Lab 2 – ParkODU Prototype Product Specification

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1. Introduction

Old Dominion University has a substantial number of commuting students and faculty members. According to statistics released by the university, 24,828 students were enrolled in 2016. Around 76% of enrolled students in 2016 lived off campus or 18,870 students. ODU reports that most of students living off campus drives their own vehicle. Assuming that only 50% of the off-campus students drive their own vehicle, the number is still as high as 9,400. ODU Facts and Figures reported 1511 faculty members working on campus.

There is a number of websites that allow students to review their universities. One example found at www.theodysseyonline.com is an article titled “Dear Future ODU Students”, which was posted by a former ODU student. The poster’s comment on ODU parking is highly negative; he compares the parking situation at ODU to The Hunger Games.

All students, especially new students, generally suffer more from the parking space shortage than faculty and staff members do. ODU reserves some spaces and even an entire garage and lot for faculty and staff use only, but the faculty and staff members are also allowed to park in other spaces, garages and lots that students generally use. In other words, there are no parking facilities reserved for students only. Continuing students and faculty and staff members eventually learn the parking traffic patterns at ODU and they are prepared to find parking at a number of other locations if needed, but new students may not know where else to go if the parking facility of their first choice turns out to be full.

ODU Transportation and Parking admits that the time of day students arrive on campus has a big impact on where they can find parking and the students may not find parking close to their destination as they would prefer. However, with five parking garages and over thirty-five surface parking lots on campus, there is a total of approximately 7,500 parking spaces. While the more

favored garages and parking lots completely fill up during busy hours, there are always available parking spaces in other less favored parking facilities, which may be located farther away from most educational and administrative buildings unless there is a special event.

Drivers who are unaware of the regular parking traffic pattern often unexpectedly find that the parking facility of their first choice is completely full and then drive to another location in search of available parking spaces; such situations can be frustrating. With no immediate plans to expand existing garages or parking lots or to create additional parking facilities, ODU needs to utilize their existing spaces more efficiently to lessen the effect parking space shortage. Students, faculty and staff members, and any other drivers who seek to park at ODU need a way of knowing which parking facilities have available parking spaces in real time; this will reduce frustration among all commuters. ParkODU is proposed as a software solution to this problem.

1.1. Purpose

ParkODU is a software solution to help drivers find available parking spaces at various ODU parking facilities and compile parking space usage data. The solution will be available in major web browsers such as Microsoft Internet Explorer, Google Chrome, Mozilla Firefox, and Safari. ParkODU will compile real-time data sent from various types of vehicle counting systems and present facility occupancy data to ODU drivers. The main objective of ParkODU is to present the real-time vehicle counts in each parking facility so the drivers can avoid traveling to full parking facilities and instead go directly to another facility that has available parking spaces. The secondary objective of ParkODU is to provide ODU Transportation and Parking Services with parking facility usage data so they have an idea of how their parking facilities are utilized and use that information for future strategic planning.

ParkODU is being developed for Old Dominion University, specifically the ODU Transportation and Parking Services department. ODU Transportation and Parking Services, along with ODU ITS software developers, will adopt this solution and make the application available to all ODU drivers.

ODU currently uses T2Systems and their inductive loops for counting vehicles. ODU in-house developers created a web application that utilizes T2System's APIs to show the vehicle counts in Garage A, Garage D, Parking Lot 42, and Parking Lot 43. However, the current web application has limited functionality. The features of this application are displaying the vehicle counts and using color codes to indicate which facility has more available spaces.

While ParkODU is projected to be for ODU use only as of now, the possibility of this solution being adopted by other universities with some modifications is not completely out of the question.

1.2. Scope

Figure 1 shows the current process flow diagram when ODU drivers are searching for available parking spaces. The current ODU web application mentioned in *1.1. Purpose* was released only recently and many ODU drivers are not aware of its existence. Due to the limited functionality and the low usage by ODU drivers, the application is not included in this current process flow diagram. The key in Figure 2 shows the frustration level of the drivers in the search of a parking space. The drivers may suffer negative consequences such as being late or receiving citations due to the fact that they do not know beforehand which parking facilities are full. While ParkODU will not completely eliminate the current parking problems, it will improve the current situation by helping drivers avoid the negative consequences in *Figure 1* and it will reduce the frustration level by simply providing information to the drivers.

