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Optimization of Traffic System using TCL Algorithm through FMSA and IMAC Agents

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***Abstract*—Based on Agent Technology, Service Oriented Architecture and RFID,this paper puts forward a 'real time paradigm' traffic congestion control strategy in metropolitan cities. This strategy uses TCL algorithm in order to provide optimal traffic performance evaluation considering the parameter, velocity of vehicles by implementing RMI & SOAP interfaces. This building block of traffic and transportation system is more suited for the proposed mobile agents FMSA(Fixed Monitor Stationary Agent) & IMAC(Interactive Mobile Agent for Client) because this model works on the Agent technology that can be developed using Java and JADE Agent platform under dynamic changing environments. The developed FMSA & IMAC agents makes real time decisions for choosing the best path in road traffic network to avoid congestion by considering the parameters for optimization like mainly the velocity of vehicles in the existing lane. This paper also compares the experimental results obtained by the system before and after the implementation of FMSA & IMAC agents to prove the significant performance for finding the best path by confirming the better efficiency & scalability improvement of our framework.**

***Index Terms*—FMSA, IMAC, MATLB, PCM, TCL**

I. INTRODUCTION

Traffic Congestion Prevention has shown great potential for solving problems in intelligent traffic & transportation system. The increase in modernization and urbanization creates an effective need to operate the existing traffic systems with maximum throughput and utilization.[One of the most effective methods is to find best path for a road network to its destination from its current position for congestion avoidance and it can be prevented by considering the velocity of vehicles as an important optimization parameter in the existing lane.

Currently the traffic and transportation application based on agent technology are discussed for making the system more effective and scalability. [5] Our literature survey shows that the techniques and approaches resulting from the field of agent technology and the agents FMSA & IMAC have been implemented to many aspects of optimizing the traffic and transportation systems that includes congestion avoidance effectively by providing the best route for a vehicle. The main parameter that consider for the ITTS[6](Intelligent Traffic & Transportation Systems) optimization in this paper is velocity of vehicles in the existing road network along with the RMI & SOAP interfaces.

This paper is organized as follows. In Section 2, we described the discussion on the past research and its related work that are concerned with traffic congestion. The framework of the proposed model of the research is presented in Section 3. The optimization parameters that are considered in this research and the implementation of agents FMSA & IMAC have been demonstrated in Section 4. Section 5 provides the experimental results and the performance measure of the model before and after implementation of agents. Section 6 offers a conclusion of the model and the possibilities of future work.

II. LITERATURE SURVEY

Our literature survey for the agents FMSA and IMAC signed the techniques and approaches resulting from the field of agent technology that has been applied to many aspects of traffic and transportation systems including monitoring the traffic, dynamic routing for finding best route, handling traffic congestion ,modeling and simulation. This paper examines an mobile agent based approach for monitoring the current traffic congestion scenario and also calculates as well as optimizes the best path for the client vehicles on the road network by implementing agents along with TCL (Traffic Congestion Level) algorithm.[2]

Traffic congestion level monitory techniques for various types of collected data are used to record the real time status of the entities in the external environment.[8] Owing to advances in agent technology, many new emerging applications are discussed. e.g. Mobile Sensors, Finance & Insurance system, Social agent technology in Urban areas [1]. Many of these new applications need to manage the functions of Intelligent Traffic & Transportation System. One of the most important functions of ITTS applications is to support vehicle –to-infrastructure system [12].The Study in [12] proposed specific service oriented middleware for handling co-operative vehicle –Infrastructure systems. In the concept of Agent Technology, agents are the building blocks and may act as stationary or mobile in road networks. Leeha Singh et.al developed traffic emulator for the representation of traffic conditions at an isolated intersection with the features that include GUI developed in JAVA .They proposed algorithm called genetic algorithm [7] that mainly focuses on optimizing the traffic signal time .The optimization parameters considered in that paper are weights ,cycle timings etc.

In this paper, we explored a model that can automatically control the traffic congestion by finding the best route for the vehicles in the existing scenario. The optimization parameters for traffic & transport Congestion system considered in this research are velocity (that provides an easy way to get the loop counter so that the total number of vehicles in the existing lane can be counted), time and distance. The optimization can be done by implementing FMSA & IMAC that are act as stationary and mobile agents. The input for these agents is handled by the interfaces of RMI, SOAP. RFID Stations act as Information Provider for ITTS.The model mainly focuses on optimization for Traffic Transportation System using TCL (Traffic Congestion Level) Algorithm.

