Smart Car Parking System based on UWB Tracking

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ABSTRACT
A better parking infrastructure is essential in a developing country like Bangladesh where both the population and the number of vehicles are rapidly increasing. The number of vehicles in use is rising swiftly, but there aren't enough parking spaces to accommodate all of them, which forces drivers to park their cars on the streets, which leads to significant congestion on the roads and slow traffic growth. Even if searching for parking spaces takes a lot of time, searching unannouncedly has a negative influence on the environment due to the release of terrible and toxic gases from moving vehicles. By burning fuel, this discharge pollutes the atmosphere by emitting different gases as well as CO2. Additionally, traffic slows down as people look for parking spaces. To tackle the above-mentioned limitation, this research propose a new car parking method based on UWB technology. This research also covered the idea of pattern classifiers. The apriori algorithm is used to build frequent rules for cars that are regularly parked, and the system then uses those rules to automatically assign parking slot for the cars. The user can find parking without wasting time by using apriori. This research experimental result shows that the proposed system needs less searching time when compared with the existing system. Basically, this system addressed how to improve the existing system with the new dimension of technology like how to switch automated parking to smart parking, add advanced booking facility etc.

General Terms
Smart cities, Internet of Things (IoT) et. al.

Keywords
Apriori; UWB; Internet of Things; Parking Lot; RFID; Frequent rule

1. INTRODUCTION
Today's parking of Bangladesh's shopping mall or Government buildings is based on manual parking. There are a lot of problems in manual parking. Users didn't know early about parking status in such kind of system that's why they suffer a lot. A better parking infrastructure is essential in a developing country like Bangladesh where both the population and the number of vehicles are rapidly increasing. The number of vehicles in use is rising swiftly, but there aren't enough parking spaces to accommodate all of them, which forces drivers to park their cars on the streets, which leads to significant congestion on the roads and slow traffic growth. The many parking options in our nation were now reviewed. The parking problems that big cities have can be solved in a number of ways. Automatic parking and advanced sensor technology are included in the proposed configuration.

Automatic Parking: A framework that is controlled by computers makes up automatic parking, which is also known as programmed parking. A car is stopped in one of numerous bays by its driver, who then bolts it and drives away [4]. The vehicle is then raised off the ground by the structure using a mechanical lift. The driver enters their login_name and credentials into the system when retrieving the car, and the notebook usages this method to locate the car. It is necessary to implement some sort of insight and booking frameworks in order to expand such a structure to a smart parking structure.

Advanced Sensor Networks: Numerous strategies utilizing advanced sensor systems have been suggested for the connection of parking offices [5]. A pedestrian or a protester can cause information to be tainted when using optical sensor detectors to identify transient automobiles, for instance. This can be prevented by installing sensors in places where only moving cars can activate the scheme, or by increasing the detection method to rise the detection system's consistency.

Now the research question is, should the existing automated or other be used to find parking spot and reserve a slot in advance is enough. The insights behind this question are, it is more important to find out something meaningful quickly find a parking spot more accurately instead of spending time in searching the entire space randomly.

To tackle the above-mentioned limitation and or research questions, this paper propose a new car parking method based on UWB technology. Ultra-wideband (UWB) technology is used because this technology is new in this arena and if we develop our parking system using UWB technology then our system works more efficiently. This article also covered the idea of pattern classifiers. The apriori algorithm is used to build frequent rules for cars that are regularly parked, and the system then uses those rules to automatically assign parking slot for the cars. The user can find parking without wasting time by using apriori. Apriori algorithm is used because it is one of the best algorithms for generating frequent rules.

To effectively processing and employing Ultra-Wideband (UWB) technology is both a theoretical and technical challenge in current smart parking research. These papers propose technology presents the following breakthroughs in smart parking arena: analyzing big data without a memory limit, the idea of pattern classifiers is used to build frequent rules for cars that are regularly parked, and the system then uses those rules to automatically assign parking spaces for the cars. By immediately performing the apriori algorithm to generate frequent itemset rules and increasing the scalability of smart parking.

