Park It

Group 11

Pooya Nejad
Omar Rodriguez
Daniel Rodriguez
Joseph Nyamogo

5/30/2012

1. Introduction

The following introduction is an overview of the ParkIt smart parking project. This section provides background and motivation to outline the project.

1.1 Background

In today's fast paced working environment, people (motorists) greatly depend on automobiles to commute to their destinations. Automobiles include: motor vehicles, motorbikes, trucks to mention but a few. The use of these automobiles has increasingly posed a demand for infrastructure to manage the parking. All around the world, parking spaces have been constructed and control points put in place. For example, in shopping malls and airports, some control points are automated whereby users can do a self-service in the use of the parking space while others are manned by control personnel. On the other hand, parking attendants have been employed in physically controlled parking bays to direct drivers where parking is empty.

The systems in place today for managing parking areas have helped a lot in ensuring that motorists easily park and easily leave their destinations. However, the demands of motorists in the fast working environment raise a need for a next generation of parking systems to match the pace at which they work. It is expected that such next generation parking systems will enable remote parking reservation and exhibit some of the features of modern real-time systems such as cell phone payment and car identification using Radio Frequency Identification (RFID) technology. It is predicted that such smart parking systems will play an important role in the transport field in terms of environment impact on climate change and commuter's savings and time management.

1.2 Motivation

Users of automobiles spend a lot of time in the parking bays trying to locate where to park. In today's ever busy working environment, drivers hardly have time to spend in parking bays looking for where to park. In many places, especially around shopping complexes, universities, city centers, and many other busy working environments, finding parking has been noted as one of the major causes of stress in lives of individuals who drive. The traditional method of finding parking by the naked eye has a number of irritating situations. In situations where a driver is walking towards a car or is in the car, the other drivers waiting to find parking often make signs, or whistle or try to do something intending to ask the other whether they are pulling out. Though this kind of asking might help most of the times, it leads to situations, which are often inconveniencing to other drivers. In busy towns and cities, parking management still poses a challenge that keeps growing more complex. The need for efficient parking management systems can't be emphasized enough for such cities. This study thus seeks to provide a solution to the issues above using the latest sensing and telecommunication technology.
Moreover this project dealt with an everyday common problem that is faced by the students of the University of Central Florida every day. UCF had a student population of about 55,000 students and there are just about 15,000 parking spaces in UCF. So we can pretty much judge the challenge it would be to find an empty parking spot during regular school hours. After discussing our project each one of our group members was totally into the idea of 'Smart

Parking'. First of all if we were successful in our project we would be helping the UCF parking services in implementing a system like ours at all the different parking garages and the open parking lots. Secondly we would be helping the students conserve their time looking for parking spaces. Thirdly all four of us in our group had personally experienced this big parking issue at UCF and because of that we had sometimes arrived late in class or late for an exam or a meeting etc.

