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ROUTE AND COST OPTIMIZATION FOR WAREHOUSES

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Abstract - *The objective of the model is to help a transport company efficiently use its resources to the optimal stature. The designed application will find the shortest route to the destination desired to optimize time and cost. It will also find the optimal truck size in order to ensure that trucks are not overloaded. Live order updates will be given to the warehouse manager on successful completion of deliveries.*

Key Words: Clustering, Regions, Routing, Real Time Tracking, Loading Sequence, Multiple destination Shortest Path, Cost-Volume Ratio.

1. INTRODUCTION

In today's current situation, a warehouse of a multinational company gets flooded with tons of deliveries to be dispatched every day. The logistics department of the company leaves this responsibility to the transporter. The transporter may reap profits on the basis of long-distance trips, excess diesel costs and prolonged deliveries to increase fares of the bill. To help companies reap benefits, we have designed an intelligent system. This system will help the warehouse manager to choose the transporter based on the quotation they prepare. It will provide the shortest path for all the deliveries to take place. It will also provide the optimal truck size in order to ensure that trucks are not overloaded. Live order updates will be provided to the warehouse manager on successful completion of deliveries. Finally, a database to store the transactions where in case of decisions to be made by a line manager about the growth of the company or critical situations, the application will be able to provide data about the past and future predictions. The project will use the concept of extracting data required for understanding the location of delivery of the product and then using that data we will create multiple shortest paths. For each path generated, we create a specific itinerary helping save both costs by optimizing the consumption of fuel and making the efficiency of deliveries on time better. Our system will ensure that the products are delivered to the customers on time and products are packaged well. Optimal truck sizes and placing the products in the truck as per size such that the truck is not overloaded will ensure the safety of the truck so that it doesn't topple.

2. LITERATURE SURVEY

The paper identified the problem of multiple destination routes with cost and time constraint. Initially, they analyzed solution of TSP (Travelling Salesman Problem) as a good solution but realized that it does not consider all required constraints. BMDC (Basic Multiple Distributed Cost) incurred high computational overhead when applied to larger networks. Hence, the second algorithm AMDC (Advanced Multiple Distributed Cost) was based on an enhanced pruning criterion which required heuristic function to estimate whether the sub-route could completely visit all targets in the whole destinations schedule. Through a series of experimental evaluations, it was demonstrated that the proposed algorithms delivered excellent performance in terms of efficiency and effectiveness. This helped route planning that considered handling multiple deadlines for multi-destinations as well as optimizing trip cost, simultaneously.[1]

According to them, almost all existing route prediction algorithms made use of location data traces. Data was decomposed into trips based on distance or time as parameter. This trip was set of location data traces. Even if data was collected on the same route, one could not expect one to one correspondence between the two trips. So a measure was required to establish the similarity between the trips. They took an approach to convert the trips as a set of location traces to trips as a set of road network edges. [2]

The proposed map matching method predicted future routes by using a probabilistic route prediction model and the estimated route was then updated by the observed trajectory. The experimental results showed that the proposed method had an accuracy as high as the naïve online HMM (Hidden Markov Model) method, even without parameter training. Furthermore, it was faster than the online HMM method. Moreover, parameter training based on historical trajectory data improved the accuracy of the proposed method significantly, well above that of the naïve online HMM method. [3]

They implemented a concept which coupled the Global Positioning System with Google maps and gave the live position and the postal address of the lost mobile accurately. They also implemented the concept of tracking children and finding their exact location and the call log details, which helped them to track their activities. When the mobile user loses his mobile phone, there is no other efficient mechanism in place which can help the owner of the mobile recover his mobile phone. Although it can be tracked through IMEI (International mobile Equipment Number) that process is time consuming and requires special privileges.[4]

The distributed multiple path (DMP) routing strategy was proposed in this paper. Computer simulation tested on the scale-free networks showed that the DMP routing strategy can provide networks with better anti-congestion performance, as well as reinforced routing robustness against random partial network failures. The DMP routing strategy is suitable to be applied in routing-based transmission networks in which the traffic is busy, and the O-D traffic demand distribution may frequently change with time. It can also be used in the assistance of diverting traffic in networks when extreme events occur, such as emergent evacuation.[5]

3. CHALLENGES IDENTIFIED

In our implementation of the Route and Cost Algorithm, we have to cluster the group of close locations based on distance as a parameter. When narrowing down the shortest path using the algorithm using BMDC (Brute Force), we encounter high iteration of distance calculation causing the complexity to increase. An alternative approach will be using the AMDC (heuristic algorithm), where we set a specified Heuristic Function as a minimum distance to reduce the amount of iteration.

