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PLC Based Fully Automated Railway System

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ABSTRACT

This paper aims to replace the manual work in railway protection system by automatically controlling and monitoring the train movements using PLC& SCADA. Nowadays even though automation plays a vital role in almost all areas but still railway system is not completely automated. Currently the railway network protection parameters like gate control, identifying track cracks, track collision, track changing and traffic light (indication) are controlled individually by their respective process either manually or semi-automatically, Even then the simultaneous control of all parameters does not exists to ensure safety operation. And at the same time the entire control is given only from control room using embedded technology which is tedious in monitoring and providing the required control under critical situations. To overcome those problems the proposed idea provides both monitoring and control of all the above said parameters with the provision of issuing automatic control in the locomotive itself uses PLC. Programmable Logic Controller (Keyence) senses the input from its respective sensors and according to the ladder program it issues the necessary control automatically. The entire operation is monitored using SCADA software.

I. INTRODUCTION

In Indian Railways has the world's fourth largest railway network in the world. Railway safety is a crucial aspect of rail operation. Railways being the cheapest mode of transportation are preferred overall the other means. To avoid such accidents the project proposed will analyze few vulnerable areas of accidents and help to find out the possible way to reduce the number of accidents. The accidents occurring are mainly due to the carelessness in manual operations or lack of workers. It will describing few major features namely anti-collision, automatic gate control, accident detection and tunnel power saving. Anti-collision will avoid the collision between two trains or train hitting a heavy mechanical object. Automatic gate control will help the accidents reduce occurring at railway crossing. The feature accident detection will enable the immediate help needed after the accidents taking place without human interference. Tunnel power saving will help efficient use of power in tunnel.

II. LITERATURE SURVEY

The existing conventional signaling most of the times relay on the oral communication through the telephonic and telegraphic conversation as input for the decision making in track allocation for the train. There is large scope for miscommunication of the information or communication gap due to the higher human interference in the system.

This miscommunication may lead to wrong allocation of the track for the training which ultimately leads to the train collision. The statistics in the developing countries showing that 80% of worst collision was occurred so far is due to either human error or incorrect decision making through miscommunication in signaling and its implementation.IR sensors are also used to identify the cracks in the railway. IR sensors have limitations due to the geographic natures of the tracks. The anti-collision device system also is found to be ineffective as it is not considering any active inputs from existing railway signaling system, and also lacks two ways communication capabilities between the trains and the control centers or stations. Later geographical sensors have also been used which makes use of satellite for communication but the system is costly and complicated to implement.

At present laser proximity detector is used for collision avoidance, IR sensors identifies the cracks in the railway track and gate control is done by manual switch controlled gate, but there is no combine solution between trains, train derailment in curves an bents and the automatic control of railway gate.

Proposed System

The proposed Train Anti-collision and level crossing protection system consist of self-acting plc system which works round- the- clock to avert train collision and accidents at the level crosses. Thus enhances safety in train operations by providing a non signal additional safety overlay over the existing signaling system. The system operates without replacing any of the existing signaling system.

The system operates without replacing any of the existing signaling and nowhere affects the vital functioning of the present safety system deployed for the train operation the proposed system gets data from the vibration sensors. The efficiency of the system is expected to the considerably increased as the proposed system takes input from sensor and also from the level crossing gates.

As more relevant data included, it is expected that the present system may assist local drivers in averting accidents efficiently. The system has been designed and simulated using trilogy real time simulation software.

III.DESIGN OF SYSTEM

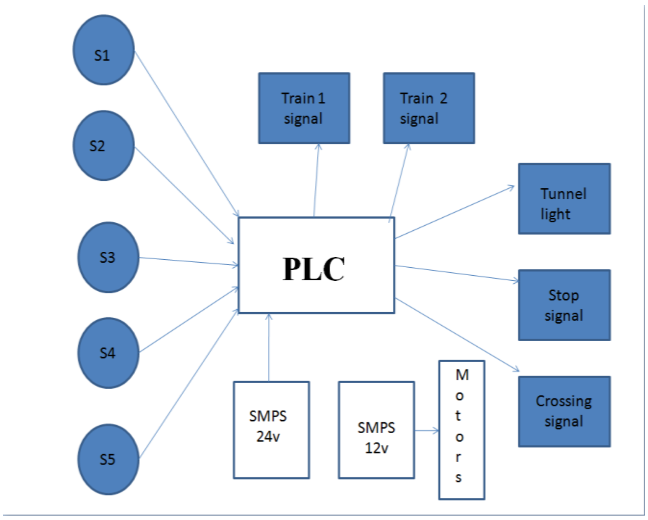

Fig: Block Diagram

Specifications of PLC:

Manufacturer: Allen Bradley, Siemens, Rockwell, Micro logics, Mitsubishi etc.

