\documentclass[conference]{IEEEtran}

\IEEEoverridecommandlockouts

% The preceding line is only needed to identify funding in the first footnote. If that is unneeded, please comment it out.

\usepackage{cite}

\usepackage{amsmath,amssymb,amsfonts}

\usepackage{algorithmic}

\usepackage{graphicx}

\usepackage{textcomp}

\usepackage{xcolor}

\def\BibTeX{{\rm B\kern-.05em{\sc i\kern-.025em b}\kern-.08em

T\kern-.1667em\lower.7ex\hbox{E}\kern-.125emX}}

\begin{document}

\title{Smart Traffic Lights with RSUs\\

{\footnotesize \textsuperscript{\*}Note: Sub-titles are not captured in Xplore and

should not be used}

\thanks{Identify applicable funding agency here. If none, delete this.}

}

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\maketitle

\begin{abstract}

Current traffic lights approach is based on predefined cycles or manual control, we have observed this\cite{b7}

would create an unnecessary load on traffic congestion.To solve this issue we developed a new approach.

\end{abstract}

\iffalse Assign links to abbreviations with our approach.\fi

\begin{IEEEkeywords}

RSU(Road size unit)

\end{IEEEkeywords}

\section{Introduction}

This approach is about calculating cars on the road and optimizing the lights on behalf the calculated data.For processing the data , we can use weight based priority algorithms with road superiority restrictions.As for the real life implementation, we can use road side units(RSU) to calculate car number on a road via their connections to unit and after the data collected we can distribute it to algorithm to decide traffic lights cycles.

With this approach we can ease the congestion problem created by traffic lights also we can arrange the road flow for the high priority vehicles like ambulance and we can make savings from electricity which is used by idle traffic lights.

\section{BACKGROUND, RELATED WORKS AND OUR CONTRIBUTIONS}

\subsection{Current Approaches}

For normalizing the flow of traffic there are already some methods. One of the method is putting surveillance cameras on top of the traffic lights. With these cameras there are two techniques to regulate the traffic.

\begin{enumerate}

\item Assigning a person to watch the camera outputs and then detect in which hours the traffic is congested or not.

\item Using image recognition and machine learning techniques to overcome the need for humans. The AI behind this process does the same thing as humans assigned to do this job.

\end{enumerate}

\subsection{Problems of Current Approaches}

\begin{enumerate}

\item Assigning a human :

\begin{itemize}

\item Assigning a worker to implement traffic lights timer calculations is inefficient and it is bound to affiliate with human error.

\item Continuous loss of money for wages of human workers.

\end{itemize}

\item Using recognition and machine learning :

\begin{itemize}

\item Hard to get accurate data sets to train AI with machine learning techniques.

\item It needs high level computation power for every new training sets.

\end{itemize}

\iffalse \textbf{we may back this accusation with individual data sets} \fi

\end{enumerate}

\section{Artificial Intelligence And Calculations}

\subsection{Rsu Assumptions}

\subsection{Rsu Calculations}

\subsection{AI Template}

\subsection{AI Assumptions}

\section{Training Environment And Experiment Case Setup}

We will use SUMO simulation environment backed by an AI which was created with Java to

create and test data sets with our approach. Also, we need Python in order to dynamically change traffic light's state. With Python we will have access to "Traci" library which can be used to dynamically manipulate the traffic lights.

\begin{enumerate}

\item Environment Setup

\begin{itemize}

\item First we need to install the SUMO framework in order to simulate our tests.

\item Then we need to create the test environments.

\item At last we implement our approach on the created simulation and produce a data set to compare with other implementations

\end{itemize}

\item Case Selection

\begin{itemize}

\item Multi road cross-overs etc.

\item Changing road sizes

\item Different vehicle speeds

\item Different vehicle amounts

\end{itemize}

\end{enumerate}

\iffalse \textbf{Edit here again with "after test" perspective on later} \fi

\section{Feasibility Test}

We have done our feasibility test. According to our feasibility test we can calculate the (best red light / green light) ratio before the simulation starts. After this calculation we can send the vehicles one by one in each lane. This way, we can simulate the server-client relationship between RSU's and AI. "ADD NetEdit and SUMO works HERE"

\section{Performance Evaluation}

In order to come to conclusion that our proposed system is better than standard traffic lights, we need to check a few variables. Those variables are:

\begin{itemize}

\item Difference between ratio of vehicle amounts

\item Different road combinations

\end{itemize}

In "Different speed of vehicles" and "Difference between ratio of vehicle amounts" tests we will use the following map in SUMO.

