Mobile Agents based Smart System for Accident Free Level Crossing in Railways

R. Immanuel Rajkumar, G. Sundari

Abstract: ***Safety travel is an important motto of every journey. A massive improvement in technologies development which implemented in railway systems influenced travel a comfortable one. A track circuit, signaling system, data logging system and monitoring system makes a system a close monitored for every moment. But due to manual operations, human mistakes, signaling failures, manual overrides and human innocence creates a large disaster by accidents which lead to maximum loss of life. Mobile agents is a concept which periodically collect the information from various nodes by having mobility characteristics and without influence of any human operations, carry an information from one node to various nodes. Nodes like trains, signals, level crossing, track sensors which periodically update in the remote server, computing the actions based on the data received from the mobile agents. This leads to provide a smart intelligent system to predict and to avoid chance of occurrence of accidents. Mobile agents can override the current operations in railways, and even predict the chance of any accident occurrence. The more advantage of the proposed system is, it can be easily installed over the currently existing system which leads to better performance.***

Keywords: Mobile Agent, Colision Avoidance, Level Crossing Sensors, Remote Tracking.

I. INTRODUCTION

Indian Railways is a very old, highly accessed transport in India. A huge technology transformations which exploited in railways which in turn make it as flawless operations in India. But there are few places where manual operations are mandatory which lead to a possible accident occurrence. A human innocence is also a very big threat that leads to an inevitable possible accident occurrence. The level crossing is a point where more concentration needed to provide a satisfactory operation procedure. A well-organized signaling operation will avoid an unnecessary traffic accident in both rails and roads. The unmanned level crossing is an another important point where more concentration needed to provide a better safety system. An alarming system and signaling system is an existing system happening in railways in unmanned level crossing for providing an effective service. B. Ai [1] clearly states the challenges of high-speed railways in wireless communications. S.Bruni et al [12] also speak about the Control and monitoring of railway vehicle dynamics.

A well-disciplined lane following is the only solution for providing a better service in level crossing. Every human should have more patience and more caution for crossing the level crossing.This solution will avoid the major unwanted accidents happening in level crossing.To provide a better service in this the proposed system comes with the better solution which is none other than the implementation of Mobile Agents for operations.

The mobile agent is a piece of software code which has the ability to migrate from one node to another node and interact with the corresponding nodes and collect the related pieces of information and deliver the possible messages and if needed execute specific actions and return back to the user or it will die in the same node. A. Verma et al [2] describe the agent's contribution for railways in moving block signaling. Mobile agents are used in the proposed system to collect information from the various sources and update the information to the centralized system or server. a level crossing will be considered as one node where all informations like nearby signaling system, gate close operation, track circuit current information, nearby trains location details will be collected in one node and this information will be received by Agents and get back to the server and update the information.

A server will be a centralized point where all nodes and all sub-node information are received and processed and controlled subsequently. Anshul Verma et al [4] [5] showcase the involvement of agents in railway management system. Mobile Agents Assigning protocols, data updating procedures, data processing analytics will discuss later in this paper. Johnny Wong et al [3] also points out the smartness of agents in its operations. Yashpal Singh et al [10], Ali Pouyan et al [11] discuss the involvement and issues of Mobile Agent Technology. Deepti Singh et al [13] speak about the issues and various factors of Mobile Agent Security. R. Immanuel Rajkumar et al [21] explain the Mobile Agents necessity in Automatic Blocking System for Railway Sectors.

II. EXISTING SYSTEM

Track circuits or axle counter are the very important sensors in railways which will update the train movements between the blocks to the nearby control station. A geographical size of rails will be subdivided into a block in which the trains will be allowed to move from one block to another through signaling system. This information will be updated as an electrical signal to the nearby master control unit most preferably a station. Through the sensing of axle counters or track circuits, the further signaling system will be updated. If the trains move into nearby occupied blocks the signaling system will provide red signal to the consecutive signal to stop the trains. A. Anastasopoulos et al [6] explains the inspection of rail wheels. Xiaoqing Zeng et al [9] reveal the detailed study of Railway Control System Model.

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F. Marquez et al [15] discuss the Failure analysis and diagnostics for railway trackside equipment. K. Sekula et al [22] showcase Piezo-based weigh-in-motion system for the railway transport. R.Immanuel Rajkumar et al [28] discuss the train tracking using GPS & Ethernet. R.Immanuel Rajkumar et al [34] discuss the real Time Wireless based Collision Avoidance System for Railway Sectors".

