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February 18th, 2008

Mr. Patrick Leung
School of Engineering Science
Simon Fraser University
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Re: ENSC 440, *Functional specifications for the Wireless Parked Car Finding System*

Dear Mr. Leung:

The attached document contains our functional specifications for UFind, the wireless parked car finding system. The document describes the overall functionality of the product. The specifications are categorized mainly into two models: proof-of-concept and final marketable product. The goal of the project is to create a product that would assist users in finding their parked car in parking areas.

Weiibo Inc. comprises of Karl Simard, Hooman Jarollahi, Dennis Xu and Diwaker Malla, who are 3rd and 4th year Engineering students. The motivation for developing this product is a great market potential for the product as well as the technical design challenges and the team work experience we will gain. The development cycle will allow us to apply the knowledge and experience achieved in our engineering academic career.

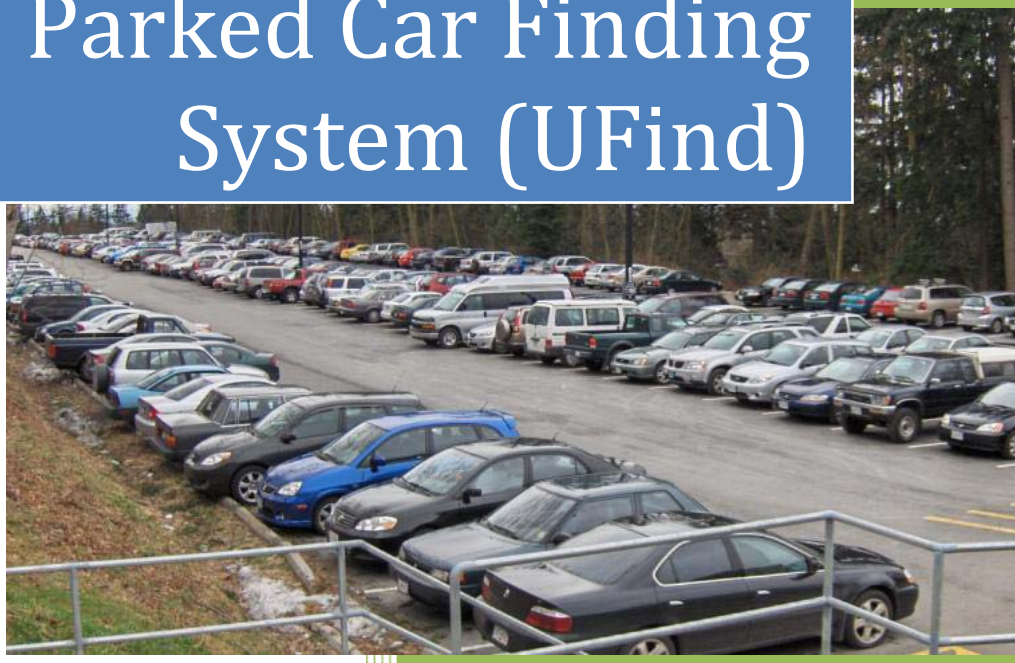
Please do not hesitate to contact us with questions and comments via phone at (778) 862-2242 or e-mail at hjarolla@sfu.ca.

Regards,

Hooman Jarollahi
CEO, Weiibo Inc.

Enclosure: *Functional specifications for the Wireless Parked Car Finding System*

# Functional Specifications for the Wireless Parked Car Finding System (UFind)

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## Executive Summary

Finding a car in large and crowded parking areas can be time consuming, stressful and disturbing when a driver has been away for a while. Examples of parking areas are shopping malls, airports and stadiums.

Wireless parked car finding system (UFind) aims at saving people's times and consequently improving productivity by relieving stress, aggressions and exhaustions caused by searching for a parked car.

