School of Engineering Science
Burnaby, B.C.
V5A IS6
crystal-tech@sfu.ca

October 15th, 2001

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 340 Functional Specification for SensorMate Parking System

Dear Dr. Rawicz,

The enclosed document, *Functional Specification for SensorMate Parking System*, outlines and defines the functional specifications for our ENSC 340 project. The SensorMate Parking System is a parking lot status indication system that allows drivers to view the location of an open parking space on a large display device. Using various sensory and display components, we hope to reduce driver frustration at finding available parking space.

The objective of the attached document is to provide detailed system overview, system and interface requirements, physical and electrical requirements, along with testing methods for verification. The specifications are defined for the basic system, as well as, for the potential upgraded product, providing time and resources are available. In addition, the document considers a wide scope of priorities and regulatory concerns.

Crystal Technologies is made up of four dedicated forth year engineering students – Jimmy Kan, Richard Fung, Steven Soong and Lawrence Tam. If you have any inquiries or concerns, please contact us at (604) 773-6658 or through email at sltam@sfu.ca.

Sincerely,

Lawrence Tam
CEO, Crystal Technologies

Enclosed: Functional Specification for SensorMate Parking System

Functional Specification for

SensorMate Parking System

Submitted by:
Jimmy Kan
Lawrence Tam
Richard Fung
Steven Soong

Contact:
Lawrence Tam
sltam@sfu.ca

Submitted to:
Dr. Andrew Rawicz
Steve Whitmore
School of Engineering Science
Simon Fraser University

Date:
October 15, 2001

Executive Summary

The functional specification is an extension to our project proposal. In this document, we will outline the functional behaviours, limitations and requirements for our system. Both the basic system, as well as the upgraded version, will be considered in this document.

SensorMate Parking System is designed to allow drivers the ease of parking during the parking phase of driving. With our parking indication system, drivers will immediately know whether spaces are available in a parking lot. Drivers will not only know if the parking lot still have vacancy, but they will also be able to locate where the vacant spaces are. The implementation of this system is aimed towards easy adaptations to other similar problems, such as luggage storage system to allow movers to easily see which spaces can still hold additional luggage.

This document outlines the system set-up of our system components and how each part will interact with each other. The system contains three major subsystems: sensory, control and display. Sensory components will be made up of reflective ultrasonic sensors that will relay space status to the controller. The controller will then interpret the data and output the result to a multi-display system consisting of a LED (Light Emitting Diode) cluster and a LCD (Liquid Crystal Display).

Four innovative forth year engineering students who have experience in analog circuit design, digital analysis, micro-controller and software programming, staffs Crystal Technologies. The project will be multi-phase, consisting of research, development and construction of the SensorMate Parking System. The completion date for this system is set on December 10, 2001.

Table of Contents

List of Figures

List of Tables

1. Introduction

This document details the functional specification for the SensorMate Parking System. For an overview on the project, timeline and budgetary concerns, please refer to our *Project Proposal for SensorMate Parking System*. First, the document gives a general overview of the system and its components. Next, system and interface requirements are provided to define the functional behaviours of our project. In addition, physical and electrical requirements are also considered. Together with the requirement definitions, a testing method is outlined to provide verification steps in conforming to our requirement definitions. Finally, regulatory concerns, users training and documentation requirements are considered.

The objective of our project is to develop an indication system that provides drivers with vacancy status information of a parking lot. This project is not intended to restrict the driving behaviour of drivers; rather, it only serves as a device that assists drivers in locating a vacant parking space. With the aid of this system, a parking lot can operate in a much more efficient manner. The target goal of our team is to complete the basic system by December 10, 2001 with an estimated budget of $1000 Cdn. If time and resource permit, the upgraded system will also be developed as well.

1.1. Objectives

To better understand the notations used in this document, the following references are provided. As there are different function requirements for the basic system and the upgraded system, we have indicated each with a reference number.

R[X] - Functional Requirement reference number.

(n) - The priority of the requirement.

1.2. Acronyms

FAQ	Frequently Asked Questions
LCD	Liquid Crystal Display
LED	Light Emitting Diode

2. System Overview

Figure 1 depicts the simplified overview of the SensorMate Parking System. Sensors are placed at each parking space, and the vacancy status is obtained and sent to the central processing unit. According to the input signals, the processing unit will output corresponding messages to a billboard, which is located at the entrance of the parking lot.

