

# Vision Based Parking Lot Monitoring: Available Parking Spaces Information

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## Abstract

*A project involving vision- based parking detection is available using camera feeds and it detects how many A, B, and S spots are available. We propose a system that will take the output of the vision based system and disseminate it to users via mobile phone. This will help commuters to UCSD easily find the open spaces. This system makes use of Voice XML technology offered by VOXEO corporation. Also, the server-side languages such as JSP and Java Script are used to help accessing the output and prompt the user. This project deals with a real life problem, so much concern was needed for the user side of system. The menu of this system is created to help the user find a nearest vacant parking space as soon as possible. We obtained feedback from students and faculty, and we conducted numerous trials to optimize the menu in this system. This system will be integrated with the vision based parking detection system when it is successfully implemented.*

## 1. Introduction

UCSD has very limited parking spaces during week days. It is very frustrating if the driver is running out of time and looking for a vacant spot in a huge parking lot. If the driver is notified in advance of how many parking spaces are available in each parking lot, he or she would not have to waste time looking for a vacant space. There is an on-going project by a UCSD graduate student that detects a vacant space in parking lots. This paper proposes a system that sends available parking space information via mobile phone to commuters to UCSD using the system provided by this student's system. It will help them easily find a vacant space without wasting time and gas.

## 2. Related Work

### 2.1. San Diego Wireless Traffic Report

San Diego Wireless Traffic Report[1] is the traffic reporting system created by Dr. Ganapathy Chockalingam at Calit2. The user with a mobile phone can call this system

and receive a real time traffic report. This system uses IVR(Interactive Voice Response) technology that automates interactions with telephone callers. This is the basis of Parking Spaces Information system via mobile phone.

### 2.2. Parking Space Vacancy Monitoring

Catherine Wah, a UCSD graduate student, works on computer vision based parking space detection system[2] to detect vacancies in parking lots. The output of this on-going project is sent to the user using the Parking Spaces Information System via Mobile Phone.

### 2.3. Smart Parking System with a Mobile Phone

In many cities, the smart parking system with a mobile phone has been proposed and developed to manage traffic congestion. For example, in San Francisco, several projects have been initiated [3] [4] [5]. Companies involved in this project have used a wireless sensor to gather parking space information on the street and in a parking garage. Similar to the system in this paper, they use a mobile phone to deliver the information, such as the location and the price of a vacant spot.

## 3. VoiceXML Technology

The Parking Spaces Information system utilizes VoiceXML technology. VoiceXML technology allows users to interact with the internet through voice-recognition technology. It relies on a voice browser and/or the telephone instead of relying on HTML, keyboard and a mouse. With VoiceXML, a user interacts with a voice browser by listening to audio output and submitting audio input via the user's voice or a keypad. The major goal of VoiceXML is to bring the advantages of web-based development and content delivery to IVR (Interactive Voice Response) applications.

### 3.1. VOXEO's Evolution developer portal

VOXEO's developer portal website allows a user to create a free hosted IVR application with VoiceXML technology. It also includes a free tutorial, phone numbers,

Skype access, and local static web hosting for voice applications. The Parking Spaces Information system utilizes this VOXEO's developer portal to create an easy-to-use web-based IVR application. The basic structure of VOXEO system is in Figure 1 below.

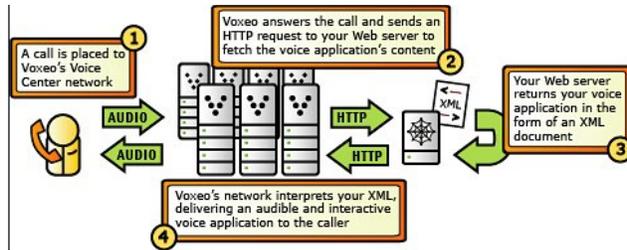


Figure 1: How the VoiceXML application works with VOXEO

## 4. Parking Spaces Information System

### 4.1. System Overview

The system overview is shown in Figure 2. The user makes a phone call to Parking Spaces Information system with a mobile phone and requests for information on the status of parking lot that the user is trying to reach. Then, Parking Space Information system retrieves the information on the specific parking lot for which user made a request from the black box, which is designed by Catherine Wah. After retrieving the data, this information is sent back to the user via audio output. (E.g. There are 5 A, 7 B, and 10 S spots in P502)

### 4.2. System Menu

This will be a general overview of VoiceXML Menu. The UML(Unified Model Language) specification is used to draw a state chart diagram of the system in Figure 4 at the end of this paper. When a call is made, it will prompt this message to user. This menu is intended for UCSD professors, faculty, and students who come to school on a regular basis.