People resort to find their parked cars with the help of sound or light produced by using lock/unlock, or panic buttons of keyless entry systems. These products are not designed for such a purpose and when misused can cause disturbance in the public. A frequent misuse of such types of products adds to the ignorance towards real car alarms and increases the level of noise pollution. Moreover, these devices only operate within 30 meters [7] of the car which makes them ineffective.

UFind will conveniently direct users towards their cars. The system can be installed in two different ways: it can be integrated in an already existing system or it can function as a stand alone product. As an important feature, the device will display the proximity between the car and the user. The user should first turn around in a full circle in order to find the direction of the car, and then move in that direction. Once within close range to the car, if necessary, the user has an option to turn on a special beeper or turn on the car lights for more help. Furthermore, the hand-held will display the parking lot information previously entered by the user.

The functional specifications of UFind are laid out in two major phases. The first phase consists of the development of a prototype that demonstrates proof of concept. The second phase will be aimed towards the commercialization of the product. Upon the completion of the first phase, early April 2008, UFind will have the following functionalities with an accuracy that will be tremendously improved by the end of the second phase:

- Display proximity between the user and the car and guide them in the correct direction.
- Allow user to enter parking lot information (PLI).
- Display time, date and previously entered parking information by the user. Perform best in open parking area.

The commercial product will meet quality standards such as water resistibility, secure wireless communication and maximum possible precision. It will also ensure that the end product complies with all governmental regulations.

## Glossary and Definitions

ANSI: American National Standards Institute
CSA: Canadian Standards Association
FCC: Federal Communications Commission
IC: Industry Canada
ISM: Industrial, Scientific, Medical
LOS: Line of Sight
Portable: Can be carried in the pocket
RF: Radio Frequencies
RSS: Radio Standards Specification
SUV: Sport Utility Vehicle
UFind User : Any person who meets all of the following characteristics:

- At least 10 years old or with supervisions by someone older
- Without impairments in visions and hearing for complete usage of the device

UUT: Unit Under Test

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# 1. Introduction

UFind assists the users to find their parked cars. It consists of two major parts, a portable fob-key type hand-held with a display system and a car module. In order to find the car, the user should first turn in a full circle to find the direction of the car. While the user moves in the right direction, the device will display the proximity to car. The hand-held has the capability of storing information such as the parking lot number entered by the user such that it can be displayed as requested. Figure 1.1 is an application example of this product.

