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http://www.drivomatic.com
Drivomatic Technology Corporation

February 18, 2008

Dr. Patrick Leung
School of Engineering Science
Simon Fraser University
Burnaby, BC V5A 1S6

Re: ENSC 440 Project Functional Specifications for a Self-Driving Wheelchair System

Dear Dr. Leung:

I am submitting to you the Functional Specifications for a Self-Driving Wheelchair System from Drivomatic Technology Corporation. We are focused on developing a self-driving wheelchair system that allows the mobility impaired to navigate within buildings such as airports or nursing homes with maximum independence.

The purpose of this document is to provide high-level specifications to the functionality of our wheelchair control system. The document is meant as a reference containing a framework of design guidelines for the Operations Officer and design engineers. The document does not contain design specifications.

Drivomatic Technology Corporation consists of five team motivated engineering students: Jonathan Hung, Andy Chen, Jian Guo, Benjamin Chang, and Ammar Zaidi. If you have any questions or concerns about the functional specifications, please do not hesitate to contact me by phone at (604) 721-0585 or via e-mail at ensc440-spring08-dtc-ensc@sfu.ca.

Sincerely,

Jonathan Hung
President and CEO
Drivomatic Technology Corporation

Enclosure: *Proposal for a Self-Driving Wheelchair System*

DTC Drivomatic Technology Corporation

Functional Specifications for a

Self-Driving Wheelchair

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EXECUTIVE SUMMARY

Drivomatic Technology Corporation's Mission:

"To provide innovative solutions for the mobility impaired to increase the individuals' independence and security in everyday life."

For centuries, dating back to the 1670s [1][4], the wheelchair has been the main source of transportation for disabled individuals, such as paraplegics. Operating a conventional wheelchair requires a degree of upper body strength. Wheelchair users with disabilities that hinder their ability to propel the wheelchair on their own must require external assistance. Advancements in technology have pushed forward a new alternative to the wheelchair, which allows the user to control the wheelchair by means of a joystick.

Drivomatic Technology Corporation (DTC) goes one step further to improve on the existing electric wheelchairs by integrating a control module. The users' safety is our top priority when we are determining the functional requirements for our system. DTC contains an ethics department to ensure that all professionals working on the project comply with the codes of ethics.

DTC's Self-driving Wheelchair will undergo two phases of development. The first phase of development would be implemented in the prototype, which would include the following components:

- Electric wheelchair integration.
- Navigation System.
- Feedback System
- Safety features.

The second phase would include construction of the production device and further feature development such as safety and reliability improvements.

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1 INTRODUCTION

The Self-Driving Wheelchair (SDW) System is a control module that integrates with an electric wheelchair to enable auto-navigation within designated areas. Through a calculated path, the SDW System transports the user to a desired location with the aid of environmental feedback. During transportation, the system intelligently avoids obstacles in its path. Proposed by Drivomatic Technology Corporation, requirements for this SDW System are described in this functional specification document.

1.1 Scope

This document describes the functional requirements that must be met by a functioning SDW system. Requirements in this document fully outline the prototype device and partially outline the future production device. The listed requirements will also facilitate the design of SDW system and will be available for future design documents.

1.2 Glossary

ANSI	American National Standard Institute
RESNA	Rehabilitation Engineering & Assistive Technology Society of North America
FCC	Federal Communications Commission
User	Existing or new wheelchair user that would potentially take advantage of DCT's self-driving wheelchair.

1.3 Intended Audience

This functional specification is intended for use by all members of Drivomatic Technology Corporation. The functional requirements will serve as a measure of progress throughout the development phase for use by the project manager. Engineers in the project will refer to the requirements as goals in the design and implementation process. In addition, these requirements will be used by the Quality Assurance team to verify the functionality of the actual system.

1.4 Convention

Throughout this document, the word "module" refers to the control module of the system. Also, the following numbering convention will be used:

