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An Effective Approach for Solving Carpool Service Problems Using Genetic Algorithm Approach in Cloud Computing

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Abstract: ***Now a days we encounter a lot of traffic congestion problems in cities and urban areas around the world. To minimize such problems carpooling can become and effective solution. Carpooling means increasing the occupancy rate of cars with a reduction in the number of empty seats in those vehicles. In this paper, we have presented an advance d carpooling system and described it in detail. This system can also be called as Intelligent Carpool System (ICS), which will provide the carpooling participants to use the carpool services using simple handheld smart devices anywhere and at any time. Here the carpooling service agency is equipped with abundant information about geographical, traffic and societal features and thus is used to handle user requests. For the coordination of the ride matches through the carpool service agency, we have applied the genetic algorithm approach and proposed the genetic based carpool route and matching algorithm (GCRMA) for this multi objective optimization problem called the carpool service problem (CSP).***

The GCRMA has a significantly small amount of computational complexity used to match the response in the match results and also reduced processing time by including the termination criteria called as early stop.

Keywords: Carpool service problem (CSP), genetic algorithm, intelligent carpool system (ICS)

I. INTRODUCTION

There is a tremendous economic growth and development recently in many urban and industrial areas. This growth has led to a rapid increase in the number of vehicles on roadways, further leading to serious traffic congestion problems in large cities all around the world. Such severe traffic congestion problems can lead to many adverse effect such as air pollution, time loss and increased fuel consumption. Of course public transportation has the capacity to decrease this traffic congestion but it comes with its own discomforts like less flexibility, comfort and freedom that personal cars provide, which have by far been the most popular way to commute. But as is obvious each car has a limited capacity and many times just has one or two individuals seated leading to many empty seats. For example, a vehicle in the U.K. is used to transport, on average, 1.5 people [2]. This above problem reflects the underutilization of vehicles as resource s, and a solution to such a problem will require considerable time and effort

Carpooling is a relatively environmentally sound system of transportation in which empty seats are offered to additional passengers and has been found to be one of the best solutions to traffic congestion [3], [4].

In this scenario the drivers will share their cars with one or more people having similar transportation routes. Thus by reducing the number of empty seats the occupancy rates are increased dramatically. Hence, far fewer vehicles would be required to transport the exact quantity of commuters to their respective destinations. This will result in substantially fewer cars on the road

Some additional benefits of carpooling can include reductions in energy consumption, travelling cost, and also reduced vehicle emissions. As a result of technological advances such as the development of smart handheld device software and

hardware, along with mobile Internet technology, the website-based carpool system has become more advanced and is now appropriately referred to as the intelligent carpool system (ICS) [1].

Now a day's people use a lot of smart handheld devices equipped with Global Positioning Systems (GPS) navigation and mobile communication abilities. Using such instruments will enable drivers and passengers to instantaneously access such real time carpooling services through the integrated structure of ICS. Here the drivers and passengers can have their current locations and other required information inputted in through their smartphones, tablets, computers and other devices.

Several such start-up systems, such as Carma [5], sidecar [6], Flinc [7], Zimride [8], and go2gether [9], have been developed to coordinate ridematch communication between drivers and passengers in real time carpool settings.

The systems mentioned above however lack the optimization abilities for adapting performance capability to resource distribution. We have used an optimization technique incorporated in ICS called BlueNet-Ride.

In the kind of transportation system described above it is necessary to develop algorithmic methods for optimal matching of drives and passengers registered with the ICS system. A theoretical classification to address the above mentioned type of optimization problem represented in the form of driver to passenger mappings is given below:

1. Single driver to single passenger (S-to-S);
2. Multiple drivers to single passenger (M-to-S); and
3. Single driver to multiple passengers (S-to-M) [10]

The first arrangement of S-to-S describes that one driver or each driver wishes to provide a ride to only a single passenger. This implies that the passenger will be assigned to a single vehicle, hence the passengers will be delivered to their destinations without any transfers in the middle. The second arrangement, M-to-S says that each driver will take on a single passenger, but that passenger can transfer himself/ herself to another vehicle en route.

The third arrangement S-to-M indicates that each driver can pick up and drop many passengers to their destinations en route. As seen from the above in the first two cases of S-to-S and M-to-S the driver takes on only a single passenger hence the seat utilization ratio is meagre in this arrangement and should not be considered. Hence our paper focuses on solving the problem represented by the third arrangement that is S-to-M.

II. LITERATURE STUDY

We have closely seen the carpool service problem (CSP), where the location of each participant in the problem, the driver and the passenger is a complicated origin to destination pair. This implies that the CSP is an NP Hard problem.

