ENSC 305W/440W Grading Rubric for Functional Specification

Criteria	Details	Marks
Introduction/Background	Introduces basic purpose of the project.	**/05%**
Content	Document explains the functionality of the proposed product without excessive design content (i.e., outlines the "what" rather than the "how").	**/10%**
Technical Correctness	Ideas presented represent valid functional specifications that must be considered for a marketed product. Specifications are presented using tables, graphs, and figures where possible (rather than over-reliance upon text).	**/15%**
Process Details	Complete analysis of problem. Justification for chosen functionalities. Sources of ideas referenced. Specification distinguishes between functions for present project version and later stages of project (i.e., proof-of-concept, prototype, and production versions). Comprehensively details current constraints.	**/20%**
Engineering Standards	Outlines specific engineering standards that apply to the device or system and lists them in the references.	**/10%**
Sustainability/Safety	Issues related to sustainability issues and safety of the device are carefully analyzed. This analysis must cover the "cradle-to-cradle" cycle for the current version of the device and should outline major considerations for a device at the production stage.	**/10%**
Conclusion/References	Summarizes functionality. Includes references for information from other sources.	**/05%**
Presentation/Organization	Document looks like a professional specification. Ideas follow in a logical manner.	**/05%**
Format Issues	Includes letter of transmittal, title page, executive summary, table of contents, list of figures and tables, glossary, and references. Pages are numbered, figures and tables are introduced, headings are numbered, etc. References and citations are properly formatted.	**/10%**
Correctness/Style	Correct spelling, grammar, and punctuation. Style is clear concise, and coherent. Uses passive voice judiciously.	**/10%**
Comments		

October 17, 2013

Professor Lucky One
School of Engineering Science
Simon Fraser University
Burnaby, British Columnbia
V5A 1S6

Re: ENSC 305/440 Functional Specification for Unipark-1000

Dear Professor Lucky,

Attached is the functional specification document for the Unipark-1000, an easy to install parking sensor from SABZ Incorporated. We are designing an ultrasonic parking assist system which eliminates the complexity of installing a conventional ultrasonic parking assist system. With the Unipark-1000, anyone who knows how to operate a screw driver will be able to install the device in their own garage.

The functional specification document details the high-level requirements of the Unipark-1000 system. The document also defines the requirements for the proof-of-concept, alpha, beta, and production builds. Our engineering team from SABZ Incorporated will follow the requirements from this document closely when designing and developing the Unipark-1000.

Should you have any question or concern about the document, please do not hesitate to contact us by emailing me to cmm10@sfu.ca.

Sincerely,

Edmond Mo
Chief Financial Officer
SABZ Incorporated

Enclosure: Functional Specifications for Unipark-1000 Parking Assist System.

Unipark-1000

An Easy to Install Vehicle Parking Sensor

ENSC440 Functional Specifications

Revision 3.0

Title/Name	Signature	Date
Author/Chief Executive Officer Kenny Lam	[signature]	Oct, 17, 2013
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Executive Summary

The complexity of installing a conventional ultrasonic parking assist system has put off many consumers from purchasing the system [2]. The goal of the SABZ engineering team is to create an ultrasonic parking assist system that will eliminate the complicated installation process while maintaining the performance and reliability level of the traditional ultrasonic parking assist system.

The functional specifications of Unipark-1000 ultrasonic parking assist system are fully specified in this document. The engineering team from SABZ Incorporated will follow the listed functional specification as a guideline when designing and testing the proof-of-concept as well as other builds of the Unipark-1000.

The engineering team has scheduled the proof-of-concept build of the Unipark-1000 to be completed by Dec 2, 2013. The proof-of-concept build shall be constructed by Nov 1, 2013. Verification and Validation of this build will be complete by Nov 16th 2013. We've allowed a 2 week gap between the date of the demo and the completion of the testing phase for any last minute design changes and fixes.