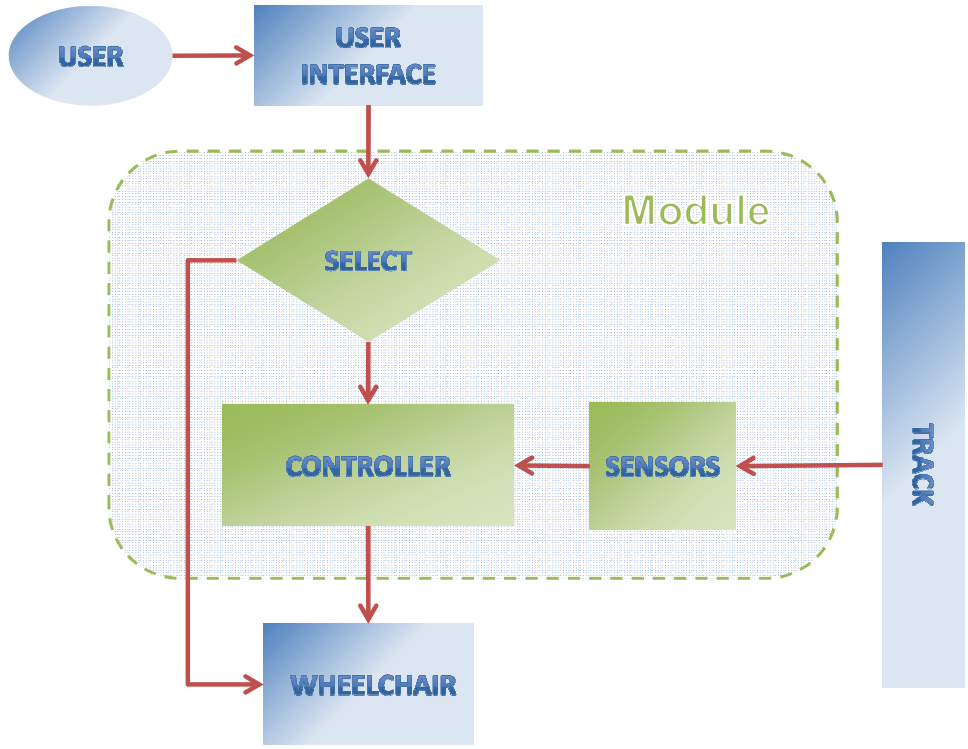
R[n-p] represent a function requirement, where **n** is the functional requirement number, and **p** is the priority of the function. The value of **p** is denoted as below:

A prototype only
B Prototype and Production
C Production only

2 SYSTEM REQUIREMENT

2.1 System Overview

The overall system block diagram is shown in **Fig 2-1**. The auto-pilot system (shown as green blocks) will act as an intermediary between the existing user interface and wheelchair (shown as blue blocks). A brief description of the block diagram is given below.



2-1: System Block Diagram.

User Interface

From the user interface, users will be able to manually control the wheelchair or select a location for auto-navigation.

Select

Based on the user's input, the autopilot mode or manual mode will be engaged.

Controller

The controller obtains information from sensors and controls the movements of the wheelchair.

Sensors

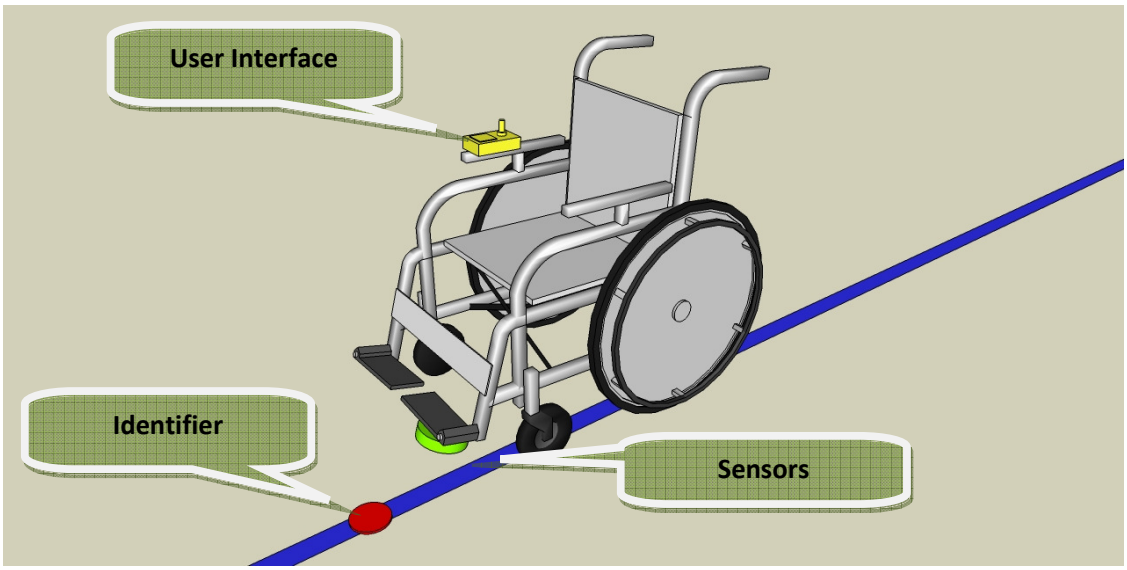
The sensors will be used to determine the wheelchair's current location and to monitor how well the wheelchair follows the tracks. The information obtained by the sensors will be passed to the controller.