The detail menu of the system is as following. When the user first makes a call, he or she needs to choose either the touch tone menu or the voice recognition menu. Both choices will take the user to the same output via two different paths.

#### 4.2.1 Touchtone Menu

If the touch-tone menu is chosen, the user needs to press one of the 6 number pads, from 1 to 6, to choose one college among 6 different college(Revelle, Muir, Marshall, Warren, ERC, and Sixth) in UCSD. For example, if the user wants to park nearby the Calit2 building, he or she needs to press

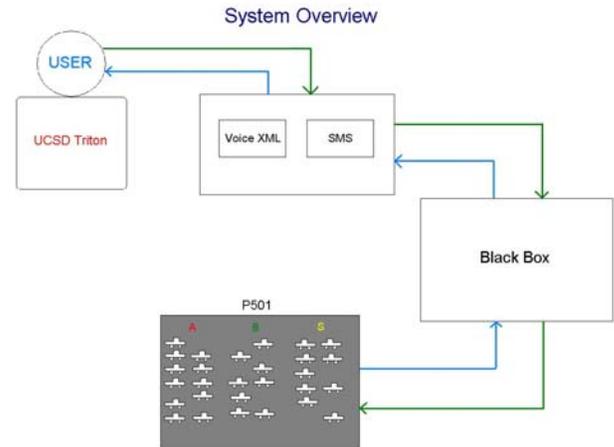


Figure 2: Basic Diagram of System Overview

4 to choose Warren college. Then, the system will ask the user about the more specific location that he or she wants to go to such as Warren lecture hall or Calit2. If the user chooses either location, the system will finally deliver the message that informs how many A, B, and S spots are available. Then, the user will have the option to also hear the information about the next closest parking by pressing 0. One important thing to note is that the user could go back to the previous step and the main menu by pressing \* or # anytime he or she wants.

#### 4.2.2 Voice Recognition Menu

The user could also choose the voice recognition menu by pressing 2 or saying "voice". This menu is aimed towards the experienced parking user at UCSD who knows the name of the location and parking lot in advance. The user can directly say either the location that the user wants to go to or the name of the parking lot. If the system recognizes the location, it will directly give the user the information about the parking lot. After the user hears about the closest parking lot, the user will have the same option that was in the touchtone menu to press 0 to hear about the next closest parking lot. In the voice recognition menu, the user can always say "back" or "main" to go back to the previous or main menu.

### 4.3. Data Access

Java Script and JSP programs are used to get the Parking Space Information when the user reaches the point where he or she is informed of the actual number of vacant spots at the end of menu in the system. Since the actual vision based detection system is still an on-going project, this system needs the Java file that generates random data in a text file to test the system. Every time the user calls this system, this Java program automatically generates the simulated

information and passes it to the system as a variable, so that the user can hear about the updated status of the parking lot.

## 5. Desired Functions

The basic structure of the Parking Space Information system using VoiceXML technology with a mobile phone is well developed, and the system is ready to incorporate new functions to improve usability using JSP and Java Script, along with XML files on the VOXEO developer portal. These functions can be implemented and tested later on.

### 5.1. The Admin Page with Handling Ambiguities

A website for the administrator that controls the output from the vision based parking detection system is needed because the vision based parking space detection involves a complicated process and the raw output of the system may not be obvious to the user. For example, as it's shown in Figure 3, it's not easy for the human visual system to determine whether a specific spot is vacant or not in the picture. Thus, the output of the detection system may be categorized as followed:

1. Occupied
2. Vacant
3. Most likely occupied
4. Most likely vacant
5. Not sure

The administrator needs to pay close attention to these raw data, so that the Parking Space Information system can be improved upon dealing with these ambiguities.

### 5.2. The Registered User with Caller ID

Most drivers who commute to UCSD are likely to park at the same parking lot throughout a quarter. If the user register the caller ID and chooses the preferred parking lot in advance, the user can have an option to directly access that preferred parking lot. The registered user can also have an option to send a text message to the system and receive the information for convenience. This function could help some people who feel uncomfortable about the voice recognition system.

