SMARTer WATER

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Group 36

MOTIVATION

“Water heaters account for nearly 17 percent of a home’s energy use, consuming more energy than all other household appliances combined.”

- To reduce energy consumption by modernizing a common appliance
- To provide more control

PROJECT goals

- Phase 1
  - Mimic current smart water heaters
  - Control it locally and remotely
  - Dynamically fine tune settings
- Phase 2
  - Tie into Nest API
- Phase 3
  - If time allows, write native nest interface
  - 3D printed enclosure

PROJECT requirements

- Comparable in size to modern water heater thermostats
- Able to control up to two heating elements and one heat pump
- Able to regulate temperature to +/- 1° C of desired temperature
- It will run from 240V mains
- It will be controlled directly though a touchscreen interface or remotely via WiFi

PROJECT overview

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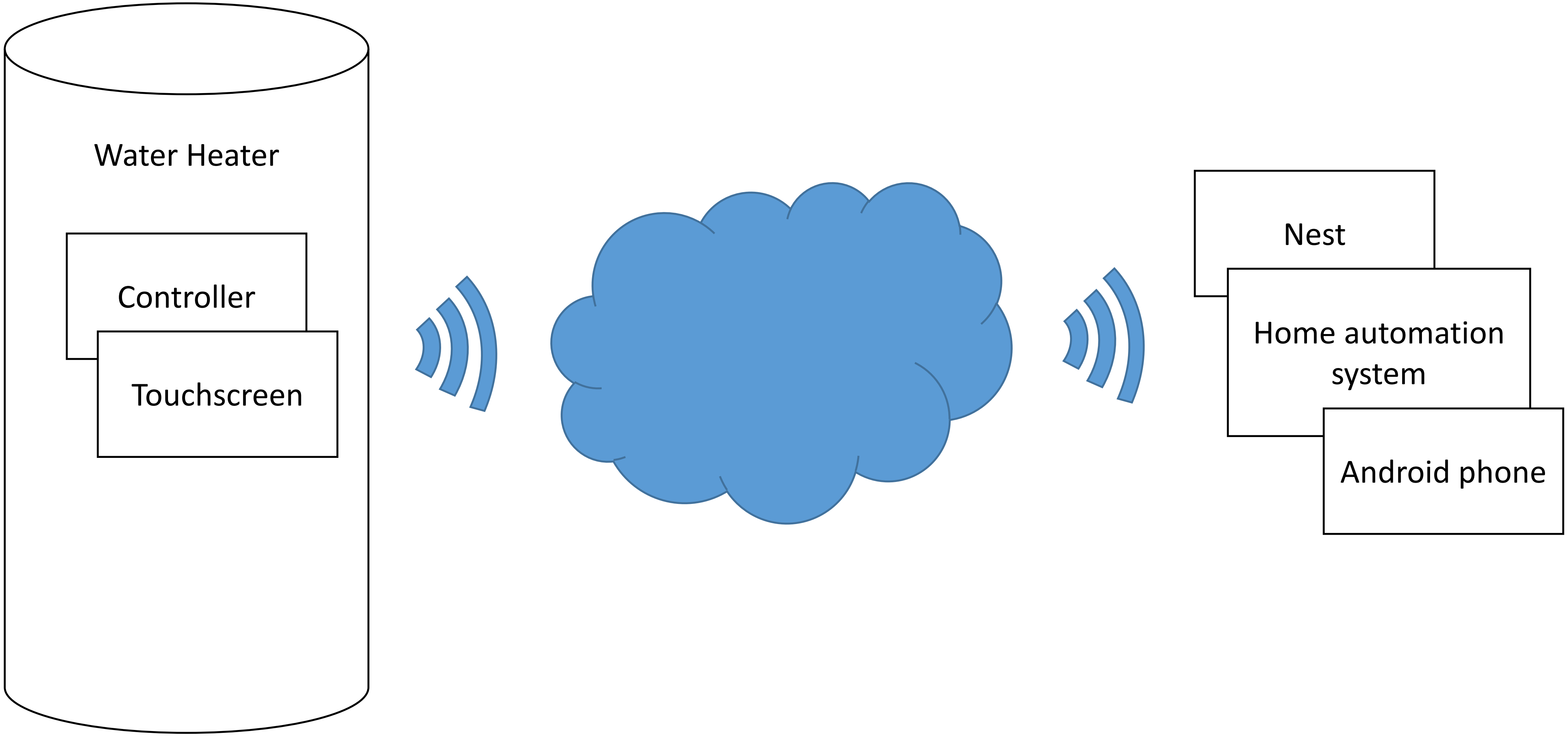
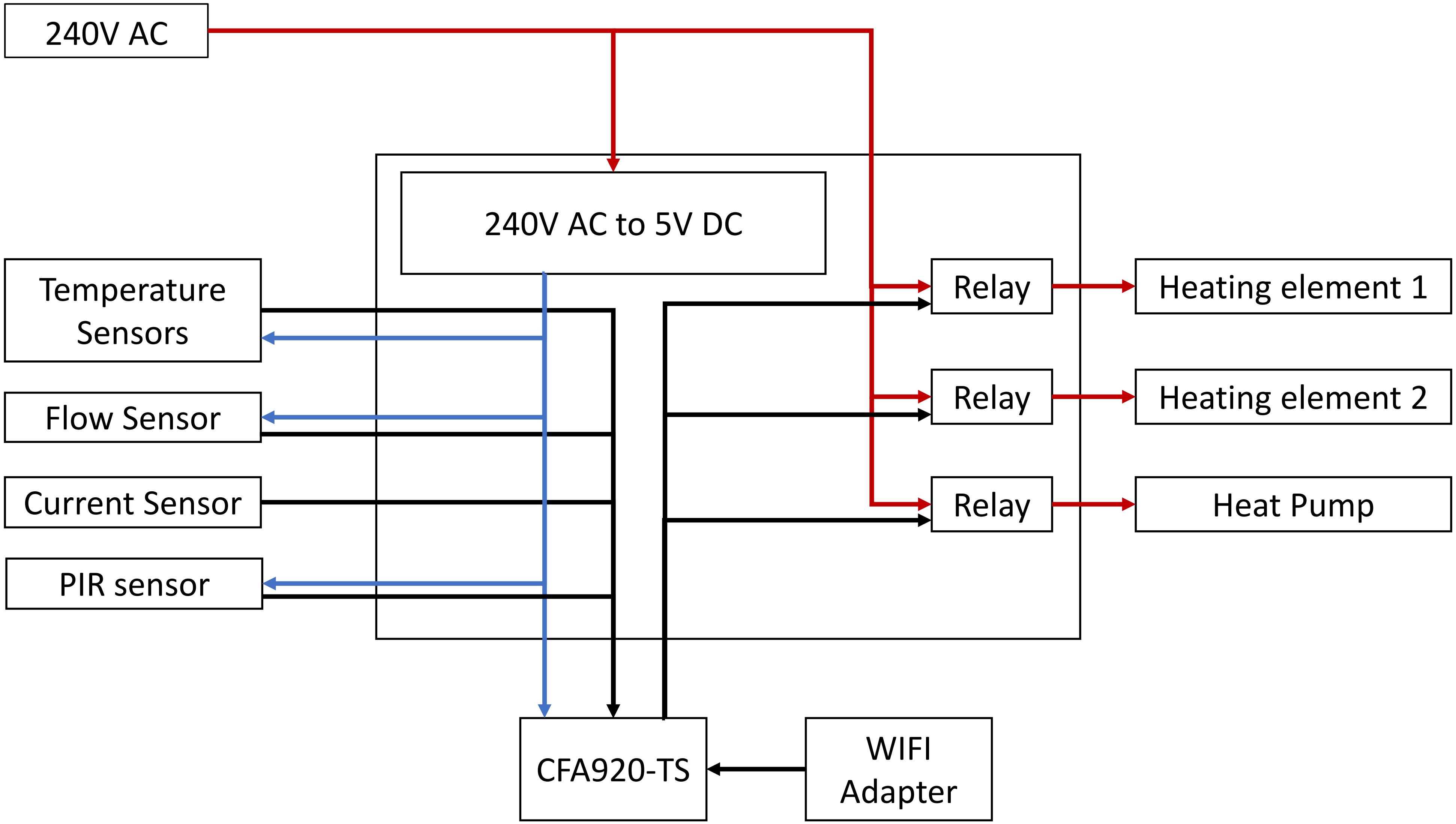
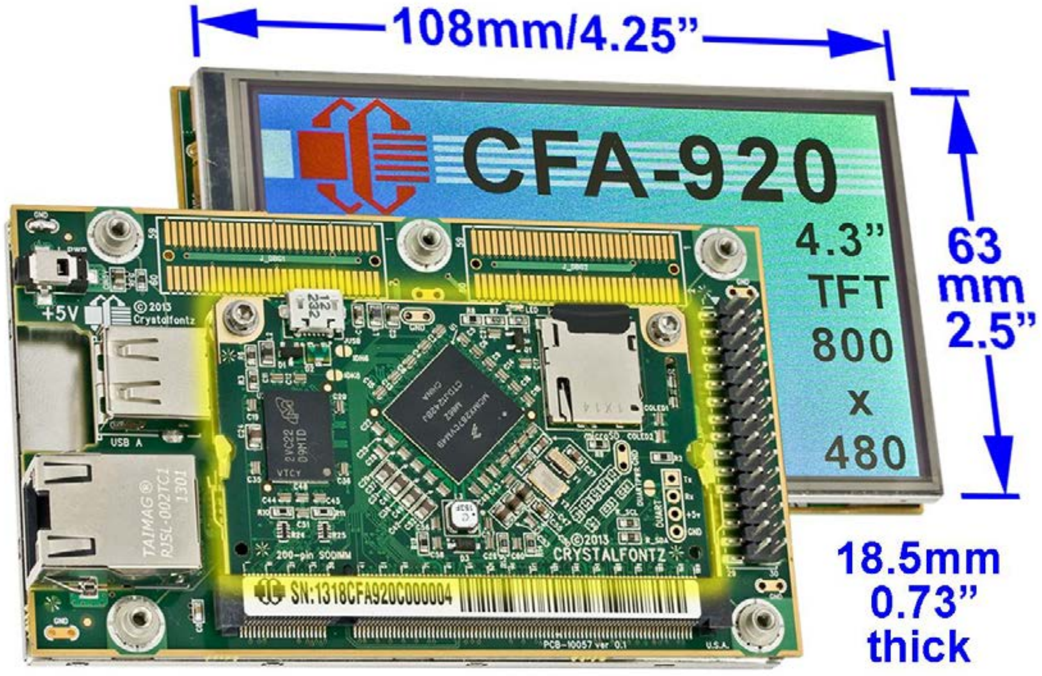


