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# Evaluating the Reliability based Park-Crowd for Real-Time Parking Space Information

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**Abstract -** The scarcity of parking spaces in cities leads to a high demand for timely information about their availability. In this paper, we propose a crowd sensed parking system, namely Park Crowd, to aggregate on-street and roadside parking space information reliably, and to disseminate this information to drivers in a timely manner. Our system not only collects and disseminates basic information, such as parking hours and price, but also provides drivers with information on the real time and future availability of parking spaces based on aggregated crowd knowledge. To improve the reliability of the information being disseminated, we dynamically evaluate the knowledge of crowd workers based on the veracity of their answers to a series of location-dependent point of interest control questions. We propose a logistic regression-based method to evaluate the reliability of crowd knowledge for real-time parking space information. Moreover, to incentivise wider participation of crowd workers, a reliability-based incentivization method is proposed to reward workers according to their reliability and expertise levels.

***Keywords*** *- Crowd worker, veracity, park crowd*

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## 1. Introduction

With the increasing numbers of automobiles in cities, finding a parking space which is close to one's driving destination is costly, time-consuming, and contributes to traffic congestion in urban areas. These problems are especially extreme in the case of on-demand parking in metropolitan centres and densely populated areas around the world. Therefore, there is a strong need to disseminate availability information of vacant parking spaces in real-time. Although drivers can view the locations of parking lots on maps offered by popular location-based service (LBS) providers, e.g. Google or Baidu, some important information of nearby unoccupied on-street or off-street parking spaces such as their parking hours, prices as well as the potential availability level are missing from these providers due to the lack of an efficient approach for collecting this information in real-time. It is therefore necessary to design and implement a system for aggregating and disseminating the relevant information for these urban parking spaces.

### 1.1. Motivation:

The scarcity of parking spaces in cities, especially metropolises such as London, New York and Beijing, leads to high demands for timely information revealing their availability during busy periods of the day. Although off-street parking garages are usually equipped with the necessary infrastructure or personnel to publish the number of unoccupied spaces, the lack of available spaces and high prices/access delays in these facilities force many drivers to alternative mechanisms such as using on-street and roadside parking spaces on demand (examples of such parking spaces are illustrated in Fig. 1). However, the lack of timely information about those kinds of parking spaces frustrates drivers, leading to an increase in congestion, and to unnecessary expenditures of time and money by the drivers looking for vacant spots. The most straightforward way to provide such information is to publish it on the Internet. This can be done by the owner of the parking space. However, this method doesn't suit scenarios such as free on-street parking and roadside parking lots as there is no incentive to publish this data. The data could be derived by constructing spatiotemporal models and applying them to historical data with geographic correlation , however the published data is usually out-of-date and inaccurate for real-time demands. A number of urban parking systems rely on specialized infrastructure, either embedded in roads or in vehicles to capture Realtime parking space occupancy. However, the cost to deploy these sensors or short-range communication technologies when scaling to large cities is significant. B.

Our Approach With the wide adoption of smartphones and other mobile devices, mobile crowdsensing (MCS), an approach to outsource data collection tasks among crowd workers, could be a promising solution for the aggregation and dissemination of parking space information. However, recent research or commercial products mainly employ sensors-based solutions which are only able to detect the existence of parking spaces, but not other important information such as parking time, hourly price and whether it is privately-owned or public. In this paper, we present ParkCrowd, which takes a "Human-in-the-loop" approach by utilizing crowd workers to identify vacant parking spots and score future availability level based on their own predictions. However, the reliability of the crowd workers' knowledge is highly uncertain and has big impact on the performance of ParkCrowd. In this paper, inspired by the location-dependent nature of parking information, we introduce point of interest (POI) related control questions into the crowdsensing process 1) to estimate the reliability of real-time availability information and 2) to improve the accuracy of estimated future availability. Moreover, to incentive crowd workers' participation as well as to encourage them to provide more reliable information, we build an incentivisation scheme into ParkCrowd to reward workers based on the reliability of contributed knowledge.
The major contributions of this paper are listed as follows:
• We design ParkCrowd, an MCS system for collecting and disseminating vacant parking space information based on crowd workers' knowledge.
• We build models to evaluate the reliability of the crowd workers' knowledge . We also propose an incentivisation scheme to reward workers based on the reliability of contributed knowledge. We perform extensive simulations to evaluate the performance of ParkCrowd. Moreover, ParkCrowd mobile application has been developed to carry out real-world experiments. Both simulation and real-life results indicate that ParkCrowd performs well in identifying unreliable information, scoring future availability of parking spaces and rewarding workers based on their reliability and efforts level.

