Chapter 12
Traffic Responsive Signal Timing Plan Generation Based on Neural Network

Azzam-ul-Asar
University of Engineering & Technology, Pakistan

M. Sadeeq Ullah
University of Peshawar, Pakistan

Mudasser F. Wyne
National University, USA

Jamal Ahmed
University of Peshawar, Pakistan

Riaz-ul-Hasnain
University of Engineering & Technology, Pakistan

ABSTRACT

This article proposes a neural network based traffic signal controller, which eliminates most of the problems associated with the Traffic Responsive Plan Selection (TRPS) mode of the closed loop system. Instead of storing timing plans for different traffic scenarios, which requires clustering and threshold calculations, the proposed approach uses an Artificial Neural Network (ANN) model that produces optimal plans based on optimized weights obtained through its learning phase. Clustering in a closed loop system is root of the problems and therefore has been eliminated in the proposed approach. The Particle Swarm Optimization (PSO) technique has been used both in the learning rule of ANN as well as generating training cases for ANN in terms of optimized timing plans, based on Highway Capacity Manual (HCM) delay for all traffic demands found in historical data. The ANN generates optimal plans online to address real time traffic demands and thus is more responsive to varying traffic conditions.

INTRODUCTION

The growth in the number of automobiles on the roads has placed a higher demand on traffic control systems to efficiently reduce the level of congestion. As such this has increased travel delays, fuel consumption, and air pollution. One of the main causes of congestion is the inherent instability in traffic flow due to the behavior of human drivers. A long-standing problem in traffic engineering has been to optimize the flow of vehicles through a given road network. Traffic control in urban networks is a nonlinear process with varying dynamic characteristics throughout the day. Accurate, reliable, and timely traffic information is therefore critical for deployment and operation of Intelligent Transportation Systems (ITSs). It is a general understanding that, traffic forecasting for travelers and traffic operators should become at least as useful, accurate and convenient as weather reports.

Increased traffic congestion and the associated pollution are forcing experts in transportation to discover new approaches in managing rapid changes in traffic and develop procedures to keep our mobility safe, comfortable, and economical. IT-driven ITSs have recently emerged to meet this challenge. This emergence is seen by many as a part of normal evolutionary adaptation to new traffic conditions and technology. They consider current ITS applications perfectly adequate, safer and a wiser response for our current and future transportation problems (Wang F. , 2005). However, technological changes and theoretical developments have created opportunities for fundamental restructuring of transportation management that could lead to significantly expanded capacity and improved efficiency. Wang in (Wang F. , 2008) presents a research that pivots around an ACP (Artificial Computational Parallel) approach, involving modeling with artificial systems, analysis with computational experiments, and operation through parallel execution for control and management of complex systems, such as transportation systems, with social and behavioral dimensions (Wang F. , 2004) (Wang F. , 2007).

Researchers have presented different approaches utilizing a multitude of different environments. For signaled intersections, Xu Jianmin (Jianmin, Ning, & Hongbin, 2000) have used waiting vehicles of the red stage and the vehicles on the link of the green stage as the inputs in obtaining the traffic timing scheme. Liu Zhiyong (Zhiyong, Jin, & al, 1999) have used the queue length of the current stage and queue length of next stage as inputs and green time extension as the output. Xu Lunhui (Lunhui, Yanguo, & Wenliang, 2005) used the queue length of current green time stage and the queue length of the next stage as the input and the current green time as the output. In the traditional signaled traffic control system, each region is considered an isolated control unit, with no coordination between regional boundaries. The aforementioned are using fuzzy control to the single or two intersections' traffic control only and not to the coordination of different regions. It is worth mentioning that regional boundary's traffic control effect has direct influence on the input traffic flow control and output traffic flow control. In (Wang, Yang, & Guan, 2008) a traffic coordination and control model of regional boundary based on fuzzy control is proposed. Two fuzzy controllers are designed to coordinate and control the regional boundary when traffic congestion occurs. The proposed method has the potential to improve traffic conditions in each region and to some extent alleviate traffic congestion.

Since the traditional actuated signal control method only considers the information of cars arriving to the current green light signal stage, it has an obvious shortcoming. In order to improve the control effect, Laichour (Laichour & al., 2001) brought forward the concept model of traffic control based on an intelligent agent. Li (Li & Huangpu, 2000) presented fuzzy traffic signal control approach for an isolated intersection and

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