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**Overview:**

Finding a parking spot in congested areas especially in major cities like New York City can be a frustrating and daunting task. A motorist may drive around for up to two hours looking for a place to park depending on the time of day. A motorist may find a parking spot just as someone is leaving if you are lucky.

This issue continues even after a motorist has found a parking spot. He or she must scramble for change in order to put money into the parking meter. Some parking meters allow a maximum parking time for up to 2 hrs at a rate of 50c/hr. The parking meters allow you to park for up to 1hr at the cost of $1.25/hr as motorists get closer to the downtown areas. The motorist must renew his or her meter in order to avoid a parking violation once it expires.

We propose a solution that will save the city expensive parking management costs while also making it easier for motorists to find parking in congested areas. The motorist's vehicle will be outfitted with a Radio Frequency Identification tag (RFID tag) that will communicate with a RFID reader. The event of parking should be easy and should require no more of the motorist than to park their car. When it comes to purchasing this service, we would like the customer to believe that they have the following options:

1. Continue parking as they do now and maybe spend up to two hours looking for a parking space and then fumble for change.
2. Register for the monthly service and park with ease and never worry about fumbling for change.

This document is the requirement specification for a service which allows motorists to find open parking spaces on the web through Internet enabled devices. The RFID tag should be placed on the motorist's car and the user should not need to interact with the tag or the reader in any way so that they don't have to remember to activate their parking meter.

**The Deliverables:** There are two deliverables as listed below:

1. One working prototype of the RFID reader and tags. The design of the packaging is not part of the product.

2. The following are the course deliverables for the class. There are due dates for specific documents and presentations. These dates may change.

| | |
|---|---|
| (a) System Block Diagram | [10/14/2004] |
| (b) Preliminary Design Review (PDR) | [10/22/2004] |
| (c) Mid-term Design Review (MDR) | [12/10/2004] |
| (d) Comprehensive Design Review (CDR) | [03/29/2005] |
| (e) Public Demo | [04/15/2005] |

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**Physical Properties of Product:**

The RFID tag will have to be small (less than 3” x 3” 1”, w x l x h) and will need to operate in all types of weather: from 0 to 120 degrees F.

The RFID reader will not need to be as small as it will be placed on a building or in a place where it is easy to access for routine maintenance. The maximum size of the unit will be restricted to a 4” cube. The operating conditions are the same as described above.

**Principle of Operation:**

**Parking the car:**

The RFID tag and reader will be used in congested cities, where there may be interference coming from mobile phones, wireless access points and other electronic devices. The RFID reader will be placed in a convenient location where it is within range of a certain number of spots. When a car parks in a parking space, the RFID tag in the motorist’s vehicle automatically activates and begins communicating with the RFID reader. As part of the communication a timer is set to count the number of minutes the car has been parked. When the motorist’s car leaves the parking space, the RFID tag communicates to the reader once again to stop the timer. The time is then rounded up to the nearest 10 minute interval, and recorded in a database. At the end of the month the motorist receives a bill with an itemized list of all the parking transactions he/she has made.

**User Interface:**

There are two distinct user interfaces: The user interface of the RFID tag and reader and the website interface.

**The RFID tag and reader:**

Once the RFID tag is placed on the car the user should not have to interact with the RFID tag and reader. The RFID reader sends a wake-up signal to the RFID tag when a car enters a parking space. The RFID communication requires no user interaction. There will be one LED on the RFID tag.

**The website interface:**

The website interface allows the user to view open spots in a parking area. There will be a graphical user interface (GUI) that will allow the user to click on the area where they would like to find a spot, and the system will report where any open spots are in that area.

**Input:** The input is the detection of the car entering the space. The RFID tag must function when it is in a 10ft of RFID reader at any angle from 0 to 60 degrees off the perpendicular. The RFID reader is responsible for 10 parking spaces.

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**Output:** When the RFID tag and reader are communicating the LED on the RFID tag will flash. There are no other physically viewable outputs, though the data collected from the reader about the length of time a car has parked is entered into a database. Every month a query of each user is run on the database. This query includes an itemized list of where they have parked and for how long. This data is formatted as a bill and mailed to the motorist's home address.

**The User's Manual:**

The RFID tag is an electronic device that communicates with an RFID reader. The information of how long your car has been parked in a spot is transmitted from the reader to the database once you leave the parking spot. The RFID tag and reader communicate without your interaction. The tag is self-powered but may need a battery in order to communicate with the reader over long distances. The battery is user replaceable and will not need to be replaced for months at a time. To ensure proper operation of the RFID tag:

- Place the tag on the inside top part of your windshield (where the windshield is a different color shade).
- Enter the space and stay longer than one minute with the engine off.
- Observe the light on the RFID tag:
- If the light is on and not blinking then the tag is active but there is no communication taking place.
- If the light is not on, then the RFID tag is off. If the light does not turn on in the presence of an RFID reader, the battery needs to be replaced.
- If the light is blinking/flashing fast (5-10 times a second), the RFID tag is active and there is communication taking place between the tag and the reader, to indicate that the tag is communicating with the RFID reader.
- If the light is blinking/flashing slowly (1-2 times a second), the RFID tag is active as it has just been woken up by an RFID reader in range and communication can now take place.

