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EFFICIENT AND DYNAMIC ROUTE PLANNING AND OPTIMIZATION SYSTEM FOR PUBLIC TRANSPORTATION

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Abstract – *Public bus transportation is ever-changing in terms of demands of commuters. These demands for the most part have been underplayed by the static and rigid nature of the existing route planning system. Failing to keep up with the demands has reduced the utilization rate of these services and in turn reduced the profitability, inevitably rendering the routes less viable. This paper is published with the idea of overcoming the aforementioned drawbacks that presently exist in the system by intelligent scheduling of buses in routes and optimizing the routes thus accounting for increased profitability and viability.*

Key Words: **Route Planning, Optimization, Dynamic Scheduling**

1. INTRODUCTION

Present day transportation systems have a major contribution from public transportation systems. One such public transportation system is the metropolitan bus service that connects people with places over a city. These buses operate in various identified routes taking commuters to their destinations and easing movement of people.

Route planning is the process of identifying viable and required routes in a geographical area based on the movement of people, the population of that geographic location, the accessibility index and frequency of movement of people. The route planners take these parameters into account and identify the set of routes that are required for effective transportation of people in that geographical area. This planning process may include modification of existing route(s) and creation of new route(s).

Present planning systems are based on manual computations and extensive analysis that involve a lot human effort that is tiresome and time consuming. So, this kind of planning is not that effective, as the demand varies from time to time due to mobility of people, changes in geographical area, growth of population, seasonal change and other such factors.

Time scheduling is the process of scheduling the buses timings and the headway between successive buses based on passenger demands. This plays a major role in the utilization of the services as an increase in the number of passengers in a route increases the demand. Proper scheduling of services along routes helps in improved quality of service. When the scheduling is not done according to passenger demands, services maybe over saturated along some routes and under saturated in others. Thus scheduling is a major deciding factor in the utilization of routes and quality of service.

Traditional scheduling done at definite intervals is not efficient. This is owing to the intermittent changes that may occur which can't be accounted for during the initial scheduling process. Thus there is a need for a system that can dynamically analyze demands in routes and schedule services in such a way that the passenger demands are met without causing much overhead.

1.1 ROUTE OPTIMIZATION

Route Optimization is the process of modifying an existing route by extending or changing the path in order to increase the utilization of service. Route optimization should be a well-planned process, as the existing routes get modified. The process should not affect the current utilization rates. This route optimization step is a necessity in maintaining an effective public transportation system as changing routes frequently for intermittent demands will be a poor strategy and leads to confusion among the passengers.

Route optimization involves analyzing the endpoints of a route and looking for improvements by means of route extension. The route improvements are taken into consideration when the total utilization can be increased by including a few more temporary stops to the route. This extension should not cause a huge overhead on the existing route. For instance, there is no point in extending a route when the existing one already covers a large distance and the passenger utilization is at a peak along that route.

2. LITERATURE SURVEY

Shuai Su, Xuekai Wang, Yuan Cao and Jiateng Yin proposed a system for improving the quality of service in public transportation system by taking the case of metro trains. The system schedules metro train's timings in precedence to bus arrival timings in the Stops within Approach by jointly optimizing the train timetable and driving strategy. The paper presents a definite driving strategy and particular timetable model which takes the headway between successive trains into account. The driving strategy is handled as a multi-step decision problem which is solved using Dynamic Programming method. The energy-efficient driving strategy for a given trip time, is calculated using this programming method. As for trip timings and headway of trains, these are taken care of using Simulated Annealing algorithm based off of the results of dynamic programming method from the driving strategy level. At the timetable optimization level, mechanical traction energy of multi-interstations and the amount of the reused regenerative energy are balanced in order to minimize the net mechanical energy consumption of the metro system. Example runs were held numerically, for real-world data of a metro-line in peak and off-peak hours. The example simulation's results exhibited the good energy-saving performance of the proposed system.

- X. Kong, M. Li, T. Tang, K. Tian, L. Moreira-Matias and F. Xia, on their paper "Shared Subway Shuttle Bus Route Planning Based on Transport Data Analytics," propose an approach to improve resource utilization of shared shuttle buses. This helps provide better user experiences. This also aids in the minimization of urban traffic congestion. The key factors of an efficient shared shuttle bus implementation are accurate travel requirements prediction and definite dynamic route planning. Considering the key factors, the paper suggests a two-stage approach, which is composed of travel requirement prediction and dynamic routes planning. Although shuttle usage data is deficient and volatile, it can be used to generate dynamic routes for shared buses in the "last mile" scene. The "last mile" scene in transportation refers to the movement of people and goods from a transportation hub to a final destination. With the data that is gathered, we analyze the user travel behaviors to obtain predictive features, such as flow, time, week, location, and bus. The features are then used to predict travel requirements precisely based on a machine learning model. Then, the results of predictions are used in a dynamic programming algorithm to generate dynamic, optimal routes containing fixed

