

An Approach to Implementation of Intelligent Signaling for Automatic Blocking System in Railway Sectors using Mobile Agents

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Abstract

Now days, averting collision of trains is a chief issue in railway sector. The prime cause for this problem is improper signaling for trains due to faulty working of sensors or result of decision making systems responsible for signaling. There are many systems incorporated for railway signaling such as Absolute Block System, Automatic Blocking system, Following Train system, and one train only system and pilot guard system. Generally Automatic Blocking system is preferred in railway sectors. Nonetheless, the system is still completely efficient for avoiding collision of trains. The proposed system comes with the solution for this problem to avoid chance of collision.

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1. Introduction

Numerous train accidents result due to improper signaling systems. Very specifically the signaling light is not properly visible or working. The centralized monitoring system provides the signaling to the semaphores but real status of the signaling will not be sent back to the monitoring system. Suppose the particular signal is supposed to glow in Red, and semaphore glows in

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different color say Green or Orange, then information does not reach the centralized monitoring station. This will result in a huge railway disaster. The proposed system responds aptly to this problem. A feedback concept is implemented, where a sensor (TCS230) informs the current status of semaphore signal's color. Based on the current status of semaphore signal compared with the signal issued by centralized monitoring station, any variation in decision will be taken immediately. This could probably avoid the chance of Collision of trains. For collecting this color status from each semaphores mobile agents are appointed, which will collect the data from each semaphore (node) and will automatically update the information in the database. The ordered signal condition issued by the central monitoring station is synchronized with the data from mobile Agents. This research work is extended to develop a GUI which will provide information of each semaphore's status in the screen (monitor) of the system. Also it provides the current train's position with respect to track and provides a Button to authenticate or Start the Agents to collect information from each nodes^{1,2}.

2. Basic Components of Intelligent Signaling System

The components used for our proposed work as follows

- TCS 230 Colour Sensor
- Microcontroller (Arduino ATMEGA2560)
- RF Transceiver Module(APC 220)
- Semaphore LED Module
- Track Circuit

Our research uses following softwares

- Processing Development Environment
- Arduino IDE
- Jade (Agent Programming)
- Eclipse IDE
- MySQL

The basic description of the Intelligent signalling system as follows

2.1 TCS230 Colour Sensor

TCS230 Colour Sensor is a perfect colour detector which is having TCS230RGB sensor chip and it consists of 4 white LED's. Endless range colour can be measured and detected by using TCS230. This sensor has a 4 x 4 array of photo detectors, out of which, TCS230 has 16 red filter, 16 green filter, 16 Blue filter and 16 are Clear. These Filters are equally distributed to reject location bias around the colours. When preferring colour filter, TCS230 allows only one particular colour to pass through and restricts the remaining colours. Suppose red filter is chosen it permits only Red incident light and blocks the Blue & Green Colour. So sensor will provide the red light intensity. An oscillator is placed inside the sensor which generates the Square wave signal whose frequency is directly related to the intensity of chosen colours.

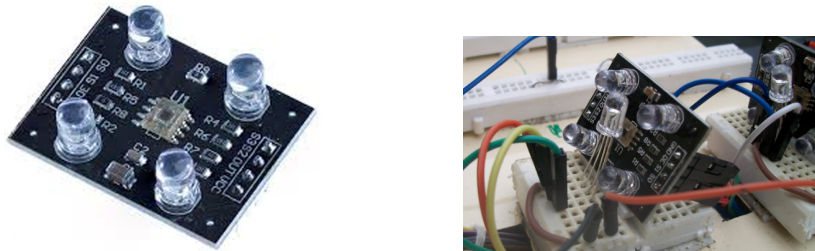


Fig. 1. A picture of TCS230 module & its view of colour sensing operation with RGB Led

2.2 Arduino Platform

Arduino is an open source platform which consist of a small microcontroller. The strength of Arduino is easily compatible with the server so it can share the information with the connected PC. An Arduino IDE is open sourced and can be freely downloadable from internet. By using the compilers in it, Arduino board can be easily reprogrammable. In this proposed work, Arduino Mega board which consists of ATmega2560 microcontroller and 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button through which various analog and digital sensors can be connected at a time and sensed and sensor values can be displayed in the PC monitor or can be processed for further applications. It can be used for varieties of applications like Robots, Data logging, Data Acquisition, Sensor monitoring, Wireless applications, Web based applications, space applications etc. This platform is preferred because of this unique feature. This board is user friendly too⁵. This platform is preferred because its having healthy and rigid performance even in tough conditions⁹.