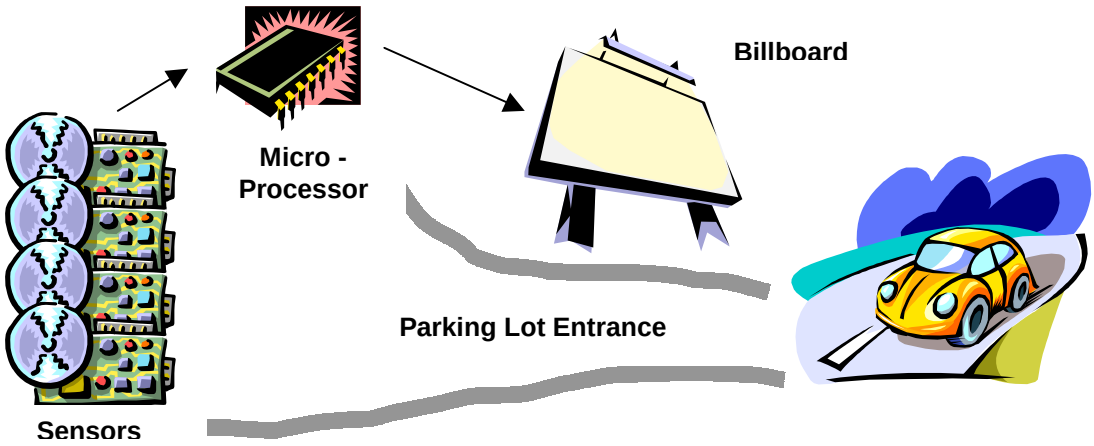

Figure 1 - System Overview

We have been pondering with the idea of using an electronic parking permit so that the sensor can detect whether a car is authorized to park at that space. If the car without a valid parking permit occupies the space, the system will notify the parking office through a network module, which directly links to a computer that has monitoring software installed. Due to the time constraint that we face, it is difficult to complete this part of the project. Nevertheless, a block diagram of this conceptual system is shown in Figure 2.

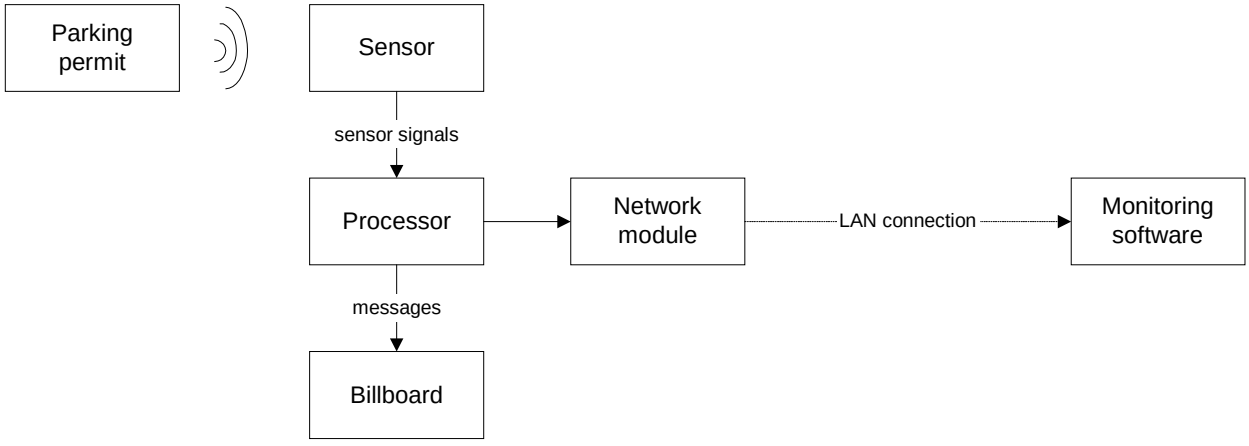

Figure 2 - System Block Diagram

3. Requirements

3.1. System Requirements

3.1.1. Components

R[1] Ultrasonic sensors required, each monitoring a parking space. Prototype system shall have eight sensors.

R[2] A vehicle counter at the entrance of the parking lot is required to obtain information to be displayed on the billboard.

R[3] Custom billboards shall be necessary with the map of the monitored parking lot.