II. FRAMEWORK AND COMPONENTS OF THE PROPOSED MODEL

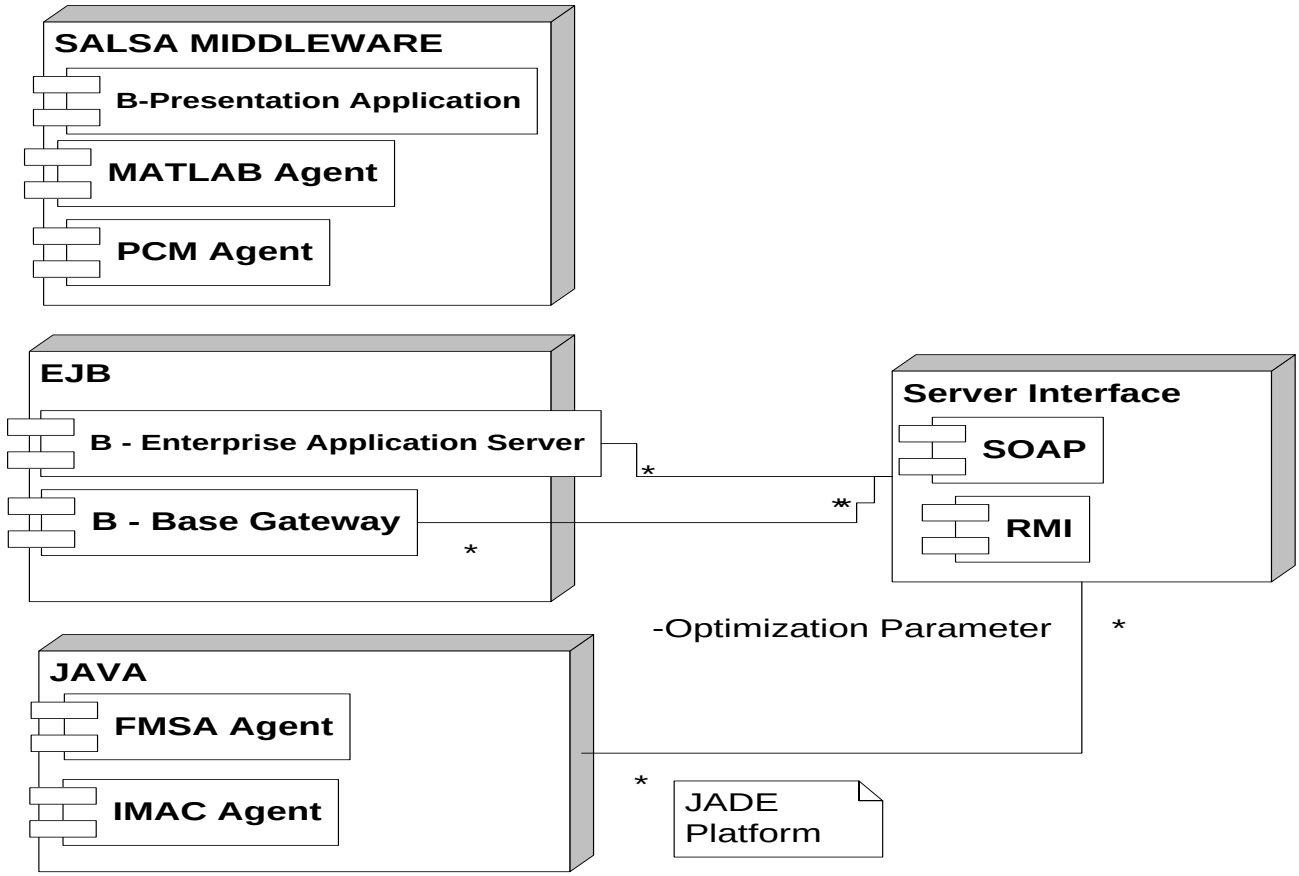

Fig 1: COMPONENTS OF PROPOSED MODEL

The framework of the proposed model is developed in JADE agent platform under dynamic changing external environments and it comprises of three layers. To demonstrate the great value of mobile agents to ITTS, Chen et al [3] [4] integrate mobile agent technology with MASs to enhance the flexibility and adaptability of large scale traffic control and management system. The first layer of the framework consists of B-Presentation application along with MATLB (Mobile Agent for Traffic Load Balancing)[11] & PCM(Prioritization and Congestion Management Agent)[10] mobile agents that are supported by SALSA middleware for calculating the threshold value and also for identifying the emergency vehicles in the existing lane. The second layer deals with the B_Enterprise Applications & B_Base Gateway that are developed in EJB by implementing the server interfaces like RMI & SOAP for receiving and delivering information from and to the Information provider (IP). The third layer of the framework focuses on actual optimization techniques through the fixed agent FMSA and the mobile agent IMAC by considering the optimization parameter, which is the velocity of vehicles in the exiting lane that gives the better solution for the effective traffic congestion prevention as well as finding the best route for the vehicles in the existing lane using TCL algorithm.

IV. IMPLEMENTATION & FUNCTIONING OF FMSA AND IMAC AGENTS

The proposed model initiates with activation of MATLB and PCM agents which were discussed in [10][11].The FMSA Agent is fixed on polls and IMAC agent is fixed in client vehicles on the road. The FMSA receive the details like initial velocity, final velocity, departure time, arrival time of vehicles from RFID Station. RFID station maintains the database for routes of highways. Even though the PCM Agent is responsible for controlling the speed and handling high priority and emergency vehicles, the better optimization of real time traffic is handled by FMSA and IMAC agents to make the effective traffic congestion prevention. The FMSA agent is functioning based on TCL algorithm.The TCL Algorithm is constrained with the threshold velocity loop counter (TV) depending upon road lane. The TV and Objective Function (OF) are calculated by,

Threshold Velocity Loop Counter (TV) = V_{min} + Pre-estimated total Velocity of vehicles on the road lane.

Objective Function (OF) = $\sum \Delta v / \Delta t = \sum (v_f - v_i) / (t_f - t_i)$

Where Δv = change in velocity, v_i = initial velocity of vehicle at departure time, v_f = final velocity of vehicle at arrival time, Δt = change in time, t_i= departure time of a vehicle, t_f = predicted arrival time of a vehicle.

