Traffic Handling Approach with Intelligent Speed Control and Prioritization of Emergency Vehicles using PCM Agent

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Abstract

The agent based architecture proposed in this paper is an intelligent traffic monitoring agent that controls the speed of the vehicles in a particular lane at a particular location using sensors, mobile agents and RFID technology. The proposed system also categorizes high priority and emergency vehicles to give priority over all the other vehicles in a lane using mobile agent approach making the architecture lightweight. By deploying this architecture, vehicles can be controlled at desired locations there by proportionately controlling traffic density and congestion management taking into consideration the movements of real time emergency vehicles.

Keywords

SALSA, MATLAB, PCM, RFID, Hall Effect Based Sensors

1. Introduction

Improved technologies and sophistication has taken the automotive industry to greater heights gradually increasing the number of vehicles and vehicle owners thronging the city roads making it a great challenge for the city development council. Due to heavy usage of vehicles with excessive or inappropriate speed, unexpected road hindrances, leads to fatal accidents and severe congestion. This situation cripples the movement of emergency and high priority vehicles.

The key idea behind this proposal is to manage congestion effectively and also to prioritize the vehicles in emergency situation using mobile agent based approach using Prioritization and Congestion Management Agent (PCM Agent).

PCM agents are autonomous agents that is capable of keeping count of vehicles in a particular lane, tracking and controlling vehicle speed, and managing movement of emergency vehicles.

2. Concept of PCM Agent

Agent technology is gaining importance in almost all the real time applications and scenario, because of its features that provide flexible and portable solutions with user-friendly and environment friendly approach. Agent technology provides dynamic services through its property of mobility and adaptability [4].

The PCM agent works in co-ordination with MATLAB agent [5], Hall Effect based sensors, RFID tags, camera, wireless module. The vehicles are continuously monitored by cameras fixed at specific locations in the highway and these images are taken by MATLAB agent and PCM agent. The MATLAB agent uses the captured image to count the movement of vehicles in a lane and the PCM agent uses the captured image for vehicle identification that helps in categorization and prioritization in emergency situation. The PCM agent takes into consideration the factors like number of lanes in a ramp, image of the vehicle, alert sound produced by the vehicle, status of beacon lights of the vehicle to identify emergency vehicles and to give priority to those vehicles.

3. Proposed Architecture with PCM Agent

The various hardware and software components that make up this architecture are camera, SALSA middleware, mobile agents MATLAB and PCM, RFID tags and Hall Effect based sensors. The camera is fixed on polls of highways or on any other tall structures to monitor the movement of vehicles in the environment [9]. The camera is used for capturing the images of vehicles on the highway.

The support of SALSA middleware is mandatory that identifies vehicles and keeps a count of vehicles along with their type in a particular lane by considering the threshold value that is predetermined. The MATLAB agent is the agent that co-ordinates the activities of the sensors, camera, SALSA middleware, filters, PCM agent, effectors [5].

The PCM agent is responsible for controlling the
speed of vehicles in case of congestion when the degree of congestion increases and it is also responsible for detecting emergency and high priority vehicles. It also clears the lane for emergency vehicles by controlling the traffic signals [6].

The Hall Effect Based Sensor located in the wheel of a vehicle is used for controlling the speed of that particular vehicle based on instruction received from the PCM agent through RFID tags [10].

4. Structure and Functioning Of PCM Agent in Traffic Handling Scenario

![Image of function of PCM Agent]

The Hall Effect Based Sensor located in the wheel of a vehicle is used for controlling the speed of that particular vehicle based on instruction received from the PCM agent through RFID tags [10].

The objective of the prescribed architecture with PCM Agent and MATLAB agent is to automatically control the speed of vehicles thereby avoiding congestion and also to identify high priority and emergency vehicles on the lane and giving priority to those vehicles by clearing the lane. This proposed architecture acts as an intelligent traffic monitor and controller that provides a hassle free driving experience considerable avoiding the problems of longer wait time due to congestion, avoidance of accidents, improve the fuel efficiency by limiting the speed of the automobile proportionately improving mileage.

