Thermal Control System for Navy Unmanned Drone Sensor POD

Jason Landolt & Yinghao Zhai
Department of Mechanical Engineering, University of New Hampshire

Advisor: Christopher White
Graduate Student Advisor: Charles Klewicki

University of New Hampshire

Introduction

The focus of this project is to program and build a physical feedback controller to regulate the inner temperature of a sensor POD being carried by a large-scale unmanned military drone. The POD houses heavy duty sensing devices (laser electronics, telescope, scanners) that produce a significant head lead that must be expelled to maintain an inner temperature of 17°C. While on a mission, the POD will operate across a broad range of atmospheric and flight conditions that requires the thermal controller to be lightweight, robust, and reliable. The controller is to be tested on master's student Chase Klewicki's POD prototype located in the Flow Physics Facility (FPF) at UNH. The results from the testing will be analyzed and the controller programming will be altered to finalize the project. The system will then be given to the Navy.

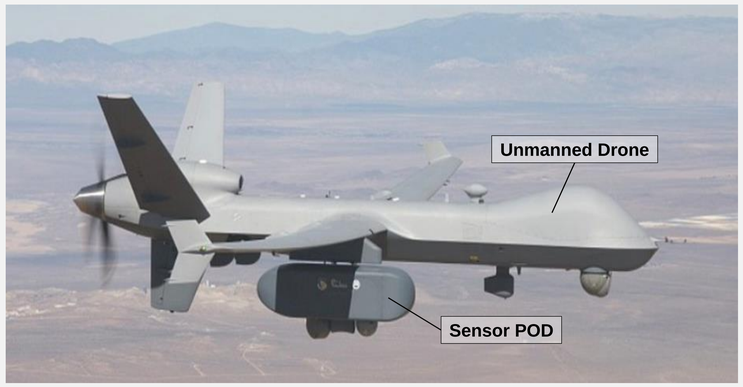
Systems to Control

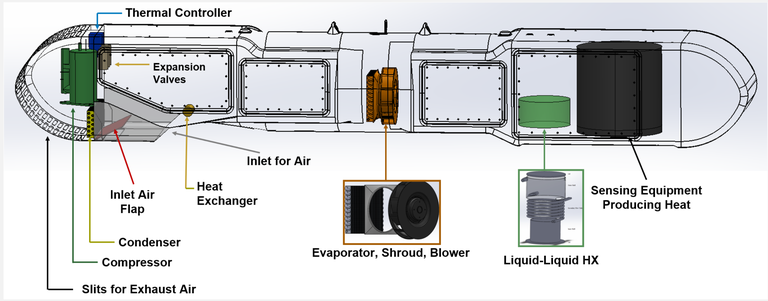
- Compressor duty cycle
- Compressor crank case heater
- Refrigerant flow
- Evaporator fan
- Inlet air flap
- Interlocks and implement a safety control system

Methods

Research was done to determine a suitable programmable logic controller to use for our system. Siemens LOGO! was chosen based on parameters: cost, user accessibility, robustness, and size. The LOGO! logic module uses *SoftComfort*, a function block programming application made specifically for the device. The application is intuitive and comes packaged with many example programs. An important feature is the ability to run in simulation mode to quickly test functionality of our control diagrams.

