Chapter 4
Design and Implementation of an Intelligent Traffic Management System: A Neural Approach

Shamim Akhter
East West University (EWU), Bangladesh

Sakhawat Hosain Sumit
Socian Ltd., Bangladesh

Md. Rahatur Rahman
Simplexhub Ltd., Bangladesh

ABSTRACT

Intelligence traffic management system (ITMS) provides effective and efficient solutions toward the road traffic management and decision-making problems, and thus helps to reduce fuel consumption and emission of greenhouse gases. Software-based real-time bi-directional TMS with a neural network was proposed and implemented. The proposed TMS solves a decision problem, dynamic road weights calculation, using different environmental, road and vehicle related decision attributes. In addition, the development of the real-time operational models as well as their solving challenges has increased in a rapid manner. Therefore, the authors integrate the design and development of a neural-based complete real-time operational ITMS, with the combination of software modules including traffic monitoring, road weight updating, forecasting, and optimum route planning decision. Collecting, extracting the insights and inherit meaning, and modeling the tremendous amount of continuous data is a challenging task. A discussion is also included with the future improvements on ITMS.

DOI: 10.4018/978-1-5225-5832-3.ch004

INTRODUCTION

Intelligence Traffic Management System (ITMS) incorporates modern emerging technologies including information processing, intelligent embedded systems, internet and wireless communication, electronics, and etc., to provide continuous or pre-selected travel information, congestion alleviation, incident detection and/or guide optimal route (re-route) to travelers, vehicles and infrastructure. Four (4) major stages including data collection, data processing, decision making stages, and information delivery, are involved within an ITMS. Software based real time bi-directional traffic management system (TMS) with Artificial Neural Network (ANN) was proposed and implemented in (Rahman & Akhter, 2015a; 2015b; 2015c). The proposed TMS solved a decision problem, dynamic road weights calculation, using different environmental, road and vehicle related decision attributes. Back Propagation Neural Network (BPNN) with Levenberg-Marquardt (LM) optimization was adopted in (Akhter et al., 2016) to replace DT. NN classifies four (4) different decision classes, and they correspond to four (4) different weight increment/decrement values. Cluster based classifications are able to find the optimum number of classifications in each attribute and can improve the classification performance of the ITMS. With this hypothesis, Hierarchical and K-means clustering were applied on environmental data in (Nawrin et al., 2017), and Dunn-Index cluster validation technique was performed better.

Current ITMS has two (2) different decision making frameworks- road weight updating and future road weight forecasting. Forecasting is helpful due to the estimation of optimum routes and reduces the effects of traffic jam in advance. Exponential Weighted Moving Average (EWMA) algorithm (Reporter, 2016) on time series data was used in (Rahman & Akhter, 2015c) to calculate the predicted factor values on time series rainfall data. However, the performance is not so adequate. Therefore, we incorporate an experimental measurement of accuracy level for other road weight factors separately. The evaluation results for weight influencing factors using EWMA achieves accuracy level 72.93% for rainfall, 85.81% for temperature, 45.15% for humidity, 18.52% for wind, and 16.45% for road status.

In addition, building the interoperability between classifications and clustering algorithms is necessary. BPNN was performing well by providing classification result only but the decision for the actual weight calculation or weight mapping was missing. Therefore, in this chapter, we integrate the design and development of a neural based complete real time operational ITMS, with the combination of software and hardware based modules including traffic monitoring, road weight updating, forecasting, congestion management, and optimum route planning decision. Figure 1 presents the integrated design framework.

Data collection is another dimension; for this kind of research. Intelligent data crawling feature is enhanced to collect required data automatically from assigned web domain. However, their coverage is limited to city level congregate information and location/area/road segment based high resolution information is necessary for real time TMS decision. Thus, in this chapter, a prospect of Internet of Things (IoT) based online integrated sensors are also included in future research directions section.

RELATED WORK

Radio and television are common service providers to broadcast traffic related estimated information. Several web sites contribute on-line based real time traffic condition services. Over the time, different