HARDWARE design

HARDWARE diagram



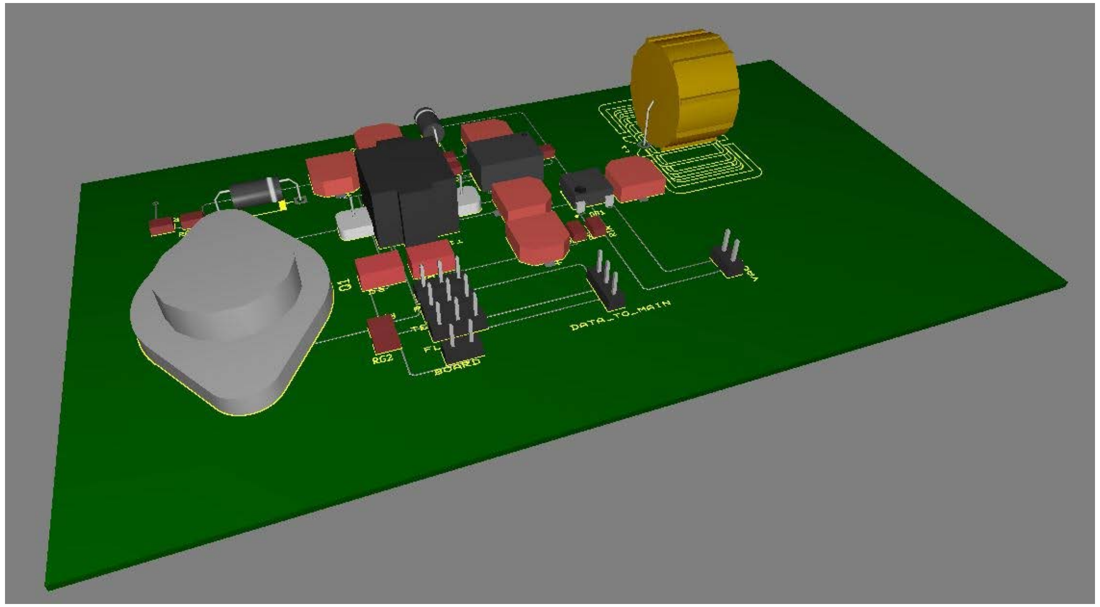
MAIN board



CFA920-TS

- 454MHz Freescale i.MX283 processor
- 4.3 inch 800*480 TFT touchscreen display
- 10/100 Ethernet port
- USB port
- 128MB DDR2 RAM
- µSD reader supports up to 64GB
- 24 GPIO on easy-access 0.1″ center header
- Up to 108 GPIO on 1mm compression connector

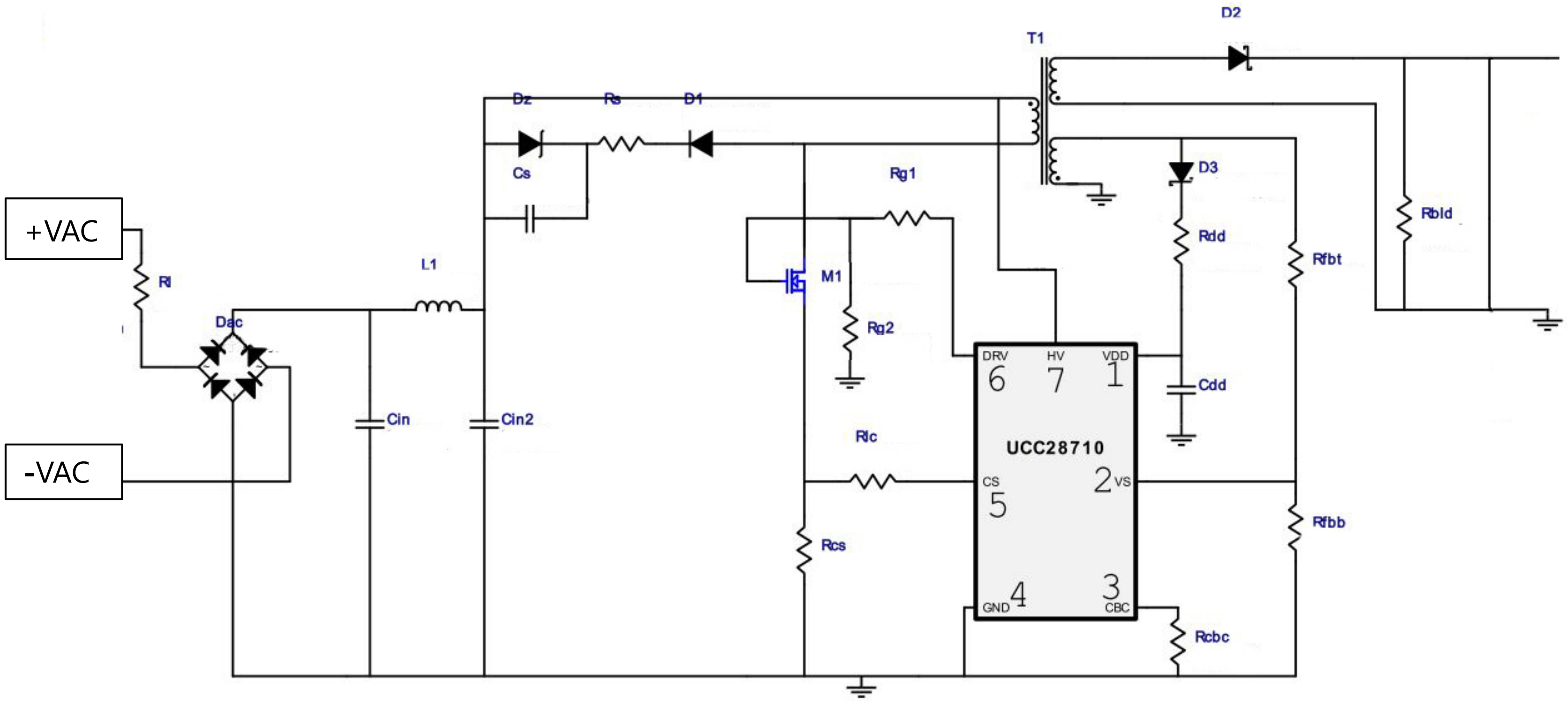
EXPANSION board



Render of work in progress

- 240v AC - 5v DC power supply
- Interface with CFA920-TS
- Sensor inputs
- Relay controlled heating element outputs