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Glossary

Beam angle	An angle that determine that detection pattern of the ultrasonic transducer.
Bluetooth	Wireless technology standard design for short range data exchange using radio frequency from 2.400GHz to 2.480GHz
Build	A version of the device which is physically constructed.
Kbps	Kilobits per second, a standard measurement use to measure a performance of a transmission medium.
Noise	Radio interference cause by other radiation sources such as cosmic radiation or simply other radio device within close proximity.
Prototype	One of the initial engineering builds of the device used for verification and validation of design concepts and specifications
Ultrasonic transducer	A piezoelectric device that is translate electric energy into acoustic wave and echo detection of the echo of the acoustic wave.

1 Introduction

Unipark-1000 is an ultrasonic parking assist system that is designed for easy installation. The conventional ultrasonic parking assist system requires the user to drill holes and run wires through the front and back bumper of the vehicle for installation [2], Unipark-1000 is designed to eliminate all the installation steps that would normally require a mechanic to perform. The goal of this project is to investigate the feasibility of such a design. We will develop a proof of concept build by Dec 2, 2013. The purpose of this prototype is to demonstrate that an acceptable parking assist system with an easy setup can be implemented.

1.1 Scope

The functional specifications of Unipark-1000 are defined in this document. The functional specification should define the requirements in terms of user interaction, power consumption, and system performance. Prototypes are defined. Functional requirements applicable to each type of prototype are identified. This document is not intended to discuss the actual implementation or design of the Unipark-1000 system.

1.2 Intended Audience

The targeted audience of this document are the members of SABZ Incorporated. Members will use this document as a guideline when he/she is designing all the components of the Unipark-1000.

1.3 Requirements Classification

Each of functional requirements is documented in the following format:

[Ri-p] A functional requirement.

Where **i** is the functional requirement index and **p** is the prototype index. The prototype index identifies the earliest prototypes which will meet the requirement. The prototype index legend is as follows:

1 Proof of Concept build.
2 Beta Build
3 Production Build
4 Accessory requirement. May be included in production build

1.4 Prototype Definition

Proof of Concept Build

The proof of concept build is a crude prototype which will be used to explore and address key technical risks in the Unipark-1000. This build shall have basic product functionality which includes accurate obstacle distance detection and easy installation. It shall satisfy all requirements with a prototype index of 1.

Beta Build

This build is the first model of the final product. The beta build should allow for product functionality to be tested in a customer environment. Fixes will be implemented for any flaws discovered in this build before proceeding to the next build. It will meet all requirements with prototype index 1 and 2. It may contain some components which are not used in the production build. The appearance may be different from final product.

Production Build

The production build is the final commercially sold product. It will satisfy all requirements with prototype indexes 1, 2, and 3. It will also satisfy as many accessory requirements (p =4) as economically feasible.

2 System Requirements

The following section lists the "black-box" requirements of Unipark-1000. System requirements include

- Requirements that must be satisfied by the system as a whole. For instance, how often the distance data value is refreshed.
- Requirements that must be satisfied by all parts of the system. E.g. environmental operating conditions.

2.1 System Overview

Unipark-1000 is a three-part device. It consists of two sensor modules and a display module. The two sensor modules are physically and functionally identical, except one will be locate at the front bumper and the other will be at the rear bumper of the automobile. The display module is located inside of the automobile where it will be visible to the user

The sensor module is equipped with ultrasonic transducers to measure the range of the closest object from the module. There will be memory inside the proximity sensing module to store the collected range data. The proximity sensing module will continuously collect range data and save only the most recent measurements into its internal memory. Upon activation, the display module will request the range data from the sensor module. The sensor module in return will send the stored range data to the display module. The display module will refresh the range data 3 to 4 times per second. The communication between the sensor module and display module are done through the wireless Bluetooth link using a proprietary Bluetooth communication protocol.

When the display module receives range data from the sensor module, it will process the range data and inform the user the closest distance from the foreign object to the sensor module. Display module will have the ability to remotely switch on/off the two sensor module via radio frequency, this feature plus the Bluetooth communication link allows for zero wiring between the modules and can dramatically reduce the complexity of installation.

