A Multi-Agent Taxi Dispatching System

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ABSTRACT

The taxi assignment problem may be categorized as a vehicle routing problem. When placed in the field of resource allocation, it is a dynamic problem in which the situation changes as the work progresses. This paper presents a new agent-based approach to tackle the taxi assignment problem. New parameters are introduced to increase the satisfaction of the drivers. The authors propose a new algorithm to improve the parameters. Simulations were also conducted to examine the efficiency of the proposed method. The results indicate the effectiveness of the proposed taxi assignment/dispatching approach.

Keywords: Dispatching Approach, Global Positioning, Intelligent Transportation, Multi-Agent System, Taxi Assignment Problem

INTRODUCTION

A taxi is one of the most convenient means of transportation and the optimized taxi dispatching is a fairly old problem (Artman & Zällh, 2005; Skok, 2007). However, with the recent advancements in location-based services, we can see new potentials for more research in this area (Artman & Zällh, 2005; Skok, 2007).

As a problem in the field of Vehicle Routing Problem (VRP), this problem is one of the important and complicated problems in this area (Lee, Wang, Cheu, & Teo, 2004; Liao, 2001; Silva, 2003; Yamamoto, Uesugi, & Watanabe, 2008) because of the dynamic nature of the requests that happen randomly and are completely dynamic; therefore, one may not tell how and when the next request is going to take place. As a problem in the field of Resource Allocation, this problem is a dynamic problem in which the situation of the problem changes as the work is in progress (Modi et al., 2001).

Using agents in the Intelligent Transportation Systems (ITS) has become common in recent years (Philippopoulos et al., 2007; Seow, Dang, & Lee, 2007). For the taxi dispatching problem, most recent researchers limit the scope of the optimization to the customer satisfaction factors assuming that this will optimize the problem from driver’s perspective too, but in real-world situations, it is not necessarily true (Liao, 2001).

In this paper, we try to focus on both players (customer and driver) more closely and present factors to measure their satisfaction along with

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an algorithm that considers and improves their satisfaction explicitly.

The remainder of this article is structured as follows. In section 2, we discuss the definition of the problem. This section discusses the current situation followed by an analysis of requirements of a better taxi dispatching system. Section 3 presents the proposed multi-agent dispatching system. This section goes on by describing the simulator we used to evaluate the effectiveness of the proposed algorithm. In section 4, we analyze the simulation results and compare the proposed multi-agent dispatching algorithm with current dispatching methods. This section starts with a definition of the parameters we used in this analysis, then goes on by comparing different dispatching methods using these parameters.

PROBLEM DEFINITION

The problem under study in this paper is a situation where taxis are scattered in the city and a dispatch center receives customers’ requests and assigns them to taxis. In this problem, we assume that customers are ready for pickup as soon as they call and we also assume that each customer needs exactly one taxi and has exactly one destination. Also, we assume that taxis always accept the mission according to dispatch center’s command.

Current Situation

The classic method for this problem divides the city to some regions and makes a queue from taxis in each region (Silva, 2003). When a new request is received, the dispatch center selects the first taxi from the queue of the region. If there is no taxi available in the caller’s region, the center chooses a taxi from top of the queue of one of the neighboring regions. When a taxi fulfills a request, it notifies the center and the taxi is put at the end of the queue of its current region.

Global Positioning Systems (GPS) can provide a modern means for location discovery. Using GPS, the dispatch center may pinpoint the exact location of each taxi at all times. In this method the center does not require to use the queue anymore and when a new request is received, it chooses the nearest taxi to the customer (Lee et al., 2004).

System Requirements

Each of the discussed methods (classic and modern) has its own advantages and disadvantages. In the queue method (classic), the first taxi in the queue is not always the closest to the customer, so the taxi may need to travel a longer distance. Longer distance means more waiting time for customer which may result in dissatisfaction of both driver and customer. The advantage of this method is that using the queue, requests are assigned in a more homogeneous manner which will result in some sort of fairness and causes driver’s satisfaction.

On the contrary, the nearest taxi method (modern using GPS) may send the taxis which has a shorter distance to the customer and this may result in less waiting time and higher customer satisfaction, but since there is no means for controlling the fairness of the dispatch, driver’s satisfaction is reduced. The fairness of dispatch is a factor which is not discussed so much in current research and most of them only tried to optimize the average waiting time of the customers. However, since this is a real world problem and driver’s satisfaction plays a major role, we need to consider this factor in the proposed solution.

Most researchers focus on finding a better route considering factors such as traffic situation in addition to various traffic related factors, and try to minimize customer waiting time. One of the problems reported for using this approach is the limited computational resources which has forced them to use estimation instead of actual results (Lee et al., 2004).

Another important fact is that although most researchers assume that all drivers behave the same, it is not what happens in real world situations and drivers behave differently in