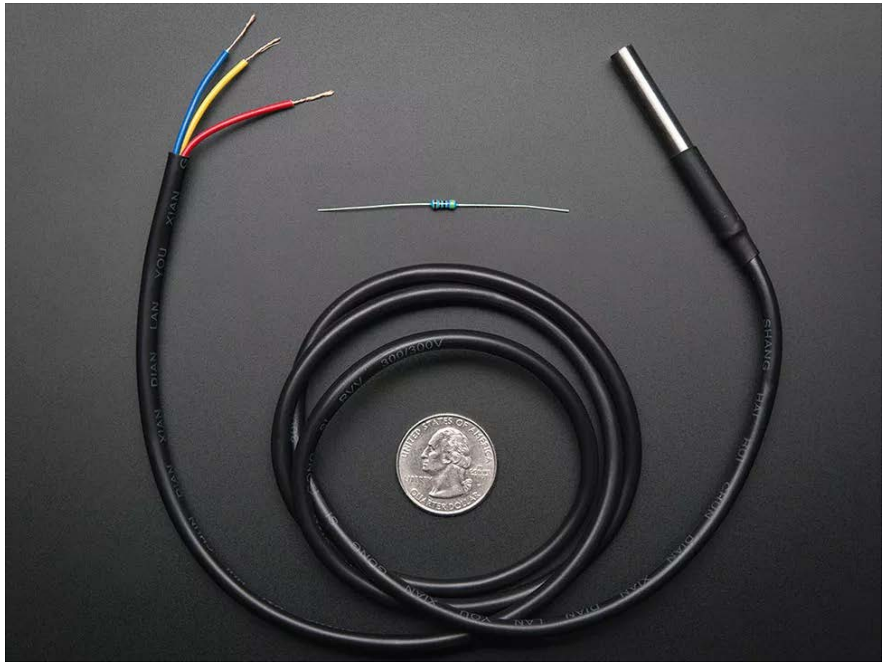
EXPANSION board



5VDC to

Sensor Headers
Main Control Board

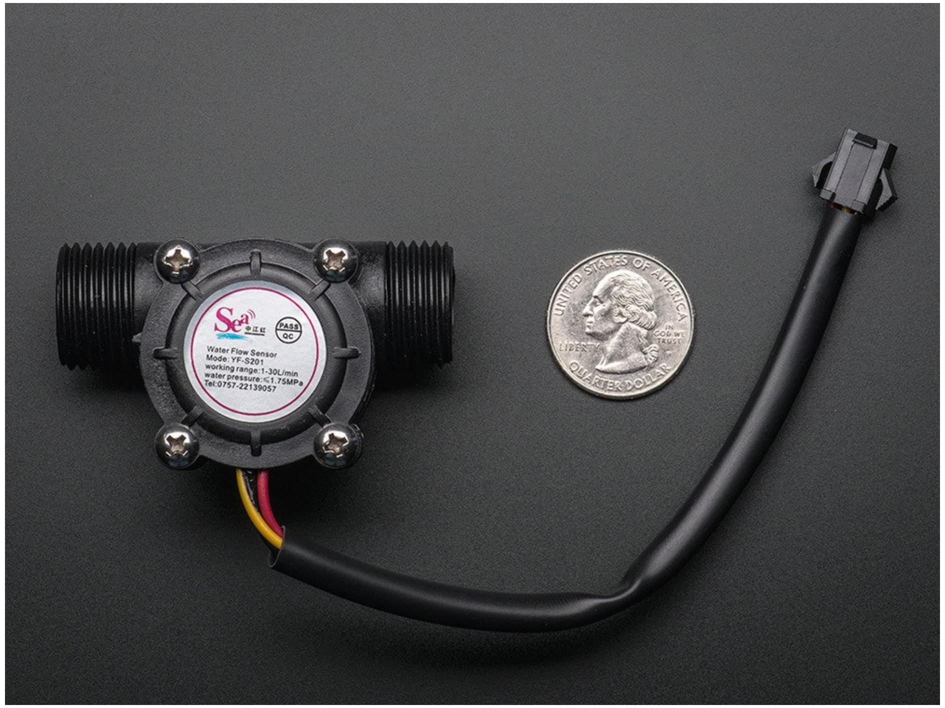
TEMPERATURE sensor



DS18B20

- Usable temperature range: -55 to 125°C (-67°F to +257°F)
- 9 to 12 bit selectable resolution
- Uses 1-Wire interface- requires only one digital pin for communication
- Unique 64 bit ID burned into chip
- Multiple sensors can share one pin
- ±0.5°C Accuracy from -10°C to +85°C
- Temperature-limit alarm system
- Query time is less than 750ms