R[4] Main processing unit with preset maximum allowable spaces in powers of two. Prototype system shall have a maximum of eight spaces.

3.1.2. General

R[5] The range of the ultrasonic sensors shall be 1 m.

R[6] The operating frequency of the ultrasonic sensors shall be 40 KHz.

R[7] The billboard shall be updated every second.

3.1.3. Accuracy and Reliability

R[8] The ultrasonic sensors shall detect the presence of a vehicle 100% of the time.

R[9] Objects, other than cars, occupying a parking space shall result in the billboard indicating that the parking space is occupied.

3.1.4. Power Supplies

R[10] All sensors shall be powered by a central 9V power supply.

R[11] A 15V ~ 20V AC adaptor shall power the billboard.

3.1.5. Component Placement

R[12] Sensors can be mounted on poles or placed on the ground depending on the specific characteristics of each parking lot.

R[13] Large billboards shall be placed at the rear of the parking lot to be visible to all users. Smaller boards can be placed at locations throughout the lot in addition to the larger billboards or in place of them.

R[14] The main processing unit shall be stored externally.

3.1.6. Serviceability and Expandability

R[15] If the owner requires more spaces to be monitored and has not reached the maximum for their particular system, the addition of more sensors shall require installing the sensors in the new parking spaces and wiring them to the adaptors of the main board. If they require more than their current maximum, the existing sensors may be used, but a new main board shall be necessary.

R[16] The sensors shall be individually replaceable components. In case one fails, it can be unplugged and replaced.

3.2. Interface Requirements

3.2.1. Sensor – Car Interface

R[17] The main function of the sensor is to detect whether the parking space is occupied of not.

R[18] The sensor shall be powered by a central DC power supply. The sensor module shall not be a battery-based module.

R[19] All sensors shall be on at all times.

R[20] In another word, for cars to work with the SensorMate Parking System, they do not need to be equipped with any special device.

R[21] Each sensor shall detect the presence of a car with different color and shape.

R[22] Sensor shall detect cars within a 60-degree horizontal range.

R[23] Sensor modules shall be placed in a parking space such that cars do not easily damage it.

R[24] Sensor modules shall be placed to avoid any unwanted blockage other than cars that can interfere with the normal operation of the system, i.e. falling leaves blocking the sensor and snow or rain covering the sensor.

3.2.2. Processing Unit – Sensors Interface

R[25] Addition of sensors shall be made easy to allow expanding coverage of the SensorMate Parking System.

R[26] Each sensor is assigned a unique address for referencing by the microprocessor of the processing unit.

R[27] The sensor output voltage level shall be adjusted to match the input voltage level of the microprocessor.

R[28] Each sensor module has an incorporated LED to indicate its status, such as power, connection error, etc.

R[29] The microprocessor shall monitor the status of the sensors periodically.

3.2.3. Processing Unit – Door Counter Interface

R[30] The door counter shall distinguish whether a car enters or leaves the parking lot and send a different signal to the processing unit accordingly.

R[31] Based on the signal sent from the door counter, the microprocessor in the processing unit shall keep track of the number of car roaming in the parking lot.

3.2.4. Billboard – Processing Unit Interface

R[32] The processing unit shall send the gathered parking lot information to the billboard.

R[33] The billboard shall have LEDs to indicate the vacant status of each parking space in the parking lot.

R[34] The billboard shall display the total number of empty parking space in the parking lot as well as the number of roaming car.

R[35] The processing unit shall update the billboard every second.

3.2.5. Programming Interface

R[36] The system codes shall be developed on a PC running the Windows platform.

R[37] The codes shall be burnt to the microprocessor through a DB-9 RS232 cable from the PC serial port to the programmer port of the microprocessor.

3.3. Physical Requirements

R[38] Each ultrasonic sensor shall only monitor its allotted space and not interfere with the operation of other sensors.

R[39] Interference from external sources of ultrasonic frequencies shall be minimized using filters.

R[40] The sensors shall fit within a case 20cm x 10cm x 2cm to minimize the presence of the sensors in the parking lot.

R[41] The sensors shall be able to operate in temperatures from –40˚C to 85˚C in all weather conditions and processing unit to be able to operate in temperatures from -15˚C to 70˚C.

R[42] The cases for the sensors, the case for the main processing unit, and the billboard shall be durable and be able to withstand reasonable accidental and natural tampering.

