Automation of Railway Signaling using PLC and SCADA

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Abstract— Railway is the lifeline of India. Presently in the real time world, commuters are using different types of transport facilities such as flights, trains, buses, cars etc. But majority of the public in our country prefer traveling in trains. The reason may be the comforts available for long journeys and relatively lesser travelling charges. Though the railways has implemented many safety standards for the safe journey, still one can witness some rail accidents that leads to the loss of many precious lives and loss of property. The major causes for accidents in rail road railings are mainly due to unmanned railway gate, mis-signaling due to fog and mist, and manually controlled railway track. This project is to provide an efficient alternative to many conventional techniques used by the railways in order to decrease accident occurrence incorporating manual operations.

Key words: PLC, SCADA, Automation, Railway Signaling

I. INTRODUCTION

Now a days, India is the country which having world's largest railway network. Over hundreds of railways running on track every day. As we know that it is definitely impossible to stop the running train at immediate is some critical situation or emergency arises. Train accidents having serious consequence in terms of loss of human life, injury, damage to Railway property. Railway safety is a crucial aspect of rail operation over the world. Railways being the cheapest mode of transportation are preferred over all the other means. There were many developments in railway system in the recent years. But always the current system have many disadvantages mainly due to the use of mechanical relay system. For this purpose we choose Programmable Logic Controller. A Programmable Logic Controller, PLC or Programmable Controller is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. PLCs are used in many industries and machines. For graphical view and easy analysis of our project, Supervisory Control And Data Acquisition (SCADA) is used. It will be easier for the operator in the control room for understanding the status of railway system. SCADA can also provide manual operations in situations where this system fails. The SCADA is a (hopefully) small rugged computer, which provides intelligence in the field, and allows the central SCADA master to communicate with the field instruments. It is a stand-alone data acquisition and control unit. Its function is to control process equipment at the remote site, acquire data from the equipment, and transfer the data back to the central SCADA system. By interfacing PLC Programming with SCADA, Train's location can be easily identified, gate control and the signals can be controlled. The communication between consecutive stations can also be controlled using this system.

II. EXISTING SYSTEM

Route Relay Interlocking (RRI) is the system used in the Indian Railways. An RRI cabin is there. RRI cabin is the central control room of the station. It consists of a panel called RRI, which gives complete layout about all the signals, field instruments, tracks etc inside the station boundary(which is extended about 1.5 Km apart from platform to both sides).All these are controlled within the panel through cables. All indications in the panel are indicated by using LEDs. Whole section of railway track is subdivided into many parts. And all these parts are connected separately to each track relay circuit. Main purpose of this circuit is the detection of the accurate movement of train. Depending upon the movement of train, when the train comes in contact with the track, the relay circuit will generate a signal. This signal will be send to the RRI panel through cables. In the panel we can see this movement by the change of LED from yellow to red. All the signals in the track is controlled by switching respective knobs in the panel. All the railway gates under the railway section is also controlled by this panel. ie, from panel, always a signal will send to the gate-keeper in order alert the coming of a train by adjusting a knob for the gate control in the panel.

A. Demerits:

Relay based system has: Low reliability due to electro-mechanical components, Complex and tedious wiring, Higher maintenance and modification cost, Higher down time, Occupies larger space, No support for Batch Processing.

III. OVERVIEW OF PLC AND SCADA

A. Programmable Logic Controller

A digitally operating electronic apparatus which uses a programmable memory for the internal storage of instructions for the implementing specific function such as logic, sequencing, timing, counting and arithmetic to control through digital or analog input/output modules various types of machines or processes. The programmable controller offers solid-state reliability, lower power consumption and ease of expandability. Overall a Programmable Logic Controller is a mini computer specifically designed for industrial and other applications. Examples are

- Hydraulic machines
- Robots
- Production processes
- Packaging Lines.
- Traffic Lights and signaling systems.

The bigger the process the more of a need we have for a PLC. We can simply program the PLC to count its inputs and turn the Outputs on for the specified time.

The PLC activates its output terminals in order to switch things on or off. The decision to activate an output is

based on the status of the system's feed-back sensors and these are connected to the input terminals of the PLC. The decisions are based on logic programs stored in the RAM and/or ROM memory. They have a central processing unit (CPU), data bus and address bus. Basis of a PLC function is continual scanning of a program A typical unitary PLC is shown below.

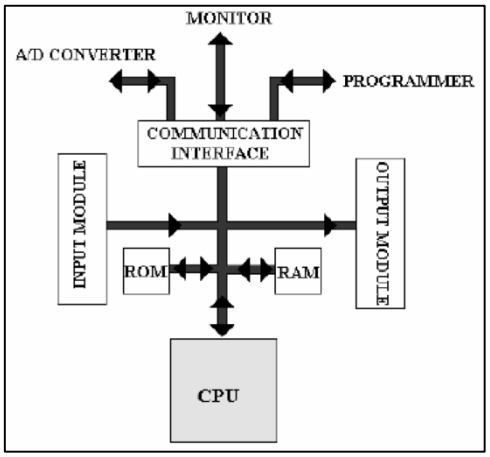

Fig. 2: PLC Architecture

B. SCADA - Wonerware Intouch

A SCADA system consists of a number of components.