2. Project Block Diagrams

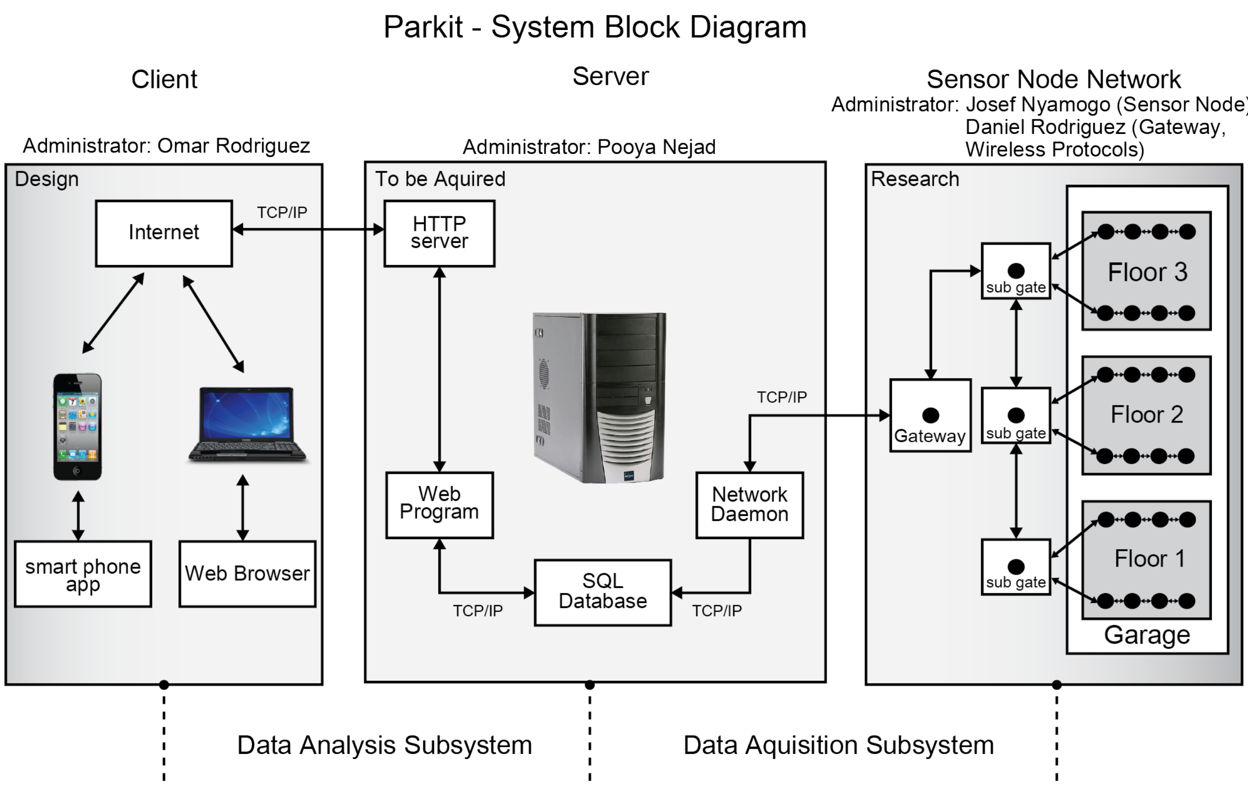

Figure 1: Complete System Block Diagram

The above block diagram shows a basic pictorial reference to our project. On the frontend we have an iPhone application showing the user a representation of the parking lot. Behind the display will be where the server will be housed. The server will talk to the sensor network and the received information about the status of the parking spaces; it will then process the received data and feed it to the iPhone application. Our project is a combination of both software and hardware challenges. The hardware challenge is to find a sensor that has suitable power and then transmits the data with a transceiver, whereas the software challenge is to make an appropriate iPhone application. This in particular is important because the iPhone application is what the users interact with and is vital to the success of the project.

2.1 Sensors & Counters

For this project we will have to main nodes to detect vehicles, the will be referred to as the Sensor Nodes and the Counter Nodes. A number of different sensors are considered to detect the car presence. We will examine three types of sensors: inductive sensors, ultrasonic sensors, and infrared sensors. Ideally, we are looking for a sensor that would only detect cars and not pedestrians. The basic function of the Sensor Node is to determine whether or not a space is occupied by a vehicle, whereas the counter node will be used to count the vehicles entering and exiting a garage/lot and the floor/rows. The sensors are being designed so that they will be functional and a good fit for several parking lot scenarios since logistics will vary, they are to work in both a garage and open lot environment.

The purpose of the Counter Nodes is to count the number of cars entering and exiting both the garages/lots and the floor/rows. The logic behind this is simple, let’s say there are three spaces available but there are six cars driving on a floor/row possibly all looking for parking the probability of someone just entering the floor/row getting a space is lowered significantly. The same is true for an entire garage/lot; if there is 98% occupancy with more vehicles then the remaining 2% can accommodate then the probability of someone just entering the garage finding parking is also lowered significantly. The algorithm used to determine availability will also have to consider which cars are likely exiting being that not all vehicles are searching for parking. The Counters will then communicate wirelessly to the sub gates to transfer their collected data.

The Sensor Nodes are used to determine the state of a parking space; it will be either occupied or vacant. They will communicate wirelessly with one another as to relay their collected data to a sub gate where it will then manage it and relay it to the server.

