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A Genetic Algorithm Approach to Autonomous Smart Vehicle Parking system

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Abstract

The shopping malls are source of entertainment and pleasure for the public during weekends. People struggling to park their vehicle in parking bay of shopping mall is a usual scenario witnessed at those peak times. Customer precious time and fuel is wasted and they get only few time for shopping. Authorities find it difficult to cope up with this situation even after appointing more employees to manage the traffic experienced in the bay. A smart car parking system that could elevate this problem is an urgent requirement for the shopping mall. This paper falls light on this issue by proposing a new prototype for the smart vehicle parking system. A genetic algorithm approach has been taken to address the issue of scheduling the vehicle to the parking bay.

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1. Introduction

With evolution of IoT paradigm, devices and systems are replaced with ‘Smart’ devices and systems that could capture, process, analyze and even make intelligent decision with the help of sensors, actuators, data mining and evolutionary techniques. One of the booming IoT application is development of a ‘Smart City’. Other applications include but are not limited to smart waste disposal, smart assisted living, smart transportation. This paper focus on smart city application of IoT. As a step towards the development of smart city, a smart parking system is proposed for the shopping mall.

Shopping mall which is the heart and soul of city is one of the focal point of attraction of the public. The parking bay of the shopping mall congested with vehicles causing a big traffic jam is a usual scenario during the weekends.

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The shopping mall personnel find it difficult to manage the deadlock situation. Due to the inefficiency of the parking system, vehicles are parked even at the roadside nearby the shopping mall. This hectic problem is addressed in few of the national newspaper yearly [1, 2]. But the situation remains the same even after apply different strategies to alleviate the problem. The root cause of the problem analyzed is the poor parking system employed in the shopping mall. When the problem is closely inspected, the reason for the traffic congestion is not because of lack of parking space but due to the lack of efficient scheduling of vehicles to the parking space. To alleviate the problem, the parking system should implement proper scheduling measures to schedule the vehicle effectively to the appropriate parking region without compromising precious waiting time of the customer. Genetic algorithm (G.A) is an evolutionary algorithm well suited for solving such scheduling problems. Genetic algorithm is a very good optimization technique that iterates through different stages like selection, crossover and mutation to obtain an optimal solution. Genetic Algorithm mimics the process of natural selection using bio-inspired operators like crossover and mutation. It is based on the theory of survival of the fittest. Genetic algorithm consider a population of solutions (individuals). The fitness of each solution is calculated by evaluating a fitness function against each solution. The survival of the individual to the next iteration is purely based on the fitness value of the individual. The individuals with least fitness value will be removed from the population. Good characteristics derived from parent solutions are propagated to the next generation by applying crossover and mutation. This paper propose a prototype and derive the essence of genetic algorithm to solve the scheduling issue experienced in the proposed parking system.

The rest of the paper is organized as follows: The prototype is discussed in detail in section II. Mathematical modelling and genetic algorithm approach employed in the system is also discussed in section II. Section III present the experimental set up and expected results of the system. Section V will concludes the paper.

2. Proposed System

2.1. System Overview

As shown in Fig. 1., the proposed system includes an android application for customers to book the parking lot in advance. Each user is given a customer id. Customer id can be used by them for future booking. This is to identify frequent customers to shopping mall. At the time of booking, customers are requested to enter the duration for which they will park the vehicle. When the parking time exceed the duration, the system will send a 'Time Exceeded' alert message to customers to take appropriate action. They are given a grace period of 30 Minutes to take the vehicle from the bay or if the customer wish he can extend the time duration by paying an extra charge at the exit. PayPal is used as the payment gateway to deal with parking payments. Both the payment details and allotment details are stored in a cloud database. The core part of the proposed system is an autonomous trolley. The trolley is used to take the vehicle from the entrance to correct parking slot identified by the system. The customer can leave their vehicle at the entrance and enjoy the shopping. The trolley capture the image of the surrounding after the vehicle is successfully parked in the slot. The image and location map is send to the customer mobile application. The image act as an acknowledgement for the customer that vehicle is correctly parked and location map help them to track their vehicle. Thus the advantage of using an automated trolley is that customers can enjoy their shopping without wasting their precious time in parking and tracking the vehicle. Ultra-sonic sensors are used to detect the parking and unparking of vehicle in a parking slot. These sensors constantly give parking updates to the system and is an important component in the proposed model.

2.2. Problem Definition

As shown Fig. 1., the parking bay is divided into different regions $R_1, R_2, R_3, \dots, R_m$. Each region is again divided into parking lots $L_1, \dots, L_2, \dots, L_n$ in R_1, R_2, \dots, R_m . An automated trolley is used to carry the vehicle from the entrance to the slot in the appropriate region. 'k' number of automated trolley T_1 to T_k are assigned to the parking bay to do this task. The count 'k' is determined by employing a mathematical model discussed in next section. These 'k' number of trolleys are employed to avoid the waiting queue that may built up at the entrance. The problem is to properly schedule 'k' trolley to appropriate $1, \dots, m$ regions so that maximum efficiency score, utilization score and reduced waiting time to park the vehicle is achieved. It can also be redefined as the problem to find the best parking region and parking lot to park the vehicle.

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