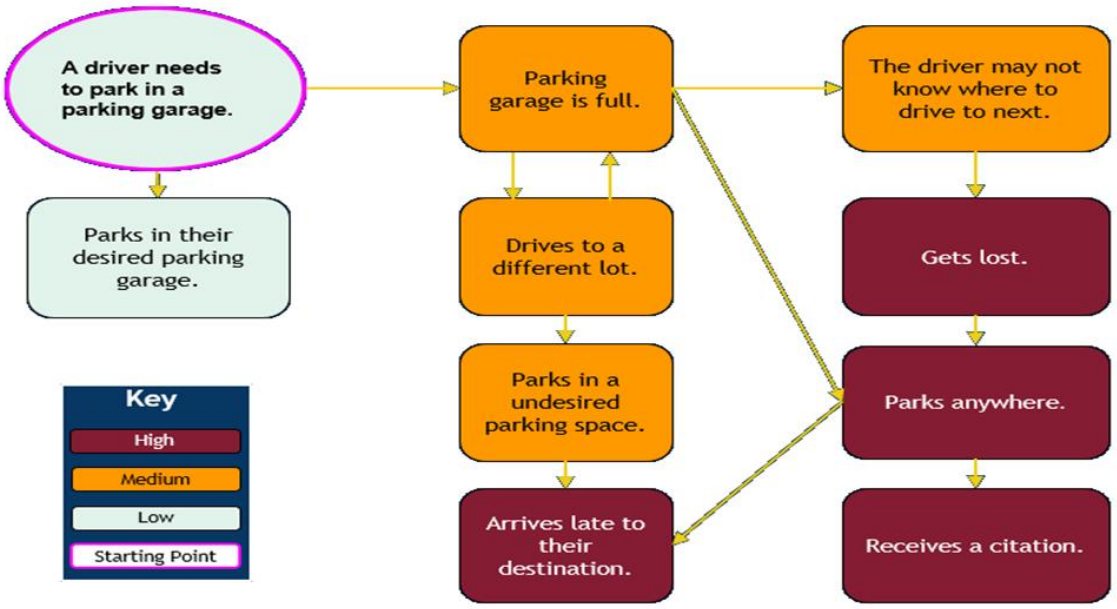

Figure 1: Current Process Flow Diagram

Figure 2 shows the major functional components of the real working system. There are 5 total components. Two components are specific to ParkODU: web server (Center) and database (Bottom). One component is the customer's choice of vehicle detection system (Top). The last two components are end user interfaces: web application (Left) and digital signs (Right).

The customer will select and purchase the vehicle detection system of their choice. The common types of detection technology are IR sensor, inductive loop, and IP camera. Some technologies, such as IR sensors, are capable of counting by space because they are installed at each individual parking space. Some technologies, such as inductive loops, are only capable of counting by floor because the loop is installed on each floor. The data collected by the detection system will be sent to the vendor's server. Normally, ODU accesses the vendor's web portal to see the occupancy data. However, the vendors provide APIs that ODU software developers can use with their own applications. The software developers in ODU ITS will be responsible for building applications to interface with the vendor's API and send proper HTTP requests to ParkODU's REST endpoint.

Figure 2: Major Functional Component Diagram

The prototype of ParkODU will support all of the features and capabilities of the real working system except digital signs. The data that would be normally obtained from vehicle detection systems, such as inductive loops, IR sensors, and IP cameras, will be simulated with a REST client application. The ParkODU prototype will compile the simulated data and demonstrate all the features and capabilities of the real working system.