<u>Parking space sensor node</u>

- Be able to detect a car entering the space in <5 sec.
- Be able to detect a car leaving the space in <5 sec.
- Be able to acquire the parking space status in < 15sec.
- Operating temperature of 0°F – 150°F.
- Parking sensor node weight < 0.5 lb.
- Communicate using wireless for up to a distance of 300ft.
- Operating voltage of < 5 V.
- Continuous current < 1A

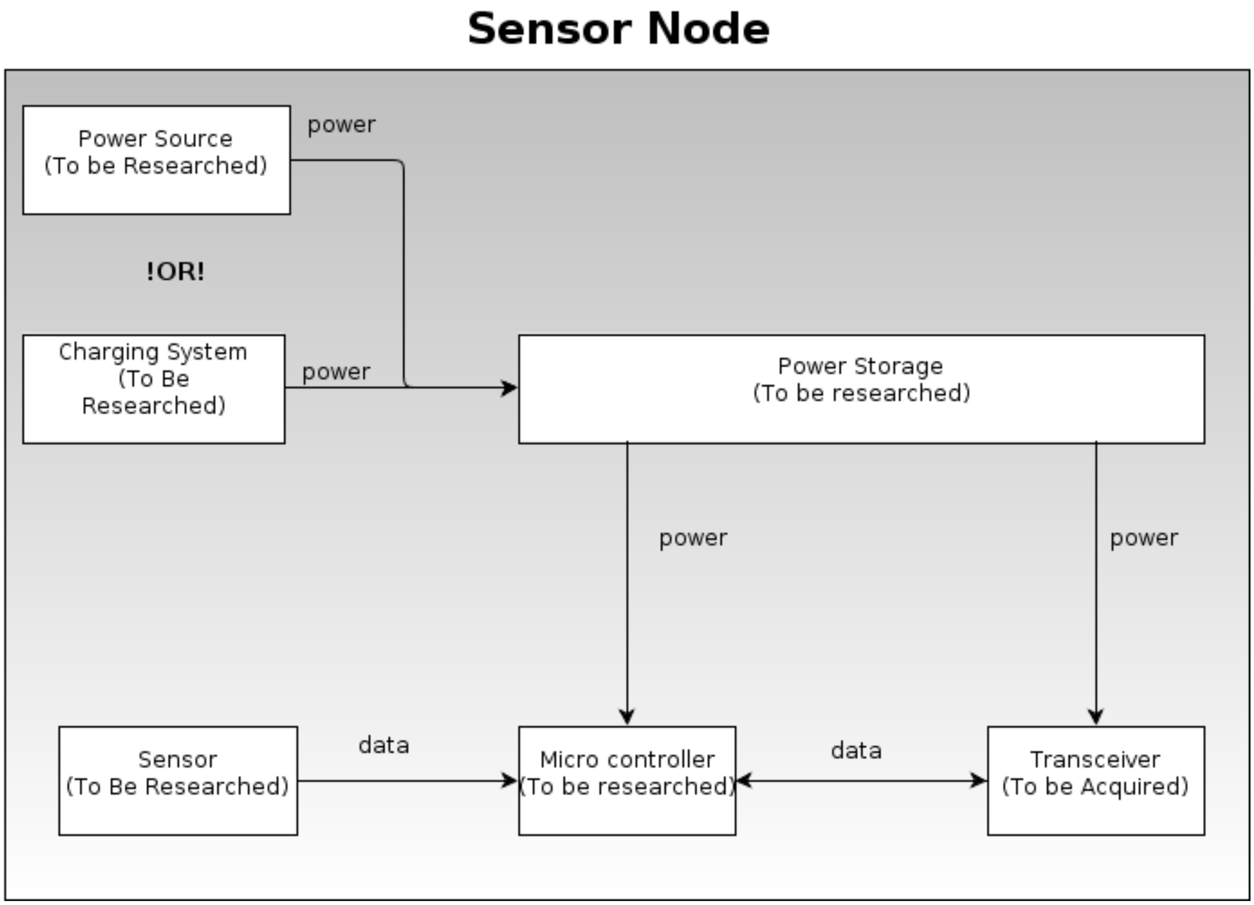

Figure 2: Sensor Block Diagram

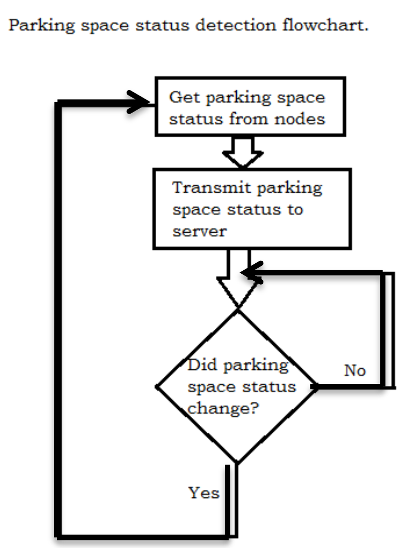

Figure 3: Node Sensor Block Diagram

2.2 Gateway & Sub Gate

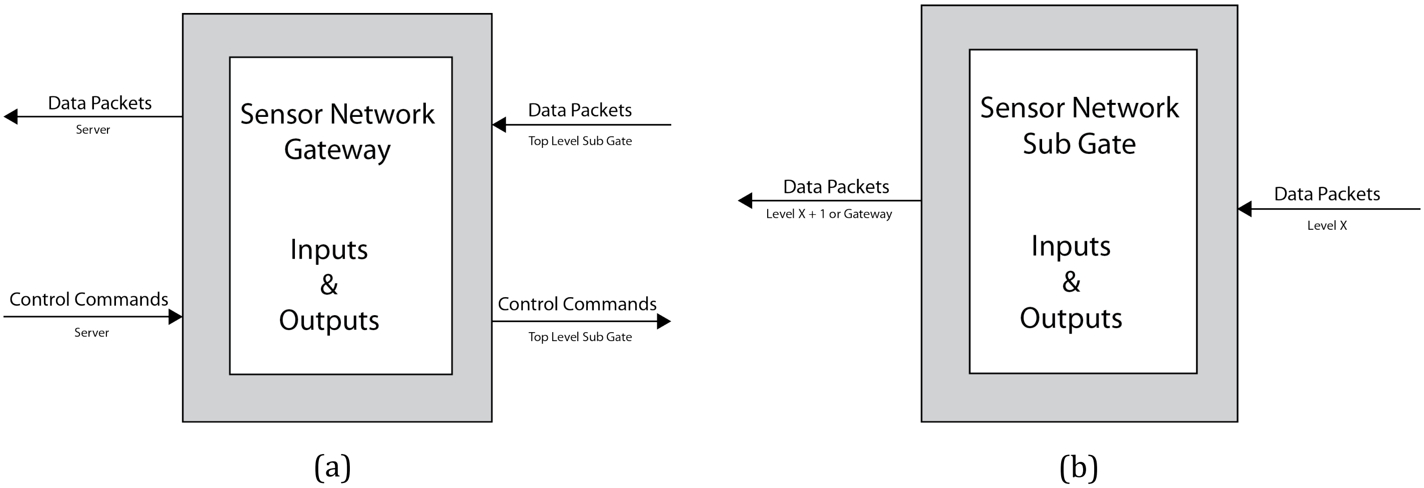

Figure 4: a) Gateway Block Diagram, b) Sub Gate Block Diagram

The gateway and sub gates serve as the distribution channels for the data packets collected by the sensor network and for the commands sent by the server. On each level of a garage there will be a large amount of data being collected by the network of sensor nodes. All the collected data is channeled to the floor's singular sub gate. The sub gate has two functions, to relay the data packets, gathered from the first floor's sensor nodes, to the sub gate located directly above it, and to relay commands from the above sub gate to all of the sensor nodes in its floor. The sub gate will contain the same hardware as the sensor nodes, minus the sensor.

The gateway is the bridge that links the wireless sensor network to the server. It receives all of the commands directly from the server and channels them to the top level sub gate. It will also handle the combined data collected from all the floors of the garage and transfer them to the server. The gateway will have one more component than the sub gate. The diagram below shows that the gateway will not only contain a microcontroller, a transceiver, and memory, but it will also have an antenna to wirelessly connect to the server.