- Usable with 3.0V to 5.5V power/data

FLOW sensor



YF-S201

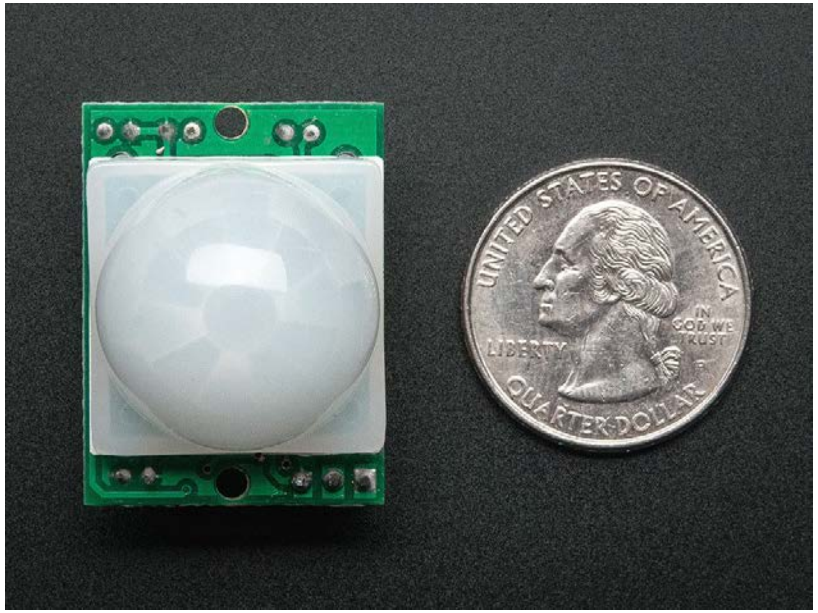
- Working Voltage: 5 to 18VDC
- Max current draw: 15mA @ 5V
- Working Flow Rate: 1 to 30 Liters/Minute
- Working Temperature range: -25 to 80°C
- Maximum water pressure: 2.0 MPa

CURRENT sensor

SEN11005

- Rated Current: 1-60A
- Current Ratio 30A/15mA
- D.C.Resistance at 20 ℃ 250 Ω
- Accuracy @RL≦10Ω 2%
- Linearity @RL≦10Ω 0.5%
- Phase error at rated current range ≦4˚
- Operating Temperature Range -40~65℃
- Storage Temperature Range -45~85℃

