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Smart City-Scale Taxi Ridesharing

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Abstract - *Proposed and developed to taxi-sharing system that accept taxi passengers' real-time ride requests sent from smart phones and schedules proper taxis to pick up them via ridesharing, subject to time, capacity, and monetary constraints. The monetary constraints provide to incentives for both passengers and taxi drivers: passengers will not pay more compared with no ridesharing and to get compensated if their travel time is lengthened due to ridesharing; taxi drivers will make money for all detour distance due to ridesharing. Taxi riders and taxi drivers use the taxi-sharing service provided by the system via smart phone App. The Cloud first finds candidate taxis quickly for a taxi ride request using a taxi searching algorithm supported by a spatio-temporal index. A scheduling process is then performed in the cloud to select a taxi that satisfies the request with minimum increase in travel distance. A ride request generator is developed in terms of the stochastic process modelling real ride requests learned from the data set. Our proposed system demonstrated its efficiency, effectiveness and scalability.*

***Key Words*: Spatial database and GIS, taxi sharing, ridesharing;**

1. INTRODUCTION

Taxi is an important transportation mode between public And private transportations, delivering millions of passengers to different locations in urban areas. However, taxi demands are usually much higher than the number of taxis in peak hours of major cities, resulting in that many people spend a long time on roadsides before getting a taxi. Increasing the number of taxis seems an obvious solution. But it brings some negative effects, e.g., causing additional traffic on the road surface and more energy consumption, and decreasing taxi driver's income .

To address this issue, we propose a taxi-sharing system that accepts taxi passengers' real-time ride requests sent from smart phones and schedules proper taxis to pick up them via taxi-sharing with time, capacity, and monetary constraints (the monetary constraints guarantee that passengers pay less and drivers earn more compared with no taxi-sharing is used). Our system saves energy consumption and eases traffic congestion while enhancing the capacity of commuting by taxis. Meanwhile, it reduces the taxi fare of taxi riders and increases the profit of taxi drivers.

Unfortunately, real-time taxi-sharing has not been well explored, though ridesharing based on private cars, often known as carpooling or recurring ridesharing, was studied for years to deal with people's routine commutes, e.g., from home to work .In contrast to existing ridesharing, real-time taxi-sharing is more challenging because both ride requests and positions of taxis are highly dynamic and difficult to predict. First, passengers are often lazy to plan a taxi trip in advance, and usually submit a ride request shortly before the departure. Second, a taxi constantly travels on roads, picking up and dropping off passengers. Its destination depends on that of passengers, while passengers couldgo anywhere in a city.

In this paper, we report on a system based on the mobile-cloud architecture, which enables real-time taxi-sharing in a practical setting. In the system, taxi drivers independently determine when to join and leave the service using an App installed on their smart phones. Passengers submit real-time ride requests using the same App (if they are willing to share the ride with others). Each ride request consists of the origin and destination of the trip, time windows constraining when the passengers want to be picked up and dropped off (in most case, the pickup time is present). On receiving a new request, the Cloud will first search for the taxi which minimizes the travel distance increased for the ride request and satisfies both the new request and the trips of existing passengers who are already assigned to the taxi, subject to time, capacity, and monetary constraints. Then the existing passengers assigned to the taxi will be inquired by the cloud whether they agree to pick up the new passenger given the possible decrease in fare and increase in travel time. Only with complete agreement, the updated schedules will be then given to the corresponding taxi drivers and passengers.

2. LITERATURE SURVEY

P.-Y. Chen, J.-W. Liu, and W.-T. Chen, in Proc. IEEE 72nd Veh. Technol. Conf., Sep. 2010, said that Traffic congestion is a serious problem in urban areas of many countries due to the increasing amount of vehicles on surface streets and accompanies fuel-wasting and air-pollution. This problem can be alleviated by adopting a ride-sharing service. The main idea of ride-sharing service is to collect travelers whose travel destinations are nearby into one vehicle. In doing so, we can reduce the amount of vehicles on surface streets and meantime save fuel. In this paper, we focus on the taxi-sharing service and propose a dynamic taxi-sharing system based on Intelligent Transportation Systems (ITS) technology. In the proposed system, we can immediately serve each irregular ride-sharing request and find a fuel-saving taxi for it. The simulation results show that our solution can exactly select a fuel-saving taxi for each ride-sharing request and outperform in responding time, the number of compared taxis, and fuel-saving while comparing with existing solution.

De-Merits:

Communication cost of driving information is not analyze. The way which divides whole area and range of candidate area will affect the system performance. Doesn't identify travel time estimation and also improve the prediction of taxi travel time.