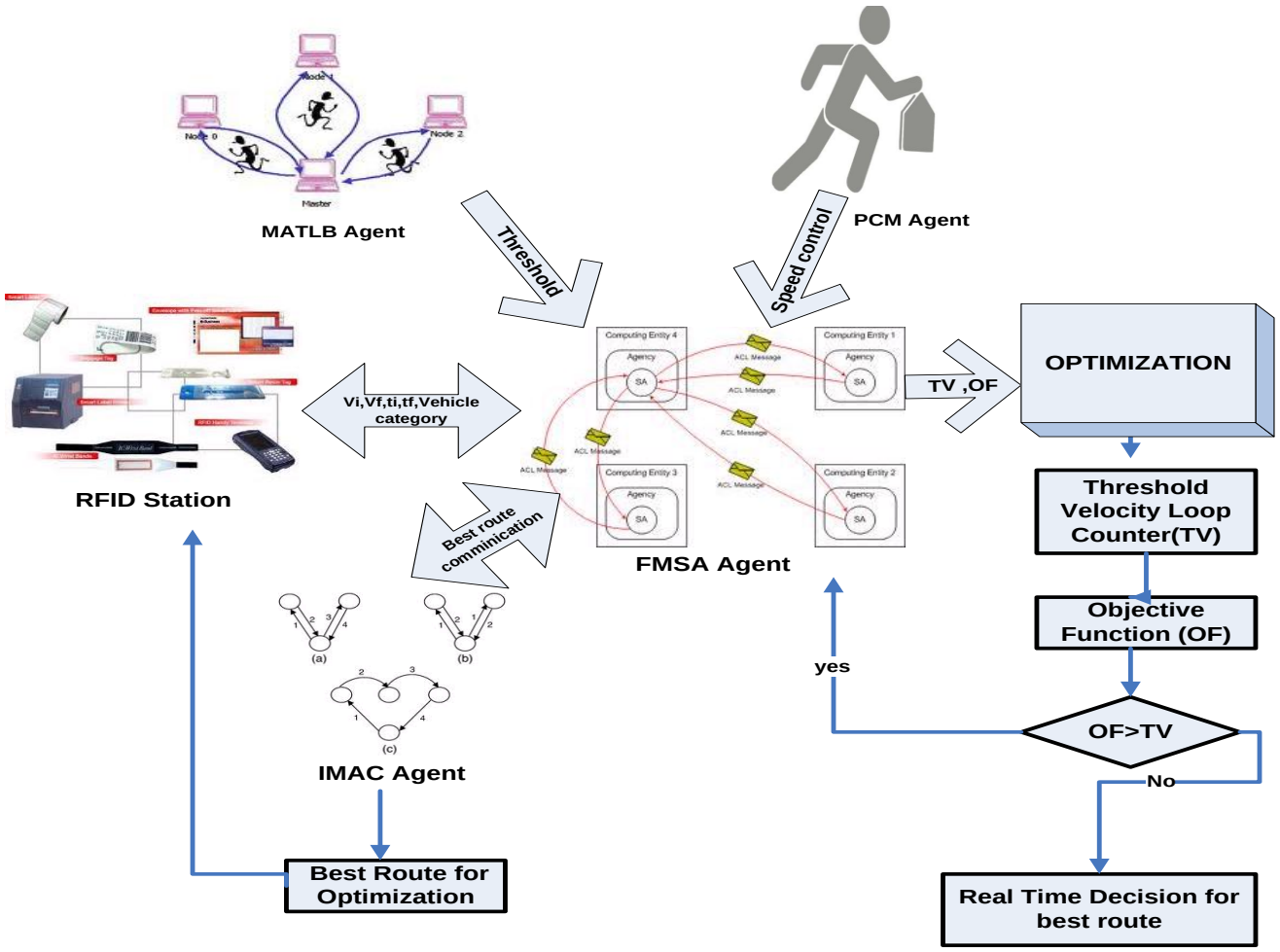

Fig 2: FUNCTIONING OF FMSA, IMAC AGENTS

The TCL Algorithm is executed on order to obtain best possible solution. The steps of TCL algorithm are as
(i) Generate threshold velocity loop counter depending upon the road lane.
(ii) Evaluate objective function by calculating the acceleration of vehicles in the existing road lane.
(iii) Check, if objective function is greater than the threshold velocity loop counter or not
(iv) If the objective function is greater than the TV, then FMSA sends communication to IMAC agent to find the best route based on departure time that is maintained in RFID stations.
(v) if not, the model makes 'real time decision' as to find best route for the vehicle.

V. EXPERIMENTAL RESULTS

The system applications appear to be very promising. The system shows the significant performance improvement with the comparison of before and after implementation of agents to avoid traffic congestion in great way by considering the velocity of vehicles in the road lane.[9] The model developed is based on TCL algorithm, which optimizes the traffic transportation system in real time providing the best route from RFID station and consuming time to reach the destination, so that the congestion can be greatly avoided in any situation.

Microscopic simulator was used to evaluate the behavior of the model using FMSA and IMAC agents shown in the figure 2 with simulated commuter traffic and actual signal phasing. JADE and Java were used in the system side of the model and the simulations have done for a one-hour duration for two cases using TCL algorithm.

(i)Objective Function (OF)>Threshold velocity Loop counter(TV)
(ii) Objective Function (OF) <Threshold velocity Loop counter(TV)

The measure of effectiveness used for comparison of two cases included Data& Time, Location, road status, TV, Objective function, Action taken. The performance of the model with MATLB agent and PCM agent & MATLB agent in co-ordination with PCM,FMSA,IMAC agents have been simulated on a particular day during the peak hours from 8.00 AM to 10.00 AM covering locations from Avinashi Road to Palladam in Coimbatore linking areas like AR(Avinashi Road), LM(Lakshmi Mills), PR(Puliakulam Road), OP(Ondipudur), LT(L&T Bye Pass Road), SL (Sulur) and PD(Palladam).

