Smart Heater

Initial Project and Group Identification Document

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Group 36

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Project description

       With an ever increasing motivation to conserve energy, much effort has been put forth lately to create smart HVAC systems. According to Duke Energy, water heaters are the second-highest source of energy usage in most homes. This is a largely overlooked area in which a smart solution could increase efficiency, reduce energy costs and carbon footprint, as well as giving the user a more refined control and ultimately comfort.

       Our motivation is to create a water heater thermostat/controller that is easily installed in an existing water heater and offers the user complete control of water temperature at any time of the day from anywhere with internet connectivity. The controller will be able to recognize patterns and learn autonomously when to heat up water and cool off/turn off without explicit programming. The water temperature will be able to set remotely from a touch screen with the appropriate GUI much like existing air conditioners and also remotely from smart phones.

Specifications

- Controller Board
    - Power input –110 v
    - Microcontroller
        - Thermostat interface. Analog/digital inputs
        - PID controller
        - PID algorithm to accurately control the temperature
        - Serial/UART interface
        - Serial console output for human-machine interface and easy debugging
        - FTDI chip
        - WIFI module
        - Full TCP/IP stack
- Touch screen
    - Power input – 110v
    - WIFI connectivity
    - Be able to talk to controller board
- Android App
    - Secure
    - Be able to control from anywhere, not just local network
    - Friendly interface

Requirements

- Thermostat(s)
    - Must be equal to or under the size of most modern water heater thermostats. Temperature control from input water temperature up to desired hot water temperature. Temperature monitoring for controller unit.
    - Size
        - approx. 5 inches high by 3 inches wide by 2 inches deep for upper thermostats
        - approx. 3 inches high by 3 inches wide by 2 inches deep for lower thermostats
        - Single element water heaters only have a single thermostat, and those sizes are approximately the same as the upper units in multi-element water heaters.
    - Voltage
        - Standard household water heaters are 220V, thermostat device will need some method of voltage step-down to power the wifi modules and electronics.
- Touch Screen
    - 4.3 inch diagonal for an acceptable merger of affordability and viewing area.
    - GUI must be responsive to user
    - WiFi connectivity
- Controller Board
    - Must have sufficient outputs to interface with touchscreen and wireless modules on the thermostats as well as enough processing capability to handle calculations for temperature control, scheduling, and learning the hot-water requirements of the household. The controller board need not be mounted directly on the water heater as it will communicate via wireless to the thermostat modules, so it can be powered via standard household 110V.
    - Voltage Regulation: Controller board will need voltage stepdown from 110V to usable 5V/12V.
    - Wifi Interface
        - Access needs to be secure. Measures must be taken to deter possible attackers of gaining control of water heater
    - Serial/UART Interface
        - Development and debugging
    - Must be able to regulate water temperature +/- 1 C of desired temperature

Project Block Diagrams

Project Budget and Financing

Portion	Item	Cost/Unit	Amount	Total Cost/Item
Control Board	Microcontroller	30	2	60
	FTDI	10	2	20
	Wifi	35	2	70
	Components	50	Various	50
Touch Screen	4.3 inch TFT	20	2	40
	Components	10	Various	10
Thermostat	Wifi Module	35	2	70
	Components	50	Various	50
	Heater Element	15	2	30
Android App	Dev hardware	0 (donated)	-	-
Test Bed	Water Heater	300	1	300
Total	700			

Finance: Potential Sponsor(s) and Group members

Project Milestone

September	October	November	December	January	February	March	April
Research							
	Design						
		Ordering Parts					
			Prototyping				
			Build	Finalize			
			Testing				
			Debugging/Troubleshooting				
						Finalize Documents	
							Presentation