RAHS TECH

RAHS TECH INC.
1690 Augusta Ave
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February 16, 2015

School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Attn: Dr. Andrew Rawicz

Re: ENSC 305W/440W Project Proposal RAHS(Remote Automotive Heating System)

Dear Dr. Rawicz:

The enclosed document is the Functional Specification for RAHS. The goal is to design and build a product that will defrost/heat vehicles before a user enters. We will focus on defrosting the vehicle and on the remote starting system. RAHS will be equipped with a heater as well as a timing system and a remote control.

This document outlines the functionality of RAHS and the required specifications needed for the design of this product. The design will be created with respect to the specifications which will ensure that the requirements are properly addressed.

The RAHS team consists of three innovative Systems Engineering Students:
Andrew Piechnik, Patrick Krzesinski, Joe Kuo. If you have any questions regarding this Functional Specification, please feel free to contact me by email at apiechni@sfu.ca, or by phone 604.349.4328.

Sincerely,

Andrew Piechnik

Enclosure: Functional Specification for RAHS

RAHS TECH

REMOTE AUTOMOTIVE HEATING SYSTEM
Functional Specification

Project Team:
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Submitted to:
Dr. Andrew Rawicz ENSC 440
Professor Steve Whitmore
ENSC 305
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Date Issued:
February 16, 2015

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Executive Summary

Motor vehicles are one of the greatest inventions and flourish in today's market. In fact, driving has already became inseparable from our daily routine in the twenty-first century. However, it is inevitable to see issues like limited energy resources and pollution come with these inventions. Saving money from gasoline is now more important for car owners. The expectation can be hard to achieve especially in winter season. The fuel consumption increases from 7 - 19 percent for idling a car just to warm up the interior according to Natural Resources Canada[1]. On top of that, carbon dioxide emissions also increase as they are an unavoidable by-product by burning fossil fuel.

In RAHS tech, our objective is to not only to decrease gasoline waste, but also to create a more sensational driving environment for the driver during the winter season. Our proposed project is to design and implement an electric heater that will increase the interior temperature of a car and defrost the windshield without going inside of a car. To make the operation of the device easy, a remote control and a timer system will be implemented to give better control of the system.

Development cycle:

Stage I

- Obtain proof-of-concept and calculation for energy consumption

Stage II

- Design and implement heater systems, timing system and remote control
- Integrating all systems together and testing

Stage III

- Installation and testing on real car

The development cycle will be done in three stages, the first stage will be obtaining proof-of-concept and the calculation of power consumption. The second stage of development will be to design and implement all possible functions with testing. At the end of second stage, all systems should be working and tested for installation. The final stage will be installation and testing of the prototype with a car.

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Glossary

CEC	Acronym; Canadian Electrical Code
CSA	Acronym; Canadian Standards Association
DOT	Acronym; Department of Transportation
RAHS	Acronym; Remote Automotive Heating System
RF	Acronym; Radio Frequency
SAE	Acronym; Society of Automotive Engineers
UL	Acronym; Underwriters Laboratories
ZigBee	Definition; specification of high-level communication protocols

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1 Introduction

RAHS is a car accessory that can be easily implemented in any car to generate heat without starting. Users can preset the timing system integrated in RAHS or remotely power on/off with a controller to power the device. By using these two methods, users can avoid entering a cold car and wasting unnecessary energy. The functional requirements for RAHS are described and explained in this document.

1.1 Scope

This document describes the functional requirements of RAHS by RAHS tech. The concepts and details will be used as foundation throughout the project design and production.

1.2 Intended Audience

The functional specification is intended for all members in RAHS tech. The requirements will be the guidance and standards for the designer when implementing the system. Testing will also refer to this document to ensure the overall system's performance. In addition, this document will serve as the fundamental description of RAHS in future development.

1.3 Classification

Throughout this document, the following convention shall be used to denote functional requirements:

[Rn-p] A functional requirement

where **n** is the functional requirement number, and **p** is the priority of the functional requirement as denoted by one of three values:
A - The requirement applies to the proof-of-concept system only.
B - The requirement applies to both the proof-of-concept system and the final production system.
C - The requirement applies to the final production system only.