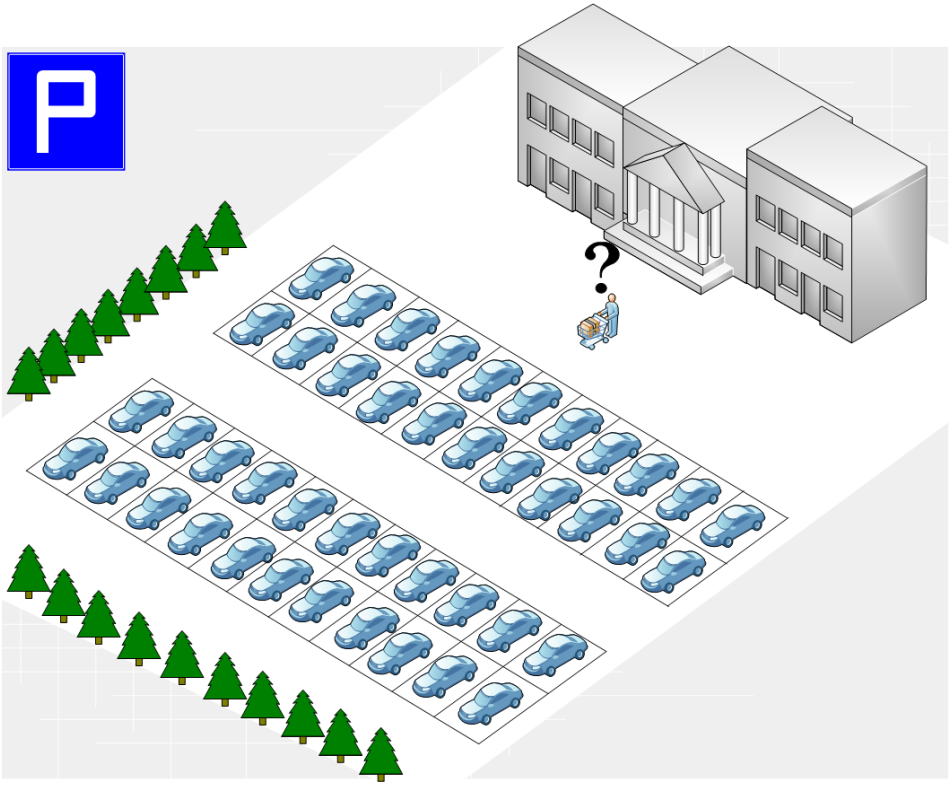

**Figure 1.1:** Conceptual Application example

## *1.1. Scope*

The scope of this document is to provide a detailed description of the high-level functionalities of UFind. It can be used to distinguish functional requirements between the prototype and the production model. The specifications will outline the requirements that the actual design at different phases must include.

## *1.2. Intended Audience*

The document is intended for the use of all Weiibo Inc. members. With proper layout of functionality requirements and standards for different phases of the development cycle, design and test engineers will understand the detailed requirements of the product.

Therefore, confusions on design decisions and test results can be avoided and clarified. The project manager shall use this document to evaluate the progress and ensure the compliance with all required standards and requirements and hence organize the team.

### *1.3. Classification*

In the course of developing the product, it is necessary to distinguish between requirements for proof-of-concept prototype and the end user production product. In order to make the distinction, throughout the document the following conventions will be used:

**[Rx-p]:** Functional requirement.

where **x** refers to the requirement number and **p** refers to the requirement's priority according to the following scheme:

**I**: Applies to the proof-of-concept prototype.
**II**: Applies to both the prototype and the commercial product.
**III**: Applies to the final commercial product.

## 2. System Requirement

In this section, an overview of the functional requirements will be presented.

### *2.1. System Overview*

A general descriptive model of UFind is demonstrated as a functional block diagram in Figure 2.1.

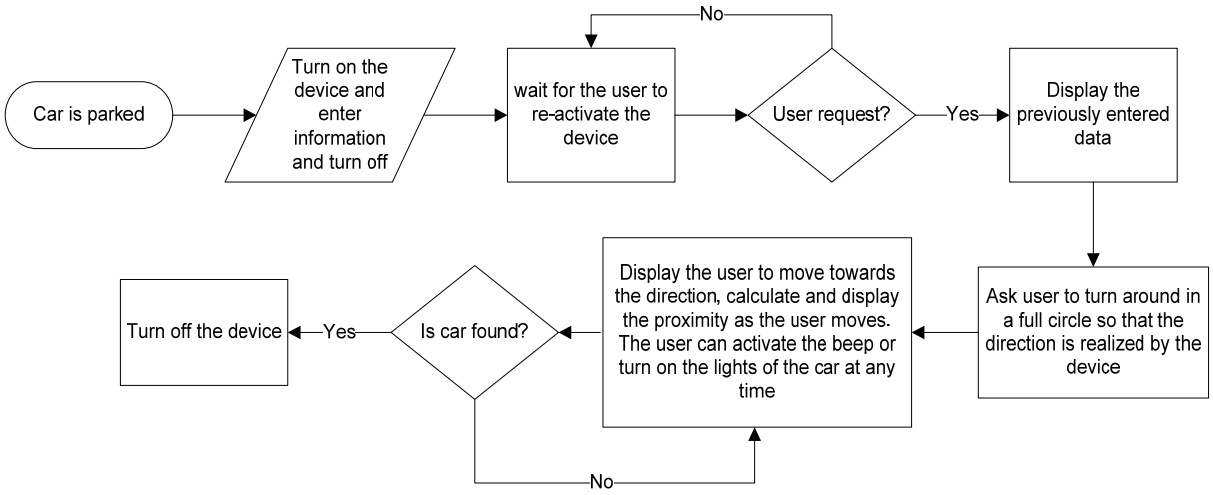


**Figure 2.1:** General system functional block diagram

The device consists of two parts, the car module and the user module. The car module is installed in the car and the user module is carried by the user as a hand-held with a display system.

