Name: Alan Kilian PIL 3281 Fall 2011 Major Project

Title: Implement a Robot for the Trinity College Fire Fighting Robot Competition.

Description: The goal of the Fire Fighting Robot contest hosted annually by Trinity College is to provide an environment where high school and college students can compete to complete a well-defined task in a known environment. The challenge for the entrants is to build a computer controlled robotic device that can move through a small model of a single floor of a house, detect a lit candle and then put it out. For my major project, I will design, build and test a robot which meets all criteria for the competition however, I do not intend to submit the robot to the competition. I will write a 7-10 page paper describing the process used to design, build and test the robot and what I learned through the process that was applied to the computer controlled robotic device.

Background and Rationale:

The successful completion of an individualized degree in Mechatronics requires an understanding of mechanical, electrical and computer systems as well as the tools used to design and implement each of these systems to produce a machine capable of performing a specific task. This major project will allow me to learn these tools through self-paced experiential learning, the learning method which is most successful for me.

In my previous individualized study projects *Design and Construct a Holonomic Motion Platform and Control System;* and, *Design and Construct an Absolute Heading Sensor for a Robot.* I built a three-wheeled robot and a computer to control it as well as a sensor to determine the direction the robot is pointed.

For my major project, I will add a flame detector and write software so that the robot can complete several tasks described in the 2013 Trinity College Fire Fighting competition documents to include the requirements originally stated in my Project #2 *Design and Construct a Holonomic Motion Platform and Control System* and to add the **Fires** and **Extinguishing the Candle** requirements:

Operation: Once turned on, the robot must be autonomous: self-controlled without any human intervention. Fire-fighting robots must not be manually controlled.

A robot may bump into or touch the walls of the arena as it travels, but it cannot mark, dislodge, or damage the walls in doing so. The robot must not leave anything behind as it

travels through the arena. It must not make any marks on the floor of the arena that aid in navigation as it travels.

Dimensions: The robot must fit in a Bounding Box with a base 31 x 31 cm square and 27 cm high. If the robot has feelers to sense an object or wall, the feelers will be counted as part of the robot's total dimensions.

Fires: For obvious reasons of safety and economy, fires will be simulated by small candle flames. The candle flame will be from 15 cm to 20 cm above the nominal floor level. The candle thickness normally will be between 2 cm and 3 cm. The exact height and size of the flame will change throughout the contest depending upon the condition of candle and its surroundings. The robot is required to find the candle no matter what the size of the flame is at that particular moment.

Extinguishing the Candle: The robot must, in the opinion of the Judges, have found the candle before it attempts to put it out. For example, the robot cannot just flood the arena with CO2thereby putting the flame out by accident. The robot must not use any destructive or dangerous methods to put out the candle. The robot may extinguish the candle by blowing air or other oxygen-bearing gas. The robot must come within 30 cm of the candle before it attempts to extinguish the flame. There will be a white 30 cm radius solid circle (or circle segment, if the candle is near a wall) on the floor around the candle, and the candle will be placed in the center of the circle. The robot must have some part of its body over the circle before it extinguishes the candle flame.

This project is informed by learning in my Depth Criteria and my Extended Studies in Mathematics, Physics and Mechanics. The knowledge gained in the courses of Engineering Fortran, Operating Systems and Data Communications and Distributed Processing allowed me to write the software algorithms required to accomplish the goals of the fire fighting competition. The courses I took in Mechanical Engineering: Systems Dynamics and Control and Analog and Digital Control, as well as my Project #1 Develop a tuning guide for PID control systems allowed me to select, write and test appropriate motion controlling algorithms so that I was able to cause the robot to move in a way necessary to accomplish the goals of the fire fighting competition.

Objectives:

1. To understand the mechanical, electrical and computer systems; and tools to design and implement each system in the production of a machine capable of performing a task.

2. To understand the rules, regulations and goals of the Trinity College Fire Fighting competition.
3. To determine a computer system that allows the robot to complete the competition's goals.
4. To build a working robot, specifically select electrical components, fabricate parts, write software and assembly, to meet the rules and complete goals of the Trinity College Fire Fighting competition.
5. To test the robot's ability to complete task of the Trinity College Firefighting competition including a formal test plan.

Methods:

- I will conduct a literature review.
- I will study the rules, regulations and goals of the Trinity College Fire Fighting competition.
- I will research possible systems that will allow the robot to complete the task.
- I will write the required software.
- I will assemble and test the robot and write a formal test plan.
- I will write a 7-10 page project report discussing my research and results.

Results:

The project will result In a robot capable of completing the Trinity College Fire Fighting contest, as well as a 7-10 page paper addressing the theoretical and conceptual framework and process that I used in the design and development of the robot. This paper will include a formal test plan.

Schedule:

November 2012	Study Trinity College Firefighting competition rules.	40 hours
December 2012	Literature review	20 hours
January 2013	Modify robot used in previous projects to add hardware required to complete additional tasks	40 hours

	in this project	
July 2013	Write software and test software for completing the contest tasks.	150 - 200 Hours
October 2013	Write draft paper	40 Hours
October 2013	Submit draft paper to evaluator	
November 2013	Edit final paper	16 Hours
November 2013	Submit paper to evaluator	4 Hours

Evaluator: Dr. William Durfee, Professor Department of Mechanical Engineering, University of Minnesota, Minneapolis, Minnesota

Evaluation:

1. Please discuss how well the student understands the mechanical, electrical and computer systems; and tools to design and implement each system in the production of a machine capable of performing a task.
2. Please comment on how well the student understands the rules, regulations and goals of the Trinity College Fire Fighting competition?
3. How well did the student determine a computer system that allows for the robot to complete the competition goals?
4. How well did the student build a working robot, specifically select electrical components, fabricate parts, write software and assembly, to meet the rules and complete goals of the Trinity College Fire Fighting competition?
5. Please comment on how well the student tested and documented the robot's ability to complete task of the Trinity College Firefighting competition.
6. How does the quality of this project compare to other undergraduate projects of a similar nature?

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