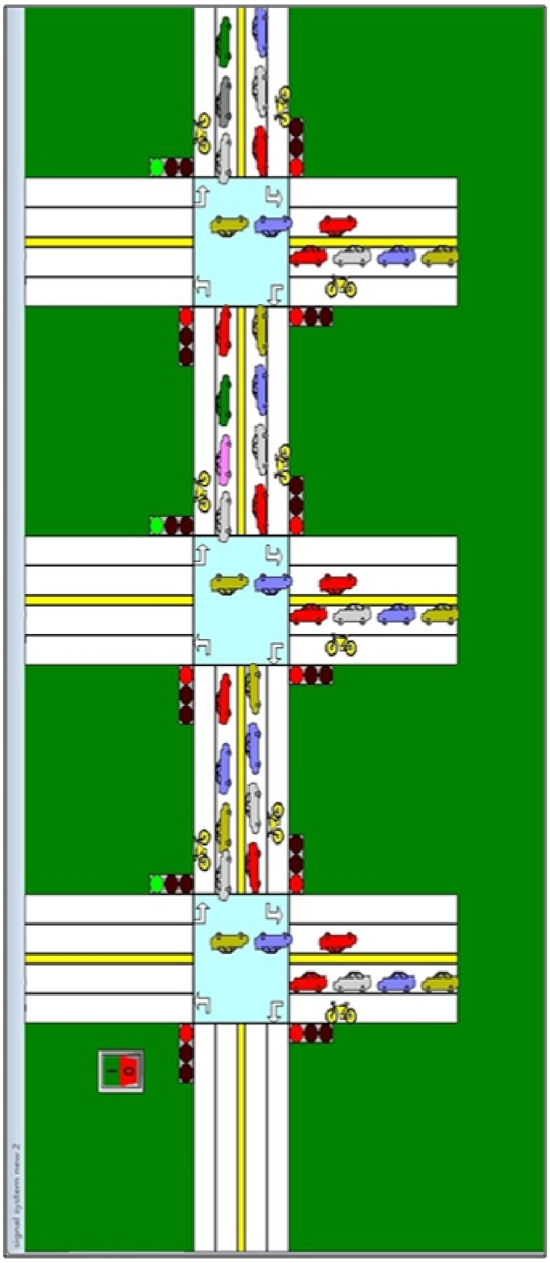

SCADA Screen 1 in Wonderware InTouch Software

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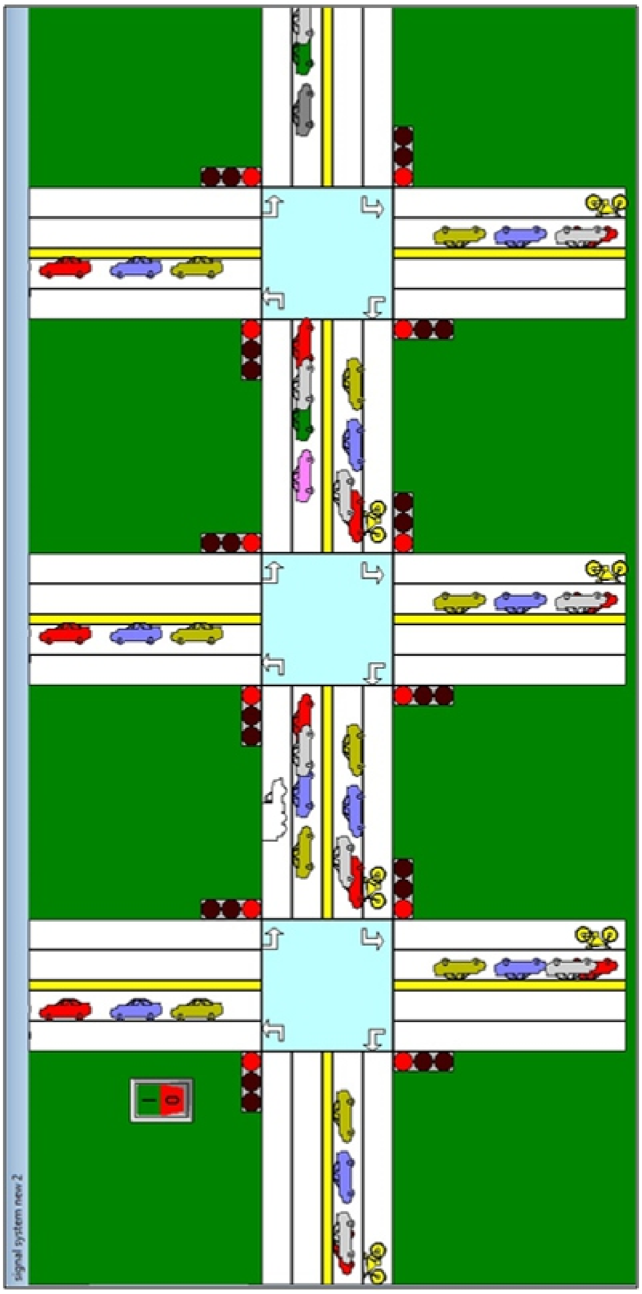

SCADA Screen 2 in Wonderware InTouch Software

Conclusion:

A detailed model of PLC and SCADA based Emergency Route clearance request for traffic signalling application is designed. A control system based on Ladder Logic technique which clears the route for Emergency vehicles on a busy road has been presented. The simulation shows that the Emergency route clearance and the traffic controlling signals are automated.

From the simulation results, it is also shown that the emergency route clearance using ladder logic technique compensates the time and provides excellent traffic regulation. The monitoring system provides the operator to monitor and control the traffic without any difficulties under emergency situations.The main advantage of the automated systems is that it is highly efficient and its control is simple. This system is high cost but the cost can be compensated in future as it is one time investment.

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