In order to use the device, the UFind User is required to press an associated button on the hand-held to start up the device. After the start-up, the user should select the appropriate option on the display. The different options are:

- Find car
- Enter Parking information
- Date/Time
- Turn off

Upon selection of “Find car”, the previously entered parking lot information will be displayed. Then, as shown in Figure 2.2, the user must turn around in a circular path (slower than 30 degrees per second) so that the device can detect the direction. The user must then move in that direction. The device will display the proximity between the car and user by turning on numbers from 1 to at least 10 gradually on the display system; 1 indicating the farthest and 10 indicating the closest proximity. When the user is within a few meters of the car, the user has the option to press another dedicated button to activate the beep of the car module or another button to turn on the lights of the car for ease of detection. The device will not work well if the user is within 10 meters or less due to operational limitations.

Upon selection of “Enter Parking Information” on the hand-held, the user can enter the necessary information regarding the parking area such as the parking lot number using an associated button on the hand-held. The information will be stored and displayed upon the selection of “Find car” automatically.

Upon the selection of “Turn off”, the device will shut down.

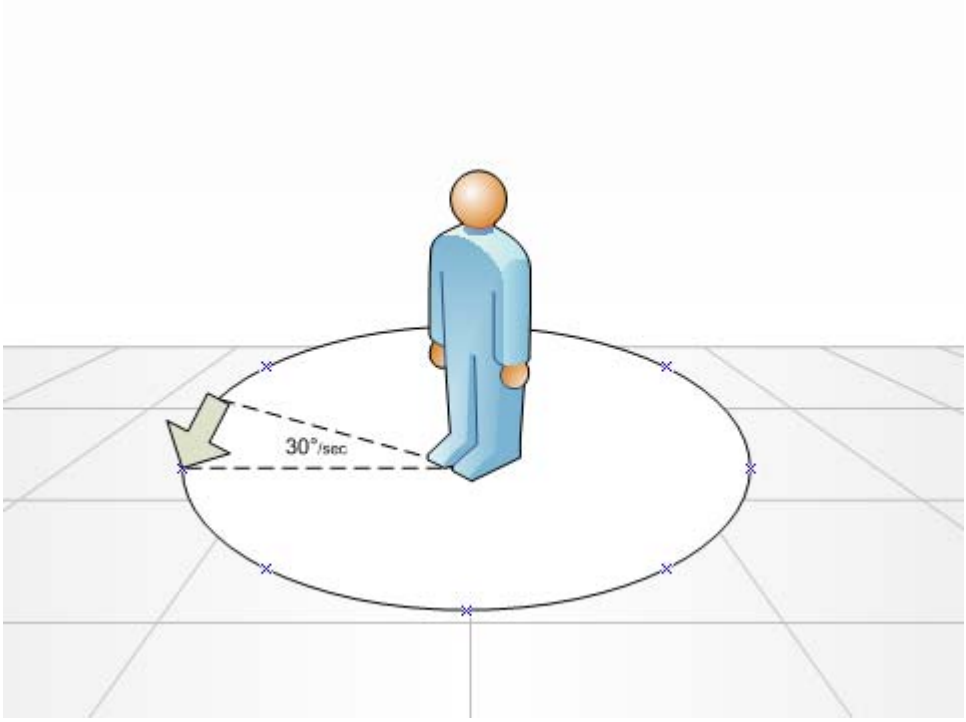


**Figure 2.2:** Graphical presentation of the user movement in full circle

## *2.2.Constraints and performance constraints*

The technology involved in this product is Radio Frequencies (RF). In fact, it is RF's nature that enables the functionalities of the product to be possible. The most significant functional requirements are proximity detection and direction sensing. Due to several limitations and constraints existing in the environment and the nature of the RF, the precision of prototype performance and final end user product will be affected. In general, the performance of the product will be affected by the existence of one or more of the following:

- Signal absorptions/reflection in material such as concrete, tree, metal (bus, large SUVs, trucks, …) in line of sight (LOS)
- Effects of near-by conductive planes such as the roof of a near-by car or the side of a school bus
- Water in the air, rain, fog, snow, etc.
- Antenna size and orientation
- Near-by human body – handheld unit's location with respect to the user and the car)
- Distance – The device will not detect proximity closer than 1 meter; however, it can still turn on the lights or activate the beep. The device will not work farther than 200 meters.

## 2.3. General Requirements

**[R1-II]:** The hand-held shall be turned on or off upon user request.
**[R2-III]:** The maximum retail price shall be under $100.
**[R3-III]:** The hand-held must be portable.

## 2.4. Physical Requirements

Figures 2.1, 2.2 and 2.3 are the graphical presentations of the handheld and the car module.

**[R4-III]:** The hand-held shall be no larger than 10 cm by 5cm.
**[R5-III]:** The hand-held shall not be thicker than 2 cm.
**[R6-III]:** The car module shall not be larger than 13cm by 8cm by 4cm.
**[R7-II]:** External antennas shall be used with the car module.
**[R8-I]:** External antennas shall be used with the user hand-held.
**[R9-III]:** Internal antennas shall be used with the user hand-held.
**[R10-II]:** The car module shall have a proper enclosure for simple installation.
**[R11-III]:** The hand-held shall be portable i.e. small and light (<150 g).

