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A Comparative Study of Different Algorithms used in Parking Availability Prediction

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Abstract:

In metro cities, congested streets are a serious issue. In recent years, many cities have faced far more issues than in the past, particularly those linked to people movement and land use. One of the most difficult challenges is to solve parking management, which connects transportation and land use. When there aren't enough parking spaces, especially during rush hour, parking might be a pain. The scarcity and management of parking places are the most significant challenges. This is due to unfulfilled demand as a result of a lack of parking spots and inefficient use of existing facilities. In most large cities, finding a parking place is difficult, especially in the mega city. It is estimated that vehicles spend half an hour on average looking for a parking spot. As a result, the purpose of this study is to assist the parking management team in improving the efficiency of the parking spaces available in order to optimize the parking area. In this paper, we present a comparative study of different parking availability predication algorithms.

Keywords: Parking Spots,meta-heuristic,parking management

1. Introduction:

Because of economic progress in recent years, the average person now has at least one car, yet finding parking places is not easy. As a result of parking-related concerns, time is spent and fuel is consumed. So, the solution to this parking dilemma is Intelligent Parking (I-Parking), in which the motorist receives a notice about an unoccupied parking lot, saving time and increasing vehicle economy.

Automobiles have been more prevalent in cities around the world in recent years. As a result of urbanization, there are more people living and working in cities. Due to its low cost and convenience, street parking remains a popular choice for motorists. However, this choice results in a high concentration of automobiles, which causes traffic congestion and blockage. This situation is exacerbated as drivers wait for others to exit parking spaces or search for open spaces. An intelligent technique is offered to alleviate this difficulty by generating an

appropriate parking space based on the car position and planned destination. The proposed strategy adapts its operators and derives optimality from the search optimization process's synergy between a genetic algorithm and a local search technique. When compared against existing approaches across a number of iterations, the proposed method outperforms them.

It is estimated that vehicles spend half an hour on average looking for a parking spot. On a micro scale, some studies forecast parking occupancy based on individual driver behavior. Such studies frequently examine parking habits and use probability distributions to model vehicle arrival and departure times. As a result, the purpose of this study is to assist the parking management team in improving the efficiency of the parking spots available in order to maximize the parking area. Furthermore, the goal of this research is to increase the number of parking spaces available.

The organization of paper in the way that after the introduction part, section 2 highlights the related work. Section 3 is research gap .Section 4 highlights Different Techniques used in Paring Management and Section 5 depicts the conclusion.

2. Related Work:

This section discusses the past studies related to parking management using different techniques. In smart cities, traffic congestion is a common problem that occurs due to the development of technology. The visitors often use vehicles for even short distances.Many researchers used a theory-driven approach to predict parking occupancy status by examining individual drivers' parking behavior and simulating the arrival and departure process using various distribution models.

Singh et al.(2020) proposed a novel method for parking vehicles using metaheuristic approaches. The developed approach provides consistent results considering two parameters, parking efficiency and parking space search time. The parking efficiency is improved and parking space search time is reduced using the Firefly Algorithm (FA) and Feed Forward Back Propagation Neural Network (NN) approach. The architecture provides guidance to driver, which reduces the need of man power at parking sites. The developed system also works for the visitors to search a vacant space in shorter amount of time. This can reduce the waiting time of the visitors. The effectiveness of proposed approach is evaluated using the parking efficiency and parking space search parameters. The average of non-parked vehicles without using FA-NN is 70 while other has only 16. In addition, the average search time reduces from 22.84 seconds in case of without using FA-NN to 12.23 seconds by using FA-NN[1].

Camero et al.(2018) proposed a new technique based on Deep Learning with Recurrent Neural Networks which is used to address the prediction of car park occupancy rate. They introduced two metaheuristics approaches to RNN architecture optimization: a GA-based and an ES-based. Both strategies proved to be suitable for solving the problem, and not only that: they also provided useful information to improve our understanding of the RNN architecture optimization problem [2].

Shao et al.(2018) used a large real-world dataset and proposed a framework which is used to predict the parking availability with LSTM and clustering techniques. The framework consists of two modules: parking occupancy prediction and duration time estimation. In the parking occupancy module, they introduce popular recurrent neural networks called LSTM to learn the pattern of the occupancy rate of each region clustered by k-means. For duration time estimation module, they use the regression analysis method to estimate the probability of car leaving with time t and evaluate the potential influential factors [3].