**Acceptance Tests:** The tests are the physical communication, interference, website operations and database operations.

**Testing of Physical Communication:**

1. We will first place the RFID tag within range of the reader. If the light turns on then we know that the RFID tag is now active.
2. We will then check to see if the tag is blinking slowly (1-2 times a second). If this is happening then we know that the RFID reader has just woken up the tag, and it is ready to communicate
3. We will then test the communication of the tag and reader by keeping the tag in the range of the reader for more than a minute. If the light blinks fast then we know that communication is taking place.
4. After another minute we remove the tag from range of the reader, observe the tag's light turn off.

5. We then check the database for the particular date and time to see if we see the amount of time that the tag was in range of the reader, and a value that is that time rounded up to the nearest 10 minute interval.
6. If this procedure succeeds then we have correctly working communication.

**Testing of Interference:**

1. We will attempt communication with the RFID tag and reader while items that produce interference are nearby.
2. First we place a cell phone near the RFID tag to see if this alters the communications.
3. Repeat with a PDA.
4. Repeat with a laptop.

**Testing of Website operations:**

1. We will visit the website and create a new user account and attempt to view available spaces in a certain area.
2. We will place RFID tags in the area so the database will update that the spot is in use and reflect how many free spots are now in the area.
3. After 10 seconds we refresh the webpage (or wait 60 seconds for the auto-refresh)
4. We should now see certain spots taken up (depending on the resolution of spots, which is set to 10 cars). We will see a count of taken spots and free spots in a certain area.
5. We repeat the test by removing the tag from the area, and refresh the page as in 3.
6. We should see an updated count after the refresh is complete.

**Testing of Database Operations:**

1. We will make an entry into the database simulating a motorist parking their car for 5 minutes. We will then simulate another situation on the next day.
2. We will run a query on the database that will tabulate the amount of time that the user has spent parking, and also display the amount of time the user has been charged for, and the specific charges for each different parking instance.
3. We will then generate an invoice from the information

**Product Reliability:**

The RFID tag should work flawlessly for about 2000 parking transactions (entering & leaving a parking space). Depending on use, this is about 5 parking transactions a day for a whole year.

The RFID reader should work flawlessly for about 100,000,000 parking transactions. Depending on use, this is about 100 parking transactions a day for a whole year, for an RFID reader managing 10 parking spaces.

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**Product Maintainability:**

The maintenance costs of the RFID tag are minimal. The RFID tags are not very expensive and with a usage life of about a year, our service can afford to replace them.

The RFID reader is an industry proven device and is known to be in constant use in day to day operations. Most reader's will last more than 7 years as mentioned above which is reasonable. The unit may need maintenance, but it is more feasible to replace the unit instead of repair it.

**Product Cost:**

The end product cost is directly proportional the cost of the parts. To realize this project with a $500 budget we must buy one RFID reader and a few tags and demonstrate that our project will work without actually implementing it in a city.

The manufactured cost will be determined by the components that make up the system:

1. The RFID reader
2. The RFID tag
3. Electronic components such as resistors, LEDs, etc
4. Server computer for storing the database
5. Website hosting on a separate computer
6. UPS backup systems for both the website hosting server and the database server

**Dispute Resolution Mechanism:**

All disputes will be settled by listening to the fellow engineers on the team. The project leader has the power of veto, but his/her veto must be valid and a solid reason needs to be given. This veto may be overridden by majority vote

In this three person design group there is a Gold leader, Silver leader and Scrap leader.

- Gold Leader is responsible for arranging meetings and making sure deadlines are met.
- Silver leader maintains direct contact with the Gold Leader, and tries to provide solutions to problems that occur during the project. Silver leader must also keep in touch with Scrap Leader.
- Scrap leader is called upon when Gold and Silver leaders are too busy to turn in a deliverable. He must organize all the group's responses and write them up professionally and hand in the deliverable to the appropriate parties. (Prof. Hollot and Prof. Soules)

If a dispute cannot be solved within the group the Advisor will enter us into binding arbitration. Prof. Gao will be provided with all the information needed to make a decision. Gold Leader must set up this meeting with Prof. Gao and everyone must be present at every meeting in order to resolve the dispute in a reasonable time.