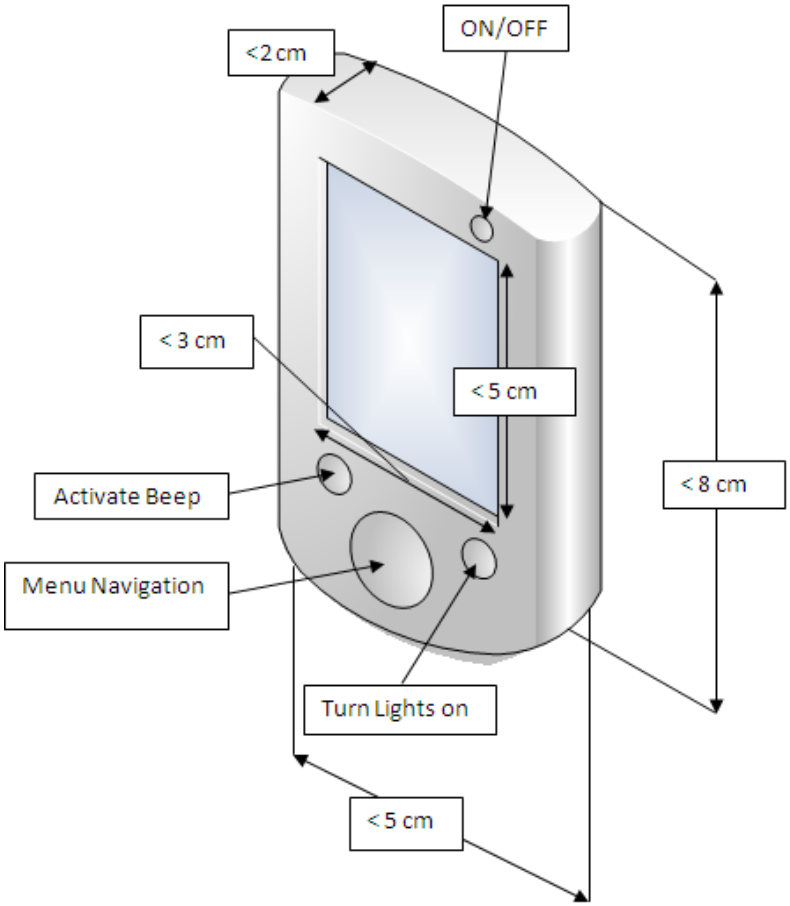


**Figure 2.3:** Graphical presentation of the handheld with some approximations on dimensions


**Figure 2.4:** Example of handheld display when displaying the proximity and parking information

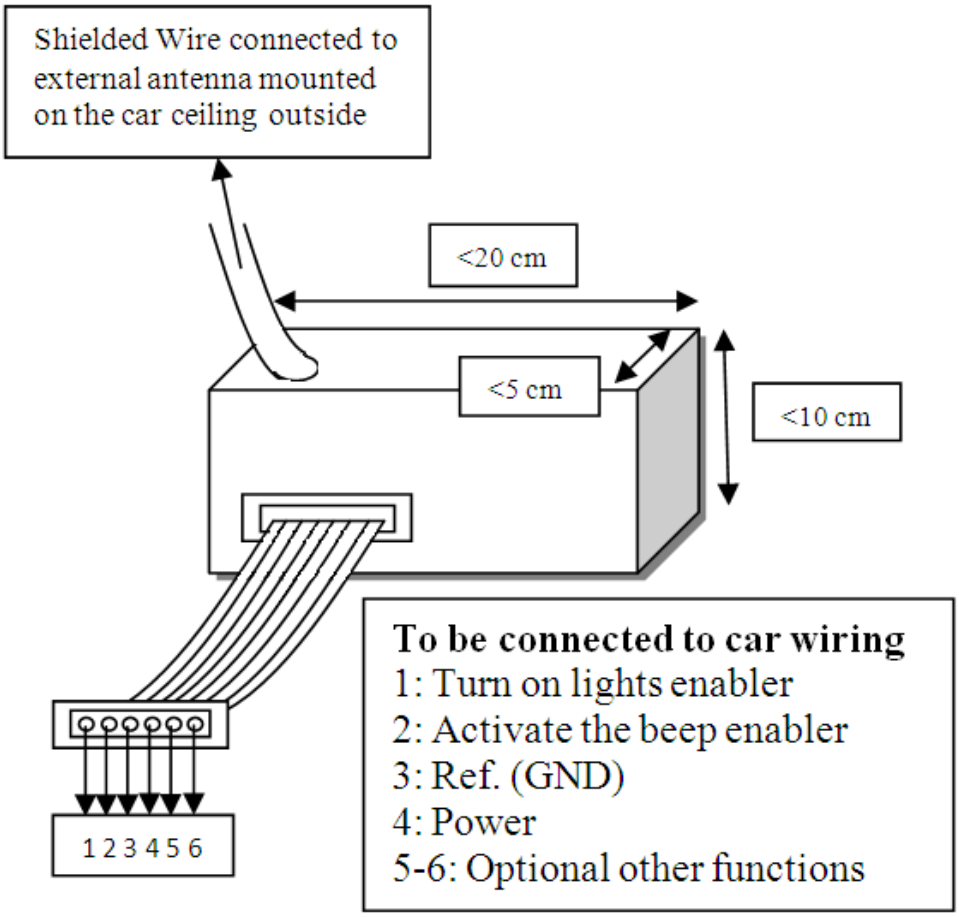


**Figure 2.5:** Conceptual representation of the car module with some approximations on dimensions

## *2.5. Electrical Requirements*

### 2.5.1. Wireless Requirements

**[R12-II]:** The device shall operate securely in presence of other sources of interference.

**[R13-II]:** The operation of multiple UFinds shall not cause operational interference.

**[R14-I]:** The operation range between the hand-held and the car module shall be between 1 to 80 meters.

**[R15-III]:** The operation range between the hand-held and the car module shall be between 1 to 200 meters.

**[R16-III]:** The device shall be compliant with regulatory standards set by FCC and IC.

### 2.5.2. Power Requirements

**[R17-II]:** The hand-held and the car module shall be capable of being powered by portable power sources.
**[R18-III]:** The car module shall be capable of being powered using the car power source.
**[R19-III]:** The life period of the power sources shall be at least one year.
**[R20-III]:** The hand-held shall turn off if the device remains inactive for more than 3 minutes.