- The central SCADA master system.
- A communications network.
- The RTU's. Remote Telemetry (or Terminal) Units.
- Field instrumentation.

The SCADA RTU is a (hopefully) small rugged computer, which provides intelligence in the field, and allows the central SCADA master to communicate with the field instruments. It is a stand-alone data acquisition and control unit. Its function is to control process equipment at the remote site, acquire data from the equipment, and transfer the data back to the central SCADA system. There are two basic types of RTU - the "single board RTU" which is compact, and contains all I/O on a single board, and the "modular RTU" which has a separate CPU module, and can have other modules added, normally by plugging into a common "backplane" (a bit like a PC motherboard and plug in peripheral cards). The single board RTU normally has fixed I/O e.g. 16 digital inputs, 8 digital outputs, 8 analogue inputs, and say 4 analogue outputs. It is normally not possible to expand its capability. The modular RTU is designed to be expanded by adding additional modules. Typical modules may be a 8 analog in module, a 8 digital out module.

IV. PROPOSED SYSTEM

PLC is used as a main tool for controlling the signals of the train and taking appropriate actions. Programmable Logic Controller is used for gate control and also for track changing. SCADA is used for monitoring the signals and collecting the data of PLC.

The below architecture shows the control of railway system using PLC. Here each and every components is connected in such a way to communicate and to do control function of all the components. By having a monitoring area all the process can be monitored at a single place. PLC is placed in central because it does all the functions according to the sensor inputs. The signal from the vibration sensor will play a major role in complete process, as an initial state the signal is sent to PLC then it produces the output based on our ladder program, then it is fed to the corresponding drivers. That is, either to track controller, Signal controller or to the stepper motor. As a monitoring area we will have some display arrangement to monitor complete process. Here signal to the monitoring area will be taken from the PLC. To monitor the process Supervisory Control and Data Acquisition (SCADA) is used.

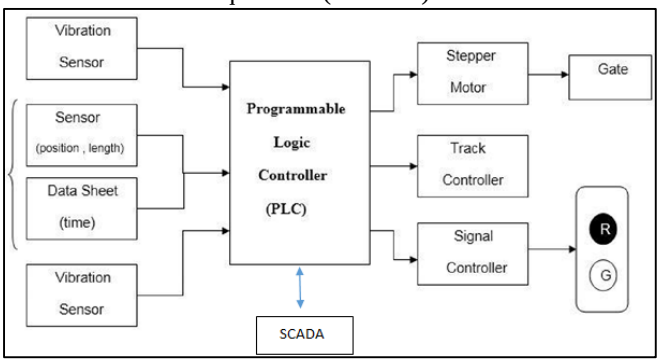

Fig. 3: Block Diagram

A. Stages:

There are mainly four stages in our project.

- PLC PROGRAMME
- SCADA
- HARDWARE INTERFACING

B. Stage 1: PLC Programme

PLC is a device which can control the output devices depending on the developed program and the input devices. To get maximum efficiency from machine and control them with human logic to reduce complex circuitry of entire system. To eliminate the high costs associated with inflexible, relay-controlled systems. Ladder Logic Programming language used to represent electrical sequences of operations. PLC is designed to provide flexibility in control based programming. RSLogix 500 is the software used for our simulation. This is easy to construct and provides faster results.

PLC defines as "a digitally operating electronic apparatus which uses a programmable memory for the internal storage of instructions for implementing specific functions such as logic, timing, counting and arithmetic, sequencing to control through digital or analog input/output modules, various types of machines or processor".

1) Advantages of PLC:

- Ø Programming a PLC is easier than wiring the relay control panel.
- Ø PLC can be reprogrammed. Conventional controls must be rewired and are often scrapped instead.
- Ø PLC takes less floor space then relay control panels.
- Ø A PLC has facility for extensive input/output arrangements.
- Ø Maintenance of the PLC is easier, and reliability is greater.
- Ø PLC can be connected to the plant computer systems more easily than a relay.
- Ø PLC has very few hardware failures compared to electromechanical relay.

2) PLC Ladder Diagram

PLC ladder diagram plays an important role here without it no function is possible. Here PLC diagram means the program for the PLC which is stored in it to do the function according to the diagram. Ladder diagram for all the sensors and signals shown in the Track Layout has been drawn.

PLC Programming has been done in RSLogix5000. The ladder diagrams were drawn by dividing the entire track layout into three sections. Each section has a signal part and a track point part.