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2 System Requirements

The problem RAHS is facing to solve is a problem millions of people experience around the globe every winter. When temperatures drop below freezing levels, moisture in the air freezes forming a sheet of ice on the vehicles windshield. This prevents the driver from simply entering their vehicle and driving due to an extremely limited visibility hazard. As such the driver must start their engine and wait for the ice to melt. Furthermore the vehicle interior is also freezing cold, meaning that the driver must sit in a freezing cold vehicle waiting for the car interior and windshield to warm up. To add to all this the driver must also wake up earlier in the morning so that their vehicle can defrost and be ready for driving by their usual departure time. Waking up on a cold dark winter morning when the sun still hasn't risen is a very unpleasant experience and having to wake up earlier only makes matters worse. Our team's solution to this problem is the RAHS design. The RAHS design will solve all these issues in an eco-friendly sustainable way by integrating our several different functionalities.

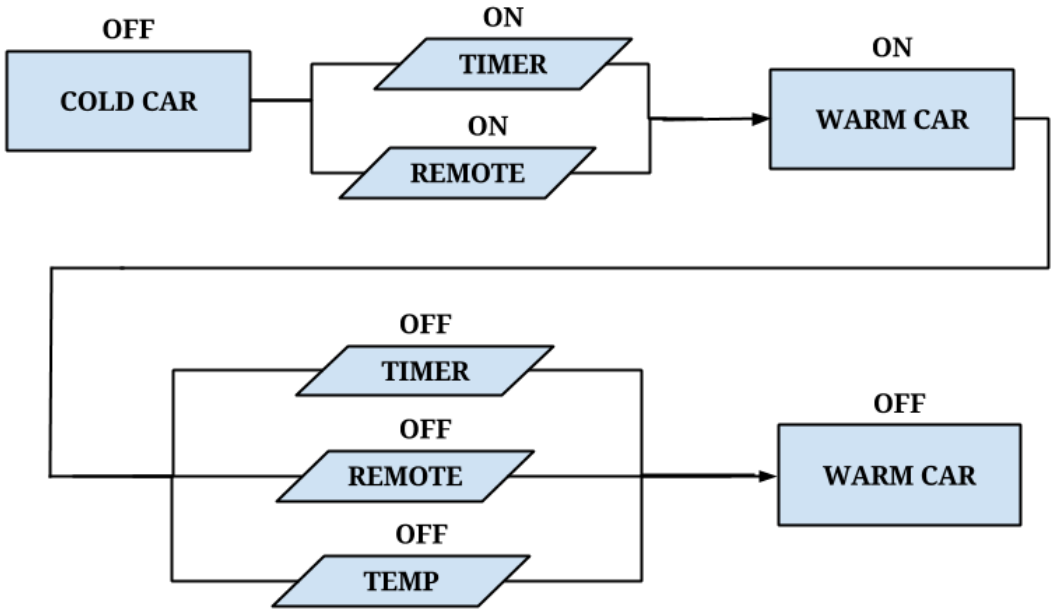

Figure 2-1: RAHS State Diagram

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2.1 System Overview

The RAHS will have the following functionality to be a great user-friendly product:

- Heating system (5) - to heat the interior of the vehicle and defrost the windshield
- Timer system (3) - to set desired startup time of heater as well as auto shutdown
- Remote control system (4) - for the user to remotely activate/deactivate the RAHS eliminating the need to enter the vehicle
- Fully Electric (1&2) - no wasting gas or waking up neighbors environmentally friendly