Types: Fixed – fix no of Inputs & outputs. Modular-Variable no of inputs & outputs.

Number of I/O:

Cases: 1. I/P=o/P - controlling all parameters.

2. I/P >o/P- more no of parameters to be control & high no of parameters to be measure.(Ideal condition)

Types of I/O - Discrete, Analog, Digital.

CPU : PLC cycle :

I/P scan – To read the inputs.

Scan time – Time between two consecutive scan of same input.

It is measured in ms/KW i.e. millisecond per kilo word

Program execution – to execute the program

o/p updating – o/p writing

Housekeeping – internal task of CPU. e.g. Checking the status of battery

Memory: It is measured in kilo words.

Programming Device: It depends on the S/W size, Speed etc.

Communication type :

Serial -RS 232 protocol is used

Parallel – RS 485 protocol is used

Power supply :

AC : 85 V

DC : 24 V

5.1.2. Hardware Specifications:

Allen Bradley

PLC used – Micrologix 1400

Cables used : CAT 5/6 UTP (Category 5/6 unshielded twisted pair cable)

Connectors : RJ 45

I/O module : 1762IF20F2

Flash ADC

Software Specifications:

Programming software: RS logix 500 – used to program by ladder diagram. To use other language expect ladder diagram- RS logix 5000

For communication between PC & PLC : RS linx classic gateway

Topology used: Ring

Protocol: Token passing

SCADA S/W – RS factory Talk view

Communication between SCADA s/w & PLC: RS links enterprise.

RSLogix programming packages are compatible with programs created with Rockwell Software DOS-based programming packages for the SLC 500 and MicroLogix families of processors, making program maintenance across hardware platforms convenient and easy. In addition, RSLogix 500 benefits include:

Cross-reference information

Drag-and-drop editing

Diagnostics

Dependable communications

Database editing

Reporting

FLOW CHART

Tunnel Power Saving System

Tunnel power saving is implemented using two pairs of IR Sensors. One pair will be fitted at entrance of the tunnel and other pair at the end of the tunnel. The lights are initially OFF, when the train crosses the line of sight of IR sensor at the entrance the signal is giving to the PLC at the field and PLC will take the necessary action to switch ON the light in the tunnel. Similarly, the train crosses the line of sight of the IR sensor Pair at the exits of the tunnel. Then signal is given to the PLC and light will switch OFF again.

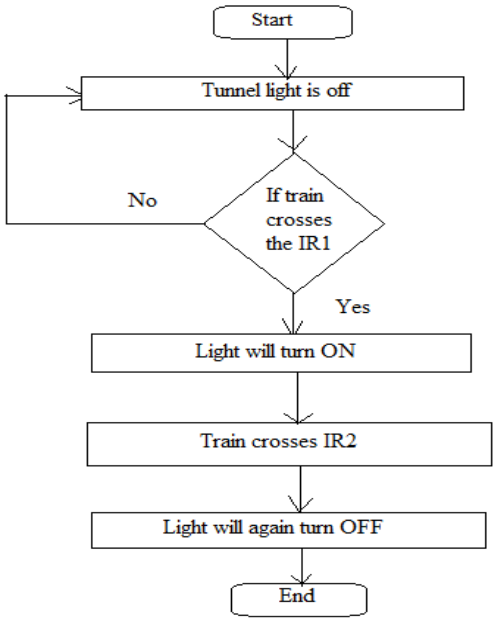

Fig Flow chart of tunnel power saving

Anti-collision System

Anti-collision will be implemented using the obstacle sensors fitted on the Train side. The obstacle sensor sense the obstacle using infrared LED and infrared detectors. The signal will be fed to the PLC.As soon as the signal is received the PLC will take the necessary action to stop the train. The Obstacle sensor essential is a transceiver which helps to transmit the signal to the programmable logic controller(PLC). Using the same principle as that for gate control, we have developed a concept of automatic track switching. Considering a situation where in an express train and a local train are travelling in opposite direction on the same track, the express train is allowed to travel on the same track and the local train has to switch on to the other track, indicator lights have been provided to avoid collision. Here the operation is performed using a stepper motor. In practical purpose this can be achieved using electromagnets.