If the train reaching the nearby blocks of the level crossing, it will be get indicated and try to make the gate closed. Till the gate is getting closed, the corresponding signal for the level crossing will be in red not to allow to the bock of the level crossing. Once authentication is provided after the gate is closed, the signal will open for a train to get crossed the level crossing. after the train passing the previous signal of the level crossing, but suddenly any disturbance happening in level crossing will not allow the passing train to stop. There is no current system engaged to stop the train after a train crossing a particular point or once enter inside the block. Once the train crosses the level crossing premises the axle counter will update this information to the master control unit which will release the condition for opening the gate and put the two incoming signals on both sides to remain red.

The main drawback in the existing system is the train cannot be able to stop at any point other than approaching signaling point. Once the train enter inside the block, there is no system till now evolved to make the moving trains to stop other than point devices which are in the mid of the rails can send signals to stop once the train is passed over the device. This is not a successful device during a chance of accident occurrence. The proposed system coming with the solution for this above-stated problem. S.Zller [30] reveals the wireless sensor networks efficient real-time monitoring of multimodal transports. P. Li [14] shows the railway vehicle suspension parameters for condition monitoring. H. Yazdi [29] confers the monitoring of railway signaling equipment. M. McHutchon et al [23] discusses the Signal processing for remote condition monitoring of railway points. J. Reason [24] confer about Ambient intelligence for freight railroads.

III. PROPOSED SYSTEM

The signaling system, track circuits, level crossing system each act like sensor nodes and when there is a possible change in its output or on time basis it will update the necessary information to the central nodes. The signaling device, track circuit, level crossing gates, possible trains will act as sub-nodes for common nodes. The subnodes will act like the client and provide the information or receive the information from the remote server and act accordingly. A centralized node will be a collecting point where it collects all the informations from the sub-nodes. The centralized node will be connected to the remote server through wire or wireless (RF) or dedicated communication medium. P. Bennett [7] and F. Flammini [17] pointing the importance of Wireless sensor networks for railway applications. E. Berlin et al [8] also focus on Railway monitoring using Sensor Networks. H. Tsunashima et al [16] and A. Wilkinson [18] discuss the condition monitoring of rails using in-service vehicles. Mamoru Sekiyama [26] and Altaf Hamed Shajahan et al [27] and M. F. AL. Faisal et al [32] showcase the data logging of various sensor data using portable IoT device and android based platform. Shubham N et al [31] discusses device to device interaction analysis in IoT based Smart Traffic Management System. Milan Matijevic et al [33] discusses the Overview of architectures with Arduino for data acquisition and control systems.

A server is a computational source which collects all the information, process their information and provide control signals or signaling information to the signals to change the current status if required. In a critical situation, the system can directly communicate with train system to even stop the trains and to change the signal status nearby correspondingly. A server is a computational source which collects all the information, process their information and provide control signals or signaling information to the signals to change the current status if required. In a critical situation, the system can directly communicate with train system to even stop the trains & to change the signal status nearby correspondingly.

IV. SIGNALING MODULE

The responsibility of signaling module is to provide enabling the lights on signals. Its connected Zigbee module receives the data from the previous node or from the centralized node and based on getting data, update the signaling to "red", "green", "oran ge" or "double orange". It also having real time cl ock, periodically update the current status to the centralized node wirelessly through Zigbee module. An optocoupler based relay control is used to activate the signal output.

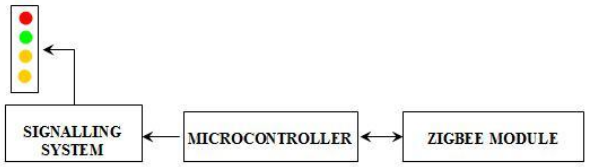

Figure 1: Block of Signaling Module

V. SENSOR MODULE

Sensor module comprises of intelligent microcontroller & sensors like track circuit & axle counters. Axle counters are used for counting the number of wheels of training and track circuit sensors a magnetic contact variation confirms the crossing of trains on the specific location and the sensor module update this event to the centralized node. Also, this module periodically updates its informations to the centralized node trough Zigbee module.