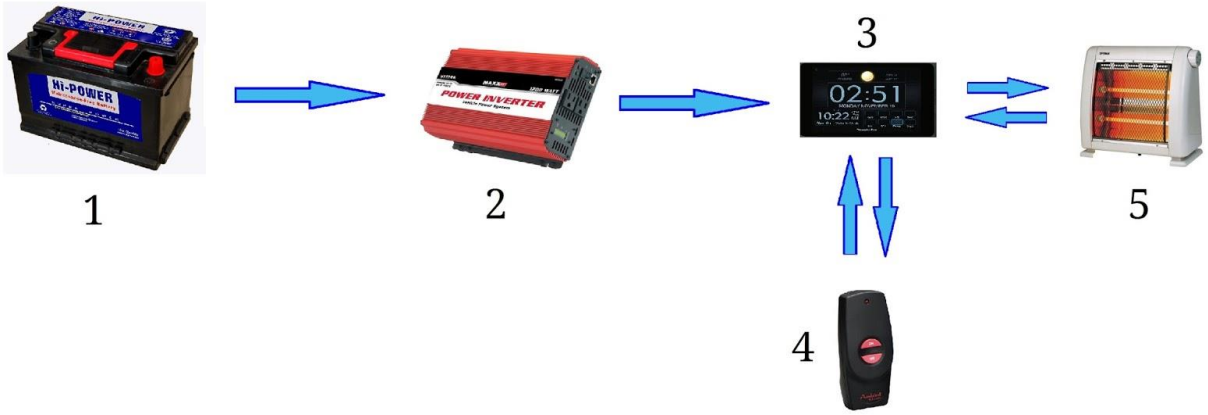

Figure 2-2: RAHS System Diagram

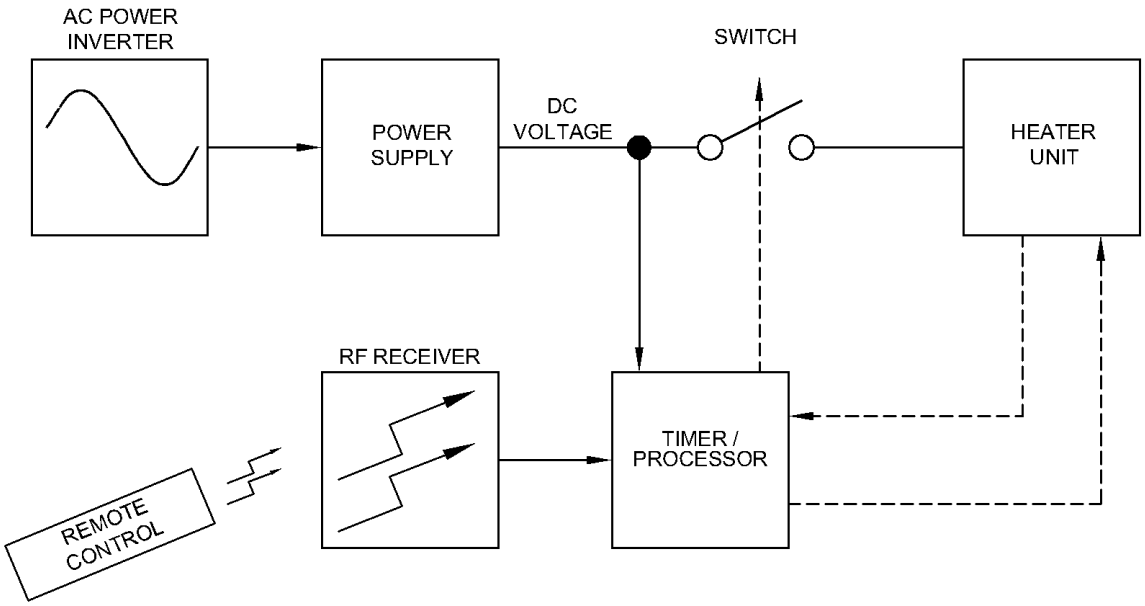

Figure 2-3: RAHS Circuit Diagram

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2.1.1 Safety Analysis

Due to our product utilizing electricity to produce heat, due care must be taken when analyzing the possible hazards to the user or the users vehicle through device usage. Possible hazards include electrocution, shock, burns, and/or burns to the vehicle. Considering all these possible hazards our team has ensured that, all applicable CSA, CEC, and DOT safety standards have been applied to all electrical and mechanical components of our device. Project standards are listed under the system requirements for the various components. Moreover, when all components are integrated into the final system our team must ensure that the final design conforms to all safety standards and is not harmful to the user.

2.1.2 Sustainability Analysis

Sustainability is a major concern for our team. The RAHS itself helps promote a more sustainable way of life by eradicating the need to run cars unnecessarily in the morning. However an important factor of the project is the cradle to cradle life cycle of our product. RAHS relies heavily on electrical equipment such as wires, power inverters, control timers, and the electric heater. Fortunately all of these components can be easily separated and salvaged and or replaced. Furthermore each component may be used elsewhere in other applications until their eventual breakdown.

2.2 General Requirements

[R1-A] Retail price of RAHS will stay below CDN$400
[R2-A] Device will successfully defrost windshield
[R3-A] Device will successfully warm vehicle interior to preset temperature
[R4-A] Device will start at preset time
[R5-A] Device shall automatically shut off after given amount of time
[R6-B] The device will be toggled on/off via remote control switch

2.3 Electrical Requirements

[R7-A] Device will operate with a 60Ah 12V standard car battery
[R8-A] Device will operate at a maximum voltage of 120V
[R9-A] Device shall not fully drain vehicle battery to non-operational levels
[R10-B] No electrical components shall be exposed
[R11-B] Remote control shall have on/off feedback LED
[R12-B] Device timer shall operate on 4 ‘AA’ 1.5V batteries
[R13-C] Device timer batteries to be rechargeable
[R14-C] Device timer batteries shall be easily accessible and interchangeable
[R15-C] Remote control to be operational up to a distance of 200m