2.2 General Requirements

[R1-3] The production cost of the final implementation must fall under $50 CAD per unit.

[R2-3] The retail price of the system will be under $100 CAD per unit.

[R3-1] The system shall be have an install time of no more than 15 minutes

[R4-1] The system shall not require more than 2 hand tools for installation.

2.3 Physical Requirements

[R5-3] The system shall look aesthetically pleasing and professionally designed.

[R6-3] The system should not have any sharp edges.

2.4 Electrical Requirements

[R7-2] The system shall be battery operated with a minimum battery life time of at least 3 months under normal usage. Normal usage is defined as the device assisting with parking 6 times a day every day.

[R8-2] The system shall draw no more than 100mA of current.

2.5 Environment Requirements

[R9-2] The system shall operate correctly within the temperatures of -25 to 70 degree Celsius.

[R10-2] The system shall operate correctly in humidity levels ranging from 0% to 90% RH.

[R11-2] The system shall operate correctly in atmospheric pressures from 94 kPa to 103 kPa.

2.6 Reliability Requirements

[R12-2] The system shall be resistant to shock.

[R13-2] The system shall be resistant to vibration.

[R14-2] The system shall not experience any mechanical or electrical failure within the first year of its lifetime.

2.7 Usability Requirements

[R15-2] The system shall be intuitive in term of user interface

[R16-1] The system may require a calibration procedure after installation.

2.8 Standard Requirements

[R17-2] The system shall comply with all applicable CSA standards [3].

[R18-2] The system shall comply with ISO 26262 [4].

[R19-2] The system shall comply with all applicable FCC standards for unintended radiation [5].

3 Component Requirements

The following section outlines the component specific requirements. A brief description of the component is given before the requirements are outlined.

3.1 Display Module

The display module is a physical component that is mounted on the car dashboard. It serves the following functions

- Collects range data from sensor modules
- Displays the distance to the closest object on a digital LED display
- Sounds an audible alarm whose beeping frequency corresponds to obstacle distance
- Remotely power on sensor modules for distance measurements
- Remotely power off sensor modules when the system is not in use.

A detailed block diagram of the Display Module is shown in Figure 1.