A method for solving the above problem has been undertaken in which integer programming model has been used. In this method the CSP problem is tried to be solved using the workplace environment, which facilitates sharing of the employee vehicles. Integer programming however belongs to the family of exact optimization. It is a deterministic method which will always obtain the same and exact approximate solution for many different runs of the same problem. So it doesn't prove to be effective in solving the carpooling problem and generating an adequate solution for it using a large number of carpool users.

Another advanced method was presented by some others in the area of genetic algorithm. Here the designing of recombination approach is implemented by a single point crossover operator.

The mutation procedure implemented in this approach uses merely five operators as follows:

1)a push backward operator; 2) a push forward operator; 3) a remove–insert operator which randomly selects an origin–destination pair which is to be removed from the route; 4) a transfer Operator picks an origin–destination pair from the list of

the given routes and inserts it into other route; and 5) a swap mutation operator performs the swapping operation between a random point and a neighbor point en route.

The above mentioned five operators all perform their respective operations in a random manner. As random algorithm are not effective and productive in providing a deterministic solution to our problems these methods are not useful. Moreover we need an algorithm which will tailor to the specific problem orientation necessary to encompass characteristics of the carpool problem.

The genetic algorithm approach that we are using has been successfully applied in many situations. It is proved to be effective to determine solutions with almost optimal quality and they have achieved this in a reasonable amount of time.

In this paper we have presented a movement model which is used to characterize the moving patterns of all the residents living in the metropolitan area. We have also proposed a genetic-based carpool route and matching algorithm (GCRMA). This algorithm will help to solve the CSP by inadvertently acquiring optimal match solutions and also reducing the required computing time at the same time.

Besides providing riding services to the drivers and passengers we are also going to implement the cost factors involved in ferrying the passengers to and forth from their pick up and destination points. The cost factors involve getting statistics about the current locations of the passengers and then using the OpenGIS to get the location coordinates in terms of the longitude and the latitude. Once such coordinates are obtained the cost is calculated in accordance with the location from which the passenger is picked up and the relative distance he gets to travel in the vehicle to reach his destination. Mathematical equations and formulae have been used to calculate the same.

III. ICS AND CSP

In this paper we have presented a carpool service framework called the ICS, done using cloud computing, as shown in the figure given below.