2.3 RF Transceiver

The proposed system mainly relies on this wireless transceiver. The transceiver used for this work is APC 220, which is manufactured by Appcon Technologies from china. APC 220 is a low power cost effective RF telemetry device used for communication up to 1000 meters line of sight and works within a range of communication up to 5Km distance. The proposed work executed in laboratory condition successfully worked within a range of 1Km with APC220. This could be interfaced to the microcontroller via UART / TTL and connected to the Arduino for extended work.



Fig. 2. A Screen shot of APC 220

2.4 Semaphore LED Module

Semaphore LED Module is used as a Semaphore signal. The series of this led is used to make a signal post as three state colour indicators with cathode common. This is achieved with Pulse width modulation. The three colours used are Green, Red & Orange.



Fig. 3. A Screen shot of RGB LED \

2.5 Track Circuit

Track circuit is a device which uses the continuity principle for finding the train's movement. If the train cross over this circuit, this device will provide high output (+5v) otherwise this sensor will provide 0v based on this sensor output the Signals will be changing its status from various colour⁸.

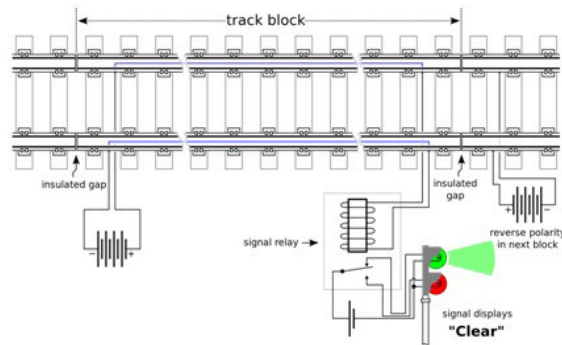


Fig. 4. A systematic view of Track Circuit

2.6 Processing

Processing software is a development Environment which is mostly used for visualizing Programs which runs on this environment will be called as sketch. Processing is a power tool which is used because it can deal with any application and can easily interface with database access. it can easily communicate with external device like Arduino, APC 220 etc, through Serial communication and execute command operations.

2.7 Jade Platform

JADE (Java Agent Development Framework) is a software Framework fully implemented in the Java language. It simplifies the implementation of multi-agent systems through a middle-ware that complies with the FIPA specifications and through a set of graphical tools that support the debugging and deployment phases. A JADE-based system can be distributed across machines (which not even need to share the same OS) and the configuration can be controlled via a remote GUI. The configuration can be even changed at run-time by moving agents from one machine to another, as and when required. JADE is completely implemented in Java language and the minimal system requirement is the version 5 of JAVA (the run time environment or the JDK)⁴.

2.8 Eclipse IDE

Eclipse is an Integrated Development Environment. It consists of base workspace and an extensible plug in like jade etc for customizing environment and for agent based applications. This is the environment where complete agent programming are coded and executed. Within this workspace only Agent communications are initialized. This is very essential software incorporated in this work.

2.9 MySQL

MySQL is the world's best appreciable relational database management system. Its SQL stands for Structured Query Language. MySQL database is much preferred for high end website applications. Because of its high profile we have opted MySQL for this work. Also by using processing sketch coding it can be easily updated, retrieved and edited.

3. Block Diagram of Proposed Work

3.1 Automatic Blocking System:-

Automatic Blocking System is one of the current concepts used in railways to assist signaling. With the help of tracking circuit this system will identify the movement of trains and the results will be given to the Blocking

System. A long train track will be converted in to small tracks and each small track will be provided with semaphores at the entry. Each semaphore consists of Red, Green, Orange, Double Orange color Light condition.

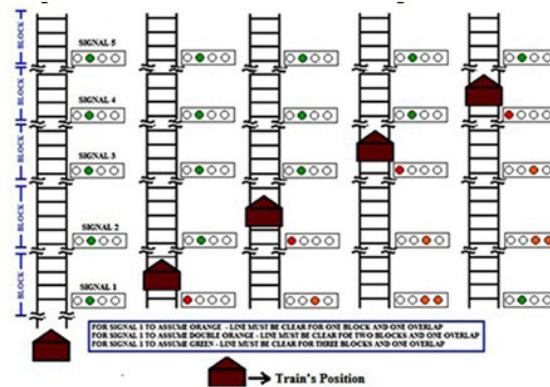


Fig. 5. A Flow diagram of Automatic Blocking System

Each small track will isolate them by small gap and is individually called as “BLOCK”. If the train is running in one block then the two blocks ahead of the existing should be clear then the moving train is shown a Green signal for moving. Even If anyone block ahead of the moving train out of at least two is active with a running train then the semaphore will immediately returns back to Red and informs the train to Stop. Blocking System will allow the train to the next block only when there exists no other train in the same Block. The concept of Automatic Blocking System is clearly explained in Fig. 6.^{6,7}

If by chance without proper notice, the driver runs the train when the signal is Red then the Automatic Blocking system will make all the signals Red for next ongoing blocks. This will make all the trains on that previous and ahead block to stop. This avoids the intense of railway disaster. This condition is implemented in proposed work.