Floor Track

A floor track will be implemented in the designated facilities and will serve as an environmental feedback instrument to the wheelchair system.

Modes of Operation

- Active Mode: The system shall enter autopilot active mode when a valid destination input is made by the user.
- Idle Mode: The system shall be able to enter power saving idle mode when autopilot is not required.



2-2: Self Driving Wheelchair System.[8]

2.2 General Requirement

R[1-B] The system shall be easily installable to compatible power wheelchairs (see **4. POWER WHEELCHAIR REQUIREMENT**).

R[2-B] The auto-pilot module shall cost no more than $600 (CAD).

R[3-C] Modification to the system shall be provided if a wheelchair is not compatible.

2.3 Physical Requirement

R[4-B] The module must have appropriate dimensions in order to be secured to most wheelchairs.

R[5-C] The module shall provide a convenient and easy-to-access connection to the wheelchair.

R[6-B] The module must weigh less than 2 Kg.

2.4 Electrical Requirement

R[7-B] The power supply of the module shall be sufficient to power the control module for long hours.

R[8-B] The power supply must produce stable DC voltage and current.

R[9-B] The power supply shall be portable and easy to recharge.

R[10-B] The power adapter for charging the supply shall be in compliance with North America Standard. i.e. 110V/120V, 60Hz. [9]

R[11-C] The module shall have pins easily accessible for debugging and testing.

R[12-C] The module shall be shielded from possible electrical interference from the environment.

R[13-B] The module will comply with part 15 of the FCC regulations.[3]

2.5 User Interface Requirement

R[14-B] Interface should have an auto-navigation function.

R[15-B] Interface should be simple for SDW users.

R[16-C] Large buttons should be accessible to users with a specific range of disabilities.

R[17-C] Interface must provide additional buttons for personalized use by the users.

R[18-C] Interface should have visual feedback to users.

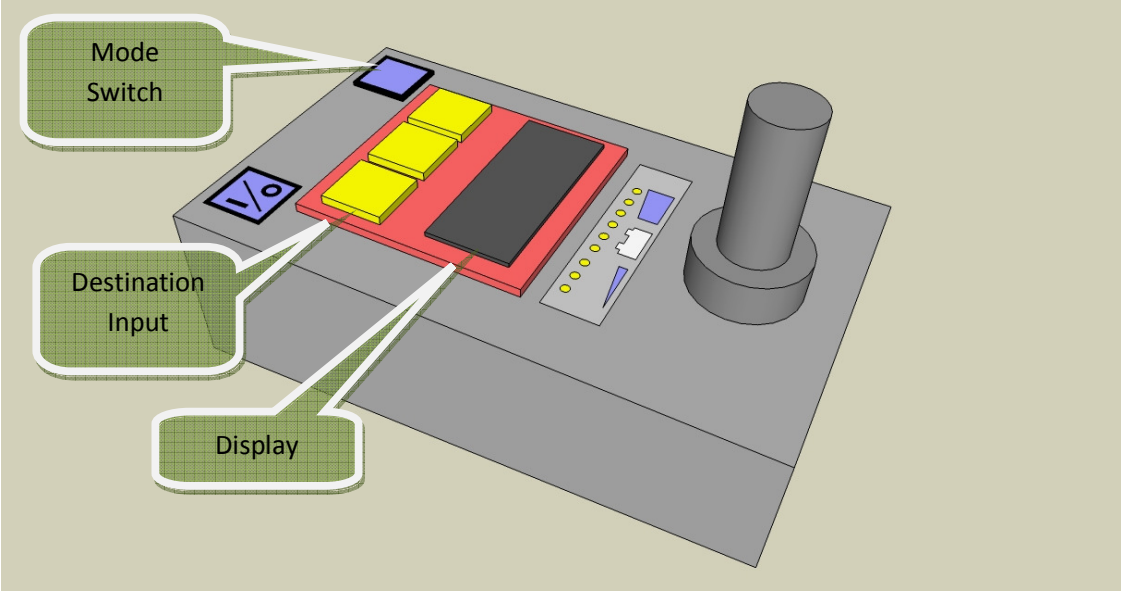
R[19-C] Interface shall have audio feedback to users.

R[20-B] Interface shall have an ON/OFF switch.

R[21-B] Interface shall allow users to override the auto-navigation feature if needed.

R[22-B] Interface shall be easily accessible to seated users

R[23-C] Frequently used buttons should be larger and more accessible.



2-3: User Interface.

2.6 Environmental Requirement

R[24-B] The module should be able to operate in a reasonable range of temperatures.

R[25-B] The module shall be operated in enclosed buildings

R[26-B] The path of operation should be at least 2 wheelchairs in width.