With the help of a UWB tag and an apriori algorithm, this research aims to examine a novel method of producing frequent itemsets for parking cars. The allocation of parking spaces may take some time under the current method since each time the user's authentication must be needed, a parking space must then be checked. The goal of this research is to create a new smart parking system where frequent pattern rules are produced for the regular user by applying the apriori algorithm. The system will automatically assign a slot for the user's automobile if they frequently park it there. The new breakthroughs on methods

and technology will significantly increase the performance and scalability of smart parking arena. The main research tasks of this project include: (1) Use the apriori algorithm to automatically allot space for cars that regularly arrive for parking; (2) To park a car and assign a space, parking lots contain UWB readers. (3) This sophisticated technology automates the method of locating a parking space that is available and paying for it. (4) The user/driver has a smart parking app, which updates the car's information instantly after reading the UWB code; (5) development of demos on the new information and communication applications.

2. LITERATURE REVIEW

The structure and general layout of an Arduino-based car parking framework are described in [1]. The primary requirement for parking a car in a spot is the driver's or user's approval. Each user will receive an approval card, which includes information such as the vehicle's number. If there is room available in the parking lot and the user is authorized, the parking entrance will accessible, allowing the driver to park the car where it is not permitted even though the user is authorized. A smartphone notification concerning parking will be sent to the user if the automobile is allowed to park. In addition to providing security for a car and ensuring that unauthorized users are prevented from entering a parking space, it resolves the parking problem in urban areas. It parks a car in a multi-story garage and indicates which floor has available space.

Shih, Chihhsiong, and Zhaolong Liang, their research offered a design for a system for parking advice that consists of both software and hardware[2]. Numerous IoT sensors are included in the hardware, including proximity sensors, Light Emitting Diode displays, magnetic field sensors, and devices allowing far-off correspondence. The writer creates methods and algorithms to govern how all sensor devices are turned on and off as part of the product design.

Kotb, Amir O., Yao-chun Shen, and Yi Huang, they provides in their research background information on parking problems and examines and discusses suitable algorithms, frameworks, and smart parking techniques [3]. The checking, booking, and direction, aspects of the intelligent auto parking are thoroughly covered in this article, along with suggestions for future development.

A framework for route- and booking-based parking recommendation for smart cities was created in [4]. The IoT technology will be used to enhance the improvement of tiny devices that transmit information to the web. Exploiting a genetic algorithm, the closest available parking space is located.

The framework described in [5] includes sensor nodes that can detect when a parking space is occupied, hand-off knobs for communication between the server and sensor nodes, a server app that gathers data from impart nodes and sends it to a cellular app, and a cellular app that displays parking spaces and their vacancy on a map. The automobile sensing sensor node was made using low-power and affordable components and sensors. Magnetic and distance sensors made up the vehicle identification sensor node. The magnetic sensor recognizes the car's existence, and the space sensor makes it clear. The server app is hosted on AWS, while the cellular app was implemented utilizing Android (Amazon Web Services).

A useful method to confirm the parking space's accessibility and reserve a place was put forth in [6]. Only the parking space's accessibility is the focus of current improvement. Drivers, however, are unable to determine whether a parking place is available upon request in this fast-paced society. Booking-oriented smart parking using a cloud-integrated setting is suggested to get around this restriction. This makes it easier for the drivers to park their cars and remove any obstructions to mobility. To determine the availability of the parking space, drivers might start requesting to use a reservation application on their Android smartphones. A driver can reserve a place using an online payment system if the opening is open. The proposed framework also gives drivers the option of erasing parking spaces that have been saved.

An IoT-oriented cloud-based intelligent parking architecture was put forth in [7]. The IoT module that is deployed on-site and used to track and signalize the accessibility of each parking place is part of the proposed smart parking framework. Additionally, a mobile app is offered that enables drivers to both check parking space obtainability and reserve a parking place. The study also shows the framework design from a broad perspective. An illustration that shows the correctness of the suggested demo is used toward the end of the paper to understand how the framework functions.

Article [8], talked about a smart car parking system that followed RFID tracking and did not use any mobile apps in their proposal. They mention many techniques including a priori algorithms but focus on RFID.

Article [9], a wireless framework for locating parking spaces remotely via a mobile phone is presented, together with a remote sensor node that determines whether or not parking spaces are available. The framework is found to be extremely capable and precise, even at great distances [10].

Article [11], illustrates a smart parking framework solution that uses the IoT to bypass parking restrictions and clarifies how it can cut greenhouse gas releases. Using a network of connected Space Sensor, Pi Camera gadgets, and Raspberry Pi, IoT enables smart parking systems. This equipment interacts with one another, gathers data, and sends it to cloud server.