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1.3. Definitions, Acronyms, and Abbreviations

Administrator - a special user with access to additional tools for user account and space management

Agile - a methodology that anticipates the need for flexibility and applies a level of pragmatism into the delivery of the finished product

Best Garage - the closest garage to the destination building with the specified minimum number of available spaces

Driver - anyone who drives and parks at ODU

Driver Entry Rate - the number of vehicles entering the garage each minute

Driver Exit Rate - the number of vehicles exiting the garage each minute

Event - an occasion which affects garage and/or space availability

Garage Rate – [Driver Entry Rate] – [Driver Exit Rate] (a positive number denotes that the garage is filling up)

Operating Hours - 7:00AM - 10:00PM

Permit - a physical decal that specifies in which spaces the vehicle is allowed to park

Predictions - a guess based on current and historical data about garage space availability

Real-time - current time

Reconfigurable - software-based creation, deletion, or editing of spaces, floors, and garages

Rush Hours - 7:45AM - 9:00AM, 12:00PM - 1:00PM, 3:00PM - 4:30PM

Sensor - any device which indicates to the software whether a space is occupied or not

Signage - signs that indicate the number of available spaces

Statistical Analysis - the ability to use sample data to form predictions

User - an entity using ParkODU

Vehicle Detection Technology - any device which indicates to the software that a vehicle has entered a specified area

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1.5. Overview

This product specification provides the high-level description of components, interfaces, and capabilities and features of the ParkODU prototype. The information provided in the remaining sections of this document includes a detailed description of the hardware, software, and external interface of the ParkODU prototype; the key features of the prototype; the parameters that will be used to control, manage, or establish that feature; and the performance characteristics of that feature in terms of outputs, displays, and user interaction.

2. General Description

The ParkODU prototype is mainly a software solution. The main interface of ParkODU prototype will be provided by the web application and end users will access the interface on their own personal device such as smartphone, tablet, laptop, and desktop. The ParkODU prototype will not have any hardware interfaces such as digital signs. While digital signs are optional hardware interfaces that the real working system can support, the digital signs will not be a requirement of the ParkODU prototype.

The main difference between the real working system and the prototype is how the data are obtained. The real working system will obtain real-time data from vehicle sensors. However, the

prototype will receive data from a simulator without the need of physical sensors. The ParkODU prototype will perform operations on the simulated data as if they were from actual physical sensors and demonstrate the capabilities of the real working system by analyzing the data and presenting information to end users.

Table 1 shows the features and capabilities that are available in the prototype. With the simulated data closely resembling the actual ODU parking traffic pattern, the prototype will demonstrate all of the non-trivial features with the same volume of data that the real working system is expected to handle. All of the features in *Table 1* are designed to accomplish the objectives of providing real-time parking facility occupancy data to drivers and compiling parking facility usage data for the ODU parking staff.

Feature	RWP	Prototype
Real-time vehicle counts on every level of each garage	*	*
Display floor plan to show counts by space on each floor	*	*
Display average vehicle count at each location by time of the day	*	*
Allow users to sort garages by walking travel time	*	*
Allow users to filter garages, floors, and space by their parking permit type and space types	*	*
Allow ODU parking staff to configure parking garages, floors, and spaces.	*	*
Provide directions to each garage from user's current location	*	*
Predict future vehicle counts based on the current and historical traffic pattern	*	*
Upload special event schedules and allow the apps to display notification to end users	*	*
Send data to digital signs at the entrance of every garage	*	

Table 1: Prototype Functionality vs. Real Working System Functionality

2.1. Prototype Architecture Description

The major functional components of the prototype are shown in *Figure 3*. This prototype major functional component diagram is similar to the major functional component diagram of the real working system. Simulation will replace the vehicle detection technology. The simulation will be accomplished with a REST client application that will send proper HTTP requests to ParkODU's REST endpoint in order to update vehicle counts and add or remove garage spaces. The client will send the vehicle count update requests in a way that mirrors the actual ODU parking traffic patterns during normal operating hours on weekdays. The current ODU parking traffic patterns will be obtained from ODU's current solution, T2System, which is installed in Garage A.