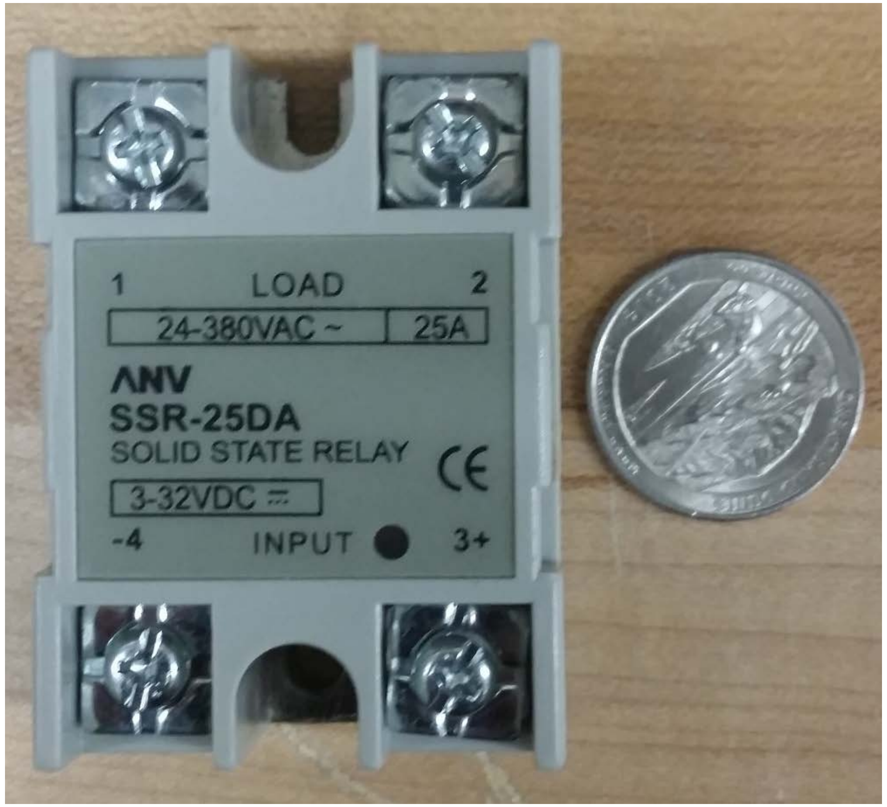
MOTION sensor



Parallax 555-28027

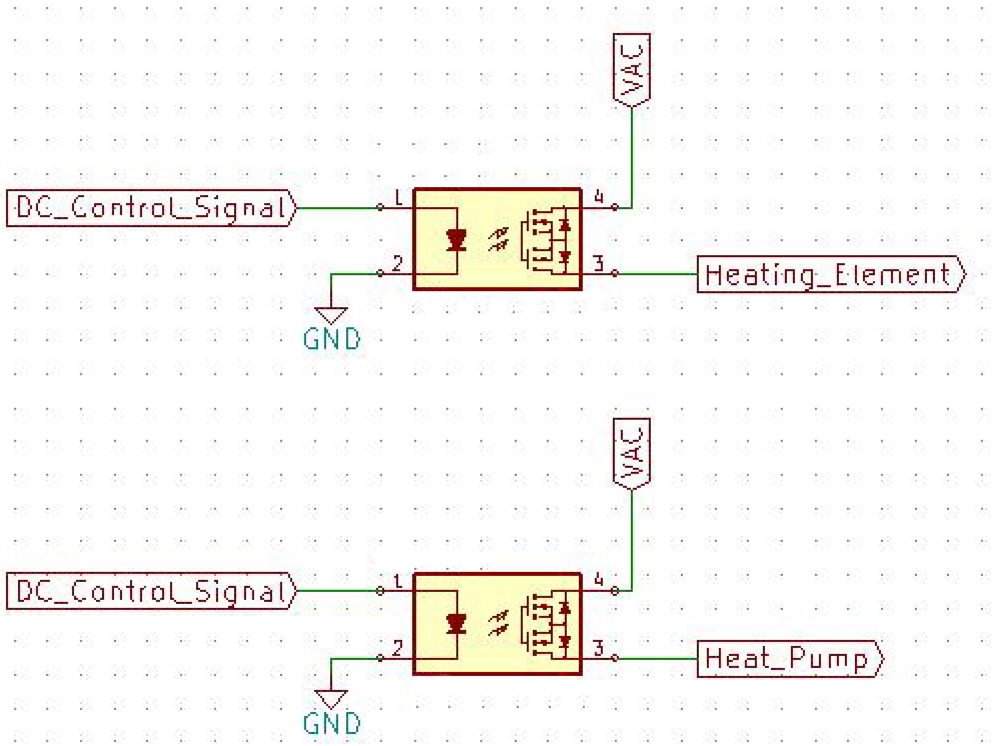
- Built-in selectable trigger mode
- Detection angle: 120°
- Detection range: up to 7m
- Supply voltage: 5V-16V

