Dynamic Approach For Optimizing Bus Timetables And Passenger Waiting Time

Toby Subhash[1],Nisha Mohan P.M[2], Smitha C Thomas[3]
[1, 2, 3] Dept of Computer Science & Engineering
[1, 2, 3] Mount Zion College of Engineering Kadammanitta, Pathanamthitta, Kerala

Abstract- *Public transit is one of the most important service sectors of a modern city to satisfy people's intra-city transportation requirements.Dynamic bus dispatching in transit system plays a very important role since it is directly related to the daily operations of a transit agency. The main difficulty of dynamic bus dispatching lies in the fact that a lot of exceptional events or factors are required to be efficiently processed in transit system based on the current bus running plan and crew allocation plan. In the literature papers on dynamic bus dispatching, the assumption that bus timetables on stops are predetermined may not be true for many developing countries, and a set of state space variables corresponding to real time environment information related to transit system is not fully integrated into the dynamic bus dispatching models. Targeting the above challenges, this paper proposes a bus dispatching model based on arrival time and passenger flow prediction. First, the transit data from the bus and passenger waiting data from the bus station are collected & processed. Second, the components of bus arrival time and passenger flow are predicted based on long short-term memory. Finally, the genetic algorithm-based bus dispatching model searches the minimum waiting time for passengers by using stay strategy.Such a strategy would produce a minimal passengers' average travel time coefficient. It is a great help for promoting the transit service level and increasing competitiveness.*

Keywords- Bus dispatching, public transit, minimizing passenger waiting time, long short term memory

I. INTRODUCTION

Public transit is one of the most important service sectors of a modern city. India's transport caters to the needs of 1.3 billion people and contributed about 5.6 percent to India's GDP, with road transportation contributing the lion's share. Compared with private means of travel, public offers of low fare and large passenger capacity and it can effectively reduce road traffic flow; alleviate traffic congestion and air pollution.

India has traditionally boasted an extensive public transportation system, being the second largest producer of buses, accounting for 16 percent of world's total bus production. However, the share of public transportation in Indian cities has been on a steady decline over the last few decades due to, among other reasons, poor management of services. One of the major factors responsible for the success or failure of any public transport service is its reliability. One way of improving the reliability is to provide passengers with accurate and reliable information regarding the service. This report describes a study performed on this important aspect, viz. bus arrival time prediction, a key field covered under the wide umbrella of ITS.

II. LITERATURE REVIEW

Methods to forecast bus arrival times are proposed by Dessouky et al. [1], and they further presented a variety of real-time strategies executed at the transfer stops and comparisons of these strategies based on real-time information.

Chien et al. [2] developed link-based and path-based ANN models to predict bus arrival time dynamically. They used simulated data on volume and passenger demand using CORSIM simulation software. They developed an adaptive algorithm for bus travel time prediction. They stated that conventionally used back propagation algorithms are difficult to implement for real time applications due to its lengthy learning process. They reported that ANN outperformed the models without integration of adaptive algorithm.

Lin and Zeng [3] considered dwell time as one of the independent variables in their travel time prediction models. The RTIS algorithm for estimating the current and instantaneous travel times using automatic vehicle identification (AVI) data was proposed by Tam et al [4]. Ma et al. [5] proposed a short-term bus passenger demand prediction method using an interactive multiple model-based pattern hybrid (IMMPH). Suwardo et al. [6] proposed an Autoregressive Integrated Moving Average (ARIMA) to predict bus travel time using travel time series data. Yang et al. [7] proposed a prediction model of bus arrival times based on a Support Vector Machine with a genetic algorithm (GA-SVM) in Shenyang A short-term railway passenger demand forecasting model based on multiple temporal unit neural network (MTUNN) and parallel ensemble neural network (PENN) was proposed by Tsai et al [8].

Luo et al. [9] provided an optimization model for dynamic bus dispatching to minimize the overall waiting time of passengers in a transit system by considering multiple types of real-time information

A bus dispatching model that accounts for passenger occupancy rate and the profit of public transport companies to minimize costs has been developed by Li et al. [10]

Strathman et al. designed a framework for an assignment focuses on documenting service reliability and passenger activity at pre-operational (baseline), initial and full implementation period

III. EXISTING SYSTEM

The existing system models the bus dispatching as a finite state stochastic decision process and uses an optimal dispatching policy which was derived into its analytical form by backward induction and makes use of stored passenger information and bus routes.

IV. LIMITATIONS OF THE EXISTING SYSTEM

The three main limitations of existing works include the following: (1) most studies only considered passenger flow in the bus station and ignored the real-time information such as traffic congestion, weather factors, etc.; (2) some studies only considered simple single lines, avoiding the transfer problem of multiple lines; (3) some studies only increased departure frequency and ignored the prediction of passenger flow and the arrival time of buses. Targeting these issues, this paper introduces a dynamic bus dispatching model considering both passenger flow and bus arrival time

V. PROPOSED SYSTEM

The total waiting time of passengers can be minimized by using a long short-term memory (LSTM), which is an artificial recurrent neural network (RNN) architecture used in the field of deep learning. The training data consisting of the bus arrival time and the passenger flow data. *Fig.1* shows the workflow of the proposed system which can be divided into four parts:

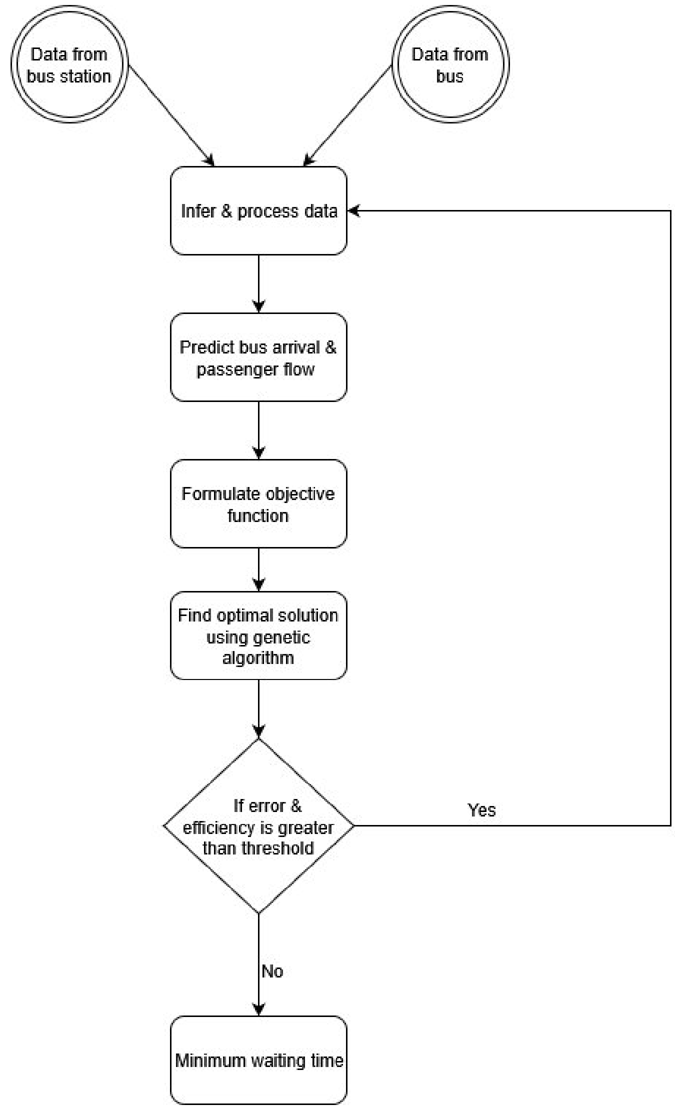

Fig 1 : Proposed system's workflow

A. Data Inference

Map matching between the bus GPS data & the location of each station is used to infer the bus arrival parameters. Each passenger must have an IC card that can be used for travel & the passenger flow is inferred from IC-card swiping records. The first swipe of the day made by the passenger while entering a bus is considered as boarding. If there are no entry swipes after the last exit swipe for a period of 20 minutes, the last swipe is considered as the alighting swipe else the passenger is assumed to be in transfer if an entry swipe is made within 20 minutes at the last alighting station or a station nearby .

B. Prediction Module

The boarding, alighting & transferring data can be used as unique features for the prediction module. The day of the week, holiday, and weather of each day are regarded as common features. The number of passengers at the next day is taken as the label of the current segment. The common features, unique features, and labels are combined into input data, which is input to the prediction model.The arrival time, boarding, alighting and transfer passengers are predicted using a Multilayer LSTM & passenger flow features and bus arrival times are estimated on different days.

C. Objective function

An objective function is defined to minimize the passenger waiting time.The decision variable to the function will be the time spent by the passenger in the bus station till the bus arrives, which includes the waiting time of passengers who were not affected by the bus stay strategy & the waiting time of passengers who were waiting for the bus that was delayed. The former quantity will be less than the latter. The optimal solution of the objective function is determined using genetic algorithm.

Genetic algorithms are used in computational optimization models. They simulates the natural evolution process, which continuously searches and updates the optimal solution after repeated iterations and calculating the value of the fitness function. More optimal configurations survive to the next ‘‘generation’’. For the current problem a ‘‘gene’’ represents a bus staying time at the transfer station. The gene undergoes multiple mutations & at each stage, the fittest gene is selected according to a selection criteria & the mutation continues till the convergence condition is satisfied. The final gene selected represents the optimized value.

D. Feedback & Adjustment Module

For feedback and adjustment model is defined, which calculates the feedback coefficient according to the prediction error of the LSTM and the convergence efficiency of the objective function. The values of feedback coefficients are used to judge the necessity of data updates and neural network retraining and adjust the probability of crossover and variation. If the value of the loss function is lower than a threshold after enough training using a three-layer LSTM neural network, the training stops and the prediction results are output from the output layer

VI. CONCLUSION

This paper introduced a bus dispatching model based on dynamic arrival times and passenger flow predictions. Future passenger flow and bus arrival time information was extracted to plan bus dispatching in advance. Two benefits of the approach are: (1) the presented method ensures that more passengers can catch up with stranded buses at transfer and subsequent stations, thus reducing their waiting time. (2)A bus stay strategy is proposed for transfer stations to avoid long delays waiting for other buses. In this way, the total waiting time of passengers is minimized. The optimal solution of the objective function is found using a genetic algorithm.

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