## *2.6. Environmental Requirements*

**[R21-II]:** The device shall operate normally in temperatures ranging from - 40 C to 70 C.
**[R22-II]:** The device shall be shippable in temperatures ranging from - 40 C to 70 C.
**[R23-III]:** The device shall operate normally under 70% relative humidity.
**[R24-III]:** The alarm power level for the beeper shall be less than 85 db. [6]
**[R25-III]:** The alarm period for the beeper shall be less than 1 second with silence period of at least 2 seconds. [6]

## *2.7. Standards*

**[R26-III]:** The device shall conform to FCC Part 15C unlicensed radio devices [1, 4].
**[R27-III]:** The device shall conform to IC RSS-210 Low Power License-Exempt, Cat. I certification [2, 3].
**[R28-III]:** The device shall conform to ANSI C63.2-1996 and ANSI C63.4-2003 standards [5].

## *2.8. Reliability and Durability*

**[R29-II]:** The accuracy of the device shall not be affected significantly in the presence of fog, snow or rain.
**[R30-III]:** The hand-held shall be resistant to normal physical treatments when used on a daily basis.
**[R31-III]:** The hand-held shall not be damaged when dropped on the ground for at least 1000 times from a distance less than 2 meters.
**[R32-III]:** The hand-held shall be water-resistant to withstand weather conditions and minor spillage of liquids.

## *2.9. Safety Requirements*

**[R33-III]:** The device shall be compliant to the radiation safety standards.
**[R34-III]:** All electrical and mechanical connections will be enclosed with the exception of the antenna for the car module.
**[R35-III]:** The circuitry of both the modules will be protected from external static voltage sources via an enclosure.
**[R36-III]:** The car module and the hand-held will be water resistant. The operation of both the modules under rainy or snowy conditions will not cause damage to the device.
**[R37-III]:** Both the modules will have smooth and rounded corners or edges which will eliminate possible bodily harm.

## *2.10. Performance Requirements and Limitations*

Due to the environmental limitations of this product and nature of RF technology, the performance and the precision of the device will significantly depend on how the antennas of the product are designed and manufactured. For example, integrable and small sized antennas are required to be designed by antenna companies for the particular design specifications of this product. This type of antenna design requires a strong physics/antenna design background which none of the team members possess. Therefore, it needs to be designed professionally by qualified equipment and antenna designers. The cost for the design and implementation of the prototype of these types of antennas, obtained from antenna companies, are beyond the scope of the available budget, time line, and purpose of this project. The course instructor has also confirmed this issue. The design of sample prototyping antennas will be able to prove the functionality of this device to some extent. The required performance is outlined in the following:

**[R38-II]:** The range of operation between the hand-held and car module shall be at most 1 Km.
**[R39-II]:** The start-up time for the device shall be less than 2 seconds.
**[R40-II]:** The proximity detection on the hand held shall be displayed within 5 seconds.
**[R41-I]:** The car direction will be detected using prototyping (proof-of-concept) antennas which will be much larger in size than the commercial product. The directionality will be affected when the proper antenna is not designed for the specific purpose of this product.
**[R42-III]:** The directionality performance shall be at its best when properly manufacturer designed built-in antennas are used.

### *2.11. Optional Features*

**[R43-III]:** The device shall be able to connect and display parking lot information and the proximity to the car on the user's cellular phone.