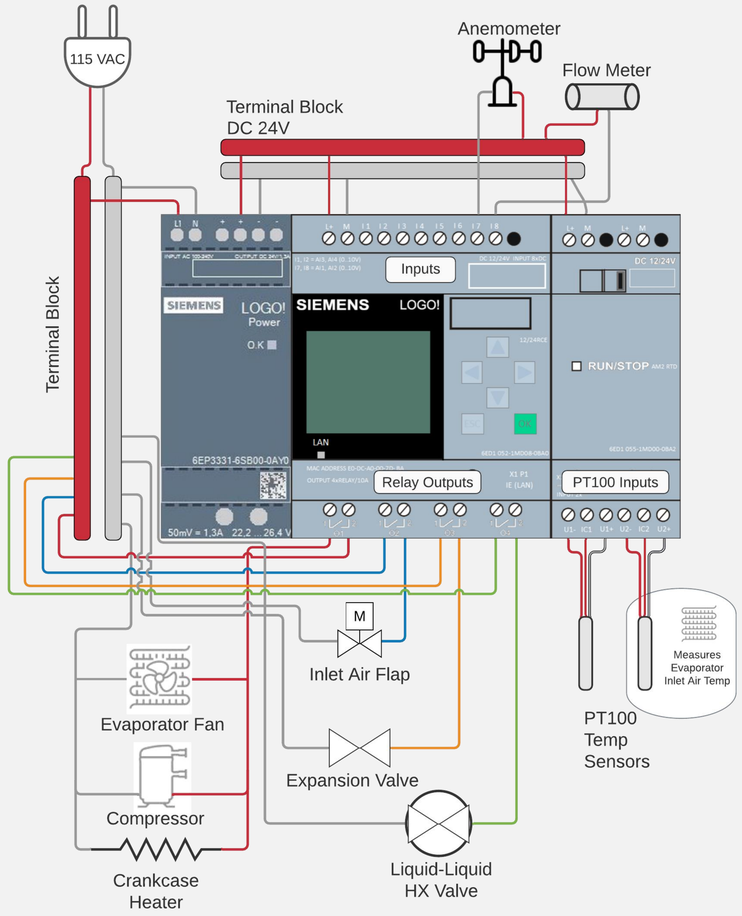
Our approach to creating a full thermal control system is to create isolated programs to test control of one output at a time to then combine everything together. We identify what input sensors are needed for the desired output, create a program in *SoftComfort*, run simulations, and conduct physical testing.





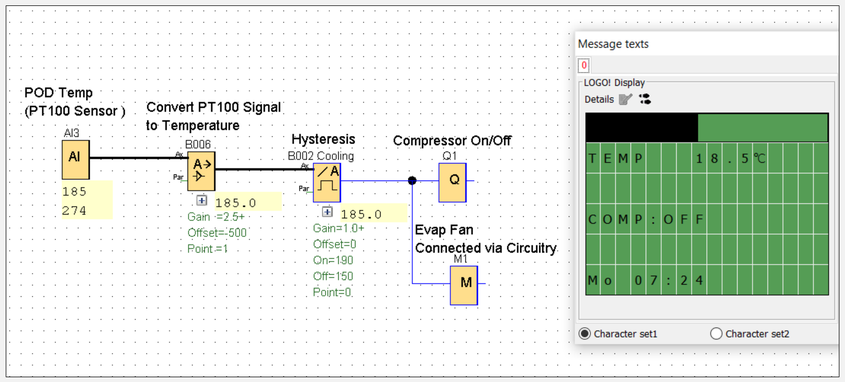
Sensor POD with Labeled Components

Controller Circuitry Diagram



Temperature Controller Wiring Diagram

Programming



LOGO! SoftComfort Programming Diagram

This is an example of isolated program created in *SoftComfort* that controls the compressor duty cycle. The compressor will turn on at 19°C and turn off at 15°C degrees due to the hysteresis block, allowing the maintenance of 17°C POD temperature. The LOGO! displays the input and output information for ease of analyzing the functionality of the program. The physical testing of this program worked as intended.

Discussion

Isolated testing of programs is still underway with promising results this far. We do not have all sensors and output equipment available yet to complete this. Currently, we are creating the full thermal control program by joining the isolated programs. Once the POD prototype in the FPF is complete, we can fully evaluate our thermal control system. Alterations will be made based on the results to finalize the project.

One challenge is that LOGO! does not have look-up table capabilities for multivariable analysis. We are investigating a solution to this problem.

Future Plans

- Connect thermal controller system to POD prototype in Flow Physics Facility
- Increase efficacy/efficiency of controller
- Website with live updates on controller status and POD information (temperatures, refrigerant flow, etc.)