close proximity. Energy-efficient train operation was the ultimate aim of the proposed system. It is regarded as an effective way to reduce the operational cost and carbon emissions in metro systems. Energy efficiency is mainly be achieved through limitation of traction energy and promotion of regenerative energy. These attributes are closely controlled by train timetable and driving strategy. In order to minimize the systematic net energy consumption, the paper proposes an integrated train operation

destinations based on operating characteristics of shared buses. Numerous experiments carried out on garnered shared subway shuttle bus data proves that the approach excels in dynamic route planning for the "last mile" scene. The approach also proved to be suitable for other scenes, such as commuting scenes, urban transportation hub scenes, and destination scenes of the tourist market. This approach is aimed at trips with fixed destination. Other existing approaches are usually designed for traditional transportation, such as public bus transit, taxis and so on. This paper, however proposes a novel two-stage dynamic route planning approach based on the existing operation characteristics. Finally, a resident travel behavior analysis is carried out in order to improve the accuracy of travel requirement prediction. This helps come up with better optimal routes for the scene.

3. PROPOSED WORK

3.1 Overview

The public bus transportation system is one of the most widely used mode of transportation methods enabling daily commute of people to their destinations. This transportation system has its services planned manually and is based on a static requirement data and needs restructuring over few years. This involves extensive manual work in planning the routes and analyzing the existing routes.

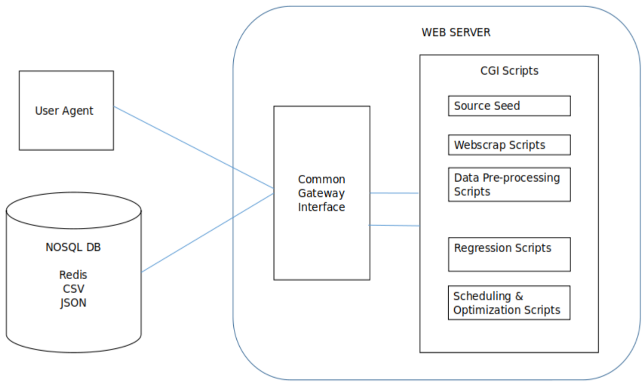

Fig-1: Architecture Diagram

In order to avoid this extensive manual work and to achieve better quality of service provided, this paper has been proposed, which can plan routes and schedule services dynamically on a day to day basis, thus increasing the utilization of the services provided and achieving better quality of service.

3.2 Modular design

The system has been modularized to enable easy changes in further iterations of development thereby making improvements in modules to be localized without involving complete redesign of the system.

3.1.1 Data Preprocessing:

The data obtained from various sources in web for service routes and the scheduled timings for each service routes is initially processed. Each route is individually analyzed to identify the stops covered in that route. Thus the list of stops present in a geographical area is then obtained and a graph is constructed out of it that maintains the stop adjacency.

3.1.2 Regression of data:

The passenger data is bound with each stop that is present in a geographical area that contains the number of passengers present during each of the 15 minute time interval along with their probable destinations. This data is regressed using ARIMA to forecast the data for the next day. ++++

3.1.3 Route Scheduling:

The dynamic route scheduling process is to account for the varying demands that arise on a day to day basis in public transportation. The forecast data obtained by means of regression is used to perform scheduling of services on a day to day basis. The regressed data consists of the passenger count as 15-minute time series based data that also consists of the probable destinations of each passenger present at that stop. This data is then analyzed by taking one stop at a time and identifying the destinations of passengers present at that time interval. Then clustering of passenger destination is done so that passengers with destinations that are part of same service route can utilize the same service. The service route is then analyzed by checking its availability and the probable number of passengers that might already be utilizing the service. If the existing passengers can be accommodated in that service, then no rescheduling is done. If the service is available but it fails to meet the demands, then it is rescheduled based on the existing demands. If there is no service available but a demand arises for the same, then a new service schedule is created for that service route.

3.1.4 Route Optimization:

Once the scheduling of service routes are done, the unused services can then be rerouted to different routes based on demands. Route optimization involves two processes namely route extension and rerouting. The precondition for rerouting is that the two service routes must have a common origin or destination so that the service route can be rolled back as and when demand changes.

A minimum spanning tree of a route is initially created for the purpose of route extension. Then the utilization of route is then analyzed for that time interval. If it is less and if it can be increased by extending the route then the extension process is done by analyzing the adjacent stops to the destination and identifying route with minimal extension that at the same time increases utilization.

This route optimization process is done only for specific time intervals, when the demands differ from usual values and thus making this optimization bound only for that specific time interval, hence temporary. On passage of that time interval, the service routes are rolled back to their original paths and the services are mapped back to their original routes.

4. CONCLUSION

This project aims in resolving the existing loopholes and inconsistencies that are currently present in the public transportation system by incorporating the passenger data in order to provide better services and offer better utilization rates of the services provided. Thus by using the passenger data to the fullest extent possible, the services that are being provided can be improved manifold by accounting for dynamic variation and seasonal variation in demands and providing services accordingly, thereby increasing the quality of the services provided.

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