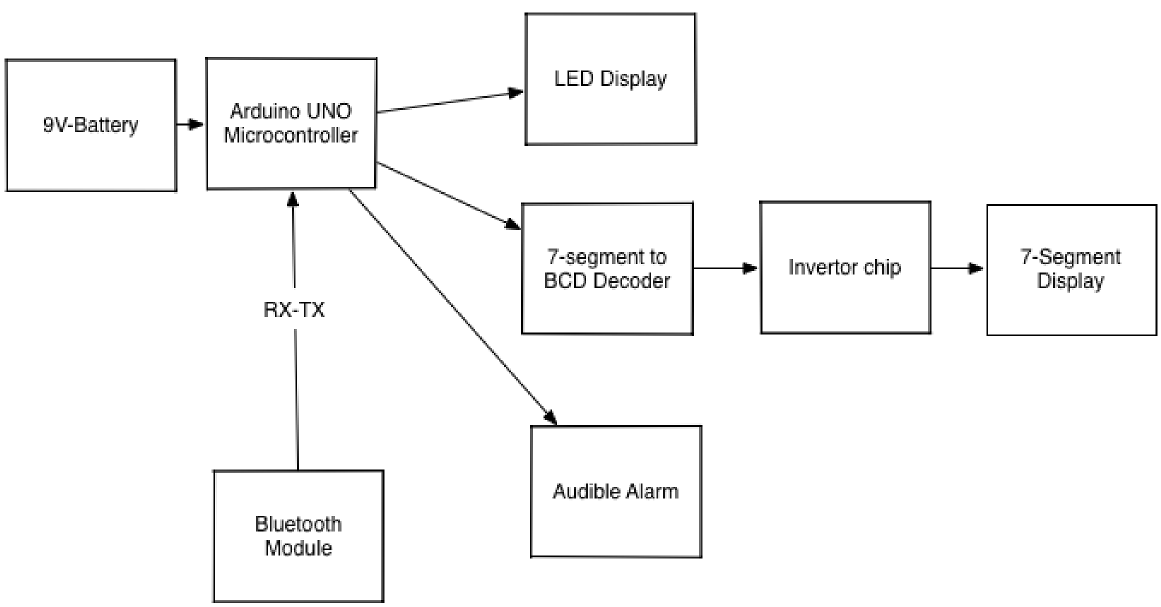

Figure 1: Display Module Detailed Block Diagram

The following lists out the functional requirements of the display module.

3.1.1 General Requirements

[R20-1] The display module shall display the obstacle distance in cm using a digital LED display similar to that shown in figure 2.

[R21-1] The display module shall display the obstacle distance using the LED dot display method shown in the figure below. Green LEDs indicate a far distance. Yellow LEDs indicate a medium distance. Red LEDs indicate a close distance.

Figure 2: Proposed distance display method

[R22-1] The display module shall use Bluetooth communication to retrieve the proximity data from the sensor module.

[R23-1] The system shall have an audible alarm which beeps faster as the object is closer and turn into a continuous tone at a distance of less than 30 cm.

[R24-2] The audible alarm sound shall have an adjustable volume level with a max value of 80 dB.

[R25-1] The display module shall refresh the range data 3 to 4 times per second.

[R26-1] The display module shall have a power button to turn the system on/off.

3.1.2 Physical Requirements

[R27-1] The display module will be mountable to the dashboard with double-sided tape.

[R28-2] The display module should weigh less than 300g.

[R29-2] The dimensions of the display module shall be no larger than 12 x 5 x 5 cm.

3.1.3 Electrical Requirements

[R30-4] The display module can be powered by the 12V DC cigarette lighter socket in the automobile.

[R31-1] The display module will use a 9V battery for power.

3.2 Sensor Module

The sensor module is in charge of performing distance measurements and sending that information to the display module. The following is a functional block diagram of how the sensor module works.

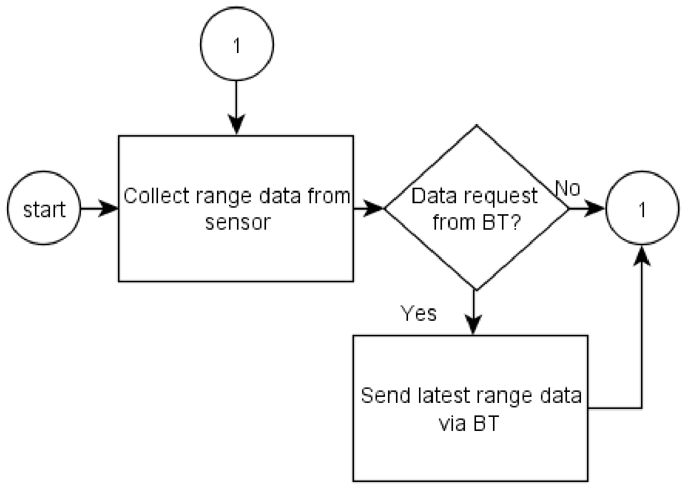

Figure 3: Functional block diagram of sensor module

The sensor module takes on the form of a license plate frame. It is mounted onto the car bumper.

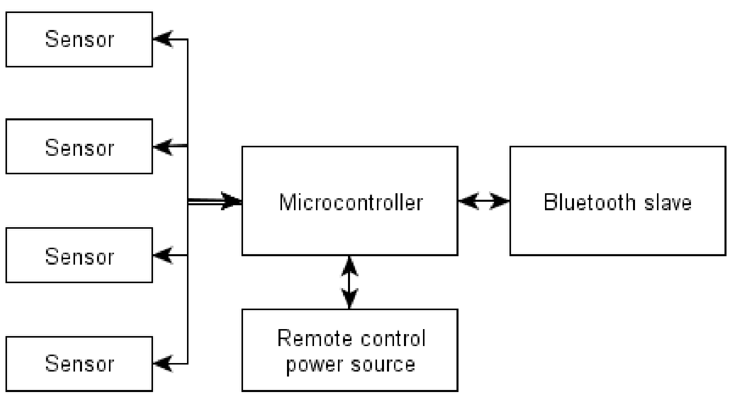

Figure 4: Sensor Module Detailed Block Diagram

The following lists out the functional requirement of the sensor module.