Article [12-20], authors proposed new smart parking system but didn’t combine UWB technology and apriori algorithms.

There is no system existing where UWB technology and apriori is used but combining these two features in one system for parking will be much more efficient. So, this research focus on this.

3. PROPOSED METHOD

The managing pipeline of the methods for the intelligent parking system is shown in Fig. 1. Every time a car user requests parking, the system initially reads the UWB tag where the car is equipped with UWB tag. After positively understanding the UWB tag with the UWB tag reader, a parking spot is assigned to the automobile, and all the ABCs are updated in the cloud server, in that way the parking lot is designed for the proposed system. In essence, it checks the tag in the cloud database, and if the tag corresponded in the cloud database, then it allocates the spot for parking. As with the current system, allocating a parking place can take some time since each time the user's authentication must be needed, a parking space must then be inspected, it’s just a manual system. As a result, the apriori algorithm is used in this system to build frequent pattern rules for the frequent user. If the user or driver frequently parks the vehicle, the system will provide a spot for it.

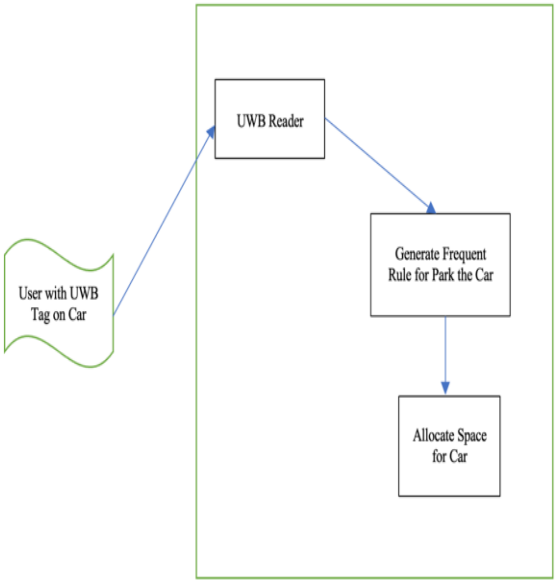

Fig 1: System model

Figure 1 graphically shows the proposed system where car, parking lot, UWB tag, UWB reader all components are described clearly. The proposal concludes that proposed system lessen every hassle of car user/driver if todays' current parking system is modified with this proposal.

Algorithm

Algorithm 1: Algorithm for this proposal

A well-known and well-researched approach for detecting fascinating affairs between variables in ample databases is association rule learning. Its goal is to locate robust rules that have been noticed in databases utilizing various interestingness indices. The algorithm's steps are as follows:

Apriori Algorithm

procedureApriori (T, min-sup) (//T is the dataset, and min-sup is the minimum support)

Ck: Candidate itemset of size k

Lk: frequent itemset of size k

LI= {frequent items};

for (k= I; Lk! =∅; k++) do begin

Ck+1= candidates generated from Lk;

for each transaction t in dataset do {

increment the count of all candidates in Ck+1 that are contained in t

Lk+1= candidates in Ck+1 with min-sup

} end

return ∪k Lk;

Mathematical Model

Mathematical model for apriori algorithm

Let X = $\{g_1, g_2 \ldots, g_n\}$ be a set of n binary attributes named items.

Let Y = $\{y_1, y_2, \ldots, y_n\}$ be a set of transactions named the database.

Each transaction in Y has a one-off transaction ID and comprises a subset of the items in X.

T-1 = {g1}

T-2= {g1, g2}

T-3= {g1, g4}

T-4 = {g3, g1}

T-5 = {g2, g4}

T-6 = {g2, g1}

T-7 = {g2}

Where, X = {g1, g2, g3, g4}

Database comprising the items (codes existence value is 1 and value 0 is nonexistence of an entry in a transaction). The proportion of transactions in the data set that include the itemset is defined as the support sup(I) of an itemset I. For instance, the support for the itemset {g1, g2} is 0.1 i.e., 1/7=0.1. The formula for a rule's confidence is conf(I=>O) = sup(I ∪ O)/sup (I).

Set model

Let P, be a scheme such that,

P = {S, E, I, O, N, f_main, DD, NDD, f_frnd, M_req, CPU_count, Ø}

Where,

P- Anticipated Parking System

S-Starting point at T<init> i.e., Delivering the UWB tag.