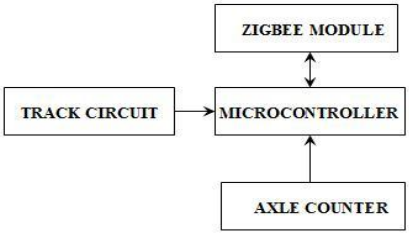

Figure 2: Blocks of Sensor Module

VI. ON-BOARD TRAIN MODULE

On board train module which will be on train comprises of GPS, RFID responsible for identifying the location on rails and it is having magnetic sensor provide the direction of the train is traveling. By using the encoder or through GPS, the speed is extracted and all the above information are sent to air through both Zigbee module and RF transmitter. APC220, an RF transceiver responsible for transmitting information up to few kilometers. The same information received by various possible or nearby nodes by another transceiver and update the information before it reaches the corresponding nodes.

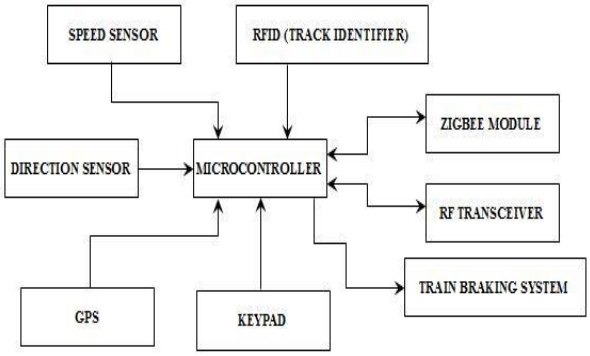

Figure 3: Blocks of Train on-Board Module

VII. LEVEL CROSSING MODULE

Level crossing module is the important node in the intelligent level crossing system. This module is responsible for the entire progress of level crossing operations. Gate sensors provide the information regarding whether the gate is open or close. Usually, signals will be enabled or triggered based on this sensor output when the gate is closed or open. Gate motor acts as an actuator for closing and opening the gate. Signaling system nearby the level crossing will be getting changed Based on the gate sensors variations. Again here also sensors and signaling information are periodically or on basis of change in the output of sensors updated to the remote server and nearby centralized system through the web-enabled device. On the access on Agents, the information will be shared with the Agent and on agent request basis after authentication, the gate and signals output is getting changed and the same informed.

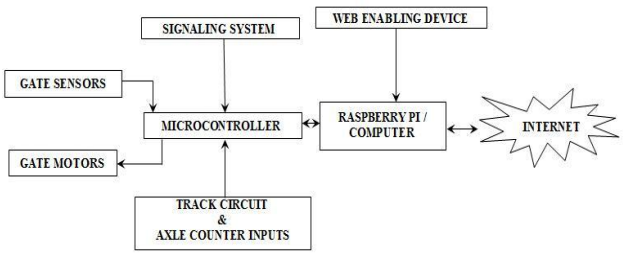

Figure 4: Blocks of Level Crossing Module

VIII. CENTRALIZED SYSTEM MODULE

Centralized system module is the main client node which comprises of various subnodes like signaling module (stationary), sensor module (stationary), train onboard module (moving). All the sub nodes updating their informations to the centralized system on change of output or periodically. This centralized system module will share this information with the server through web-enabled devices. Centralized system module comprises of raspberry pi, which is the intelligent computer through which this system module is more rugged and powerful. Pandapotan Siagian et al [19] Prachi H et al [20] discuss the ability of Web-based monitoring and control using Raspberry Pi. A microcontroller connected to Zigbee module which receives the information from subnodes and through UART the information given to raspberry pi and the same received information sent to the server through the mobile agent's concept. When the agent is created and sent to this module, this will confirm the identity of the agent which provides the necessary information to the agent and make them to sent back to the server. Web-enabled devices like GSM module or USB dongle provides the internet connectivity to the system module and make the system more efficient and dominant. G. Scholl [25] confers about SAW-based radio sensor systems for short-range applications.