\centering\includegraphics[width=5cm]{testcase\_1.jpg}

As it can be seen, there are 4 lights in the test scene. The vehicles will come from all sides of the road. The roads adjacent to each other are the same in all of the tests which uses this map.

Default red light duration is 2 minutes. Default green light duration is 30 seconds. We accept that these values are the standard traffic light values. We need to get better results in each cases in order to prove that our system is better.

\subsection{Difference between vehicle amounts}

\begin{table}[h!]

\centering

\begin{tabular}{||c c c||}

\hline

Car Amount In Vertical & Car Amount In Horizontal & Time(s) \\ [0.5ex]

\hline\hline

30 & 60 & 428 \\

\hline

30 & 90 & 492 \\

\hline

30 & 120 & 506 \\

\hline

\end{tabular}

\end{table}

The figure above represents the standard traffic light's values. The first column represents the amount of cars in the vertical road in our map. The second column represents the amount of cars in the horizontal road in our map. The third column represents the simulation's duration in seconds.

\begin{table}[h!]

\centering

\begin{tabular}{||c c c||}

\hline

Car Amount In Vertical & Car Amount In Horizontal & Time(s) \\ [0.5ex]

\hline\hline

30 & 60 & 351 \\

\hline

30 & 90 & 481 \\

\hline

30 & 120 & 506 \\

\hline

\end{tabular}

\end{table}

The figure above represents the proposed traffic light's values. The first column represents the amount of cars in the vertical road in our map. The second column represents the amount of cars in the horizontal road in our map. The third column represents the simulation's duration in seconds.

As it can be seen from the above two tables, proposed system is much more efficient if there are uneven load of traffics in each lane. The reason behind this is simple. Let's say, there are 60 vehicles in the vertical road at the start and 30 vehicles in the horizontal one. In standard system every lane gets the same time to pass the lights. So, in the end the road with the highest amount of cars will stay congested even though other road is empty. So, the cars are losing too much time in the red light.

In our system. RSU detects how many cars each road has, then AI calculates the optimum light durations for each light. So, the road which has the highest amount of vehicles, gets more green light.

The duration of the lights are listed below:

\centering\textbf{Case 1:}

\begin{table}[h!]

\centering

\begin{tabular}{||c c c||}

\hline

Cars & Red(s) & Green(s) \\ [0.5ex]

\hline\hline

30 & 135 & 45 \\

\hline

60 & 45 & 135 \\

\hline

\end{tabular}

\end{table}

\centering\textbf{Case 2:}

\begin{table}[h!]

\centering

\begin{tabular}{||c c c||}

\hline

Cars & Red(s) & Green(s) \\ [0.5ex]

\hline\hline

30 & 49.8 & 100.2 \\

\hline

90 & 100.2 & 49.8 \\

\hline

\end{tabular}

\end{table}

\centering\textbf{Case 3:}

\begin{table}[h!]

\centering

\begin{tabular}{||c c c||}

\hline

Cars & Red(s) & Green(s) \\ [0.5ex]

\hline\hline

30 & 120 & 30 \\

\hline

120 & 30 & 120 \\

\hline

\end{tabular}

\end{table}

\iffalse \textbf{ADD REFERENCE \fi

\centering\includegraphics[width=8cm]{vehicleAmountDif.JPG}

\centering\textbf{Results in graph}

\subsection{Difference between road types}

For this test we have prepared 3 test areas. Those areas are a Major road(5 lanes road) vs. Street road(1 lane road), Minor road(4 lanes) vs. Street road(1 lane) and Primary road(3 lanes) vs Street road(1 lane road).

\centering\includegraphics[width=8cm]{MajorvsStreet.JPG}

\centering\textbf{Major road vs. Street road}

\centering\includegraphics[width=8cm]{MinorvsStreet.JPG}

\centering\textbf{Minor road vs. Street road}

\centering\includegraphics[width=8cm]{PrimaryvsStreet.JPG}

\centering\textbf{Primary road vs. Street road}

\end{document}