3.2 Automatic Blocking System Module:-

Signaling Module used in our proposed system is a conventional method of Automatic blocking and signaling system. The heart of Signaling system is Track circuit. This system is connected common to more than 3 semaphores. this module identifies the train movement. once train's first wheel crosses over, it immediately will change the signal state to Red.

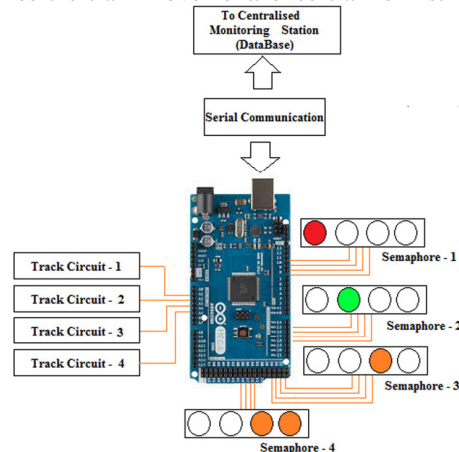


Fig. 6. A block diagram of Automatic Blocking System & Signaling Module

In the proposed work the information is transferred to the server or nearby control monitoring station by wired through serial communication and update the information in database. Each semaphore will identify by its unique address. So when semaphore transfers the information back to the server using wireless communication it provides the unique address. so server can easily identify the semaphore which updated its information

3.3 Intelligent Signaling color sensor System Module

Intelligent Signaling Color sensor system uses the above blocks for its operation. Its intelligence is purely based on a color Sensor TCS 230. This Sensor is focused toward semaphore of various color lights. This sensor is capable of providing information of the present color of active Signal. This module is connected to control monitoring station (CMS) or nearby Server by RF Transmitter APC 220. So the communication through Module and CMS by RF Transmission but the module will provide information only on Agent Request. So now mobile Agents come in to picture such that when it requests the information of Semaphore status then this module will provide the information after getting the updates from Color Sensor. The Approximate period of delivering information from the module back to server once request initiated is about 1500mSec. A picture flow structure of Module is given in fig 7.