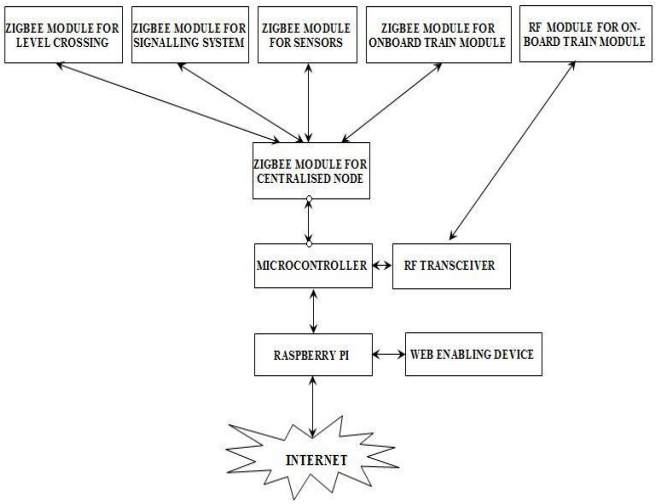

Figure 5: Blocks of Centralised System Module

IX. SERVER MODULE

Server module exhibits the entire process of mobile agent based level crossing system. R.Immanuel Rajkumar et al [35] [36] discusses the importance of Agents for Railway Sectors and its strength for the avoidance of collision occurrence. The server is the centralized and controlling main node connected to all other nodes through wireless using internet access. Each client nodes will update their sub-node information to the server on basis of Agent request or on time basis. An Agent environment will be embedded in the server module will be get created and sent to the specific client node for data collection. Based on received information from agents, server will update it in its database and keep process the database. In the chance of a collision occurring or malfunction, an Agent will be initialized and sent back to specific client for changing their outputs, especially in level crossing node, agents will be entirely taken into control and controlling the opening and closing of the gate and changing the signaling operation is possible and bring the system under control. This sequence will avoid the possibility of accident occurrence.

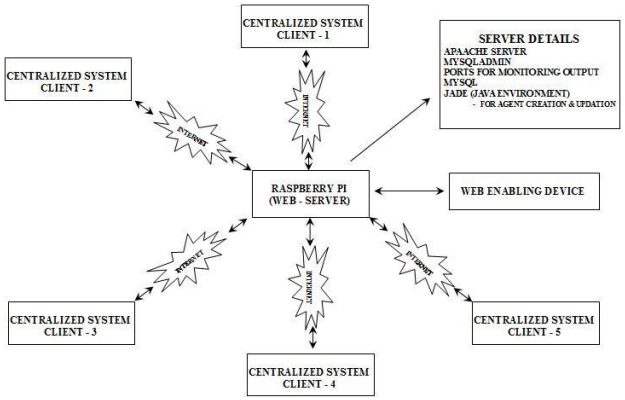

Figure 6: Blocks of Server Module

X. ALGORITHM

Mobile Agents which will be created will physically move on to the individual systems and collect the datas and update the same to the remote server. Server will process this data and if needed any immeadiate action the agents will be super imposed to moeve to the target to take any effective action. The sequence of operations as follows

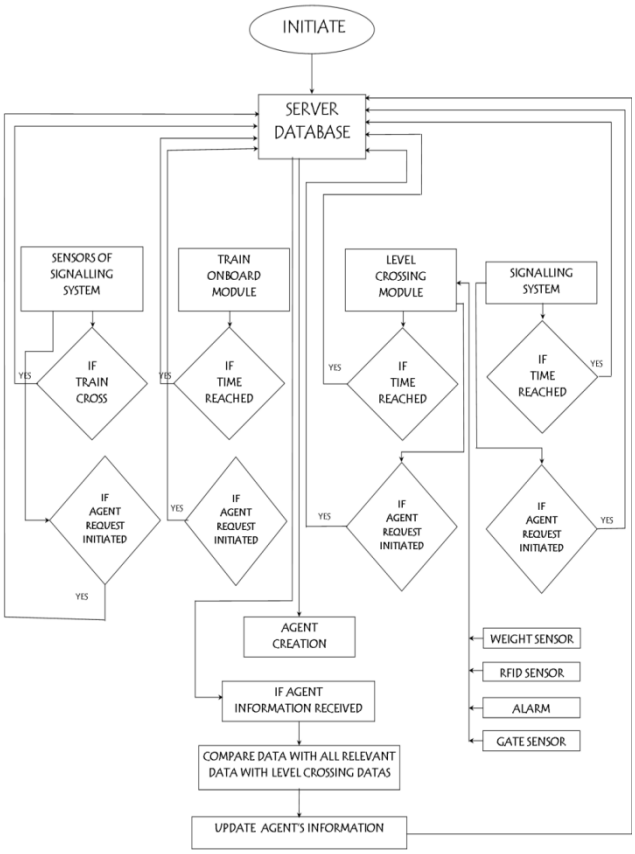

Figure 7: Flow diagram of Mobile Agents based Level Crossing System

XI. RESULTS

The various test bed setups are created which act like a node ie. Sensor node, Onboard train module, signaling system, centralized node, server node. All these nodes are practically talk to other nodes wireless and executed outputs and events based on its concept nature. The software like processing, Arduino IDE, Jade Environment using Eclipse for Agent environment and database created in Mysql. So the systems are connected and various results been obtained. The nature of output are as follows.