R[43] Billboards shall have minimum dimensions of 1m x 2m in order to be seen clearly.

3.4. Environmental Requirements

The SensorMate Parking System shall comply with the following environmental requirements. Because the sensor module and the billboard are designed to operate in both indoor and outdoor environments, it is required to be functional even in extreme weather conditions.

Categories	Requirements
Processing Unit:	
R[44] Operating Temperature	-15 ~ 70 ^{o}C
R[45] Operating Humidity	Full range of atmospheric humidity
R[46] Heat Dissipation	Minimal
Sensor Module & Billboard:	
R[47] Operating Temperature	-40 ~ 85 ^{o}C
R[48] Operating Humidity	Full range of atmospheric humidity
R[49] Heat Dissipation	Minimal

Table 1 - Environmental Requirements

3.5. Electrical Requirements

The SensorMate Parking System shall comply with the following electrical requirements.

Categories	Requirements
Processing Unit:	
R[50] Supply Voltage	10 ~ 15V DC
R[51] Power Dissipation	10 W maximum
Sensor Module:	
R[52] Supply Voltage	5 ~ 10V DC
R[53] Power Dissipation	6 W maximum
Billboard:	
R[54] Supply Voltage	15 ~ 20V DC
R[55] Power Dissipation	20 W maximum

Table 2 - Electrical Requirements

4. Testing Methods

4.1. LED Cluster

R[56] The output of the LED cluster shall be tested for data integrity with a logic analyzer. The logic analyzer information of the state of the LED cluster shall be compared to the actual output it should obtain during a series of tests.

4.2. Ultrasonic Sensor

R[57] The ability of the sensors to function properly under extreme conditions such as temperatures below 0 degree Celsius and temperatures above 40 degrees Celsius shall be verified.

4.3. Pass Validation System

R[58] The pass validation system shall be tested for it's sensitivity within a range of 1 meter between the sensors and the actual pass.

R[59] The ability of the sensors to read the pass through windshields of different types of cars shall be verified.

R[60] The ability of the sensors to function properly under extreme conditions such as temperatures below 0 degree Celsius and temperatures above 40 degrees Celsius shall be verified.

4.4. LCD Display

R[61] The LCD display shall be tested for operation longevity and shall have a burn in session of at least 24 hours before the product is deployed.

R[62] The ability of the display to withstand a with range of temperature and environment changes shall be verified.

5. Regulatory Standards

R[63] The *SensorMate Parking System* shall be UL, CSA, and CE approved for domestic use.

R[64] Safety standards:

i) UL 3111-1
ii) IEC 1010-1:1990 +A1:1992 +A2:1995
iii) CSA C22.2 No. 1010.1-92

R[65] Radiation emitting device standards:

i) R.S., c. 34(1st Supp.), s. 1.
ii) R.S., c. 34(1st Supp.), s. 10; 1984, c. 23, s. 4.
iii) R.S., c. 34(1st Supp.), s. 11; 1984, c. 23, s. 5.
iv) R.S., c. 34(1st Supp.), s. 14; 1984, c. 23, s. 7.

R[66] All parts and components that make up the exterior of the system shall be such that they do not possess sharp edges or points that could injure the users.

R[67] All electrical parts and interconnection shall be secured and inspected before the product is shipped to customers.

6. Documents and Users Training

R[68] The main documentation of the *SensorMate Parking System* is a five-page manual produced in five languages: English, French, Chinese, German, and Italian.

R[69] The manual shall provide quick operating instructions.

R[70] The manual shall provide more detailed operating instructions.

R[71] The manual shall provide troubleshooting procedures.

R[72] The manual shall provide technical support contacts.

R[73] All documentation included with the product shall be written for the general user with little working knowledge of real-time systems.

R[74] The company website shall provide updated support FAQs and troubleshooting instructions.

R[75] All the training required in operating our system shall be provided in the accompanied manual.

R[76] Additional tricks of operating the system shall be provided in the support section of the company website.

7. Conclusion

This document has outlined the functional requirements of the *SensorMate Parking System* project. We are confident that our project will address the needs of frustrated drivers when they arrive at a parking lot already late for an appointment. Based on our initial speculation, our basic system requirement shall be able to satisfy our goal completely. The future enhancements requirements are extraneous but do however give the system more functionality. The future enhancement shall be implement also if time and budget permits.