ARCTECH

February 16, 2011

Dr. Andrew Rawicz
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Re: ENSC 440/305W Functional Specification for a GPS Ice Tracking System

To Whom It May Concern:

We enclose a functional specification for a GPS ice tracking system that outlines the requirements of the system as provided by our client and end user. The system is designed to track arctic ice floes and provide data about the surrounding environment and will have a corresponding set of functional requirements.

This document outlines the specific requirements of our tracking system and assigns a corresponding criticality requirement which indicates if the requirement will be met in the proof-of-concept, prototype or demonstration/production-quality units. We have also provided a possible test plan that will be adhered to for each stage in the design and construction process.

ArcTech consists of five senior engineering students with a wide range of expertise in both technical and non-technical areas. If you have any questions about this document, please contact me by email at bjm11@sfu.ca.

Sincerely,

Brendan Moran
CEO, ArcTech

encl: Functional specification for a GPS ice tracking system.

Functional Specification for GPS Ice Tracking System

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Executive Summary

Public opinion on climate change has moved from one of indifference towards one of greater concern, but many of those polled were unable to identify concrete examples of it affecting their daily lives. [1] Clearly, more information and data is required to continue educating the public about the implications of climate change in the hopes that real action can by taken by governments around the world.

The Arctic is a very sensitive environment and thus is a good indicator of global climate trends. In particular, collecting data about the location of large sheets of ice can be very informative about the macroscopic trends of ice formation. In addition to the position of these ice floes, the air temperature and relative humidity as well as several other characteristics of the surrounding environment can provide a better long-term picture of ice formation in the Arctic.

To collect more information about ice formation, we present the ArcTech GPS Ice Tracking System as an autonomous battery-powered system that allows an end user to track the location of large ice floes and receive data about the surrounding environment. Its reliability and durability requirements are governed by the marine environment it is expected to withstand and the life cycle of arctic ice floes. The specific sensor and communication requirements are provided by the client and end user. [2]

ArcTech is currently in the design and testing stage of individual sensor and communication modules with integration expected to be underway by the end of February. A proof-of-concept module is expected to be operational by February 28, 2011 with a demonstration quality product intended for the end of March 2011.

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Glossary

EEPROM Electrically Erasable Programmable Read-Only Memory is a type of non-volatile memory found in many microcontrollers.

GPS The Global Positioning System is a network of 32 low-orbit satellites maintained by the US government that can determine the location of a receiver to, depending on the quality of the receiver, within 1 metre. [3]

Heave One of the six degrees of freedom of a rigid body; heave is the measure of motion in the z direction, or "up and down". It can be roughly measured by double-integrating the output of an accelerometer. [4]

Ice floe Also known as sea ice, an ice floe is a floating piece of ice that can be up to 10 kilometres in width or length. [5]

IP-67 An International Protection or Ingress Protection rating that indicates a vessel is dust tight and water sealed for immersion up to 1 metre. [6]

Iridium Iridium refers to the Iridium Network, a privately maintained network of low-orbit satellites that provides global data and voice communication to users with an Iridium account. [7]

RoHS This standard regulates the Restriction of Hazardous Substances in electrical and electronic equipment and is maintained by the Environmental Agency of the British government. [8]

RTC A real time clock allows for the timing of a microcontroller to be based on the date rather than an internal oscillator.

1 Introduction

The ArcTech GPS Ice Tracker is an autonomous monitoring station intended to provide GPS location and surrounding environmental data for objects in remote arctic location. The primary objects these are intended to track are ice floes but the system is intended to be capable of marine asset tracking as well. The requirements of the system, as specified by the client, are outlined in this document with a distinction between critical and non-critical requirements. The following classifications will be used to differentiate between the two where the # denotes the requirement number.

Requirement Criticality Classification

R#-1 Indicates a critical requirement that will be present in the proof-of-concept, prototype and demonstration units

R#-2 Indicates an important requirement that will be present in the prototype and demonstration units

R#-3 Indicates a possible requirement that could be met for demonstration or production units

This document is intended to be a reference for the members of ArcTech during the design process and a confirmation with the client about critical requirements of the system.