3.2.1 General Requirements

[R32-1] The system must reliably collect proximity range data.

[R33-1] The sensor module shall provide good coverage for the front bumper if it is mounted on the front bumper and for the rear bumper if it is mounted on the rear bumper.

[R34-1] The system shall have a measurement error of no more than 10% or ±15 cm, whichever is greater.

[R35-1] The sensor module shall have a maximum detection range of at least 200 cm.

[R36-1] The sensor module shall have a minimum detection range of no greater than 50 cm

[R37-1] The sensor module shall use Bluetooth communication to send data to the display module

[R38-1] The sensor is capable of being powered off/on remotely by display module

[R39-1] System shall use ultrasonic transducers for distance measurement

3.2.2 Physical Requirements

[R40-1] The sensor module shall be mountable onto the car vehicles' license plate frame.

[R41-1] The sensor module must allow the license plate to be mounted on it.

[R42-2] The dimensions of the sensor module shall not be larger than 35 x 20 x 3 cm.

3.2.3 Electrical Requirements

[R43-1] The sensor module shall be powered by a 6V DC lithium or NiMH battery pack.

3.2.4 Environment Requirements

[R44-2] The system shall be resistance to out-door environments such as rain, hail, snow, and wind.

[R45-2] The system shall be water proof and moisture proof.

3.3 Ultrasonic Transducers

The ultrasonic transducer will be our key to collecting the proximity range data. The transducers are built into the sensor modules. They are facing outward.at different angles in order to detect objects around the front/back of the car. The following section lists the requirements of the ultrasonic transducers that will be used in our system.

3.3.1 Performance Requirements

[R46-1] Ultrasonic transducer must produce a beam angle of at least 30 degrees.

[R47-1] Ultrasonic transducer must able to detect an echo within at least 75 cm regardless of the detecting objects' orientation.

[R48-1] Ultrasonic transducer must be capable of reading range at least four times per second.

3.3.2 Physical requirements

[R49-1] Size of the ultrasonic transducer must be no greater than 2 x 2 x 2 cm.

3.4 Remote Switching

The remote switching function will allow the display module to power on/off the sensor module remotely. The switching signal should be transmitted and received through radio frequency. The following lists the requirements of the remote switching function.

3.4.1 Performance Requirements

[R50-1] The remote switching circuit must allow the display module to power on/off both sensor modules (front and back) remotely.

[R51-1] The remote switching must operate as intended in a noisy environment. A noisy environment is defined as one where other RF signals are present. This represents the worst case scenario.

[R52-1] The signal transmit and receive range must be at least 10 meters long.

[R53-1] The wireless communication shall use the 433.92 MHz radio frequency with amplitude shift keying (ASK) modulation

3.4.2 Physical Requirements

[R54-1] The transmitting portion of the remote switching circuit must be fitted into a printed circuit board in the display module

[R55-1] The receiving portion of the remote switching circuit must be fitted into a printed circuit board in the sensor modules

3.5 Bluetooth Communication

Both the display module and the sensor module will employ a Bluetooth communication link to communicate with each other and transfer distance data. The following list the requirements of our Bluetooth communication protocol.

3.5.1 Performance Requirements

[R56-1] Bluetooth effective range must be at least 3 meters long.

[R57-1] Bitrate of the Bluetooth communication must be at least 10Kbps or higher.

[R58-1] Pairing must be automatically done between the display and sensor module on power-up of both module.