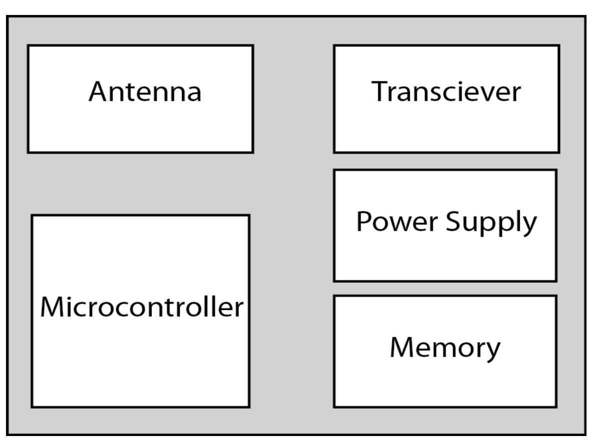

Figure 5: Component Diagram for Gateway

2.3 Server

The server will perform several key functions; it will execute a network daemon that will connect to specified gateway(s) in order to retrieve data from the sensor network. The daemon will need to parse data at a rate that matches the flow rate of incoming data. It will parse the data to identify: the individual sensor or counter node ID and the status/count of the nodes. Once the data is parsed it will be inserted into a MySQL database that will be sorted by garage/lot and floor/row and lastly by spaces. The sensor/counter ID's will be linked to their respective space/entrance/exit using the front end where the web program will write the respective ID's into the SQL database per space/counter, the daemon will then scan the SQL database to locate the relative ID where it will update the SQL entry for that space or counter based on the data received.

The web program will be programed to retrieve necessary information from the SQL database and produce the necessary HTML to display the data to an end user. An end user does not have to be logged in to use the system however he/she will have the ability to log into the system by creating a login. Once logged into the system the end user will be able to access extra features like set an estimated time frame he/she will be using the space, friends of the end user may be able to request the space based on the time frame. For example John Doe inserts the time frame 10AM-1PM into the system for a specific space, Jane Roe then logs on and checks to see if any of her friends have a space that will be available around 1PM and finds that John will be leaving around that time. Jane can then use the front end to send John a message requesting the spot upon his departure and they arrange to meet at the spot at 1PM. However if John does not have any specific friends to offer the space to it will be available to anyone, the system can also use the estimated times of departure to estimate which garage/lot is most likely to have available parking at certain times. The web program will also have a back end where statistical data can be used to manage the system.
The web program will also check for equipment faults, it will identify which nodes have not reported a change in status/count within a pre-determined amount of time. If no change has been reported the nodes are identified and a report is generated to determine which nodes may require physical inspection, which can require maintenance or repair.