### 1.2. Problem Definition

With the increasing numbers of automobiles in cities, finding a parking space which is close to one's driving destination is costly, time-consuming, and contributes to traffic congestion in urban areas .

These problems are especially extreme in the case of on-demand parking in metropolitan centers and densely populated areas around the world . Therefore, there is a strong need to disseminate availability information of vacant parking spaces.

OBJECTIVE

Moreover, to incentive crowd workers' participation as well as to encourage them to provide more reliable information, we build an incentivisation scheme into ParkCrowd to reward workers based on the reliability of contributed knowledge.

## 2. Literature Survey

### 2.1. I Parker—A new smart car-parking system based on dynamic resource allocation and pricing

Parking in major cities, particularly with dense traffic, directly effects the traffic flow and people's life. In this paper, we introduce a new smart parking system that is based on intelligent resource allocation, reservation, and pricing. The proposed system solves the current parking problems by offering guaranteed parking reservations with the lowest possible cost and searching time for drivers and the highest revenue and resource utilization for parking managers. New fair pricing policies are also proposed that can be implemented in practice. The new system is based on mathematical modeling using mixed-integer linear programming (MILP) with the objective of minimizing the total monetary cost for the drivers and maximizing the utilization of parking resources.

### 2.2. On-street and off-street parking availability prediction using multivariate spatiotemporal models

Parking guidance and information (PGI) systems are becoming important parts of intelligent transportation systems due to the fact that cars and infrastructure are becoming more and more connected. One major challenge in developing efficient PGI systems is the uncertain nature of parking availability in parking facilities (both on-street and off-street).

A reliable PGI system should have the capability of predicting the availability of parking at the arrival time with reliable accuracy. In this paper, we study the nature of the parking availability data in a big city and propose a multivariate autoregressive model that takes into account both temporal and spatial correlations of parking availability.

The model is used to predict parking availability with high accuracy. The prediction errors are used to recommend the parking location with the highest probability of having at least one parking spot available at the estimated arrival time. The results are demonstrated using real-time parking data in the areas of San Francisco and Los Angeles.

### 2.3. ParkNet: Drive-by sensing of road-side parking statistics

Urban street-parking availability statistics are challenging to obtain in real-time but would greatly benefit society by reducing traffic congestion. In this paper we present the design, implementation and evaluation of ParkNet, a mobile system comprising vehicles that collect parking space occupancy information while driving by. Each ParkNet vehicle is equipped with a GPS receiver and a passenger-side- facing ultrasonic range-finder to determine parking spot occupancy.

The data is aggregated at a central server, which builds a real-time map of parking availability and could provide this information to clients that query the system in search of parking. Creating a spot-accurate map of parking availability challenges GPS location accuracy limits. To address this need, we have devised an environmental fingerprinting approach to achieve improved location accuracy. Based on 500 miles of road-side parking data collected over 2 months, we found that parking spot counts are 95% accurate and occupancy maps can achieve over 90% accuracy. Finally, we quantify the amount of sensors needed to provide adequate coverage in a city.

Using extensive GPS traces from over 500 San Francisco taxicabs, we show that if ParkNet were deployed in city taxicabs, the resulting mobile sensors would provide adequate coverage and be more cost-effective by an estimated factor of roughly 10-15 when compared to a sensor network with a dedicated sensor at every parking space, as is currently being tested in San Francisco.

### 2.4. SPARK: A new VANET-based smart parking scheme for large parking lots

Searching for a vacant parking space in a congested area or a large parking lot and preventing auto theft are major concerns to our daily lives. In this paper, we propose a new smart parking scheme for large parking lots through vehicular communication. The proposed scheme can provide the drivers with real-time parking navigation service, intelligent anti-theft protection, and friendly parking information dissemination. Performance analysis via extensive simulations demonstrates its efficiency and practicality.