2.4 Physical Requirements

[R16-A] Physical size of device shall fit inside a car
[R17-A] Device can be easily handled when on or off
[R18-C] Device shall come in one package and be portable

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2.5 Thermal Requirements

[R19-A] Device shall reach a comfortable temperature for the user
[R20-C] Device shall generate heat to defrost the windshield

2.6 Environmental Requirements

[R21-A] Device will not consume any fossil fuels
[R22-A] Device shall operate in a temperature range of [-30,50]°C
[R23-C] Device feedback noise shall be less than 40dB

2.7 Standards

[R24-A] Standard for 12 Volt Power Outlet connections shall meet SAE - J563
[R25-A] Battery adapter will meet UL 2809 Vehicle Battery Adapter standard
[R26-A] Remote controller will meet ZigBee protocol for RF communication

2.8 Reliability and Durability

[R27-A] Device shall be used throughout the winter season without problems
[R28-A] Device shall not overheat the interior of a car
[R29-A] Device shall be able to withstand minor vibration during driving

2.9 Safety Requirements

[R30-A] Device will not cause any electrocution or sparks
[R31-A] Device will conform to CEC standards
[R32-A] Device shall conform to all DOT standards
[R33-B] Device shall be easily moveable without causing burns
[R34-C] Internal device components shall not be exposed

2.10 Performance Requirements

[R35-A] Heater should provide enough heat for windshield to be defrosted
[R36-B] Interior space should be comfortable for owners to start driving
[R37-B] Device shall not drain battery to unusable levels

2.11 Usability Requirements

[R38-A] Device can be used with any vehicle with cigar lighter socket
[R39-B] Device can be used with any vehicle with standard 12V battery
[R40-B] Remote Control will inform users of on/off status

2.12 Luxury Functions

[R41-C] A mobile application will be available for iOS/Android device to monitor RAHS
[R42-C] Mobile application function includes setting timer, switch on/off and temperature reading
[R43-C] Air conditioning will be available to replace the heater for summer use
[R44-C] Customized size air freshener will be available in different packages

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3 Heater

Using an electric space heater the vehicle interior as well as windshield will be heated to comfortable room temperatures making the vehicle warm and toasty prior to entry. The windshield will now be ice free and not inhibit driving.

3.1 General Requirements

[R45-A] Device will defrost the window
[R46-B] Device will heat the air in the vehicle
[R47-B] No electrical components shall be exposed
[R48-B] Heater unit shall be encased in safe to handle housing
[R49-B] Heater unit shall be less than 10lbs

4 Timing System

The timer will be a twenty four hour clock which can be set in the same way as an alarm clock, and will activate the heater when the set time is reached. The timer will take only a small amount of power. This timer will also have a cut-off switch so that the heater will not drain the battery to unsafe levels. The cut-off switch will be activated when either the defroster has been on for a certain amount of time or when the user manually deactivates the system.

4.1 General Requirements

[R50-A] Timer shall be set similar to an alarm clock
[R51-A] Timer will activate the heater
[R52-A] The signal will be able to turn the alarm clock on or off
[R53-B] Timer will deactivate the heater after 15 minutes
[R54-B] Timer will have a digital display
[R55-C] Timer will be in an enclosed case

5 Remote Controller

The remote control system will consist two components integrated into RAHS which are the RF transmitter and receiver. The transmitter and receiver both have simple rechargeable batteries. The transmitter is embedded in a remote which can turn the heater on and off and be able to override the timer system. The remote control system gives the user maximum control over a vehicle in a convenient way.

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5.1 General Requirements

[R56-A] Transmitter will send digital signals to receiver
[R57-A] Receiver will switch RAHS on and off based on the signal
[R58-A] The signal will overwrite the state of RAHS
[R59-B] Range of transmission will be within 100 meters
[R60-C] The controller will be implemented with car keys

5.2 Electrical Requirements

[R61-A] Both transmitter and receiver will consume minimum power of system
[R62-A] Signal transmitting will not interfere with other communication devices

6 User Documentation

[R63-A] User documentation will include the company logo
[R64-A] User documentation will have company contact information
[R65-A] User documentation will focus on the needs of target audience
[R66-A] User documentation will be clear on product installation
[R67-A] User documentation will clearly describe how to use each product feature
[R68-A] The user documentation will be written in English

7 System Test Plan

RAHS will undergo significant testing before a final prototype is demonstrated and before finalized product production to ensure it meets all functional specifications described. Each piece of hardware will be tested separately and then finally the entire system will undergo a series of tests for product quality, functionality, and power consumption. Physical properties of the system shall be tried and tested by subjecting the device to various different stresses and temperatures as well as different environmental conditions to ensure RAHS can operate in any vehicle located in British Columbia.