### 5.3. Improvement for Visitors

The Parking Spaces Information system is so far intended for drivers who commute to UCSD on a daily basis. This system will also be able to serve visitors who never come to UCSD before. It needs to find a way to inform about the vacancy of more types of spots such as a metered and visitor spaces. Also, the East Parking lot can be recommended when all of the campus parking lots experiences overflow.

## 5.4. GPS Information

Most of the user may not know what the exact name of parking lot and where the specific parking lot is located. This system will somehow inform the GPS (Global Positioning System) to the user. With the development of technology, this system will be able to the GPS information to the user's smart phone and a vehicle GPS will catch the information via Bluetooth.

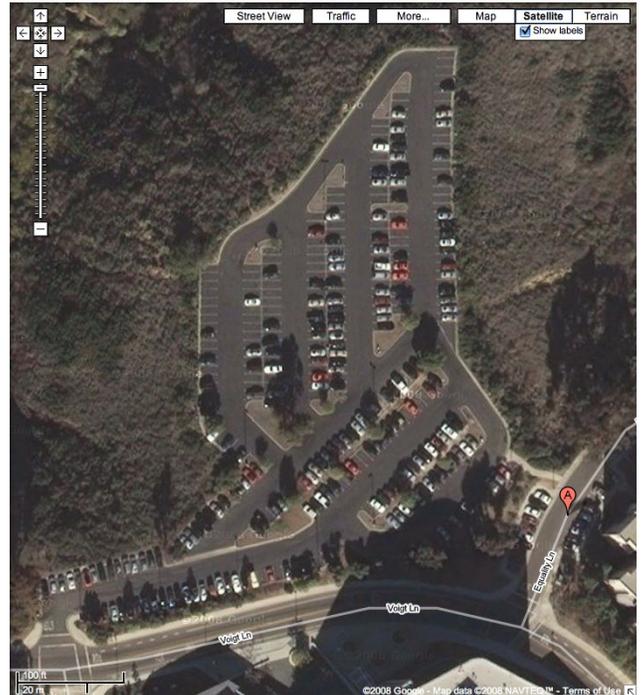


Figure 3: Google satellite image of P502 in UCSD

## 5.5. GPS Information

Most of the users may not know what the exact name of the parking lot and where the specific parking lot is located. This system will somehow inform via GPS (Global Positioning System) to the user. With the development of this technology, this system will be able to relay the GPS information to the user's smart phone, and a vehicle GPS will be able to accept the information via Bluetooth.

## 5.6. iPhone Application

This system can be also implemented as an iPhone Application for iPhone users. It will help many iPhone users easily access the system.

## 6. Conclusion

In conclusion, a system that delivers the information from the vision based parking space monitoring is proposed. The demo can be tested by calling (303)800-2532 and the detailed information is in Appendix

A. The system successfully takes a voice or key pad input from the user and the user will have access to the output, the parking vacancy information. This system is now using generated data using a Java program, but when the on-going project of the vision based parking space detection system is completed, a function that accesses the parking space detection system needs to be implemented. This system can also be implemented for any smart parking system such as a wireless sensor-based system. More research and experiments will help improve the service so that drivers may save gas and time when looking for a parking space. The documentation will be available from CSE190A class the website[6] and the code will be available from VOXEO's developer portal[7] upon request.

## 7. Acknowledgment

Thanks to good support and advice from Professor Serge Belongie and Dr. Ganapathy Chockalingam. Thanks also to the CSE 190A Winter 2009 classmates for great discussion.

## 8. Reference

[1] - San Diego Wireless Traffic Report powered by Calit2  
<http://traffic.calit2.net/sd/>

[2] - Parking Space Vacancy Monitoring – Catherine Wah  
<http://wah-psvm.blogspot.com>

[3] – “Find Available Parking on Your Mobile Phone” – Park Whiz -  
<http://www.parkwhiz.com/about/releases/3-23-2007.php>

[4] “SFpark would micromanage city's scarce spaces” -  
<http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2008/04/14/MNTO104818.DTL>

[5] “Can't Find a Parking Spot? Check Smartphone” - NY times  
- <http://www.nytimes.com/2008/07/12/business/12newpark.html>

[6] CSE190A: Projects in Vision & Learning -  
<http://www-cse.ucsd.edu/classes/wi09/cse190-a/>

[7] VOXEO developer's portal -  
<http://evolution.voxeo.com/>

## Appendix A – The Demo System

When a sample call is made, the user will hear the message, “Press 1 or say the name of location or parking lot.” If the user presses 1, the next message will be “Press 1 for Warren, 2 for Revelle, 3 for Muir, 4 for Marshall, 5 for ERC, 6 for Sixth.” Then, the user can press 1 to choose Warren and press 1 again to choose Calit2 to find out the number of available spots in parking lot P502 by hearing the message “Calit2: 5A spots, 7B spots, 10 S Spots are available.” After hearing information about the parking lot,

the user will have an option to press 1 for the closest parking and 2 for the previous menu.