Similar to the previous issue, for multiple paths to be generated in a cluster, each path will be found by the Dijkstra's Algorithm and multiple usage of algorithm will cause the complexity to increase. Another approach as cited in [3] will be to use the CDMP algorithm wherein we set the distance to cost ratio to a particular number and as the distance to cost ratio is feasible we append it to the path or else if greater we append it to penalty list where if encountered by the algorithm the penalty will make us recognize the location only if required.

Storing location as a set of points will result in a large amount of data causing the necessity of high storage database and high-speed data transfer operating system. In order to avoid that, we use the concept of sampling the data, where we store the data as a few representative traces of the location indirectly causing the reduction of data and finally increasing the speed of the algorithm. Finally, to speed the process where repeated calculation of data can be avoided, we use the HMM model to store the next states where we can improve the efficiency using prediction algorithm.

4. PROBLEM DEFINITION

In a warehouse, an invoice is generated where the warehouse refers to that invoice and uses the particular drop locations to create single or multiple shortest paths which gives the least time required to distribute the goods to the location. However, the problem here is that minimum most distance is not necessarily cost efficient. In order to resolve this issue, we will compare the transporter quotation to find out the least cost to distance ratio. Hence, we can find the most optimal route with the best cost to time ratio. In the end, we select the delivery route and the items to be delivered on the location, pertaining to the goods we have to decide the need for the type of truck based on the volume of the goods and cost of truck. Finally, the scheduling of the goods per route depends on the drop locations and the items should be arranged in such an order where the first location items is loaded last in the truck.

5. PROPOSED SYSTEM METHODOLOGY

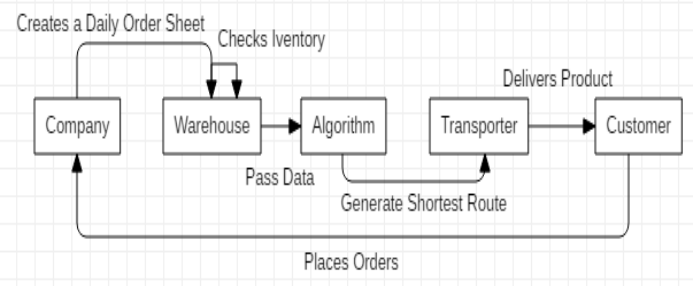

Fig -1: Block diagram of proposed solution

The Application begins with the Invoice being generated by the company and sent to the factory. Our application will then deduce the invoice into the items and their respective drop points. Later, the Algorithm generates clusters of close location points (The choosing of Clusters will be Dynamic). Those clusters will be known as regions. In each region, we run the Multiple Shortest Path Algorithm and find N-Number of shortest paths for each region. The cost for each route will be calculated from the data of quotations of multiple transporters in different regions After the routes are generated, the route is assigned with a truck size (Based on

the volume of the consignment and the cost of the transporter) and finally for each truck, a driver and an itinerary will be generated. The warehouse will get a loading sequence for loading the products on the truck based on the itinerary generated where the last location to be traversed will be loaded first. Finally, after every trip we store the data of each shipment for further analysis.

6. PREDICTION OF ROUTE ALGORITHM

The algorithm is designed to calculate the multiple shortest paths and is divided into three steps, Clustering, Optimal Clusters and execution of shortest path algorithm in the clusters.

1) K-means algorithm

For clustering the various locations for a particular date, we have used k-means algorithm. K-means algorithm is an iterative algorithm that tries to partition the dataset into k pre-defined, distinct non-overlapping subgroups (clusters) where each data point belongs to only one group. Clustering of a region can be done by taking into consideration the geographic coordinates as input of location.

2) Knee elbow method

In order to find the optimal number of clusters, we have made use of the knee elbow method. The idea of the elbow method is to run k-means clustering on the dataset for a range of values of k, and for each value of k, it calculates the sum of squared errors (SSE). It then plots a line chart for each value of k. If the line chart looks like an arm, then the "elbow" on the arm is the value of k that is the best. So, our goal is to choose a small value of k that still has a low SSE, and the elbow usually represents where we start to have diminishing returns by increasing k.

3) Travelling Salesman problem solution

After the optimal numbers of clusters are decided, we will calculate the shortest route for each cluster. To find the shortest route for each cluster, we make use of Travelling Salesman Problem solution. This solution will generate multiple routes. It will then calculate the cost for every route and keep track of the minimum cost route. This will ensure that we get the shortest route taking into consideration cost factor.