Provoost et al.(2019)developed a real-time parking area state (occupancy, in- and out-flux) prediction model (up to 60 minutes ahead) which used publicly available historic and real-time data sources. Based on a case study in a real-life scenario in the city of Arnhem, a Neural Network-based approach is used[4].

In Camero et al.(2018), the authors presented a new technique based on deep learning with recurrent neural networks to process the parking occupancy rate forecast[5].

Yucenur et al.(2020)used a the two-step meta-heuristic approach which is used for the assignment problem. In the first step clustering is performed by geometric shape-based approach and the results of this step are used for an initial solution of the genetic algorithm. In this problem, according to the known distances between bus garages and bus-line start points, it is determined which buses should park in which garages[7].

In Mago et al.(2018),author proposed a hybrid model which is used for detecting outdoor parking empty spaces available in the parking lots and the spaces/ slots getting vacant in the real-time scenario. This model is based on training, validating and testing the images (dataset) collected from various heights and angles of different parking areas stored in the repository. In this research, more advanced feature extractors and machine learning algorithms are evaluated in order to find the vacant parking lots in the outdoor parking areas[8].

Qing et al.(2017)proposed a improved Dijkstra algorithm which is used to solve the path-planning problem in the rectangular environment, which can find all equidistant shortest paths. The optimal path with both the shortest distance and time is obtained by adding running time to the path-planning evaluation. The algorithm is programmed using Visual C++, and the simulation results show that the algorithm is effective and feasible for path-planning in the AS/RS system[9].

In Guo et.al (2020) author proposed algorithm employs the evaluation strategy of group update, which not only retains the advantage of fast convergence of the dimension-by-dimension update evaluation strategy, but also increases the mutual relationship between the nests and reduces the overall running time. Then, we use the WNN model to predict parking information. The proposed algorithm is compared with six different heuristic algorithms in five experiments. The experimental results show that the proposed algorithm is superior to other algorithms in terms of running time and accuracy[10].

Fan et al.(2018)developed a novel prediction model for the number of vacant parking spaces after a specific period of time is proposed based on support vector regression (SVR) with fruit fly optimization algorithm

(FOA). In the proposed model, the SVR parameters are initialized as the fruit fly population, and FOA is utilized to search the optimal parameters for SVR. Sufficient experiments within various scenarios, i.e. predicting the vacant parking space availability in parking lots with various capacities after various periods of time, have been conducted to verify the effectiveness of the proposed FOA-SVR prediction model. Three other commonly used prediction models, i.e. back propagation neural network (NN), extreme learning machine and wavelet NN, are used as the comparison models. The experimental results show that the proposed FOA-SVR method has higher accuracy and stability in all the prediction scenarios[11].

Shariffuddin et al.(2019)used a firefly algorithm method which is used to find the maximum number of parking lot that can optimize the parking area. It is shown that with the current parking area, the number of parking spaces can be increased by 48 lanes which can optimize the parking spaces to the fullest[12].

Zhao et al.(2013) design an algorithm for this particular assignment problem and solve the parking planning problem. The method proposed can give timely and efficient guide information to vehicles for a real time smart parking system. Finally, we show the effectiveness of the method with experiments over some data, which can simulate the situation of doing parking planning in the real world[13].

Table 1: Comparative Analysis of Algorithm

Paper References	Algorithm	Technology	Strength	Weakness
Singh et al., 2020	Firefly Algorithm	Feed forward Back propagation Neural Network	to determine best route using the shortest path	slowest convergence speed
Camero et al,.2018	Evolutionary algorithm	Deep Learning with RNN	Find the nearest appropriate and unoccupied parking slot.	it does a blind search there by consuming a lot of time waste of necessary resources.
Shao et al.,2018	LSTM(Long short-term memory)	Clustering techniques & RNN	used to identify the nearest free slot based on the size of a vehicle	Not suitable for open parking plot
Provoost et.al.,2019	Random Forest	Feed forward neural network	Used to find the minimum distance between the user and each parking slot in the system.	It usually takes longer time to search, not suitable for large-scale problems.

