

**A Simulated Parking Assistance System using slot-based driving**

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**A Dissertation**

Presented to the University of Dublin, Trinity College in partial fulfilment of the requirements for the degree of

**Bachelor of Engineering (Computer Engineering)**

**Supervisor:** Prof. Vinny Cahill

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Declaration

I, the undersigned, declare that this work has not previously been submitted as an exercise for a degree at this, or any other University, and that unless otherwise stated, is my own work.

I have read and I understand the plagiarism provisions in the General Regulations of the University Calendar for the current year, found at <http://www.tcd.ie/calendar>.

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**ABSTRACT**

Large scale events, that include mass participation of the public such as musical concerts, sporting events, or even shopping centers during holidays and festivals often result in traffic congestion at the venue and even surrounding areas. One of the main reasons for this problem is inefficient parking guidance i.e. vehicle owners not aware of available parking slots, or if aware, unable to optimally reach the parking location due to their or others lack of knowledge about the parking area and the traffic flow.

To address this problem, a simulated parking assistance system with slot-based approach is proposed. The system uses Simulation for Urban Mobility (SUMO), a traffic simulation software, to simulate the flow of traffic in real time, hereby providing proper knowledge and fine-grained advice and directions to vehicle drivers to help smoothen the flow of traffic and alleviating congestion.

The project also explores whether a slot-based approach for this system is more beneficial as compared to the current parking methodologies. This approach is similar to the time division multiple access (TDMA) method in data communication in computer networking. In this scenario, the path from the entry to the parking lot inside the parking is the channel to be divided up and the vehicles are allocated slots on demand to travel towards their destination.

The potential benefits of the system comprise of proper guidance, accurate journey times and a better flow of traffic. Existing research for slot-based driving for intersections and on-ramp merging scenarios have been completed. However, this project will specifically target the flow of traffic during large scale events within the parking areas.

**SUMMARY**

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# **Introduction**

The project aims to remit the problem of traffic congestion inside the parking areas during large scale events such as musical concerts, sporting events, etc. that require mass participation of public. This congestion results in delayed, inadequate, and suboptimal journey times and routes within the setting. The proposed solution uses a real-time traffic simulation software (Simulation for Urban Mobility) to simulate every incoming car into the system and provide the most optimal route for the journey within the parking. Additionally, the project explores the slot-based driving approach as a guidance system for the cars to maintain their positions with that in the simulation throughout the duration of the journey for optimal movement. This will act as an advantage in shaping traffic by organizing the flow of traffic and alleviating congestion.

* 1. **Research Question**

Does a proper driver guidance system unequivocally affect the traffic flow, during events of mass participation, allowing for more optimal journey times ?

* 1. **Motivation**

In any given parking situation, two drivers may choose to react completely different and take different decisions. These decisions could include different parking maneuvers, driving speeds, parking style, etc. This comes in regard to the fact that people are unpredictable and have dissimilar opinions, reflexes, skills, and instinct levels. This incalculable behavior in intensified in pressurized situations such as congested driving.

Non-reoccurring congestion is a type of unusual congestion caused by unpredictable events and planned special incidents which is a major attempt to mitigate the traffic congestion during events. However, the cause of congestion experienced by drivers at events can be narrowed down to variations of these four causes: poorly planned parking management, improperly guided road networks, unexpected events, and the drivers themselves.

The project proposes a Simulated Parking Assistance System using slot-based approach to remove the need for drivers to make their own decisions and provide them with proper knowledge and driving instructions. The hypothesis is that a more organized and guided approach will help alleviate congestion and improve the flow of traffic.

* 1. **Project Overview**
     1. **Simulated Driving**

This method of driving is a totally new approach where the cars are moving inside a traffic simulation software. This approach allows vehicles to pre-establish location of all the other vehicles in the setting and optimally determine journey times. Therefore, allowing vehicles to choose paths that benefit other vehicles in the network.