[R59-1] The Bluetooth communication should not "accidentally" pair up with any foreign device.

[R60-1] Bluetooth Module should not interfere with any surrounding Bluetooth devices.

[R61-1] The Bluetooth communication link will be automatically reconnected if linked is broken

3.5.2 Physical Requirements

[R62-1] The Bluetooth circuit must be fitted in a printed circuit board.

[R63-1] The Bluetooth master device shall be placed in the display module

[R64-1] The Bluetooth slave device shall be placed in the sensor module

[R65-1] The display module shall use one master and slave pairing for communication with the front sensor module and another master slave Bluetooth pairing for the rear sensor module.

3.6 User Documentation

[R66-3] User documentation will be available online

[R67-3] User manuals must use non-technical language and be easy to understand.

[R68-3] A quick start guide will be provided containing installation and setup instructions which are presented using pictures and diagrams.

[R69-3] Technical support will be provided through the internet and by phone.

[R70-3] Support will be provided in English, French, Spanish, Mandarin and other languages as needed.

4 System Test Plan

The test plan can be divided into 3 stages. In the first stage, each component of the system will be tested individually without integrating. By testing each component separately, we can identify areas which do not meet the component specific functional requirements. We want to be confident that the components are performing as intended before going ahead with the integration process. When testing each component, we will judge it on two things:

1. Does component perform its intended function?
2. Does components' implementation conflict with the functional requirement?

Once component testing is completed, we will be integrate the components to form the proof of concept prototype. In this stage, we will run a sanity test on the system to make sure all the components are functioning as intended. We will check for any unexpected failures due to the integration process. Once the integrated system has been sanitize, the power consumption will be measured to make sure it meets the electrical requirements from the functional specification.

At the third and last stage of testing, we will take the system to the field and run some of the common parking scenario to test the reliability and accuracy of the system. The following lists the scenarios that we intended to run when our system is fully integrated and the proof of concept build is constructed:

1. In-door environment – reverse into parking slot.
2. In-door environment – forward into parking slot.
3. In-door environment – Pillar detection.
4. Out-door environment-reverse into parking slot.
5. Out-door environment-forward into parking slot.
6. Out-door environment-Parallel into parking slot.
7. Out-door environment-Pillar detection.

After the SABZ engineering team finishes with the test plan, all errors will be documented. Design changes will be implemented for areas where the product does not meet the required specifications. The testing phase is completed when the prototype meets the entire functional requirement.

5 Conclusion

The Unipark-1000 makes parking easier for automobile drivers by detecting the distance of obstacles using ultrasonic technology. This technology is commonly used in many built-in parking assist systems. It is reliable and easy to implement. The use of ultrasonic technology allows the unipark-1000 to match any other parking assist system in terms of performance. However, the key competitive advantage of the Unipark-1000 does not lie in its functionality but rather in its usability. The Unipark-1000 can be easily installed and set up without requiring technical knowledge. A proof of concept build will be ready for demonstration by Dec 2, 2013. The proof-of-concept build shall be constructed by Nov 1, 2013. Verification and Validation of this build will be complete by Nov 16th 2013. The beta and production builds will be left for future development.

6 References

[1] "cclab," Nemko, 2010. [Online]. Available: http://www.cclab.com/fcc-part-15.htm. [Accessed 10 Oct 2013].

[2] "Wikipedia," 25 Sept 2013. [Online]. Available: http://en.wikipedia.org/wiki/Parking_sensors. [Accessed 8 Oct 2013].

[3] "CSA Group," 2013. [Online]. Available: http://www.csagroup.org/us/en/home. [Accessed 9 Oct 2013].

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[5] "ELECTRONIC CODE OF FEDERAL REGULATIONS: Part 15 - Radio Frequency Devices," 2013. [Online]. Available: http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&sid=ed2208a3c3d672c5dec1d9f15c988467&rgn=div5&view=text&node=47:1.0.1.1.16&idno=47. [Accessed 16 October 2013].