2 System Overview

A schematic of our system is shown in Fig. 1. It shows the required sensors as specified by the client and end user as well as gives an overview of the interfacing between the microcontroller and its inputs and outputs. For the proof-of-concept unit, the unit may only be capable of broadcasting its location, with integration and communication of all other environmental data coming with the prototype or demonstration unit.

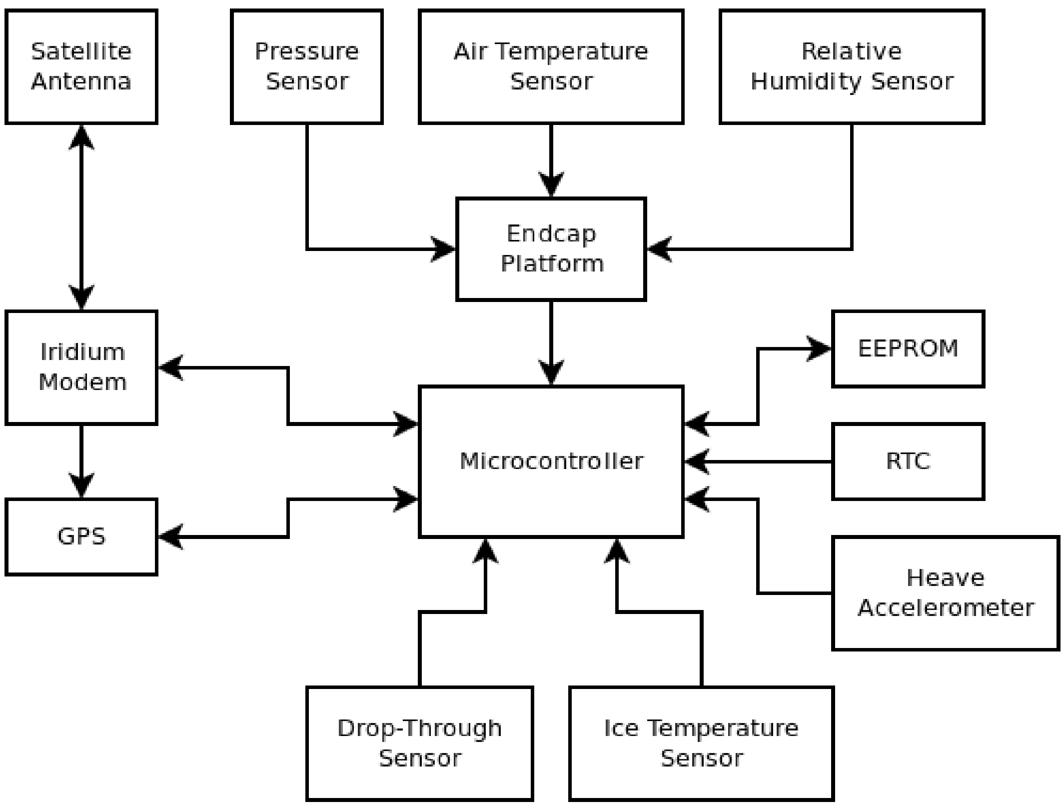

Figure 1: Block diagram of ice tracking system illustrating data flow and required sensors

3 Requirements

3.1 General Requirements

R1-1 The unit must be autonomous and self powered

R2-1 The unit must be capable of communicating its location to an end user

R3-2 The unit must be guaranteed to function in a marine environment down to temperatures of -20° Celsius as this is a reasonable lower estimate for average temperature in the proposed tracking area as provided by the client

3.2 Physical Requirements

R4-1 The unit must be at least 50 cm in length for ease of physical handling and installation

R5-1 The unit must be no more than 6 inches in diameter due to limitations of installation equipment

R6-3 The unit must have a flotation collar in the event of fall through or for tracking marine assets