* + 1. **Slot-based Driving Approach**

The slot-based driving approach is similar to the principle of Time Division Multiple Access (TDMA) in Data Communications. TDMA follows the Channel-Access Method (CAM) which allows multiple packets to be transmitted without any interference between them. On applying this method in a road network, the road acts as the channel to be divided, and vehicles inside the network act as data packets which get slots assigned on request.

* + 1. **Research Aims**

The aim for this research project is to evaluate how the flow of traffic and the journey times in the vicinity of large scale events withing parking areas are affected by the introduction of simulated parking assistance system using slot-based driving, and in turn, whether or not journey routes and journey times can be more optimized. The specific objectives of this project are:

1. Create a simulated parking scenario using various road networks to examine the effects of flow of traffic at different traffic volumes.
2. Introduce slot-based driving mechanism to analyze the degree of compliance with the parking assistance system.
3. Develop a mobile application for simulated parking assistance system to provide vehicles with proper guidance within the parking.
   * 1. **Potential Benefits of the Research**

The potential benefits of the project comprise of improvements in traffic flow within the parking, reduction in cumulative time spent in looking for free spaces and following the most optimal route to the parking destination. All these benefits come in comparison to the current unconstrained approach of driving in parking areas.

* + 1. **Project Scope**

This research project will focus on whether any convenience or advantage can be achieved by implementing this approach assuming a perfect compliance rate. The project will not consider various safety aspects which must be considered before a production release. This is since rigorous testing cannot be completed outside of the simulation environment and the simulation software also has testing limitations as to what can and cannot be controlled within the simulation. However, a cross-platform mobile application is developed to transfer the parking guidance information from the system to the drivers. Potential concerns briefly describing the future research and work required to implement the project to real world scenarios will be discussed. However, they are not the primary concern for this research project.

* + 1. **Road Map**

The upcoming sections will include several pieces of related research about parking designs, parking management systems and slot-based driving .Following on, the design and implementation of the solution will be examined and the main challenges encountered during the project will be discussed at length. This chapter will also include information on the intended implementation of the system and what was completed within the time frame. Finally, the results of the scenarios run with simulated driving and proper guidance will be compared to the control cases , accompanied by analysis and evaluation of the overall project.

* + 1. **Keywords**

Search strategy keywords: Parking Assistance System, Parking Guidance System, Smart Parking Systems, Parking Design, Traffic Congestion, Traffic Management System, Traffic Simulation, Simulation for Urban Mobility (SUMO), Slot-based driving, Time Division Multiple Access, Driver Guidance System, Parking Assistance Mobile Application, Parking Lot Details, Journey Times, Road Network, Parking Model.

# **Background**

This section of the dissertation provides an apprehension into the various scopes and areas related to the project which were explored at the beginning of the project. This section takes an extensive examination at the existing research and studies completed in the dominion of parking management systems, traffic management systems, parking guidance systems, smart parking systems and slot-based driving. The idea for a Simulated Parking Assistance System is based on the related theories of the research papers which were examined. An insight on the softwares and tools considered upright for the research project are also discussed thoroughly later in the section.

* 1. **Highest Development**

The current up-to-the-minute research on parking guidance systems and slot-based driving spotlight particular and definitive affairs where advantages can be procured. These occurrences are fixated on particular driving settings and instances which specialize in driving in a built-up road network. Thus far, there is slight research available publicly on the slot-based driving approach, which proposes advantageous gain for utilizing the slot-based driving approach within parking management systems.

* 1. **Related Research**

There are two key research topics related to this project: Real-time Simulated Parking Systems and Slot-based Driving. As earlier mentioned, there are quite a few research papers which have made an effort to instigate and investigate the slot-based driving approach for distinct driving scenarios. These researches include of on-ramp merging on highways, street intersections, arrival times with slot-based traffic shaping. However, there has been next to none research on real-time simulated parking systems. Researches like real-time parking availability estimation, real-time parking prediction system, real-time smart parking system and agent-based simulation of parking management systems have been completed but they extensively differ from our idea of simulated parking assistance systems. Additionally, work has also been carried out on analyzing layouts for parking lots, optimizing parking spaces and driver guidance systems. These will also be discussed later in the section.