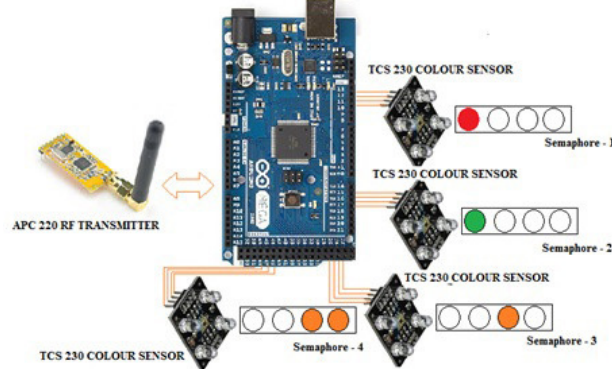


Fig. 7. A block diagram of Intelligent Signaling color sensor System Module

3.4 Server Module

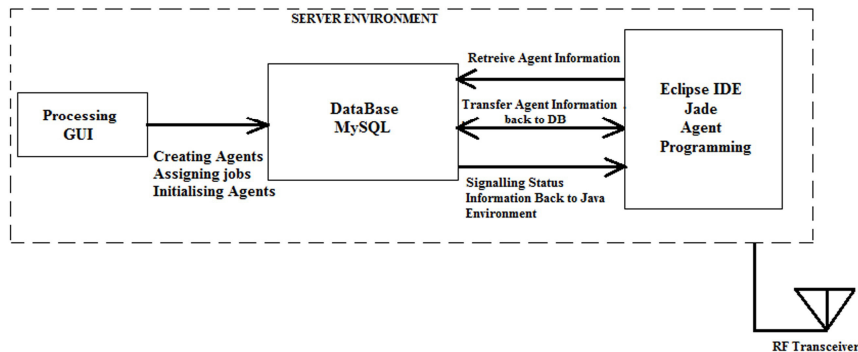


Fig. 8. A Server Module for Agent Creation & Data Providing & User Interface

Server module is one important place where maximum operations are handled. Here in this module only the databases for the entire railway systems about the train status are updated. This module connects to each node like Intelligent Signaling color sensor System Module through APC 220 by RF communication. Here in this module only agents are getting created and Assigning jobs for them like many operations occur. Each agent doing its job by accessing through Database(MySQL). If any operation want to perform its job through updating databases a User interface is created in this module by using processing software. Through that GUI only user can command the agent to perform operation sequentially or on interest. Agent Created or Assigning jobs to them are by Jade Environment through Database³. In other words, the user can interact with Agent by Database updating. Agent

manager will always read the database, once it come to user asking for request in required fashion it will do operation based on that and will provide the information back to the database.

4. Algorithm of Intelligent Signaling System

Automatic Blocking System Module by using its track circuit it finding the crossing of trains and update the signal nearby its semaphore and update information to the sever for database update. This process is independent because it's a conventional method. The algorithm flow for the system as follows.

- Agent is getting created by using Jade Environment.
- User defined input is given to agent by using GUI whether to be sequential or on request based.
- Once the input is feed by user, the agent will get this information from database.
- Once the agent received this its job, it ready to collect information from the Intelligent Signaling System.
- Now agent will send a command to node for requesting the Status of signaling.
- Once the node receive this information from remote its ready to collect information from Color sensor.
- After collecting the data from color sensor the node send back this information to the sensor module and update this information in database.
- Now received data will be compared with data from the automatic blocking system and if any mismatch it has to be viewed seriously and alarm will be immediately engaged in CMS to alert the signal Engineers to take necessary actions. This is the strength of our proposed system.
- This all information will be real time displayed in the LCD Monitor with the support of processing software.
- Jade Environment will calculate how much time taken for agent to collect this information will be displayed in Eclipse IDE result screen. If the agent request is sequential then the process will commence repeatedly.

5. Results of Intelligent Signaling System

So this proposed system is additional benefit for existing Automatic Signaling systems. This system will be acting as a feed back for the Blocking System (Automatic Signaling systems). It will provide information back to the monitoring station to ensure that system is running properly. Also designed GUI acting as front end for User to provide their defined information to get back required data.

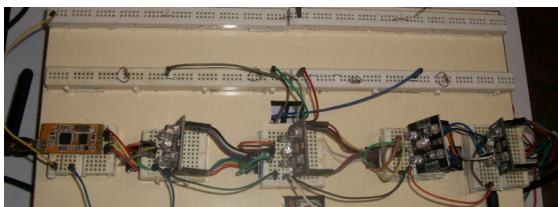


Fig. 9. A Flat Bed Setup of Intelligent Signaling Module

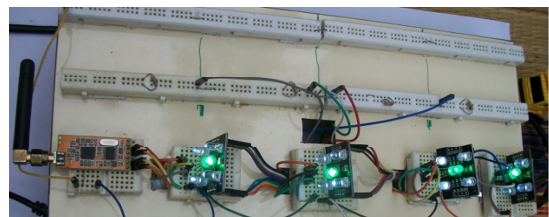


Fig. 10. A Blocking System representing all Signals Green @ Reset Condition

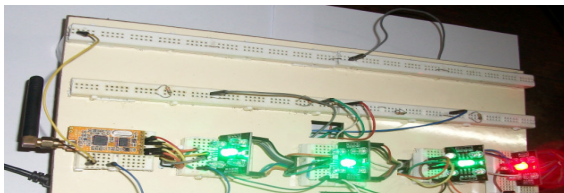


Fig. 11. A Blocking System representing Signal -1 Goes Red it

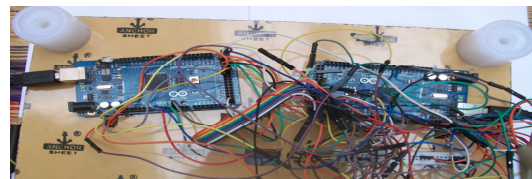


Fig. 12. A complex wiring shot of both Intelligent Signaling

after train crossed

System and Automatic Blocking System



Fig. 13. A Screen shot of Designed GUI showing Train in the Block-1 & showing Red signal of just crossed Block



Fig. 14. A GUI showing Train is in the Block-3 & showing Red signal of just crossed Block