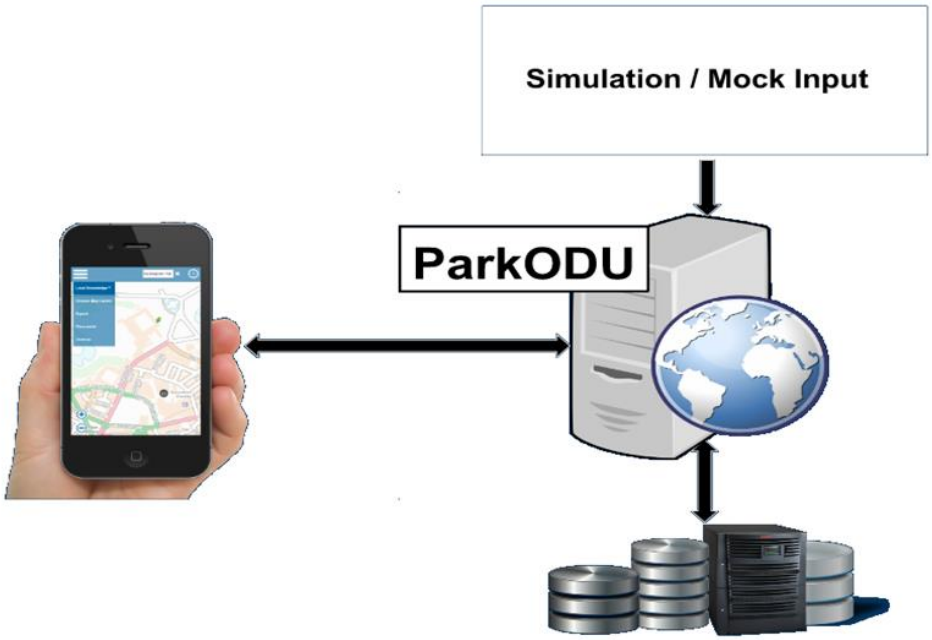

Figure 3: Prototype Major Functional Component Diagram

End users will use personal devices to access ParkODU website. Web browser configuration of the personal devices is the responsibility of end users and it is outside the domain of the ParkODU solution. However, ParkODU developers will ensure that the web application is accessible via major web browsers available in most operating systems such as Internet Explorer of Windows Operating Systems, Google Chrome, Mozilla Firefox, and Safari on many mobile operating systems. There will be no special plugins or extensions required for ParkODU. Most, if not all, capabilities and functionality will be available with the default browser settings.

Simulation will act as the physical vehicle sensors. It will send HTTP requests to the web server to mark an individual parking space as occupied or available. The web application server then will update the space in database accordingly and send the updated page to user's browser.

ParkODU will be implemented on Spring Framework. The web application server will have mechanism to provide web content to client web browsers. The server will also have mechanism for handling update requests from simulation and write new data to the database or modify existing data.

Database server will have two main database solutions: Hazelcast and MongoDB. Hazelcast will be used as a main database on a clustered environment while MongoDB will serve as a backup. The database will contain documents for sensors, garages, floors, spaces, class schedules, users, and events. The database server will provide mechanism for the web application to make queries and update data.

2.2. Prototype Functional Description

The two major functional components of the ParkODU web applications are end user component and administrator component. The end user component contains multiple views that support distinct function: main view, garage view, floor view, and search view. The

administrator component contains all the views of the end user interface in addition to admin view.

2.2.1. End User Component

When user first accesses ParkODU, the main view will be displayed. The main view will display a list of all ODU garages with vehicle count, number of available spaces, vehicle flow rate, and an option to navigate to the garage.

When user clicks a garage on the main view, the garage view will be displayed to show detailed information about the selected garage such as address, description, purpose, total vehicle count, list of floors, and vehicle count on each floor. The garage view will also provide the option of navigating to the particular garage.

When user clicks a floor on the garage view, the floor view will be displayed to show detailed information about the selected floor. It will display a floor plan that shows the status of each individual parking space, a line graph detailing the average vehicle count by time of the day, total available spaces, total vehicle count, and vehicle flow rate for this floor.

From the main view, user has an option of going to the search view. This view provides function for finding the best garage given user's permit type, space type, and destination building. User must provide input for the permit type, space type, and destination. The permit type and space type can be saved locally on user's device. In addition, user's class schedule can be uploaded so ParkODU can suggest the best garage for user's class destination and start time. User can also view predicted vehicle count in each garage based on the historical parking traffic flow pattern. User must provide input for travel time.