3.3 Sensor Requirements

R7-2 The unit must provide information about the following environmental conditions:

- Air temperature
- Relative humidity
- Barometric pressure
- Heave (via a three-axis accelerometer with the output filtered and integrated twice)

R8-3 The unit may provide information about the following environmental conditions:

- Temperature of ice below unit
- Conductivity (to determine if unit is in ice or water, i.e. the unit has fallen through the ice)

3.4 Communication Requirements

R9-2 The GPS will ideally have a time to first fix of 40 seconds

R10-2 The unit must communicate its position and environmental data at an hourly interval

3.5 Performance Requirements

R11-2 The unit must have an air temperature sensitivity of at least ±0.5° Celsius for the research purposes of the end user

R12-2 The unit must be able to avoid irreparable damage at temperatures down to -40° Celsius and return to functionality once the temperature returns to -20° Celsius

3.6 Reliability and Durability Requirements

R13-1 The unit must be self powered for a duration of eight (8) months as this is the typical life cycle of arctic ice floes [2]

R14-1 The unit must, in the event of recovery, have withstood the environment to not require significant re-equipment (with the exception of battery power sources) to be functional upon redeployment

R15-2 The unit must be sealed with IP-67 standard connectors to ensure electronics are not damaged by incident moisture [6]

3.7 Usability Requirements

R16-2 The unit must communicate its position and environmental data in a user-readable format, preferably ASCII

R17-2 The unit will require minimal user installation outside of physical placement in the environment and subsequent activation

3.8 Standards

R18-1 The unit will comply with RoHS standards to avoid environmental contamination in the event that it is discarded [8]

R19-1 The unit will comply with GPS standards to obtain its global position

R20-1 The unit will comply with Iridium standards to communicate its data to the end user

4 System Test Plan

Our system has two main functional requirements, that it determine and communicate its position and that it withstand and provide information about an arctic marine environment. These requirements will govern our test plan as they can be tested both separately and together after integration.

4.1 Separate Components

Marine Environment and Heave Test

Our client has access to a vessel that can transport the unit into a marine environment. While we cannot fully test the performance of our unit after eight months of bombardment from such an environment, we can observe the effects of several hours or days and extrapolate an estimate of its performance. This will also allow us to test our unit's ability to measure the heave of the vessel.

Temperature Measurement and Range Test

We will use a variable freezer from the SFU Physics Department to test the temperature measurement accuracy and sensitivity and the unit's performance in lower temperatures. These freezers are available down to -80° Celsius which will be more than adequate to test our device in its required range.

Barometric Pressure Test

This test involves extracting the barometric pressure determined by the unit on the microcontroller development software and comparing it to a known value from a number of reliable sources such as a barometer.

Humidity Test

A simple method we plan to use for testing the humidity sensor is placing it in an insulated area with a hot water source, for example a shower stall or steam room with a humidity measuring device for comparison.

Communication Test

Testing the GPS will involve extracting the location determined by the unit on the microcontroller development software and comparing it to the "correct" value, easily obtainable from sources such as Google Maps or, more precisely, a government issued map. To test the

Iridium modem, we will obtain an Iridium account that will allow us to receive test messages from the unit.

4.2 Integration

The previous tests, when extracted from the microcontroller, can be either directly read or stored in memory. Once we have all components working and tested independently, we can perform some of these tests again and read the values via Iridium message. The final demonstration or test will involve the unit being placed at a location other than the demonstration area, for example in the house of one of the company members, where a camera will be set up to confirm its location. The unit will then broadcast its position and environmental measurements which will be received as part of the demonstration.

5 Conclusion

This document has outlined the specific requirements of the system and their associated "criticality" classifications. Individual sensor and communication modules will be interfaced with the microcontroller and tested before any integration is performed. We expect to have a proof-of-concept unit satisfying all **R#-1** and most **R#-2** requirements completed by February 28, 2011 with a demonstration quality unit satisfying all **R#-1** and **R#-2** requirements with some **R#-3** requirements met by the end of March 2011.

References

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