### 2.5. Disadvantages:

- However, placing dedicated sensors supposes either regular data collection by an employee, or wireless access, the approach also suggests either battery or dedicated power lines per unit. Using a camera sensing approach involves similar problems (internet connectivity, power supply) in addition to the problems of camera installation alignment, adjusting and positioning, and merging images from multiple cameras.

- However, the approach requires specific hardware configuration and thus can't be used in low-end or old vehicles. In addition, it is a vehicle-based rather than a phone-based parking search solution, thus it is less applicable when planning outside a vehicle.

## 3. Existing System

- Infrastructure based solutions using sensors or cameras have been proposed to measure parking occupancy. A commercial product using sensors to detect vacancy of on street parking spaces has been built employs a multiclass SVM classifier to identify the state of parking spaces using images captured by security cameras.
- A more flexible approach is introduced to map parking spaces using vehicles' pre-installed ultrasonic parking sensors, which essentially builds a vehicle based crowdsensing system.

## 4. Proposed System

- *ParkCrowd*, which takes a "Human-in-the-loop" approach by utilising crowd workers to identify vacant parking spots . Using the knowledge of crowd workers for parking spaces, ParkCrowd is able to provide the real-time availability information. However, the reliability of the crowd workers' knowledge is highly uncertain and has big impact on the performance of ParkCrowd.

- We design ParkCrowd, an MCS system for collecting and disseminating vacant parking space information based oncrowd workers' knowledge.

- We build models to evaluate the reliability of the crowd workers' knowledge. Availability based on workers' knowledge using location dependent POI questions. We also propose an incentivisation scheme to reward workers based on the reliability of contributed knowledge.