2.2.2. Administrator Component

The administrator component will contain all the views described in *2.2.1. End User Component*. Administrator Component will have admin view, which will provide basic functions for managing garage spaces and user accounts. Access to this component requires login. Admin user will be able to configure garages: add, remove, or modify garages, levels, and individual spaces. Admin user will be able to add, remove, or modify other admin user accounts.

2.3. External Interfaces

ParkODU's external interfaces will be described in terms of hardware interface, software interface, and user interface.

2.3.1. Hardware Interfaces

ParkODU is designed to operate on user's local devices. The local devices will connect to the web application server and the web application will connect to any required databases to perform requested operations. User's device must have internet connection.

2.3.2. Software Interfaces

ParkODU database will contain a total of 8 documents or tables: Garage, Sensor, Floor, Space, Event, Affected_Location, User, and Schedule. *Figure 4* shows the 4 main documents ParkODU will be interfacing with: garage, sensor, floor, and space. These documents will provide information about garages, floors, spaces, and installed sensors. For the prototype, the sensors will be simulated. The user component will mainly read these documents while the administrator component will have the ability to write and modify the documents.

Figure 4: Garage, Floor, Sensor, and Space Document

Figure 5 shows the event and affected_location documents. The event document will provide information about any on-campus events that will impact the parking and which garages, floors, or spaces will be affected by the event. The event document will have arrays of affected_location documents. The web application will interface with these documents to identify any special events and filter garage suggestions as appropriate. It will also interface with these documents to display any notification to users about upcoming events and how the parking garages will be impacted.

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Figure 5: Event and Affected_Location Document

Figure 6 shows the user and schedule document. The user document will provide information about user’s preferred permit type and space type. The user document will contain an array of schedule documents, which contain information about any class schedules that the user uploaded. The web application will interface with these documents to customize garage searches based on user settings and uploaded class schedules.

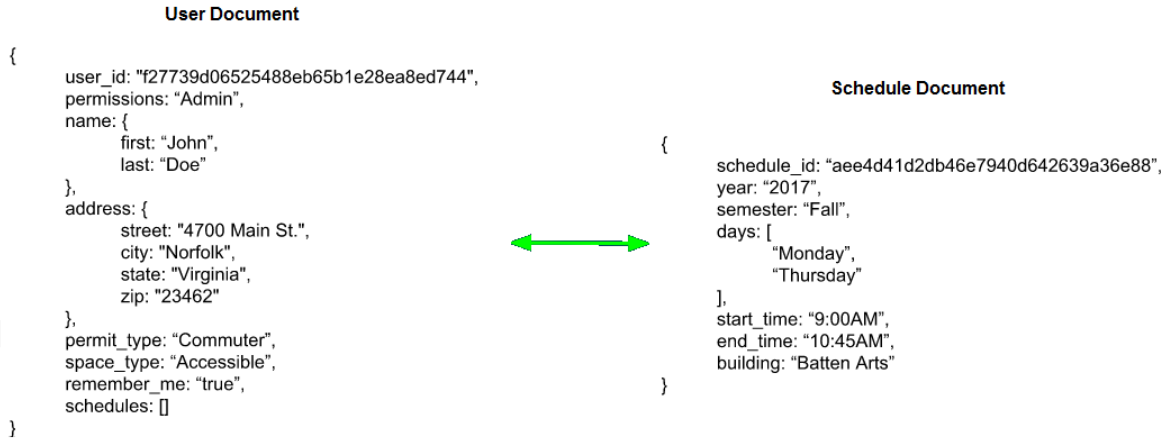

Figure 6: User and Schedule Document

2.3.3. User Interfaces

Display screen of user's personal device will display webpages. Keyboard will be used by user to provide input to textboxes while mouse and touchscreen will be used to select various menus on the webpages and interact with other webpage components.

2.3.4. Communication Protocols and Interfaces

ParkODU will mainly utilize web communication protocols such as HTTP and HTTPS for secure logins. The web application server will require TCP/IP to establish Internet connection to ParkODU database. ParkODU will test for Internet connections and database connections on a regular interval.

3. Specific Requirements

This section was submitted separately.