R[27-B] The module should not generate noise while turned off or in idling mode

R[28-B] The module shall generate a low level of noise (0-40dB).[2]

R[29-A] Module should operate in single leveled environments.

R[30-C] Module should be able to operate in multi-leveled environments.

2.7 Standards

R[31-B] The chair shall comply to ANSI/RESNA wheelchair standards.[5]

R[32-B] The system shall comply to all applicable FCC Office of Engineering and Technology standards.[3]

2.8 Reliability and Durability

R[33-B] The system must be resistant to breakage under normal operating conditions.

R[34-B] The system shall be serviceable by trained technicians.

R[35-C] The system shall be able to sustain minor physical impact of less than 5Ns of force.

R[36-C] The system shall not fail when the track has minor discontinuity or breakage of less than 10cm.

R[37-C] The system shall be resistant to electronic and mechanical damage caused by spills on the system.

R[38-C] The module shall be able to remain active and function continuously for as long as the wheelchair operates.

R[39-C] Regular service intervals shall be at least yearly.

R[40-C] The system must operate correctly at least 98% of the time.

2.9 Safety Requirement

R[41-B] The system shall not spontaneously combust.

R[42-C] The system shall not steer the wheelchair into any obstacles detectable by the system.

R[43-C] In case of an obstacle, the system shall stop the wheelchair and output a warning signal.

R[44-B] The system shall drive the wheelchair at a low speed to ensure safety.

R[45-C] The electronic and mechanical components and power connections shall be enclosed.

R[46-B] The system shall allow the user to stop the wheelchair at any given time.

R[47-C] The system will be able to detect electrical failure. If any error is detected, the chair shall notify the user.

2.10 Performance Requirement

R[48-B] The system will turn on under normal condition when properly installed.

R[49-B] The system will accept user destination input once on the track.

R[50-B] The system will change into sleep mode when it's not enabled.

R[51-C] In idle mode, the module will turn off after a pre-defined amount of time

R[52-C] The system will turn on and off with the wheelchair's power.

R[53-B] The system will not allow the wheelchair to deviate from the track for more than 2 feet.

R[54-C] The system will detect and avoid obstacle on the track

R[55-B] The user will be able to switch between manual mode and autopilot mode.

R[56-B] The system will allow the wheelchair to cruise at a predefined speed and slow down to a predefined turning speed at corners

R[57-B] In case of mode switching during autopilot, user will need to reposition the wheelchair onto the marked point on the track in order to resume.

R[58-C] In case of oncoming traffic, the system will operate as if there was an obstacle

2.11 Usability Requirement

R[59-B] The system will have a user interface for destination input, mode switching, etc. (more details in **2.5 User Interface Requirement**)

R[60-B] The system requires trained technician to install.

3 FLOOR TRACK

R[61-B] The space around the track will have a minimum clearance of one wheelchair.

R[62-B] The track must be designed to allow the wheelchair to maneuver without any difficulty.

R[63-A] The track shall be kept clean

R[64-B] Identifiers will be placed at intersections and at points of interest

4 POWER WHEELCHAIR REQUIREMENT

Our system is built upon a certain model of electrical wheelchair, which is designed and built by other vendors.

4.1 General Requirement

R[65-B] The primary means of maneuvering the wheelchair shall be through a its original steering mechanism.

R[66-B] The chair shall have a power on/off switch.

R[67-B] The chair shall carry a portable DC rechargeable power supply.

R[68-C] The chair shall comply with the "reliability and durability section of this document".

R[69-C] An agreement needs to be made with the vendors of the wheelchair before the system can be attached onto the chair.

4.2 Usability Requirement

R[70-B] The process of recharging the portable power supply of the wheelchair shall be simple.

R[71-B] The user interface and control of the wheelchair shall be intuitive and easy-to-use.

4.3 Physical Requirement

R[72-B] The control panel shall be easily accessible to the seated user.

R[73-B] The control panel shall be placed so that it is difficult to press buttons unintentionally.

R[74-C] The control panel shall be placed in the armrest.

5 USER DOCUMENTATION

R[75-C] All user documentation and technical support information shall be available as online material.

R[76-C] The user manual shall be written for an audience with minimal technical knowledge.

R[77-C] User documentation shall be provided in official languages of nations where products are distributed.

R[78-C] A detailed installation guide shall be provided for technicians and vendors.

6 CONCLUSION

The purpose of this document is to assist the engineers in future design and documentation of the project, thus it clearly states the functional requirements for DTC's self-driving wheelchair system. The project development is carried out in two phases comprising the prototype and production phase. The prototype is scheduled for completion on April 3rd.

7 REFERENCES

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