S. Ma, Y. Zheng, and O. Wolfson, in Proc. 29th IEEE Int. Conf. Data Eng., 2013, said that Taxi ridesharing can be of significant social and environmental benefit, e.g. by saving energy consumption and satisfying people's commute needs. Despite the great potential, taxi ridesharing, especially with dynamic queries, is not well studied. In this paper, we formally define the dynamic ridesharing problem and propose a large-scale taxi ridesharing service. It efficiently serves real-time requests sent by taxi users and generates ridesharing schedules that reduce the total travel distance significantly. In our method, we first propose a taxi searching algorithm using a spatio-temporal index to quickly retrieve candidate taxis that are likely to satisfy a user query. A scheduling algorithm is then proposed. It checks each candidate taxi and inserts the query's trip into the schedule of the taxi which satisfies the query with minimum additional incurred travel distance. To tackle the heavy computational load, a lazy shortest path calculation strategy is devised to speed up the scheduling algorithm. We evaluated our service using a GPS trajectory dataset generated by over 33,000 taxis during a period of 3 months. By learning the spatio-temporal distributions of real user queries from this dataset, we built an experimental platform that simulates user real behaviours in taking a taxi. Tested on this platform with extensive experiments, our approach demonstrated its efficiency, effectiveness, and scalability. For example, our proposed service serves 25% additional taxi users while saving 13% travel distance compared with no-ridesharing (when the ratio of the number of queries to that of taxis is 6).

De-Merits:

The computation cost for getting travel time of the quickest paths does not specified.
Dispatching a taxi for a query by consider minimal increased travel distance.

P. M. d'Orey, R. Fernandes, and M. Ferreira,in Proc. 15th Int. IEEE Conf. Intell. Transp. Syst., Sep. 2012, said that Modern societies rely on efficient transportation Systems for sustainable mobility. In this paper, we perform a large-scale and empirical evaluation of a dynamic and distributed taxi-sharing system. The novel system takes advantage of nowadays widespread availability of communication and computation to convey a cost-efficient, door-to-door and flexible system, offering a quality of service similar to traditional taxis. The shared taxi service is assessed in a real-city scenario using a highly realistic simulation platform. Simulation results have shown the system's advantages for both passengers and taxi drivers, and that trade-offs need to be considered. Compared with the current taxi operation model, results show a increase of 48% on the average occupancy per traveled kilometer with a full deployment of the taxi-sharing system.

De-Merits:

Address the problem of defining a fair tariff system for both passenger and taxi driver. Additionally, incentives for the early acceptance and usage of this system need to be investigated. Scenarios where demand exceeds supply need to be further analyzed since the QoS experienced by customers can differ substantially. It is also necessary to study the best communication model for the taxi-sharing system.

3. CHALLENGES AND CONTRIBUTION

The variety of constrain and objective function are used in existing literature survey, where a weighted cost function combining multiple factors such as travel distance increment, travel time increment and passenger waiting time, is the most common. Our aim to find the taxi status which satisfies the ride request with minimum increase in travel distance, formally defined as follows: given a fixed number of taxis traveling on a road network and a sequence of ride requests in ascending order of their submitted time, we aim to serve each ride request Q in the stream by dispatching the taxi V which satisfies Q with minimum increase in V's scheduled travel distance on the road network.

The real-time taxi-sharing problem inherently resembles a greedy problem. Taxi riders usually expect that their requests can be served shortly after the submission. Given the rigid real-time context, the taxi-sharing system only has information of currently available ride requests and thus can hardly make optimized schedules based on a global scope, i.e., over a long time span. Another problem is minimizing the total travel distance of all taxis for the complete ride request stream is NP-complete.

Algorithm Use:

1. Spatio-temporal indexing algorithm

2. Taxi searching algorithm (single side and dual side searching algorithm)

3. Scheduling algorithm

4. Shortest path algorithm

4. METHODOLOGY

Proposed and develop real time taxi-sharing system based on mobile cloud architecture. In the system taxi driver independently determine when to join and leave the service using App install on their smart phones. Passenger submit real time ride request using same App and also social constraints, such as gender preference, habit preferences (e.g. some people may prefer co-passengers who do not smoke). Each ride request consists of the origin and destination of the trip, time window constraining when the passengers want to picked up and dropped off. On receiving a new request, the Cloud will first search for the taxi which minimizes the travel distance increased for the ride request and satisfies both the new request and the trips of existing passengers who are already assigned to the taxi, subject to time, capacity, and monetary constraints. Then the existing passengers assigned to the taxi will be inquired by the cloud whether they agree to pick up the new passenger given the possible decrease in fare and increase in travel time. The updated schedules will be then given to the corresponding taxi drivers and passengers. The scheduling and Searching algorithm are capable of allocation "right" taxi among tens of thousands of taxi for query in milliseconds. The shortest path algorithm is capable of finding shortest route store in the database.