Pseudo Code:

Input: Destination array(D) in terms of (longitude(x), latitude(y))

1. Cluster destinations using Euclidean distance

2. For i in range(0,D):

   Plot variance with respect to no. of cluster graph

3. When Dy/Dx is max:

   Then clusters (c) is i+1

   (Dy/Dx is the slope of the graph as in Fig 2)

4. For j in range (0,C):

   Find shortest path and append to list

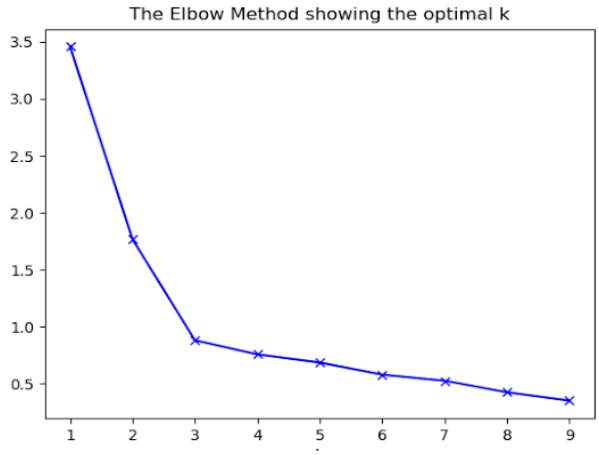

Fig -2: Graph for deciding no. of clusters

Fig. 2 is a knee elbow graph which plots the variance with respect to the number of clusters. The graph looks like an arm of a human and the point at which the dy/dx (slope) reduces drastically resembles the elbow of the hand which in turn represent the no. of clusters.

7. PERFORMANCE EVALUATION PARAMETER

The performance will be evaluated on the basis of minimum cost and shortest route together. The profit will be compared with previous data to find the difference in the cost and time. For cost, the profits can be evaluated by choosing the contractor based on the cheapest quotation for a region and also help reduce the cost and finding short routes that help consume less fuel to save money. Also, select routes having fewer tolls and avoiding rough terrain. The time parameter

can be evaluated by comparing the delivery time to the past delivery records and customer inputs.

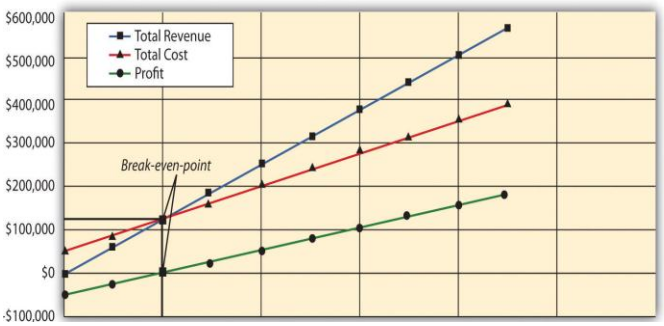

Fig -3: Graph for comparing cost and profits of past and present.

A graph similar to Fig 3 will be used to evaluate the revenue, cost and profit over the quarters.

8. EXPERIMENTAL SETUP

The application is built using Android studio. For real time navigation, the google map accessed by API (Application Program Interface) keys are used: a feature in Android Studio.

Database: There are two types of databases which contain the daily invoices that are stored on the system ERP (Enterprise Resource Planning). and the local phone app has a regional SQL-Lite android database which stores the routes and costs for faster predictions in later orders or to get business insights to compare and change things.

Dataset : The data is divided into static and dynamic data.

Static Data: It contains various cost of different transporters that will be compared initially to get the initial cost weight which will be used as cost measure.

Dynamic Data: It contains the daily invoice generated for order dispatch. The invoice will be deduced to get the orders and their respective drop location, time of delivery and packing schedule.

Hardware: A cellular device supporting GPS (Global Positioning System) facility and Internet facility. Must be running Android (8.0) and above, the reason being that multiple stops feature on Google Maps API is available only on Devices running Android 8.0 (Oreo) and above.

9. CONCLUSION

This project mainly aims to replace the manual work done by humans with an application that will provide the warehouse with the shortest route and optimize costs. We have created an application for the warehouse wherein he can get the most optimal path and least cost associated with it. We also provide the optimal truck size and cluster the items as per the location of delivery. Each truck is assigned a specific itinerary along with an assigned path that has to be taken for delivery. We provide the warehouse manager with an additional feature of tracking the status of the truck. The warehouse manager will be notified when the truck driver deviates from the path. We will ensure that the warehouse company can reap profits by optimizing route and cost. This application can be used by any company/organization that wishes to optimize route and cost. This application can be used by various food delivery industries such as Big Basket, Swiggy and so on as they too deal with tons of orders that have to be delivered on a daily basis to customers. This can also be used by large organizations that need to deliver their products efficiently without incurring any loss. Furthermore, this application can be used in any field that requires optimizing route and cost. This application is designed in a user friendly manner so that the user will not have a problem in using the application.

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