E- End point of assign spot for parking.

I- Input of Scheme i.e., UWB tag

O- Output of Scheme i.e., rules generation

N- a set of successive phases that will be carried out in a pipelined machine round. Encryption, decryption, rule creation, concise synopsis, etc. are serialized steps in the system involved.

f_main- The core algorithm, which produces the outcome Y, focuses mostly on the success specified for the solution. The Apriori algorithm is applied in the given scheme.

XX- Deterministic data aids in locating the assignment or load-store functions. such as i= {return}. Such a feature adds to the complexity of space. Deterministic data will be stored in a transactional database in the given system.

NXX- Non-Deterministic Data about the Problematized Structure. These computation functions, as well as CPU and ALU time functions, add to the complexity of time. We must secure the database in the given system.

f_frnd- Set of association rules.

M_req- Every active process will receive the RAM needed to complete all of these actions.

CPU_count- The speed and performance increase with the amount of core counts.

Ø - If any value is null.

4. RESULTS AND DISCUSSION

This research's experimental results are shown in Figure 2. This result is based on searching time for existing systems and the proposed system. From the figure, it is clear that the proposed system needs less searching time when compared with the existing system. This is why the proposed system uses an apriori algorithm to identify frequently used parking spaces in a lot, and after identifying them, the proposed system allocates the slot without wasting time. In such a way, the proposed system improved the existing parking system significantly. In this proposal, basically, the apriori algorithm is compared with the system where the system is designed with no algorithm, which means the current system. Basically, the proposed system addressed how to improve the existing system with the new dimension of technology, like how to switch from automated parking to smart parking, add advanced booking facilities, etc. that is mentioned earlier.

4.1 Figures and tables

In figure 2 the research experimental results is shown. And the data time in second are given in table 1.

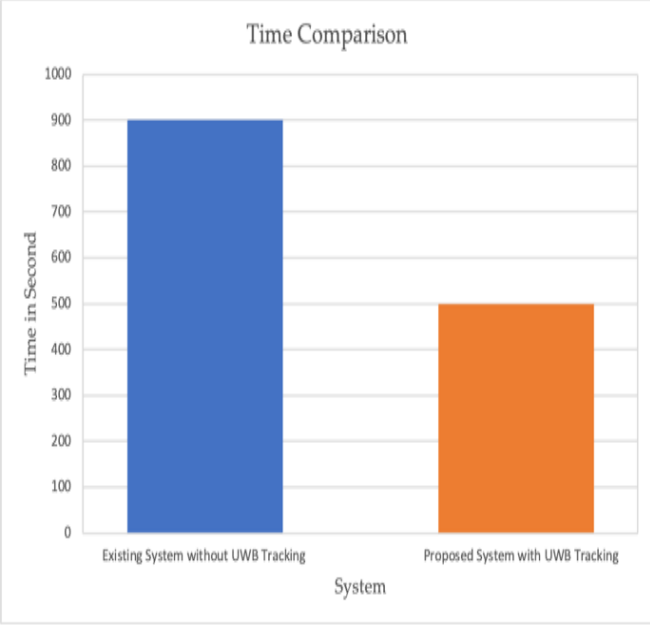

Fig 2: Experimental result

Table 1. Searching time comparison.

Existing System	Proposed System	Difference
900 sec	500 sec	400 sec
800 sec	400 sec	400 sec
700 sec	300 sec	400 sec
600 sec	200 sec	400 sec
500 sec	100 sec	400 sec
400 sec	000 sec	400 sec
300 sec	-	-

***Time in second**

5. CONCLUSIONS

In this paper, a new car parking method based on UWB technology was proposed. This paper also covered the idea of pattern classifiers. The apriori algorithm is used to build frequent rules for cars that are regularly parked, and the system then uses those rules to automatically assign parking slot for the cars. The user can find parking without wasting time by using apriori. From the experimental result it is clear that the proposed system needs less searching time when compared with the existing system [14-20]. The results of this research will open a new way for smart cities and technology development. The results will lay off foundations for developing the new generation of technologies and platforms beyond existing. The research will promote development of homemade smart parking technique and tools in any country like Bangladesh.

Further improve the scheme by employing profits building functions, for example, ad and advertising operations through the parking apps. By incorporating the information found from the motion sensors in cellphones to the scheme, improve the locating module.

6. ACKNOWLEDGMENTS

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