5. SYSTEM ARCHITECTURE

The architecture of our system is presented in Fig. 1. The cloud consists of multiple servers for different purposes and a monitor for administers to oversee the running of the system. Taxi drivers and riders use the same smart phone app to interact with the system . As shown by the red broken arrow (a), a taxi automatically reports its location to the cloud via the mobile App. We partition a city into disjoint cells and maintain a dynamic spatio-temporal index between taxis and cells in the indexing server depicted as the broken arrow (b). Denoted by the solid blue arrow (1), a rider submits a new ride request to the Communication Server.

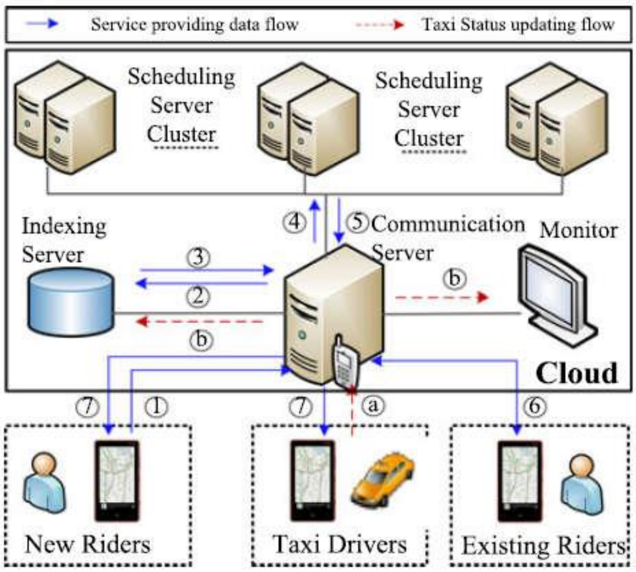

Fig -1: The architecture of real time taxi-sharing system

The architecture of our system is presented in Fig. 1. The cloud consists of multiple servers for different purposes and a monitor for administers to oversee the running of the system. Taxi drivers and riders use the same smart phone app to interact with the system . As shown by the red broken arrow (a), a taxi automatically reports its location to the cloud via the mobile App. We partition a city into disjoint cells and maintain a dynamic spatio-temporal index between taxis and cells in the indexing server depicted as the broken arrow (b). Denoted by the solid blue arrow (1), a rider submits a new ride request to the Communication Server.
Represented by the blue arrow (4), the communication Server sends ride request and the received candidate taxi to the Scheduling Server Cluster. The scheduling cluster checks whether each taxi can satisfy ride request in parallel , and returns the qualified taxi that results in minimum increase in travel distance and a detailed schedule, shown as arrow(5). Each rider who has been already assigned to the taxi will be enquired whether they would like to accept the join of the new rider, as depicted by blue arrow (6).

6. CONCLUSION

This project proposed and developed a mobile-cloud based real-time taxi-sharing system. We presented detail interactions between end users (i.e. taxi riders and drivers) and the Cloud. This paper proposed and developed a mobile-cloud based real-time taxi-sharing system. We presented detail interactions between end users (i.e. taxi riders and drivers) and the Cloud. We validated our system based on a GPS trajectory data set generated by 33,000 taxis over three months, in which over 10 million ride requests were extracted. The experimental results demonstrated the effectiveness and efficiency of our system in serving real-time ride requests. Firstly, our system can enhance the delivery capability of taxis in a city so as to satisfy the commute of more people. For instance, when the ratio between the number of taxi ride requests and the number of taxis is 6, our proposed system served three times as many ride requests as that with no taxi-sharing. Secondly, the system saves the total travel distance of taxis when delivering passengers, e.g., it saved 11 percent travel distance with the same ratio mentioned above. Supposing a taxi consumes 8 liters of gasoline per 100 km and given the fact learned from the real trajectory data set that the average travel distance of a taxi in a day in Beijing is about 480 km, the system can save over one third million liter of gasoline per day, which is over 120 million liter of gasoline per year (worth about 150 million dollar). Thirdly, the system can also save the taxi fare for each individual rider while the profit of taxi drivers does not decrease compared with the case where no taxi-sharing is conducted. Using the proposed monetary constraints, the system guarantees that any rider that participates in taxi-sharing saves 7 percent fare on average. In addition, the experimental results justified the importance of the dual-side searching algorithm. Compared to the single-side taxi searching algorithm, the dual-side taxi searching algorithm reduced the computation cost by over 50 percent, while the travel distance was only about 1 percent higher on average.

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