The proposed architecture is inevitable for the investigation and upgradation of performance in road traffic. This dynamic model initiates with the activation of camera which is fixed on polls to overlook the traffic scene and to capture the images of vehicles in a particular lane. Images extracted from the camera and then analyzed by the MATLAB Agent and the PCM Agent simultaneously for further processing. The MATLAB Agent counts the number of vehicles in that particular lane, compares with the threshold value[5] and sends the road status(Normal or Congested) to the PCM Agent in coordination with the SALSA middleware. If the status of the road is normal, the PCM Agent along with Hall Effect based sensors[1] and RFID tag, control the speed of the vehicles at four areas: the active warning area, the transition area, the activity area and the termination area to avoid accidents and improves fuel efficiency, considering road conditions, safety rules, climatic conditions and city speed limit. Else, if the status of the road is congested, the PCM Agent identifies the high priority or emergency vehicles like Ambulance (through their flashing red light, sound, image ) in that lane and clears the lane for that vehicle without controlling the speed for those vehicles. The lane is cleared by PCM Agent that controls the active traffic signal to identify the vehicles as they pass by giving preference to emergency vehicles and assisting in surveillance in a large scale. If the road has two lane ramp, the PCM Agent instructs the active signals to turn green in the lane in which the emergency vehicles can move and hold the other lane red ,clearing the path for the emergency vehicles. If the road has single-lane ramp, the PCM Agent just instructs the active signals to turn the red light to green and flush out the vehicles to clear the way for high priority or emergency vehicles[6]. This model along with MATLAB and PCM agent will results in reduced traffic accidents and safer, more efficient roadways all over the country.
5. Operation Mode of MATLAB and PCM Agents

![Diagram of Operation Mode of MATLAB and PCM Agents]

In the proposed model MATLAB and PCM Agent[5] works in co-ordination to control and handle real time traffic effectively. The MATLAB agent is responsible for providing the status of the road based on the count mechanism of vehicles done by SALSA middleware, parallel the PCM Agent is responsible for controlling the speed and handling high priority and emergency vehicles by clearing the lane.

6. Experimental Study

The performance of the system with MATLAB agent and MATLAB agent in co-ordination with PCM agent 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). The simulation has been carried out using Qualnet network simulator tool and the results show strong improvement in handling congestion, high priority and emergency vehicles.

Table 1: Simulated Results of MATLAB without PCM Agent

<table>
<thead>
<tr>
<th>Date &amp; Time</th>
<th>Road Status</th>
<th>Location</th>
<th>Duration (min)</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>28/06/2012, 08:00:01 AM</td>
<td>Normal</td>
<td>AR</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>28/06/2012, 08:15:02 AM</td>
<td>Normal</td>
<td>LM</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>28/06/2012, 08:20:10 AM</td>
<td>Congested</td>
<td>PR</td>
<td></td>
<td>Msg to Control Room</td>
</tr>
<tr>
<td>28/06/2012, 08:25:34 AM</td>
<td>Normal</td>
<td>PR</td>
<td>5</td>
<td>Traffic Cleared</td>
</tr>
<tr>
<td>28/06/2012, 08:30:17 AM</td>
<td>Normal</td>
<td>OP</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>28/06/2012, 08:45:45 AM</td>
<td>Congested</td>
<td>LT</td>
<td></td>
<td>Msg to Control Room</td>
</tr>
<tr>
<td>28/06/2012, 08:52:19 AM</td>
<td>Normal</td>
<td>LT</td>
<td>7</td>
<td>Traffic Cleared</td>
</tr>
<tr>
<td>28/06/2012, 09:15:18 AM</td>
<td>Congested</td>
<td>SL</td>
<td></td>
<td>Msg to Control Room</td>
</tr>
<tr>
<td>28/06/2012, 09:26:28 AM</td>
<td>Normal</td>
<td>SL</td>
<td>11</td>
<td>Traffic Cleared</td>
</tr>
<tr>
<td>28/06/2012, 09:49:54 AM</td>
<td>Normal</td>
<td>PD</td>
<td>n/a</td>
<td></td>
</tr>
</tbody>
</table>
### Table 2: Simulated Results of MATLB in coordination with PCM Agent