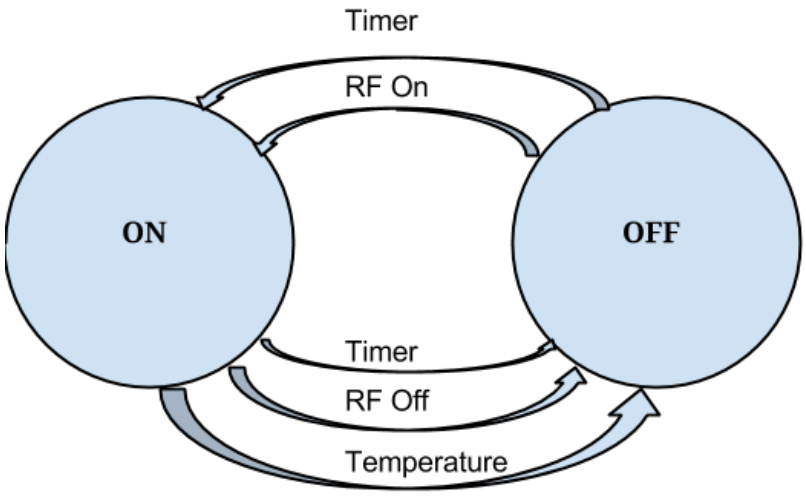

Figure 7-1: RAHS Testing Diagram

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7.1 Battery and Power Inverter Test

The power inverter will be tested to ensure it meets CSA and CEC safety standards while providing enough power to run the heating module. The power inverter shall be hooked up to a standard 12V vehicle test battery via the cars standard 12V outlet. The battery and power inverter will be tested to ensure that it can provide up to 30min of continuous uninterrupted power usage. Testing of battery and power inverter shall include:

- Measuring the device's power consumption to analyze how many hours of usage the battery can yield
- Real world testing with the device to monitor power usage
- Ensuring power inverter does not draw more than 80AH
- Ensuring power inverter can supply 120V AC at 6mA
- Ensuring power inverter shuts off when over a temperature of 24°C
- Measuring time required to recharge the battery after 30min of power inverter use
- Measuring the device's standby current consumption
- Measuring the device's current consumption when turned off

7.2 Timer Test

Our devices timer will be tested in different environmental conditions to ensure proper operation while the user is asleep or away from the vehicle. The timer must be able to open and close the circuit switch to both supply and cut off power to the heater unit.

7.3 Heater Test

The heating unit shall be extensively tested with and without the power inverter to ensure all safety requirements are to be met. The heater unit could potentially cause harm and damage to the user and the vehicle as it will be exposed therefore it needs to be extensively tested and designed with proper protection. Testing of the device shall include:

- Real world testing with the device to monitor power usage
- Ensuring heating unite does not draw more than 800W
- Ensuring heating unit shuts off when car interior temperature reaches 24°C
- Measuring time required to recharge the battery after 30min of power inverter use
- Measuring the device's standby current consumption
- Measuring the device's current consumption when turned on/off

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7.4 Remote Control Test

The Remote control will be tested to ensure the communication between user and the heater is properly transmitted. Both transmitter and receiver will be tested against its specifications for transmission at different ranges. Testing for the remote control includes, but is not limited to:

- Testing the transmission with different ranges
- Ensuring correct signal is transmitted to power on or off the heater
- Testing the transmission with different obstacles and physical settings
- Measuring the maximum distance of radio frequency
- Testing the feedback and human factor of controller

7.5 Physical Test

Physical testing will be conducted to ensure that each component of RAHS including the entire system is sufficiently durable to be hardwired into a vehicle and operate after vehicle use, as well as everyday usage. Test shall include:

- Ensuring no wiring or connections become loose during driving
- Ensuring heater unit withstands driving vibrations and movement/storage
- Dropping heater unit & housing to find weak spots and strengthen device
- Ensure all components of device that can be exposed to electrostatic discharge, water, dust, ice, and magnetic interferences are properly secured and operational.

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8 Conclusion

The Functional Specifications for RAHS show what this product will offer and the requirements of the system. This document provides a path for the Design Specifications. The Functional Specifications will ensure that of the standards and requirements of this product are met. The features in this document include priorities which will make sure that the most important features are implemented first. The tests will also provide a standard for each system that must be met. The Functional Specifications for RAHS provides a plan for what needs to be completed and to what standard.

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9 Reference

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