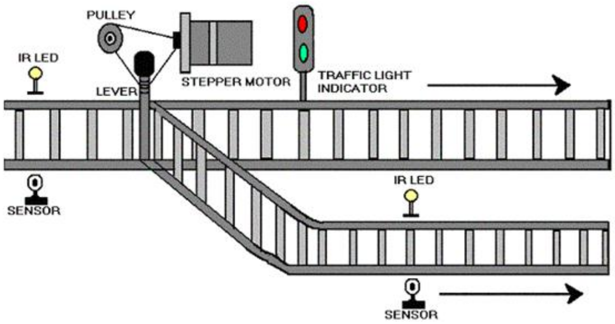

Fig Anti-collision system

To avoid collision

Collision means two trains at the same track in opposite direction or same direction. Most of the collisions are of the types of running train colliding with the standing train types. Here IR sensor are used to detect the presence of train in some (or) opposite direction. Transmitting/Receiving circuit consisting of IR-LED driver. IR sensor is an electronic instrument that is used to sense the object and detecting the motion. IR rays are invisible to the human eye. IR sensor emits narrow beam of IR rays which is used to find the presence of any train before the running train. If there is any train running behind the train the receiving circuits receives the IR beams, it is also capable of determining relative velocity between the train and the target. Those signals are send to PLC. Then according to the program it sends the signal to electromagnetic system. This controls train speed within certain distance.

Track changing

Collision process and track cracking is interfaced in electromagnetic braking system. Using the same principle as that for gate control a concept of automatic track changing is also possible. Considering a situation where an express train and a local train are travelling in opposite directions on the same track the express train is allowed to travel on the same track and the local train has been provided to avoid collisions. Here the switching operation is performed using a stepper motor. Considering a situation where in an express train and a local train are travelling in opposite direction on the same track, the express train is allowed to travel on the same track and the local train has to switch on to the other track, indicator lights have been provided to avoid collision. Here the operation is performed using a stepper motor.

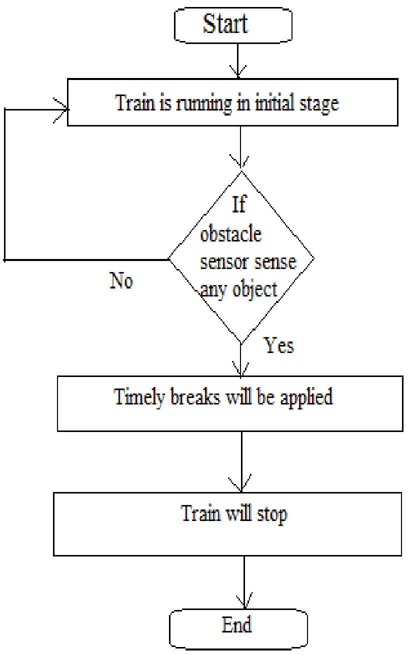

Fig Flowchart of anti-collision system

Automatic gate control system

This feature is implemented using two pairs of IR sensors, one pair is placed before the gate at a certain distance; another pair is placed after the gate at a distance. When the train crosses the line of sight path of the first pair of IR sensor. The sensor will send the signal to the PLC. This signal will be send to the PLC at the field side near the gate side. This signal send will further open the gate. Same process will repeat when the train will cross the second pair of IR sensors. This is mainly due to the carelessness in manual operations or lack of workers. We, in this project has come up with a solution for the same. Using simple

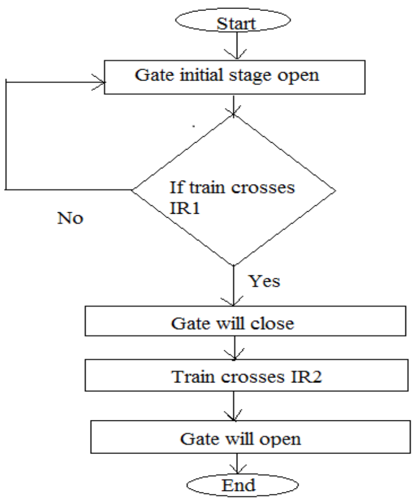

Fig Flowchart of Automatic gate control

electronic components we have tried to automate the control of railway gates. As a train approaches the railway crossing from either side, the sensors placed at a certain distance from the gate detects the approaching train and accordingly controls the operation of the gate. Also an indicator light has been provided to alert the motorists about the approaching train.

The signal from color resistive sensor will play important role in gate control and traffic light control process. When the PLC receives the signal from the sensor 1 then it produces the output based on ladder program which is fed to stepper motor driver for closing the gate. When the gate is in closed position traffic light indicate the green signal for the train. Similarly when the PLC receives the signal from the receiver-2 it indicate the train has passed away and the PLC issue the control pulse for the stepper motor to open the gate and when the gate is in open position which is indicates that by red signal for the level crossers.