**[R44-III]:** The hand-held shall also be security enabled. For example, it shall only function after the user enters a verified password or uses fingerprint.

## 3. User Interface Unit

### *3.1. General Requirements*

**[R45-II]:** The hand-held shall have a display system.

**[R46-II]:** The hand-held shall have the capability to enter parking lot information.

**[R47-II]:** The minimum number of letters or numbers the user shall be cable of entering on the hand-held display shall be 6.

**[R48-II]:** The hand-held shall have the capability to display date and time.

**[R49-II]:** The hand-held shall be capable of storing the information user has entered.

**[R50-II]:** The hand-held shall be able to retrieve the previously entered parking lot information entered by the user and display it on the display system.

**[R51-II]:** The hand-held shall have independent keys to turn on lights of the car or activate the beep at any time of the operation while the device is on.

### *3.2. Usability Requirements*

**[R52-II]:** The buttons on the hand-held shall be comfortable for use.

**[R53-II]:** The hand-held software shall be user-friendly and intuitive to use.

**[R54-II]:** The hand-held firmware shall upgradable by a technician.

### *3.3. Physical Requirements*

**[R55-II]:** The display system text shall be readable from at most 50 cm by person with a normal eye-sight.

## 4. User Documentation

**[R56-III]:** The user shall be provided with a quick start guide and a detailed user manual that explains all the functions of the device.

**[R57-III]:** The device package shall consist of an installation guide for optimal performance.

**[R58-III]:** The quick start guide, user manual, and the installation guide will be multi-lingual.

**[R59-III]:** The above documentations will be provided in the company website.

## 5. System Test Plan

In this section, test methods of the proof-of-concept prototype will be outlined as a high-level functionality test. These methods can also be used to establish a basic framework for the commercial product test procedure. The product will be tested in all different stages throughout the development cycle. Therefore, on each stage, software and hardware designs are tested concurrently to ensure the functionality specified in the document. More technical details on the tests will be explained in the design specifications document. As a verification stage, a user-level test will be conducted. The prototype will eventually be tested by potential users after the completion of the development cycle to receive feedback on product appearance and the functionality.

The UUT will be tested for all the functionalities such as entry and retrieval of parking lot information, display of proximity between the user and the car, and the turn off mode.

The entry and retrieval of parking lot information shall be tested by entering various data with different lengths and retrieving them by pressing an associated button on the handheld. Various data ranges from a single to maximum capable length of display.

The functionalities of the device especially the proximity detection will be tested in real life situations. Examples can be rainy or foggy days, underground, open, congested and less crowded parking areas.

A test procedure document will be prepared. It will outline various test conditions to fully evaluate the overall performance. The document will serve as a blueprint for testing the device under different scenarios and environmental conditions. Meanwhile, the user interface such as the display system will be visually tested. The functionality of the device to sound a beep and to turn on the car lights upon user request shall be tested in parallel.

Some of the test conditions are:

- User: different distances and angles from the car,
- Weather conditions: foggy, snowy, rainy, cold and hot
- Parking lot status: crowded or relatively empty

The response time of the UUT will be tested by turning it off and back on within 2 seconds.

The other important function of the product is to display proximity in response to user's request. The functionality shall be tested under various scenarios such as:

- Entering parking lot information,
- Pressing the beep or the lights button,
- Other typical circumstances.

Since the product will be used on a daily basis, robustness and durability of the external enclosure and internal components will be equally important. Accelerated life tests will be conducted to ensure the durability of the commercialized prototype in various conditions and scenarios when the UUT will be subject to:

- Liquid spillage
- Dropping on hard surfaces,
- Normal wear and tear

## 6. Conclusion

The functional specification outlines the functions that the product will have in the following stages: proof of concept and commercial product. All functional requirements were selected and verified by all members of Weiibo Inc. With the current pace of the project, we are confident that the proof of concept model will be successfully completed by the target date April 08, 2008.

# 7. References

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