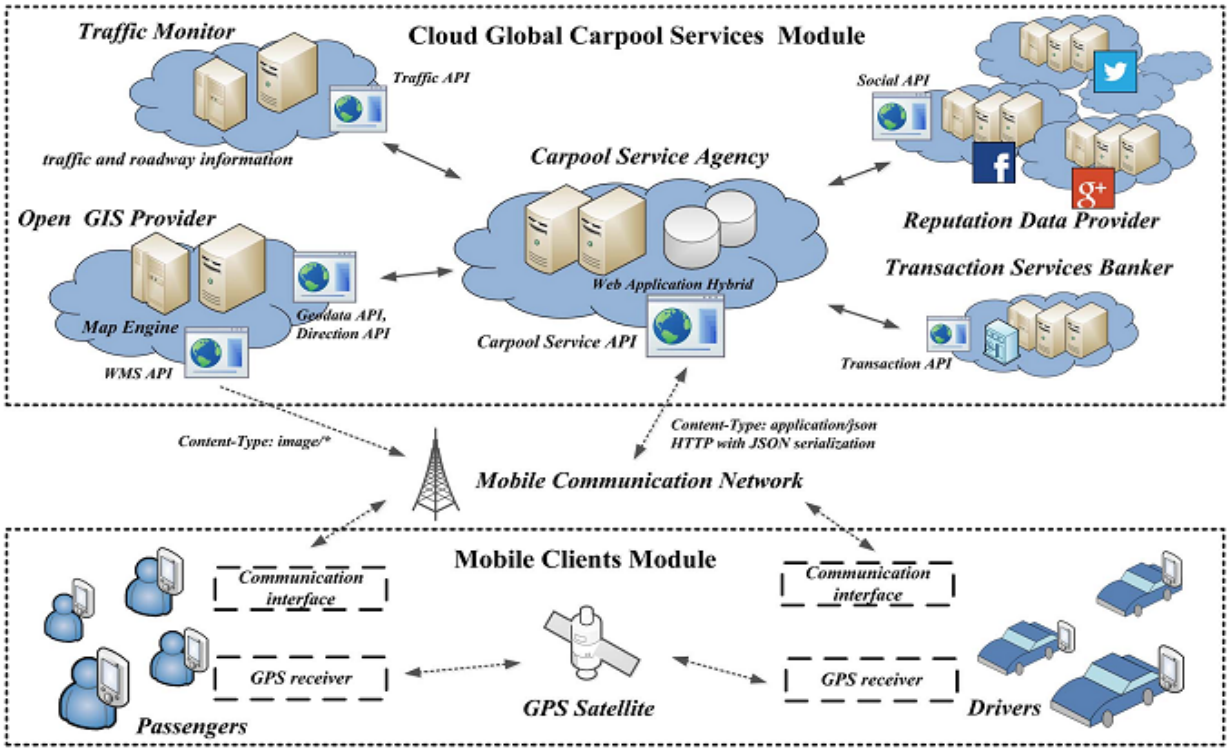

Fig. 1 Framework on Carpooling System based on Cloud Computing

The ICS system is built upon the structure of the web application which is hybrid in nature and is based on service orientation [11]. Our system consists of two primary modules: a mobile clients (MC) module and a cloud global carpool

services (CGCS) module. Communication between the MC module and the CGCS module is handles by the web HTTP protocol using the communication networks for mobiles. The communication needs to take place between the two to match the particular routes and destinations mentioned by each participant in our system

A. MC Module

Our system boasts of providing carpool matches anytime and anywhere using mobile devices. This module helps the drivers and passengers to use itself and perform various carpooling operations like requesting for a ride or offering a ride using their simple mobile devices.

As such the MC module is a mobile application which is built on top of advanced operating system platforms like iOS, Android, Windows Phone and so on. It also enhances its functionality by using integrated GPS Receivers and also has the inbuilt capacity for mobile communications. Using such services the users can easily obtain information about their current locations by automatically getting accessed and connected to the GPS signals of satellites and they are also able to retrieve geo resource images using the Web Map Service (WMS) application programming interface (API). This helps them to precisely point at their pickup and drop off/ destination locations.

The drivers and passengers can log in and use the MC module according to the functionality they desire. For example the drivers can use this module for offering the carpool ride s whereas the passengers can send carpool requests for getting a carpool ride. Whenever the above mentioned participants are within the range of each other the MC module will help them find a suitable carpool partner for their intended purpose.

Drivers can thus pick up the passengers from their respective current locations and offer to drop them at their destinations according to the carpool matches generated and received and if only allowed by the users.

A ride completion notification is send to each and every user after they have finished each ride. In addition to this the drivers and passengers also have the option of rating each other after their ride is over to share their experiences with each other and such ratings can also viewed by future potential carpooling partners.

B. CGCS Module

This module has to interact with the MC module. It can be spread across various platforms, so to have a global implementation of the ICS on such diverse cross platform devices, we have used RESTful web services application interface to support interoperability with the MC module.

This module uses a mashup development approach to seamlessly aggregate many different and powerful web service applications. These include 1) an OpenGIS provider, 2) a traffic monitor, 3) a reputation data provider, and 4) a transaction services banker, to enrich the functions and capabilities of the ICS system.

The OpenGIS provider is used as a facilitator to increase the usability of the MC module using the published WMS API. In addition to this it is also used to supply digital road information related to the complicated features like one way and two way streets etc. It is also used to contribute to the routing functions in case one of the matching algorithms is used on the system.

Traffic status is usually monitored by a department within the government. To enhance the functionality of the system and to consider certain real time traffic scenarios, the CGCS module integrates itself with the OpenGIS's contents using the traffic API which is published by the traffic monitor. This helps in enhancing routing and match estimations and also reorganizes traffic information.

Now a days due to the tremendous boom in social networking, it becomes necessary to incorporate social features in our system, which will throw more light on the social behavior of the drivers and passengers and will ensure certain amount of security. Many known social platforms like Facebook, twitter etc store many types of social information about their users like

connections, comments, recommendations etc. Such social information can be securely accessed using an open authorization standard called OAuth. This authorization standard authorizes third party access to the above mentioned resources. These ratings and social terms of the users collectively collected by the system are together normalized to form a credit score, which is used to establish interpersonal trust and responsibility in the carpooling system.

IV. CONCLUSION

In this paper, the entire framework of the ICS is described, which provides an environment in which drivers and passengers can easily find carpool matches at any time and in any place. The architecture of the Carpool System has been discussed. There are two modules proposed, the MC module and the CGCS module. The MC module enables the drivers and the passengers to respectively send their carpooling requests via a mobile application on their mobile devices. The drivers will offer for carpool ride services to pick up a particular passenger and the passenger will request for a ride. The MC module also contains the location information for a particular driver and passenger in addition to the pickup and drop off locations of the passengers. The CGCS module has many services mashed up into one. It offers for the actual route matching and selection criteria based on various parameters received from the MC module. For supporting interoperability it uses RESTful services. It communicates to the MC module using the HTTP communication protocol

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