TABLE I. SIMULATED RESULTS OF PROPOSED MODEL BEFORE IMPLEMENTING FMSA,IMAC AGENTS[10]

Date & Time	Road Status	Location	Speed Control (Y/N)	Duration (min)	Action
28/06/2012, 08:00:01 AM	Normal	AR	N		n/a
28/06/2012, 08:15:02 AM	Normal (termination area)	LM	Y		Msg to HEBS
28/06/2012, 08:20:10 AM	Normal (activity area)	PR	Y		Msg to HEBS
28/06/2012, 08:30:17 AM	Congested	OP	Y		Msg to HEBS
28/06/2012, 08:32:19 AM	Normal	OP	N	7	Traffic cleared
28/06/2012, 08:45:45 AM	Normal (transition area)	LT	Y		Msg to HEBS
28/06/2012, 08:55:19 AM	Normal	SL	N		n/a
28/06/2012, 09:25:18 AM	Congested (with Emergency Vehicle	PD	Y(other vehicles), N(emergency vehicle		Msg to HEBS & RFID tag for lane clearance
28/06/2012, 09:27:28 AM	Congested	PD	Y		Lane cleared for emergency vehicle
28/06/2012, 09:29:54 AM	Normal	PD	N	9	Traffic Cleared

TABLE II. SIMULATED RESULTS OF PROPOSED MODEL AFTER IMPLEMENTING FMSA & IMAC AGENTS

Date & Time	Road Status	Location	Speed control(Y/N)	TV m/s	OF m/s	Duration (min)	Action
22/07/2012, 08:00:01 AM	Normal	AR	N	60	43		n/a,real-time decision by IMAC
28/06/2012, 08:15:02 AM	Normal (termination area)	LM	N	60	54		n/a,real-time decision by IMAC
28/06/2012, 08:20:10 AM	Congested (activity area)	PR	Y	50	62		IMAC receivemsg from RFID for best route
28/06/2012, 08:25:34	Normal	PR	N	50	45	2	Traffic Cleared
28/06/2012, 08:30:17 AM	Normal	OP	N	50	42		n/a,real-time decision by IMAC
28/06/2012, 08:45:45 AM	Congested	LT	Y	70	79		IMAC receivemsg from RFID for best route
28/06/2012, 08:52:19 AM	Normal	LT	N	70	63		Traffic Cleared
28/06/2012, 09:15:18 AM	Congested (with Emergency Vehicle	SL	Y	60	69		IMAC receivemsg from RFID for best route
28/06/2012, 09:26:28 AM	Normal	SL	N	60	54	3	Traffic Cleared
28/06/2012, 09:49:54 AM	Normal	PD	Y	60	52		n/a,real-time decision by IMAC

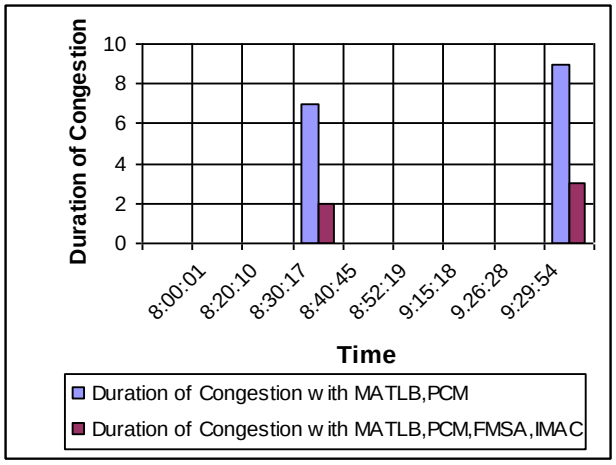

Fig 3: PERFORMANCE MEASURE OF MATLB, PCM, FMSA, IMAC AGENTS

From the simulation results, it is found that the proposed model showed 46% reduction in travel time of a vehicle in the existing lane using MATLB, PCM in co ordination with FMSA, IMAC Agents and was able to reduce the delay by 61% in traffic congestion scenario .However, it should be noted that the proposed method reduces the average delay of all the vehicles in the simulation in order to prevent traffic congestion in an effective way.

VI.CONCLUSION

This paper aims at optimizing real-time traffic which would lead to major improvement in terms of the performance of road networks using agent technology. The proposed Optimization model using FMSA, IMAC can give better results compared to the existing models using other agents. The simulation results shown in the Table I & Table II gives the output of vehicles in case of before and after the implementation of FSMA & IMAC agents respectively, thus showing a significant performance increase after the implementation of agents in the current scenario. Obviously it is worthwhile to use TCL algorithm for an effective prevention of Traffic congestion in order to improve overall performance of Intelligent Traffic and Transportations system. Coordination between this proposed model and satellite map can be considered for the future research of work.

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