Engine Control Workstation Using Simulink / DSP Platform
(COOLECW)

Functional Requirements List and Performance Specifications

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Introduction

Cooling control systems used in vehicles have become more sophisticated in recent years due to demands for lower fuel or energy consumption. A thermostat has been the common control element but better accuracy, system speed, and minimization of fan and pump energy can be achieved with a proportional actuator. Multiple temperature sensors can also improve system performance.

An Engine Control Workstation will be designed to simulate the thermal environments found in liquid-based cooling systems. The workstation will allow users to design, test and implement controllers to more precisely regulate the thermal dissipation of a motor-generator system with the goal of reducing energy use. A user friendly GUI for temperature and engine control will be designed using MATLAB and Simulink software. Workstation controller and monitoring application software will be auto-code generated within the same program with the processing of the data being done on a DSP board.

Project Goals

Engine Control:
(1) Learn software packages for auto-code generation and real-time control via Simulink/DSP interface. A major focus will be minimization of C-code and execution time.
(2) Design DSP/cooling system hardware interface
(3) Obtain a transfer function of the cooling system at different operating temperatures.
(4) Design DSP/motor hardware interface – will build off 2008 Mini Project
(5) Design software for PWM generation and velocity calculation from rotary encoder.
(6) Design active thermal load for DC generator.
(7) Design closed-loop controllers for velocity and acceleration control.
(8) Determine the limitations of the Simulink/TMS320F2812 DSP interface in terms of real-time execution and program memory.
(9) Evaluate controller performance based on system accuracy, speed, and energy use.
(10) Design Simulink/MATLAB GUI for controller parameter modification. This will include ability to graph critical output data for controller design evaluation.

Functional Requirements and Performance Specifications

The motor velocity control system will be designed with the following specifications for a command step input of 100 RPM for no-load and full-load conditions.

<u>Steady State Error</u> = +/- 5 RPM
<u>Percent Overshoot</u> =15 %
<u>Rise Time</u> = 30mS
<u>Settling time</u> = 100 mSec
<u>Stability (Phase Margin)</u> = 60 degrees

The closed loop control shall be operational over a command input range of 50 to 750 RPM. The command input shall consist of step only commands and/ or combinations of steps and ramps. The tracking error for ramp inputs shall be less than 5% over the command range of 50 to 750 RPM.

The thermal regulator control system will be designed with the following specifications for a step input.

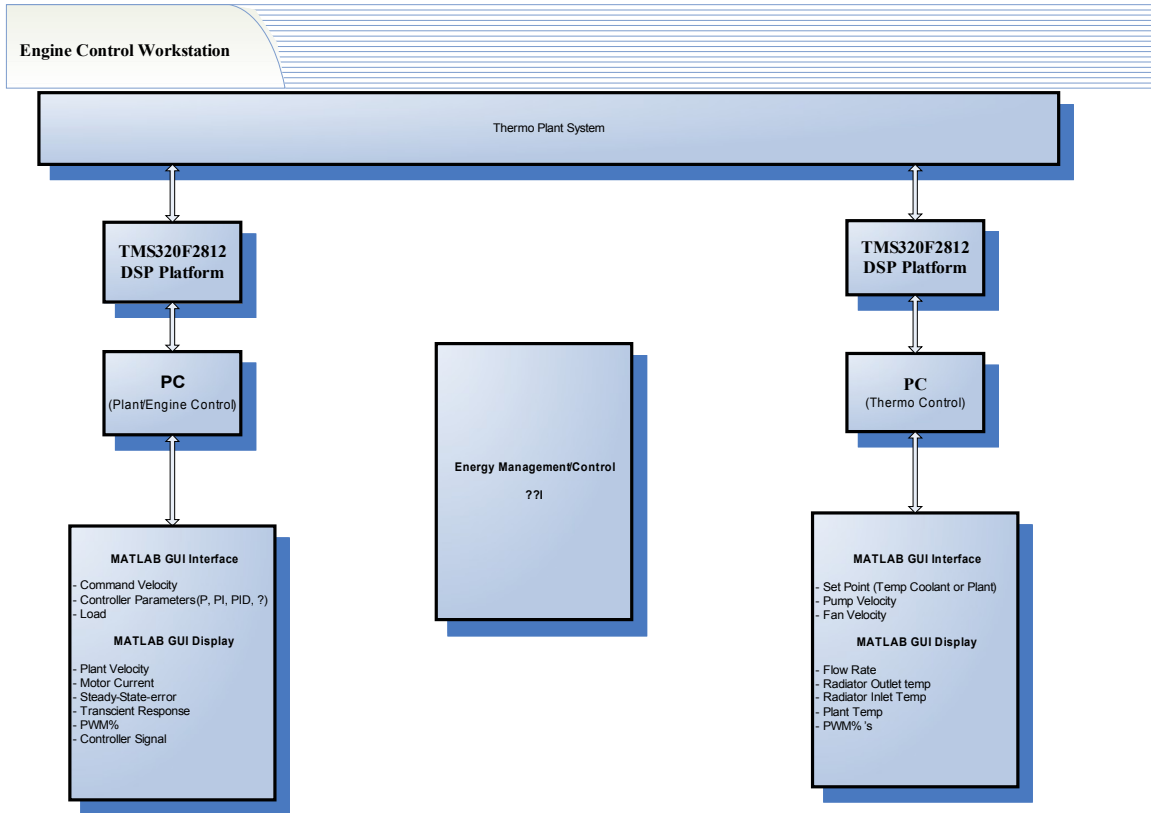<u>Steady State Error</u> = +-2 degrees C
<u>Percent Overshoot</u> = 30 %
<u>Rise Time</u> = 1 Sec
<u>Settling time</u> = 10 Sec
<u>Stability (Phase Margin)</u> = 45 degrees

Under normal operating conditions the thermal control system shall maintain the motor and generator case temperature to less than 150 degrees F. The maximum cooling fluid temperature will be limited to 120 degrees F at the radiator outlet. The thermal control system's power consumption shall be maintained by independent control of the pump and radiator fan.

Engine Control Workstation

Thermo Plant System

TMS320F2812
DSP Platform

TMS320F2812
DSP Platform

PC
(Plant/Engine Control)

PC
(Thermo Control)

Energy Management/Control

??I

MATLAB GUI Interface

- Command Velocity
- Controller Parameters(P, PI, PID, ?)
- Load

MATLAB GUI Display

- Plant Velocity
- Motor Current
- Steady-State-error
- Transcient Response
- PWM%
- Controller Signal

MATLAB GUI Interface

- Set Point (Temp Coolant or Plant)
- Pump Velocity
- Fan Velocity

MATLAB GUI Display

- Flow Rate
- Radiator Outlet temp
- Radiator Inlet Temp
- Plant Temp
- PWM% 's

System Control Block Diagram