Server

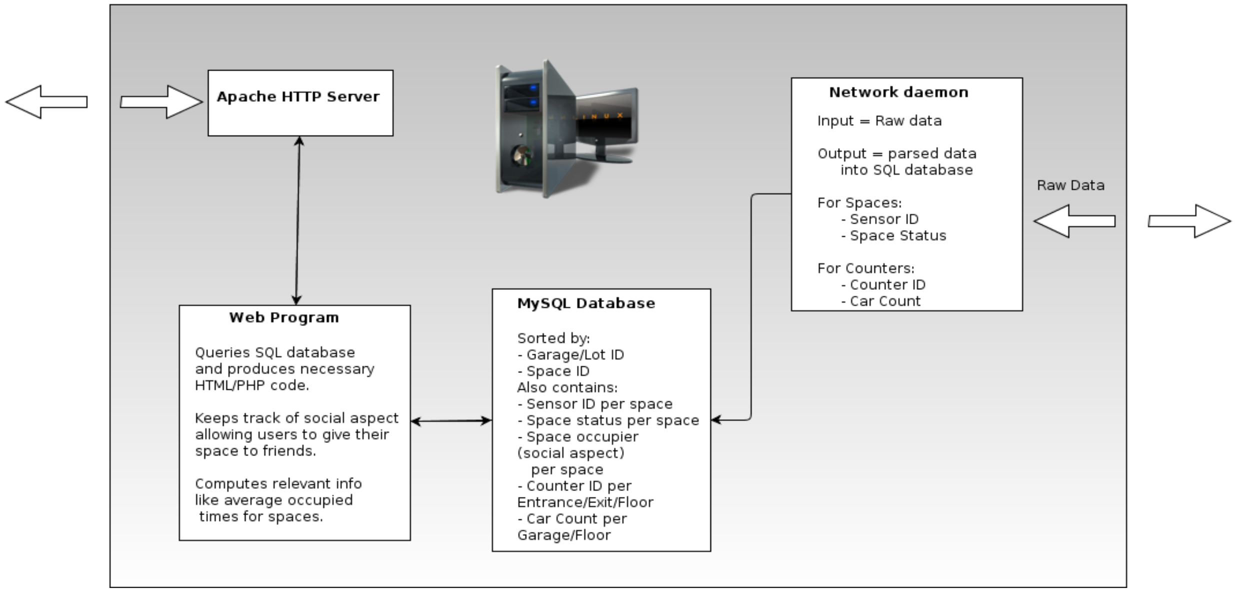

Figure 6: Server Block Diagram

2.4 User Interface

The user interface will be web based using jquery mobile, which allows for cross platform compatibility on all smart phones and tablets. The user interface will allow the end user to choose a location (UCF for example) where he/she will be parking. They will then be presented with a list of available garages/lots, after a garage/lot is chosen they will they see which floor/row has availability and finally after a floor is chosen individual parking spaces are identified. Later versions of this application might even include real depictions of the garage/lot layout and even include GPS guidance to such spots.

There will also be a social aspect to the user interface where the end user can log in and specify the time frame for which they will be using a space. Friends can then request the space and coordinate a time to meet at the space. If the end user decides not to limit it to friends then such information will be available for the general population using the system and his/her information will remain anonymous.

User Interface

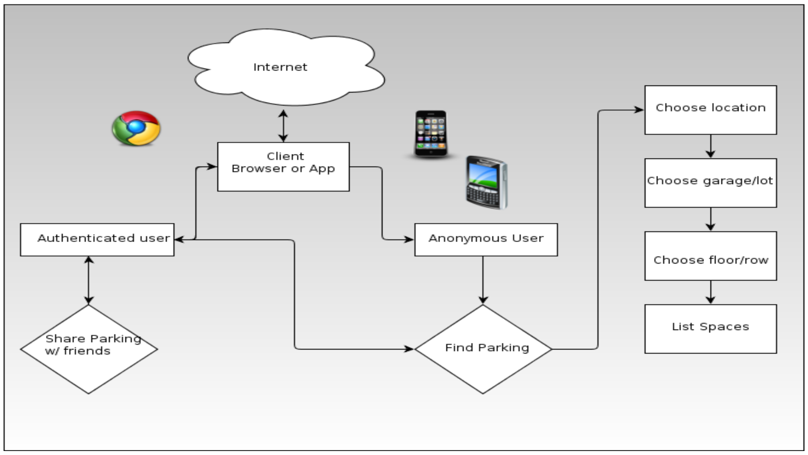

Figure 7: Client Block Diagram

3. Specifications & Requirements

- Sensor node cost less than $5
- Sensor/counter node power supply requirement, less than 5 volts
- Permanent energy harvesting power supply for sensors/counters
- Wireless communication range up to 300ftfor sensors/counters
- A maximum latency of 15s from the moment a car parks to the data displayed to the end user.
- 100% accuracy in car detection given proper parking conditions
- Reduce parking time of end users by 50% or more (research data will need to be acquired)
- Scalable design applicable to wide array of environments and scenarios.
- Minimal maintenance ranging in the time frame of every 10-20 years (e.g. replacing batteries where needed)

Project Milestone:

Event	**Estimated Completion Time**
Senior Design 1 (Summer 2012)	
Write up Specs and Requirements	May 31st

Divide Responsibilities	1st week of June
Begin Research	ASAP
Begin Writing	ASAP
Design of Sensor node research	June
Design of wireless protocol research	July
Pick Parts based on Design	July
First Draft of Final Documentation	July
Submit Documentation	August 3rd
Senior Design 2 (Fall 2012)	
Finalize Parts Accusation	August
Review Java and C programs	3rd and 4th week of August
Start coding	September
Implement sensor node	September
Implement server and UI	October
Test and error checking	November
Finishing design	November
Revise Documentation	December

Budget and Finance

Since we have not picked any parts for the project at this point, we don't have a detailed budget list at this time. However, ideally, we are looking at the following outline for the project:

Materials	Cost
Sensor	Less than $5
Transceiver	Less than $25
Sensor development kit	$0(from TI)
Microcontroller	Less than $10
Gate way	Less than $20
Server	$0
IPhone	$0