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Agent Sequential System Initiated
Time Requested on : 24/8/2014/3:14:41
Requested Message is : data to semaphore
Time Received on : 24/8/2014/3:14:43
Received Message is : data from semaphore
1796 Total milliseconds.
0 day
0 Hour
0 Minutes
1 Seconds
796 milliSeconds
Time Elapsed for Request received is 0 Minutes 1 Seconds & 796 Milliseconds
Red Green Green Green
  
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Fig. 15. A Screen shot showing Result of Agent Transaction who's received data with elapsed Time

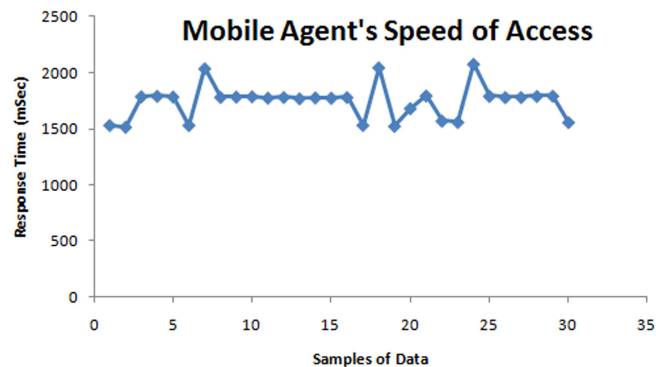


Fig. 16. A Chart of Agent's speed of response of Data Collection

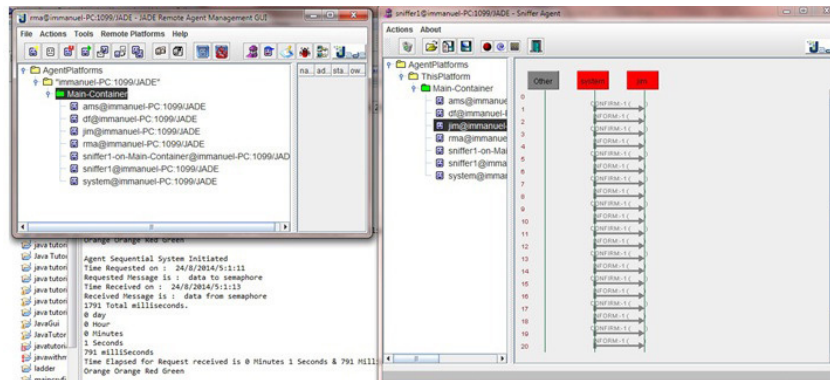


Fig. 17. JADE Environment Results of Agent (Jim) Transaction Details

6. Conclusion

The importance of Automatic blocking system is discussed in this paper. If this system fails, our proposed system will identify this problem and provide the information back to the Blocking System. Mobile Agents is once again proven that definitely it provide results back to the user when given a request. And also Speed response of agent is about 1.5 Sec (1500 mSec). The strength of this paper is that, its technology can be any time implemented along with current technology of railways with ease of installation. So this technology is ready to launch at any time anywhere in the signalling concepts. This system act as a close loop to the automatic Blocking system. So the Signalling provided by this system is purely intelligent and 100% reliable.

References

1. R.Immanuel Rajkumar, *Real Time Wireless based Train Tracking, Track Identification and Collision avoidance System for Railway Sectors*. International Journal of advanced research in Computer Engineering & Technology:2014, **3**,. p. 2172-77.
2. R.Immanuel Rajkumar, *GPS & Ethernet Based Real Time Train Tracking System* International Conference on Advanced Electronic Systems. p. 283-287
3. Muhsina shinwari1 and Sher afzal khan *Towards the Railway Traffic Management using mobile agents* published on vawkum transactions on computer sciences : 1; 1, May- June 2013.
4. <http://jade.tilab.com/> Its an official website for Jade Environment and the information related to recent developments can be found and also Jar files related plug-in can be find here in this website.
5. <http://arduino.cc/en/Main/arduinoBoardMega2560>.Its an official website of Arduino which provides the various information about Arduino platforms.
6. http://www.irfca.org/faq/faq-signal4_b.html Which deals the basics of Automatic Blocking System
7. http://www.cr.indianrailways.gov.in/view_section.jsp?lang=0&id=0,6,287,394,576 which deals strongly about the Automatic Signaling System
8. http://www.thefullwiki.org/Track_circuit. This page deals about the concepts of Track Circuit.
9. Martin, B., Juliet, V., Sankaranarayanan, P. E., Gopal, A., & Immanuel Rajkumar. R *Wireless implementation of MEMS accelerometer to detect red palm weevil on palms* International Conference on Advanced Electronic Systems. p. 248-252