SOFTWARE DESIGN

Basic PLC instructions

Load

The load (LD) instruction is a normally open contact. It is sometimes also called examine if on (XIO), as in examine the input to see if its physically on.

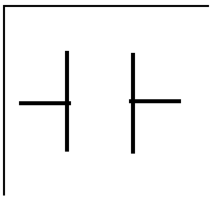

Fig A Load (contact) symbol

Load Bar/ Load Not

The Load Bar instruction is a normally closed contact. It is sometimes also called Load Not or examine if closed (XIC), as in examine the input to see if its physically closed.

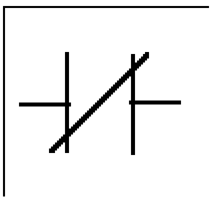

Fig A Load Not symbol

Out

The Out instruction is sometimes also called an Output energise instruction. The output instruction is like a relay coil. Its symbol looks as shown below.

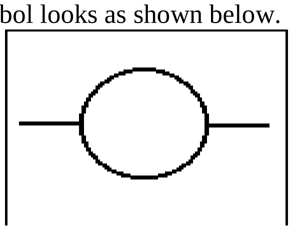

Fig An OUT (coil) symbol

Out bar

The Out bar instruction is sometimes also called an Out Not instruction. Some vendors don't have this instruction. Its symbol looks like that shown below.

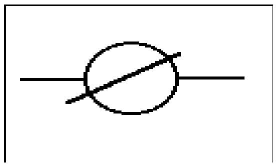

Fig An OUT Bar symbol

Example

Now let's compare a simple ladder diagram with its real world external physically connected relay circuit and see the differences.

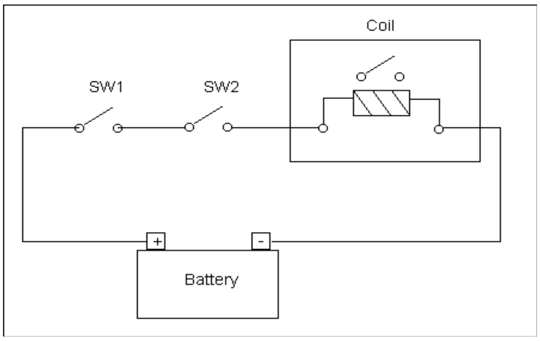

Fig Ladder Diagram

In the above circuit, the coil will be energized when there is a closed loop between the + and - terminals of the battery. We can simulate this same circuit with a ladder diagram. A ladder diagram consists of individual rungs just like on a real ladder. Each rung must contain one or more inputs and one or more outputs. The first instruction on a rung must always be an input instruction and the last instruction on a rung should always be an output (or its equivalent).

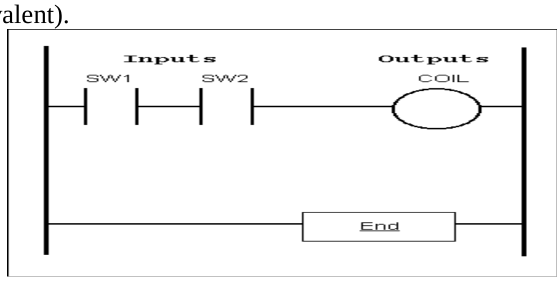

Fig Ladder Diagram

Notice in this simple one rung ladder diagram we have recreated the external circuit above with a ladder diagram. Here we used the Load and Out instructions. Some manufacturers require that every ladder diagram include an END instruction on the last rung.

Simulation

Fig Simulation Result

IV. CONCLUSION

Automatic railway gate control system is centered on the idea of reducing human involvement for closing and opening the railway gate which allows and prevents cars and humans from crossing railway tracks. The railway gate is a cause of many deaths and accidents. Hence, automating the gate can bring about a ring of surety to controlling the gates.

Human may make errors or mistakes so automating this process will reduce the chances of gate failures. Automation of the closing and opening of the railway gate using the switch circuit reduces the accidents to a greater extend. The obstacle detection system implemented reduces the accidents which are usually caused when the railway line passes through the forest. Most of the times greater loss has been caused when animals cross the tracks.

The system is able to perform all the operations without involvement of any human. This system is able to detect trains coming on same track and avoids collision also system is able to save power in tunnels when the tunnel is not in use also this system perform automatic railway gate opening and closing.

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