Otherwise, the user can directly mention the name of location or parking lot. The user can say either “Calit2” or “P502” to hear that “Calit2: 3A spots, 2B spots, 5 S Spots are available.” Then, the user will hear that “Press 1 for next closest parking, 2 for previous menu.” The user can press 1 to hear about more information or 2 to go back to previous menu.

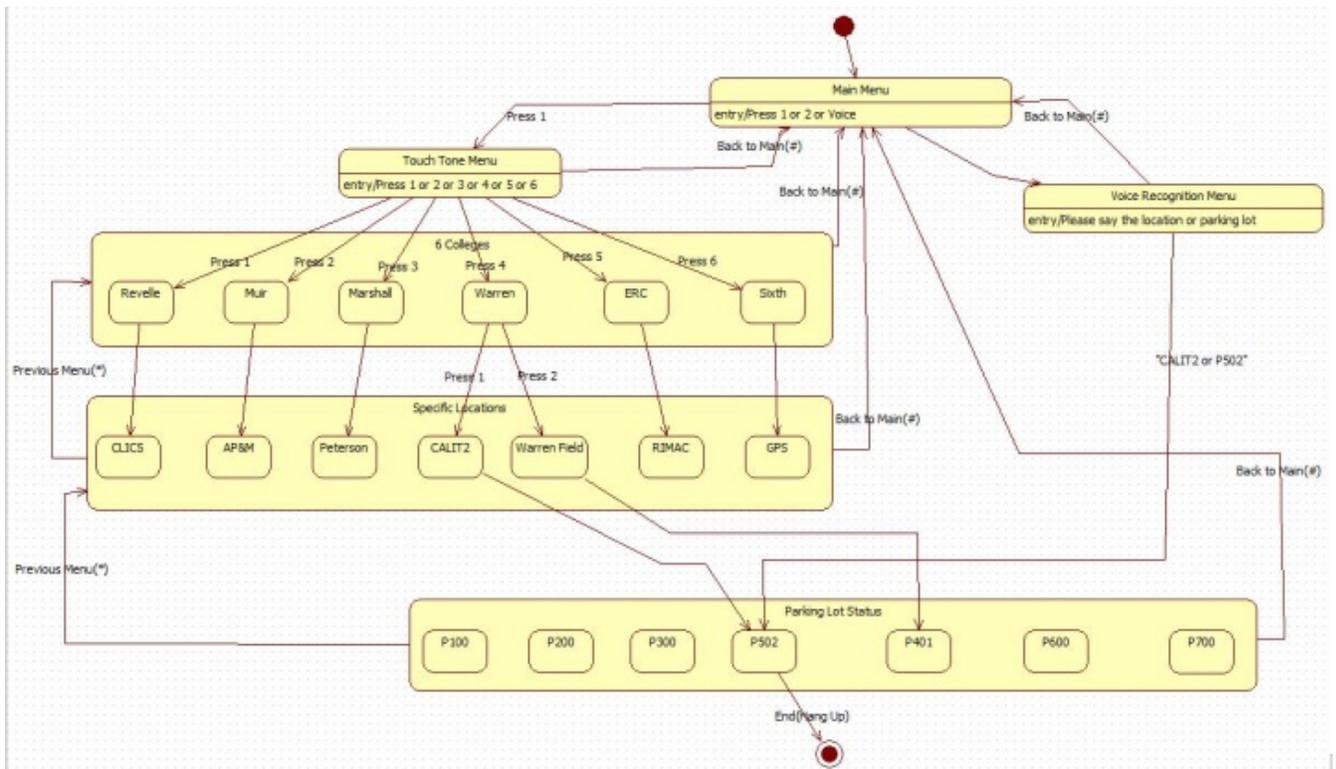


Figure 4: State Chart Diagram of the system using UML2.0.