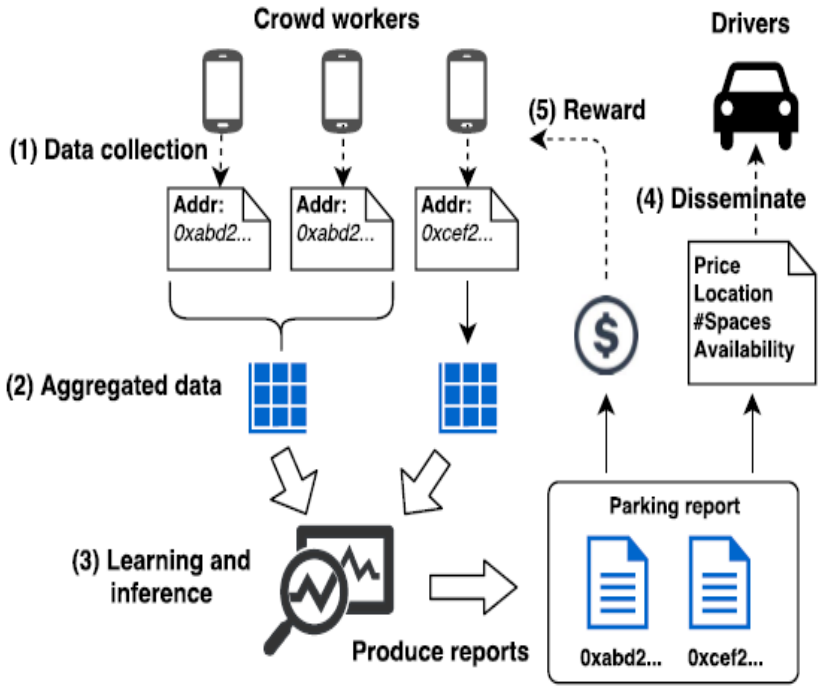


Fig.1: Architecture diagram

## 5. Results

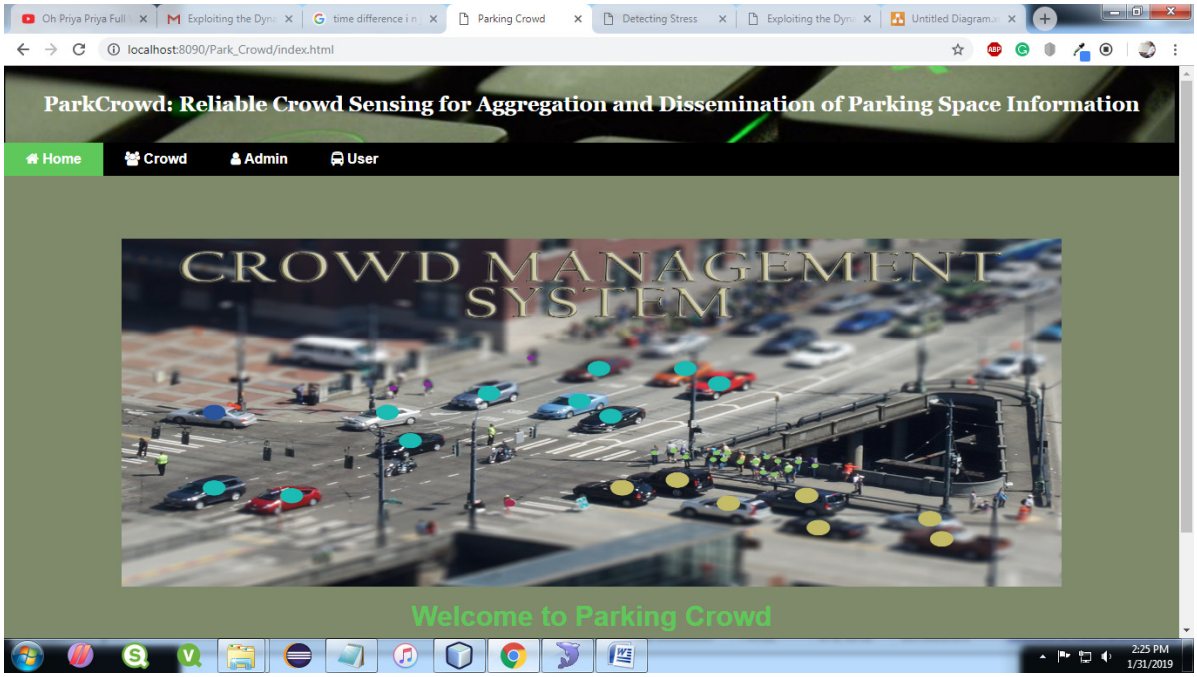


Fig.2. Home

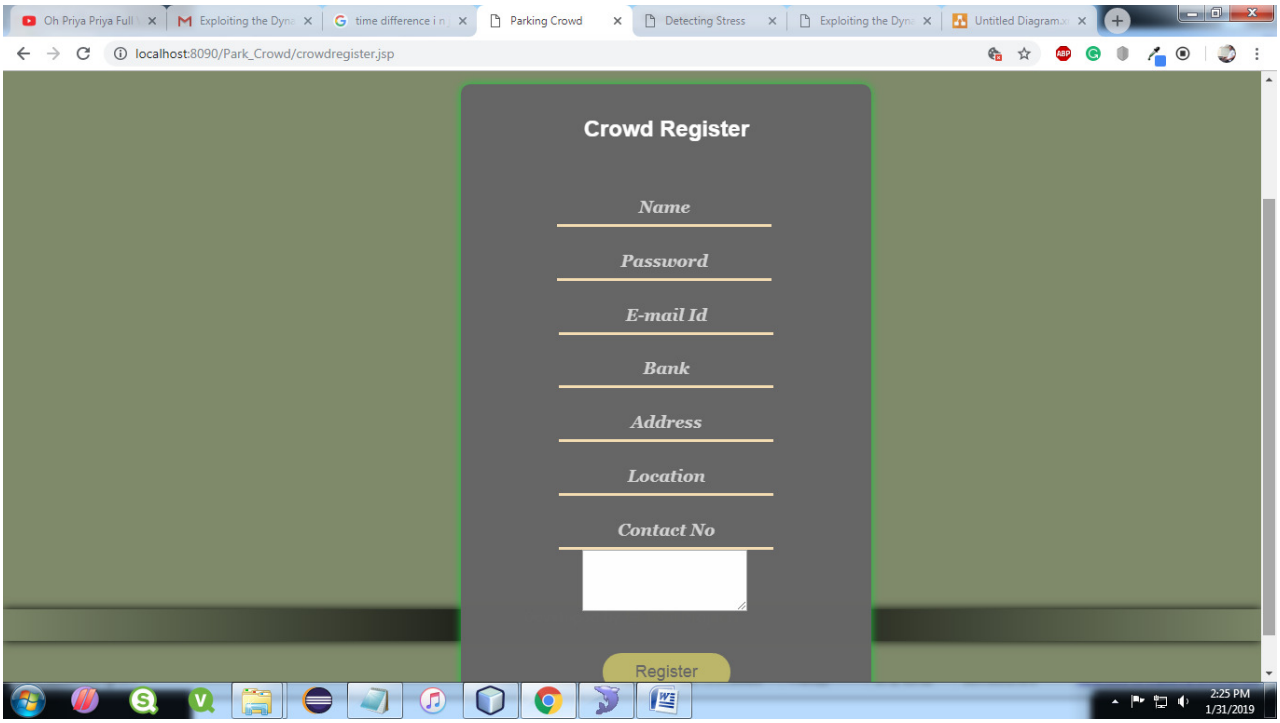


Fig.3: Crowd Register

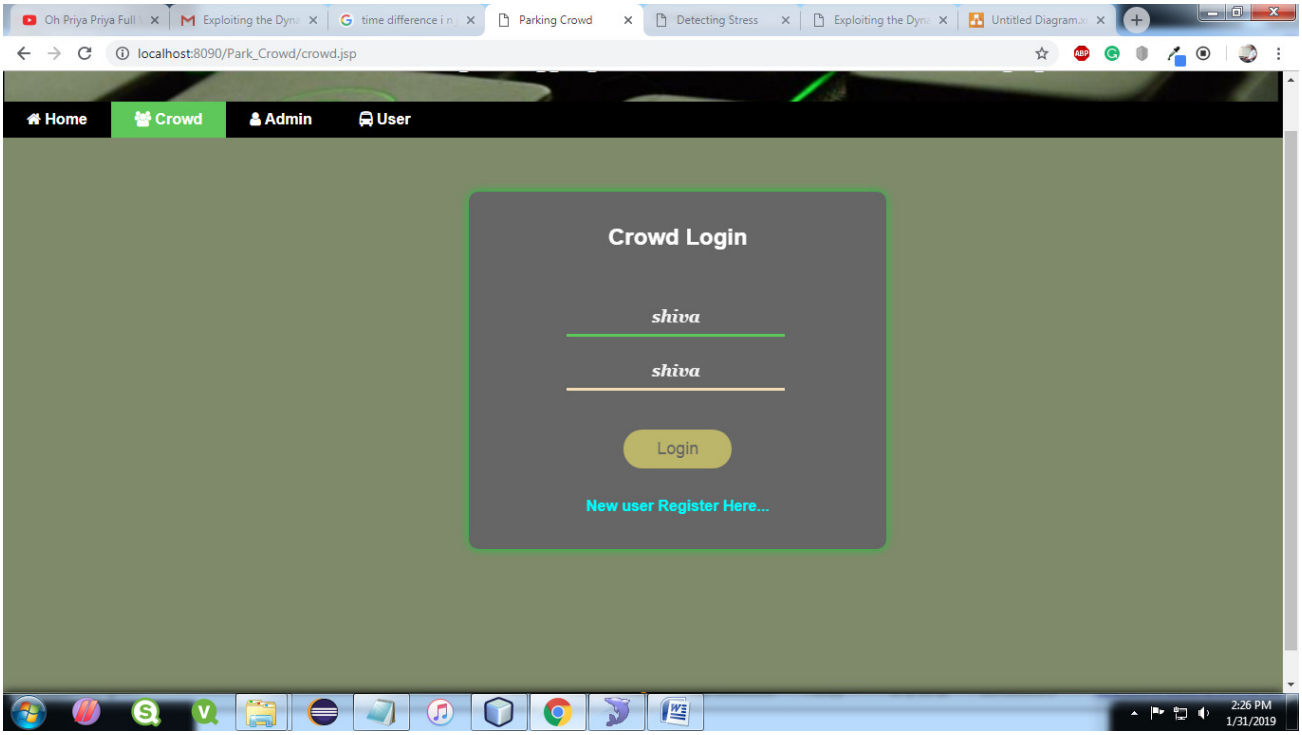


Fig .4: Crowd Login


Fig.5:View Parking Places

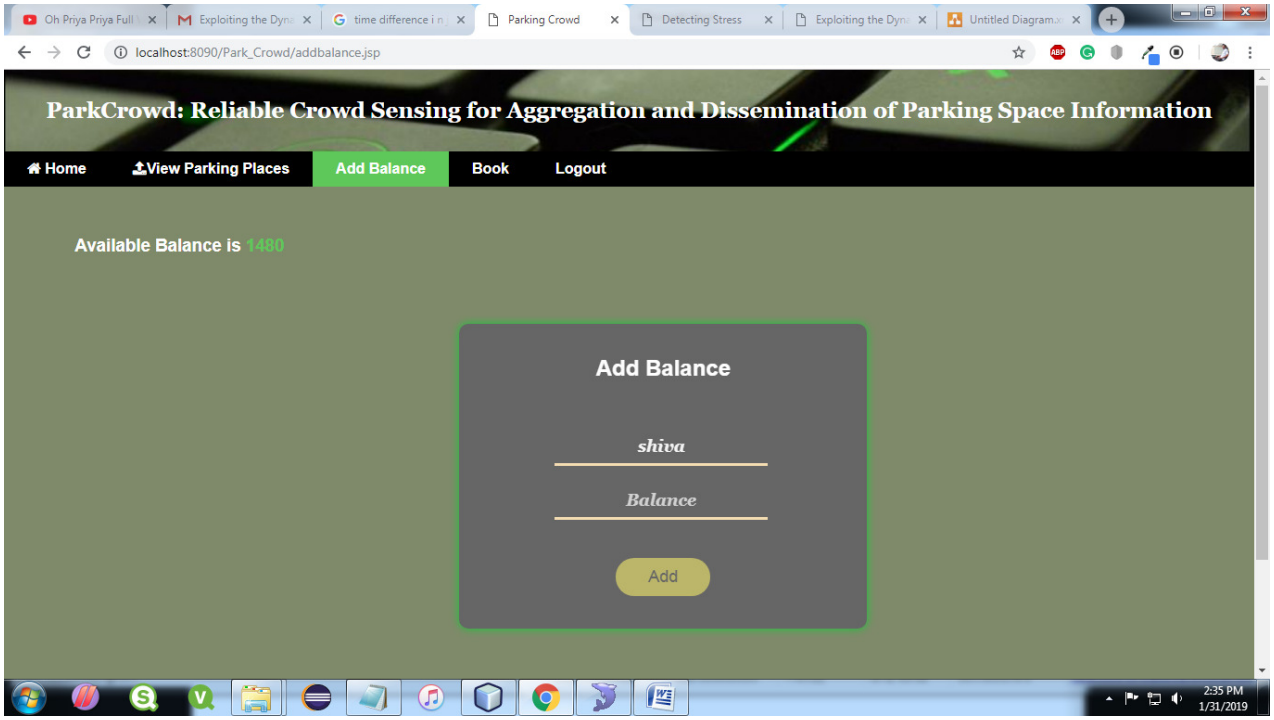


Fig .6:Add Balance


Fig.7:Book

## 6. Conclusion

In this paper, we propose ParkCrowd, which collects and disseminates parking space information based on crowd knowledge. ParkCrowd offers the drivers not only the basic information of parking spaces such as location, hourly price and real-time vacancy status, but also makes estimation of future availability of the parking spaces by aggregating crowd workers' knowledge. To estimate the reliability of the information reported by the crowd workers, we introduce location dependent POI questions to dynamically score the workers' expertise. Two different probabilistic models have been proposed to infer the collective reliability of the information for vacant parking spaces as well as the accuracy of the estimation for the availability level. Both real-world experiments and simulations indicate strong performance in identifying unreliable crowd contributed information and making accurate estimation of parking space availability. Moreover, ParkCrowd also implements an incentivisation scheme to distribute rewards to crowd workers based on their reliability and expertise level. Experiment results indicate that the rewards are paid in alignment with individual reliability and expertise level of the workers.

## 7. Future Enhancements

It is not possible to develop a system that makes all the requirements of the user. User requirements keep changing as the system is being used. Some of the future enhancements that can be done to this system are:

- As the technology emerges, it is possible to upgrade the system and can be adaptable to desired environment.
- Based on the future security issues, security can be improved using emerging technologies like single sign-on.

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