<table>
<thead>
<tr>
<th>Date &amp; Time</th>
<th>Road Status</th>
<th>Location</th>
<th>Speed Control (Y/N)</th>
<th>Duration (min)</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>28/06/20, 08:00:01 AM</td>
<td>Normal</td>
<td>AR</td>
<td>N</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>28/06/20, 08:15:02 AM</td>
<td>Normal (termination area)</td>
<td>LM</td>
<td>Y</td>
<td>Msg to HEBS</td>
<td></td>
</tr>
<tr>
<td>28/06/20, 08:20:10 AM</td>
<td>Normal (activity area)</td>
<td>PR</td>
<td>Y</td>
<td>Msg to HEBS</td>
<td></td>
</tr>
<tr>
<td>28/06/20, 08:30:17 AM</td>
<td>Congested</td>
<td>OP</td>
<td>Y</td>
<td>Msg to HEBS</td>
<td></td>
</tr>
<tr>
<td>28/06/20, 08:32:19 AM</td>
<td>Normal</td>
<td>OP</td>
<td>N</td>
<td>Traffic cleared</td>
<td></td>
</tr>
<tr>
<td>28/06/20, 08:45:45 AM</td>
<td>Normal (transition area)</td>
<td>LT</td>
<td>Y</td>
<td>Msg to HEBS</td>
<td></td>
</tr>
<tr>
<td>28/06/20, 08:55:19 AM</td>
<td>Normal</td>
<td>SL</td>
<td>N</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>28/06/20, 09:25:18 AM</td>
<td>Congested (with Emergency Vehicle)</td>
<td>PD</td>
<td>Yothe r vehicle s), Nieme rgency vehicle</td>
<td>Msg to HEBS &amp; RFID tag for lane clearance</td>
<td></td>
</tr>
<tr>
<td>28/06/20, 09:27:28 AM</td>
<td>Congested</td>
<td>PD</td>
<td>Y</td>
<td>Lane cleared for emergency vehicle</td>
<td></td>
</tr>
<tr>
<td>28/06/20, 09:29:54 AM</td>
<td>Normal</td>
<td>PD</td>
<td>N</td>
<td>Traffic Cleared</td>
<td></td>
</tr>
</tbody>
</table>

**Fig 3: Performance Evaluation of PCM with MATLB**

From the Analysis, it is found out that PCM Agent in coordination with the MATLB provides efficient congestion Management and instant handling of High priority & emergency vehicles. In case of congestion the PCM Agent consumes minimum time duration for clearing the vehicle.[5]

**7. Related Work**

In this paper the MATLB agent that works in coordination with the proposed Mobile Agent PCM is an approach defined by us in the paper Mobile Agent Approach for Traffic Load Balancing Using Sensors. This MATLB agent can be combined to work together with the PCM agent by providing appropriate road status information. Based on the information provided by the MATLB agent the PCM agent controls the speed of vehicles in case of warning area, activity area, termination area and interconnection area. The PCM agent also identifies emergency or high priority vehicles and gives clearance signal to these vehicles using RFID tags.

The MATLB agent along with SALSA middleware counts the number of vehicles in each type in a lane and compares it with a predetermined threshold value.[3] If the threshold value is less than the traffic intensity, then the traffic is considered normal else congested. This agent hence capable of determining the road status as normal or congested and this status is provided to the PCM agent for further processing [5].

According to Vikramaditya Dangi, Amol...
Parab, Kshitij Pawar & S.S. Rathod, the paper Image processing Based Intelligent Traffic Controller applies Image processing Edge detection methods to implement real time Emergency vehicle detection without considering the speed control factor.[9]

8. Conclusion

This paper highlights on functioning of Agent Technology along with sensors, SALSA middleware and RFID Technology considering real time traffic issues in metropolitan cities. This paper proposed architecture with Mobile agent PCM in coordination with MATLAB [5] for traffic control and handling high priority or emergency vehicles effectively. The PCM agent implemented in this architecture is based on the combination of two technologies (i) Hall Effect Based Sensors located in the wheels of the vehicles for high accuracy speed measurement,(ii)RFID tagging of traffic signals for controlling the active signal and clearing the lane for high priority or emergency vehicles. The experimental study described in this paper has been carried out using traffic signals, MATLAB agent, PCM Agent, RFID technology and Sensors. The simulation results showed that the proposed architecture with PCM Mobile agent handles unexpected traffic circumstances successfully by reducing congestion and time period of congestion clearance thereby providing an effective way for dynamic transportation services.

9. References