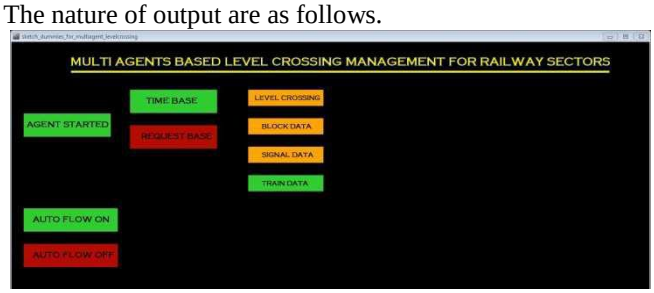

Figure 8: An GUI created in Processing software for creating Agent based on timing and on request

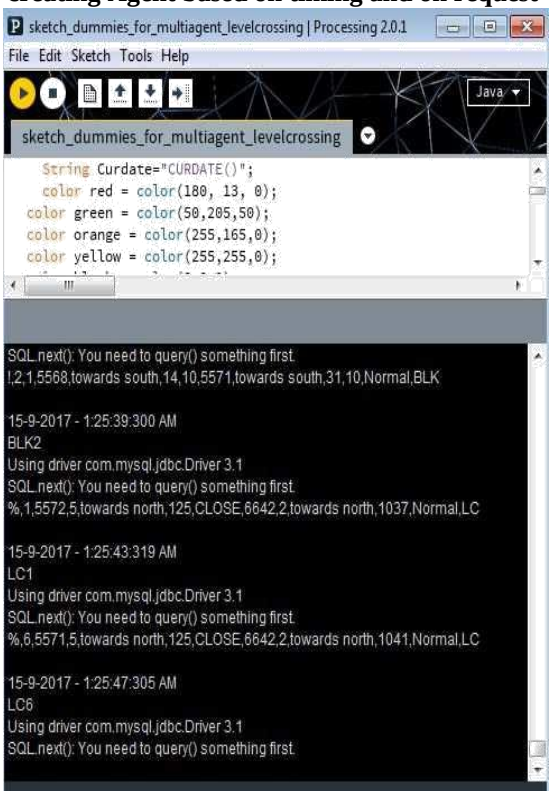

Figure 9: An view of Processing window showing execution of its program

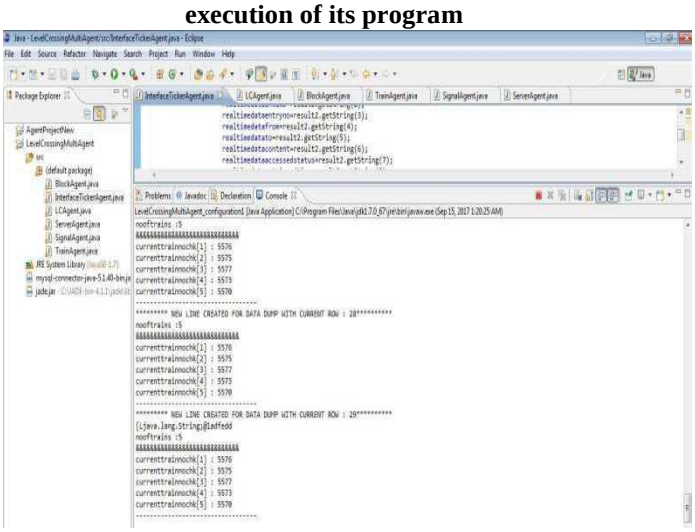

Figure 10: An view of Eclipse software executing agents concept using Jade

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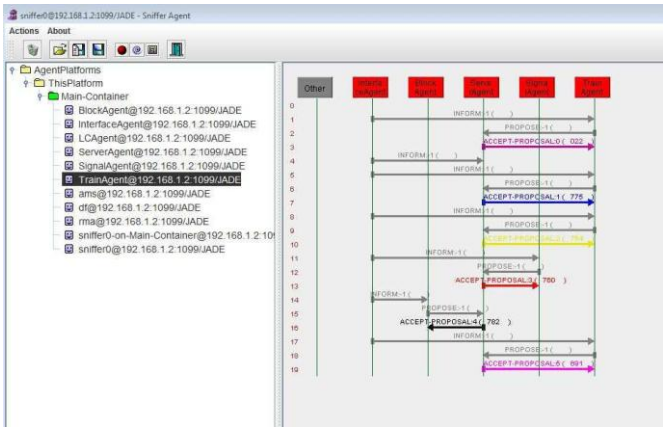

Figure 11: An Agent Environment, Sniffer view showing agents Execution

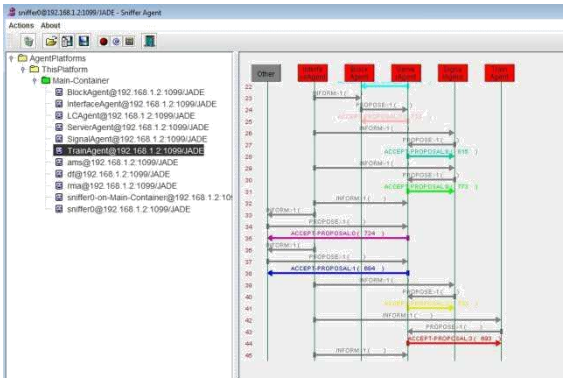

Figure 12: An Agent Environment, Sniffer view showing agents Execution for tranfering information from one agent to another Agent

Table 1: A view of Database showing the Level crossing System associated details

Result Grid | Filter Rows: | Edit: | Export/Import: | Wrap Cell Content:

SNo	Levelcrossingupdatedtime	Levelcrossingid	Approachingtrainnumber	Approachingtraintrackno	Approachingtraindirection	Approachingtrainexpectedtime	Gatecondition
1	1:30:11:718	1	5568	5	towards north	125	CLOSE
2	1:29:43:845	7	5568	5	towards north	125	CLOSE
3	1:29:59:756	4	5573	5	towards north	125	CLOSE
4	1:30:7:734	8	5576	5	towards north	125	CLOSE
NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL

Table 2: A view of Mysql data showing the entire flow of of Information of data between systems and Server

Gatecondition	Lefttrainnumber	Lefttraintrackno	Lefttraindirection	Lefttraincrossingtime	Levelcrossingrunninginformation	Agentaccesstime
CLOSE	6642	2	towards north	1305	Normal	0.334
CLOSE	6642	2	towards north	1277	Normal	0.472
CLOSE	6642	2	towards north	1293	Normal	0.362
CLOSE	6642	2	towards north	1301	Normal	0.355
NULL	NULL	NULL	NULL	NULL	NULL	NULL

Table 3: A view of Mysql Database showing information regarding Gate conditions

Result Grid | Filter Rows: | Edit: | Export/Import: | Wrap Cell Content:

SNo	Time	Entrynumber	Datafrom	Datato	Datacontent	DataAccessedstatus	Retrivedtime
1	15-9-2017 - 1:28:27:365 AM	105	SERVERBlock 8 not Responding	SERVER	@,Block 8 not Responding,SERVER ,15/9/2017/...	no	0.367
2	15-9-2017 - 1:28:31:364 AM	106	BLK2	SERVER	!,2,1,5577,towards south,14,18,5568,towards...	YES	0.485
3	15-9-2017 - 1:28:35:379 AM	107	TRAIN5575	SERVER	#,5575,12.45634,80.34267,42,N,5,8,13,Norm...	YES	0.337
4	15-9-2017 - 1:28:39:374 AM	108	BLK3	SERVER	!,3,1,5574,towards south,14,19,5569,towards...	YES	0.415
5	15-9-2017 - 1:28:43:382 AM	109	SERVERBlock 4 not Responding	SERVER	@,Block 4 not Responding,SERVER ,15/9/2017/...	no	0.337
6	15-9-2017 - 1:28:47:367 AM	110	SERVERBlock 3 not Responding	SERVER	@,Block 3 not Responding,SERVER ,15/9/2017/...	no	0.424
7	15-9-2017 - 1:28:51:379 AM	111	TRAIN5577	SERVER	#,5577,12.45634,80.34267,42,N,5,8,13,Norm...	YES	0.419
8	15-9-2017 - 1:28:55:364 AM	112	TRAIN5568	SERVER	#,5568,12.45634,80.34267,42,N,5,8,13,Norm...	YES	0.424
9	15-9-2017 - 1:28:59:365 AM	113	BLK5	SERVER	!,5,1,5568,towards south,14,20,5570,towards...	YES	0.394
10	15-9-2017 - 1:29:3:361 AM	114	SERVERBlock 4 not Responding	SERVER	@,Block 4 not Responding,SERVER ,15/9/2017/...	no	0.424
11	15-9-2017 - 1:29:7:361 AM	115	BLK10	SERVER	!,10,1,5573,towards south,14,21,5571,toward...	YES	0.367
12	15-9-2017 - 1:29:11:363 AM	116	BLK4	SERVER	!,4,1,5577,towards south,14,22,5570,towards...	YES	0.421
13	15-9-2017 - 1:29:15:355 AM	117	SIG6	SERVER	$,6,red,Normal,SIG ,15/9/2017/1/29/15/355	YES	0.356
14	15-9-2017 - 1:29:19:370 AM	118	SERVERBlock 3 not Responding	SERVER	@,Block 3 not Responding,SERVER ,15/9/2017/...	no	0.424
15	15-9-2017 - 1:29:23:366 AM	119	LC1	SERVER	%,1,5576,5,towards north,125,CLOSE,6642,2...	YES	0.399
16	15-9-2017 - 1:29:27:363 AM	120	BLK2	SERVER	!,2,1,5576,towards south,14,23,5573,towards...	YES	0.459
17	15-9-2017 - 1:29:31:372 AM	121	SERVERBlock 8 not Responding	SERVER	@,Block 8 not Responding,SERVER ,15/9/2017/...	no	0.337
18	15-9-2017 - 1:29:35:381 AM	122	LC1	SERVER	%,1,5571,5,towards north,125,CLOSE,6642,2...	YES	0.433
19	15-9-2017 - 1:29:39:373 AM	123	TRAIN5571	SERVER	#,5571,12.45634,80.34267,42,N,5,8,13,Norm...	YES	0.406
20	15-9-2017 - 1:29:43:373 AM	124	LC7	SERVER	%,7,5568,5,towards north,125,CLOSE,6642,2...	YES	0.472

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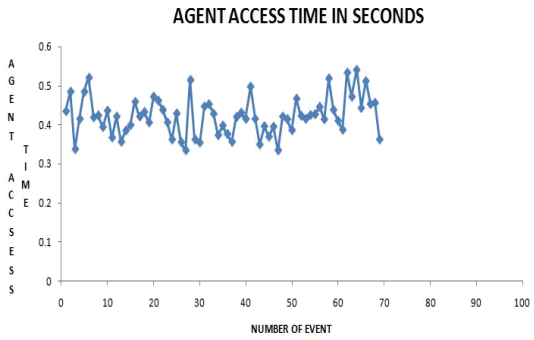

Figure 13: Showing the Execution time of Agent

The above diagram shows the execution of various systems and updating of its output in a database. The database is completely monitored by server and in case of any accident situations or during malfunction of any systems in level crossings, the will take responsibility and make the decision to change the signaling system to train or during extreme situation, the proposed system directly taking the control of movement of train and to stop at any point.

XII. CONCLUSION

Accidents in level crossing are the important factor to be considered by railways. The dedicated systems propose. Here in this paper more cautiously watch over the entire progress of the operation. Trapping of a vehicle, signal failures, human mistakes are the important reasons for accident occurrence in level crossing. The unmanned level crossing is the very important issue to be considered by railways. Even though the dedicated systems well respond for the variations of output, due to lack of awareness of human and improper decisions taken while crossing the level crossing, make the vehicles to trap in the rails. The proposed system here keeps watching the various processes happening over the rails in level crossing. They provide timely decisions to make the system and environment much healthier. Agents play the major role in keep watching the entire process around the level crossing using its mobility concepts and update the same to a server and the entire process monitored over server side to make the proposed system more intelligent and smart. The proposed system makes the Agent mobility in the mode of wireless using RF transmitter and IOT based operations. Each system arrangement make themselves as a network and share their information.

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