Guo et.al.,2020s	Cuckoo	Wavelet Neural Network (WNN)	intelligent meta-heuristic algorithm that implement local and global search mechanisms	It is not suitable for discrete problems and multi-objective problem
Schneble et al.,2021	Decision Tree and Support Vector algorithms	Deep Learning with CNN	to classify parking slots in a parking space into vacant and filled slots.	not suitable for night, foggy, or snowy conditions,
Yucenur et al.,2020	Dijkastra Algorithm	Scheduling technique	Allocation of vacant parking space by calculating shortest path available	if there are a large number of network points, Dijkstra takes a long time and storage space
Qing et al.,2017	Artificial Bee Colony (ABC)	Artificial Neural Network (ANN) warm intelligence technique	Find the nearest appropriate and unoccupied parking slot.	Slow when in sequential processing

3. RESEARCH PROBLEMS

Parking availability prediction has received a lot of attention in recent years, despite being recognized as a difficulty. It is intimately related to the interactions of various elements, such as parking patterns, parking rules, the type of parking facility, price policy, driver behavior, and traffic signals.

The actual number of parking spaces available within a parking garage is rarely provided. Hundreds of cars enter the parking lot every day, hoping for an empty parking spot. As a result, finding an open parking spot is tough. Car drivers still have to find an empty parking spot in most local parking lots. They will undoubtedly waste slot time looking for empty parking slots if they don't know where they are, especially if each row of parking slots only has a few empty parking spaces.

The available solutions are partially based on traditional systems for managing uncontrolled parking, but their main disadvantage is their long computation time and slow processing. Furthermore, the researchers' hybrid methodologies are still inaccurate because the fitness values were not calculated properly. The system is complicated due to the slow process of calculating fitness value. Furthermore, while parking the automobiles, traffic congestion must be resolved. The designed system's performance is hampered by these flaws.

4. Different Techniques used in Parking Management

After literature review, we have find that there are different techniques are used for parking management.

(1) Machine learning (ML) parking management: - ML is a subset of AI that provides a system the ability to learn and improve on a particular task from the datasets or experiences without explicitly programming the system (Fahimet al.2021). To determine the status of the parking lot, a machine learning-based parking analyses the data from the parking lot. Additionally, parking systems powered by ML and AI can forecast parking lot occupancy levels for the following days, weeks, or even months and offer a dynamic pricing structure. Intelligent parking spaces can be monitored for traffic congestion on specific roadways using ML-based systems.

(2) Deep learning (DL) based parking management: - DL is a subset of ML and a function of AI which mimics the human brain in terms of data processing and feature extraction to make decisions (Fahimet al.2021). Instead of using conventional sensors, DL algorithms may identify vacantly occupied spaces and designated parking areas in an SPS, which minimizes the system's need for sensors and cameras. DL is also used to predict parking lot occupancy.

(3) Neural Network (NN) based parking management: - NN is a combination of algorithms that extracts features and underlying relationships from sets of data through a process that mimics human brain function. In parking,Real-time video footage is used to recognizelicense plates using NN. To determine whether a parking lot is occupied, CNN and machine vision are used. CNNs can also provide information about the flow of traffic on various routes. (Fahimet al.2021).

(4)Fuzzy logic based parking management: - Fuzzy logic is a reasoning method that resembles human reasoning. It uses multi-valued logic, which means there is no absolute truth or absolute false value in fuzzy logic. Fuzzy logic is used in smart parking for predicting parking lot occupancy status (Fahimet al.2021).. But the accuracy of the prediction model based on Fuzzy logic would not be that high without validating the prediction result with the real-time data .Therefore, Fuzzy logic, along with machine vision or sensors, improves the accuracy of the overall system (Fahimet al.2021).

(5) AI –Based Smart Parking Solution: - AI-based smart parking solutions have become a crucial part of our daily lives. They are important and beneficial for both sides – parking managers and parking users. The Automatic Vehicle Identification also is one of the AI-based smart parking solutions. It works via ALPR cameras and uses the optical character recognition technique. That way, it scans and reads vehicle plates and provides automatic access to the parking lot. They help for efficient parking management and can transform and improve the whole parking industry [16].

(6)Hybrid approach for parking solution:-This method allows us to mix various models into a single combination. The short-term parking space in the parking guidance system is predicted using a combination of genetic algorithm and recurrent neural network (RNN).

4. Conclusion

The major causes of fewer parking spots, which are the foundation of irksome traffic issues, are an increase in the overall population and the unplanned city structures. If there is an issue, we must find a solution. Hence many researchers and tech enthusiasts have started their work to find worthy solutions in this particular area. The paper compares the available research on smart parking systems in detail and discusses several algorithms and their outcomes, advantages, and disadvantages. We have made an effort to provide a brief overview of the research we have conducted. Research papers are categorized in Paper based on the methodology employed. After reviewing all of the research, it was determined that the Smart Parking System, which was implemented utilizing numerous ways, would be more effective and more accurate in terms of its results.

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