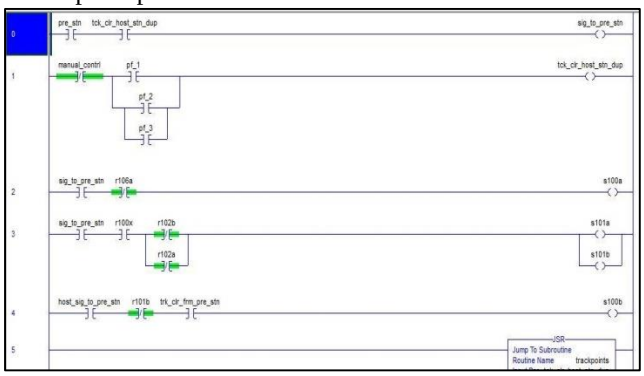

Fig. 4: PLC ladder diagram

C. Stage 2: SCADA

The Supervisory Control and Data Acquisition (SCADA) is a small rugged computer, which provides intelligence in the field, and allows the central SCADA master to communicate with the field instruments. It is a stand-alone data acquisition and control unit. Its function is to control process equipment at the remote site, acquire data from the equipment, and transfer the data back to the central SCADA system. Supervisory control and data acquisition is used for monitoring the railway system. Wonderware InTouch is the SCADA used for our project. It consist of a window script were programming is done. The graphical representation of our track layout is implemented in SCADA. It helps the operator from unnecessarily visiting the remote location. There are two modes in SCADA, they are:

- Development mode/window maker – Everything will be created in this window.
- Run time mode/window viewer – Running status can be seen here.

D. Development Window:

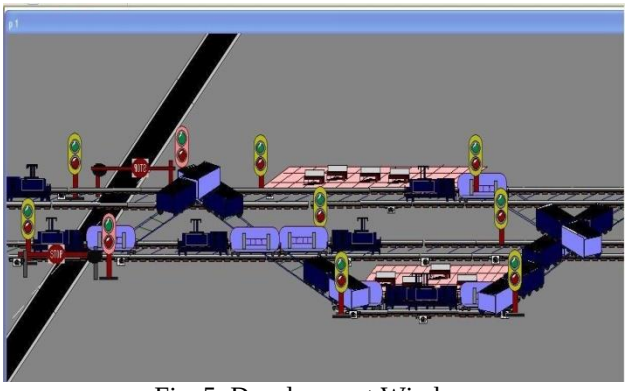

Fig. 5: Development Window

This is the window where we are making a pictorial representation of our entire plant.

Since we are dealing with railway system, an exact replica of our track layout has been drawn in SCADA. All the equipments will be created and programmed here. Necessary equipment can be taken from the wizard that is in the tool bar. Each and every equipment that is taken into the maker window can be programmed in the window script, which will be obtained by right clicking on the maker window itself.

E. Runtime Window:

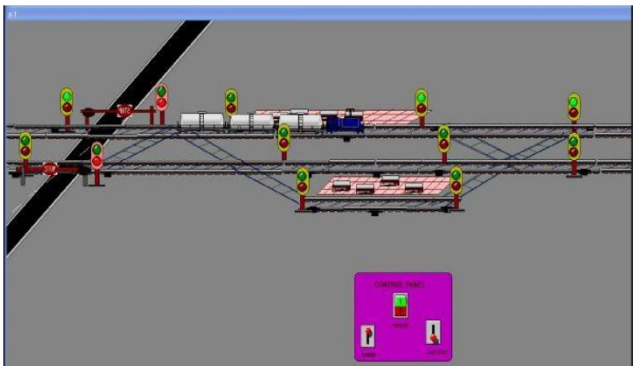

Fig. 6: Runtime Window

This is the window where we will able to see the running status of all the equipments that are programmed in the development window. In this window, we had shown switches along with the representation of our layout. By toggling the necessary switches we can change the movement of train, status of signal, and also gate.

V. CONCLUSION

Thus by determining the train's movement the signals can be controlled automatically which will avoid train accidents. These systems also provide other safety measures such as automatic railway gate control and track changing. This arrangement increases the safety of passengers and it strengthens the communication of the train. Future work includes: Fully automatic railway system, GPS System for identifying the train position in between two stations, Image Processing based track fault detection

REFERENCES

[1] R. Gopinathan and B. Sivashankar, PLC Based Railway Level Crossing Gate Control, International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE), Volume 8 Issue 1 –APRIL 2014

[2] Sindhu Bharathi B, Nivedha R, Swedha S, Enhancing Safety Measures In Metro Rail By Using Plc And Scada, International Journal of Computing Communication and Information System (IJCCIS), Vol 6. No.1 – Jan-March 2014

[3] P. Kiran Kumar, B.S. ShivaShankara, , PLC Based Automatic Fault Detection of Railway Track and Accidence Avoidance system, International Journal of Engineering Research and General Science, Volume 3, Issue 2, March-April, 2015

[4] Dr. A. Selwin Mich Priyadharson, GPS and PLC – Hmi Based Lavatory Flush Control In Indian Railway Compartments, International Journal of Electrical Engineering and Technology(IJEET), Volume 4, Issue 5, September – October (2013), , pp. 130140