RELAY



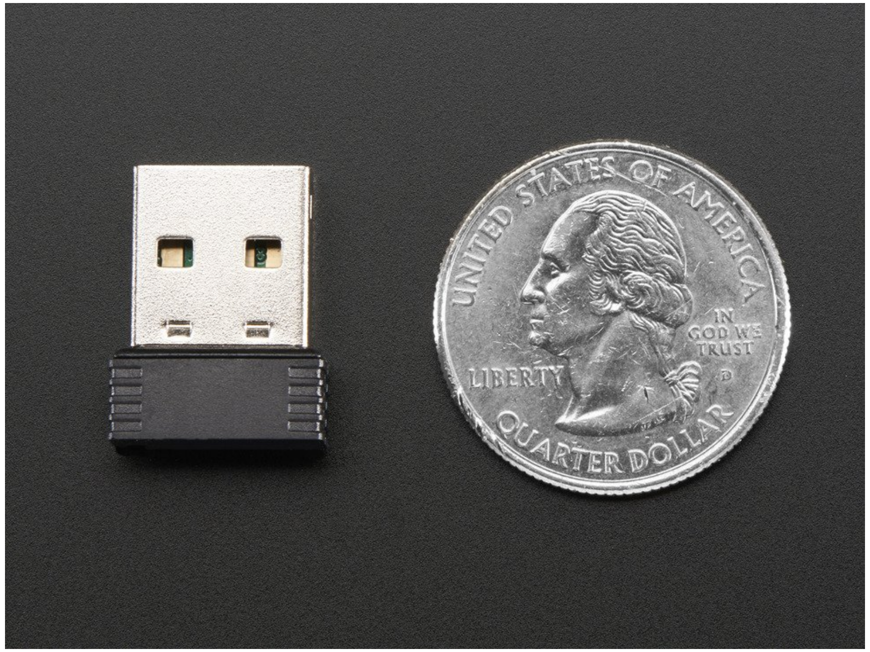
- Input: DC 3~32V
- Output: AC 24~380V
- Current: 25A
- Dimensions: 2.44 in x 1.77 in x 1.02 in
- Weight: 4.06 oz (115 g)

RELAY



- Master Controller Board controls relays
- Allows for isolation of AC and DC voltages

WIFI adapter

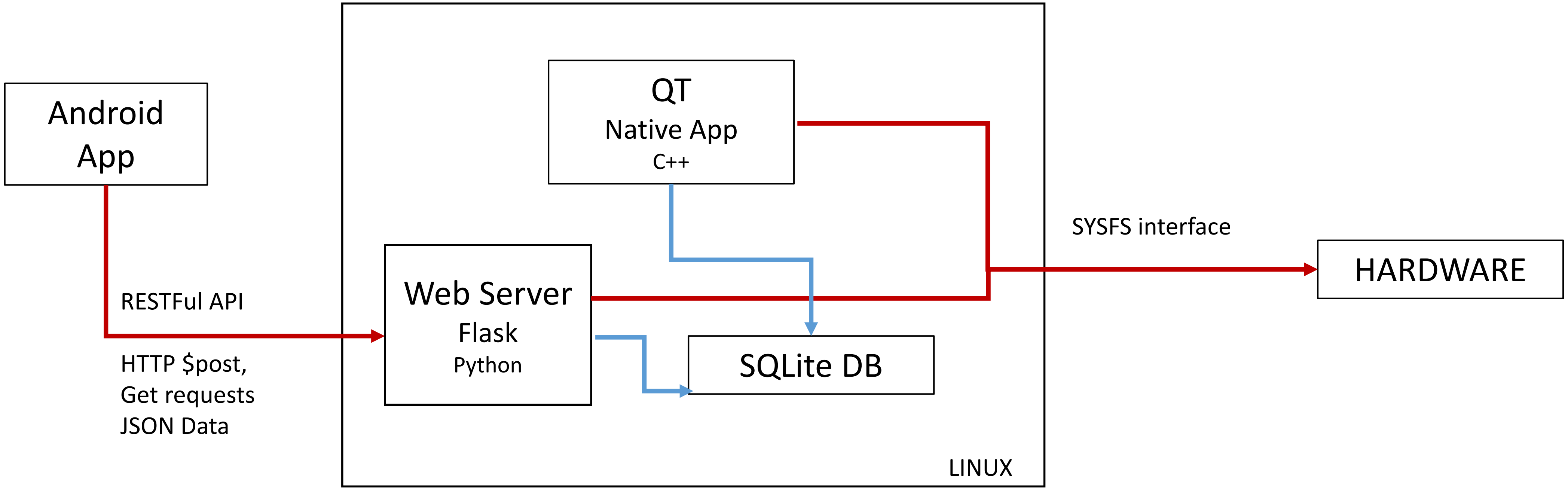


CFA-WIFI-01

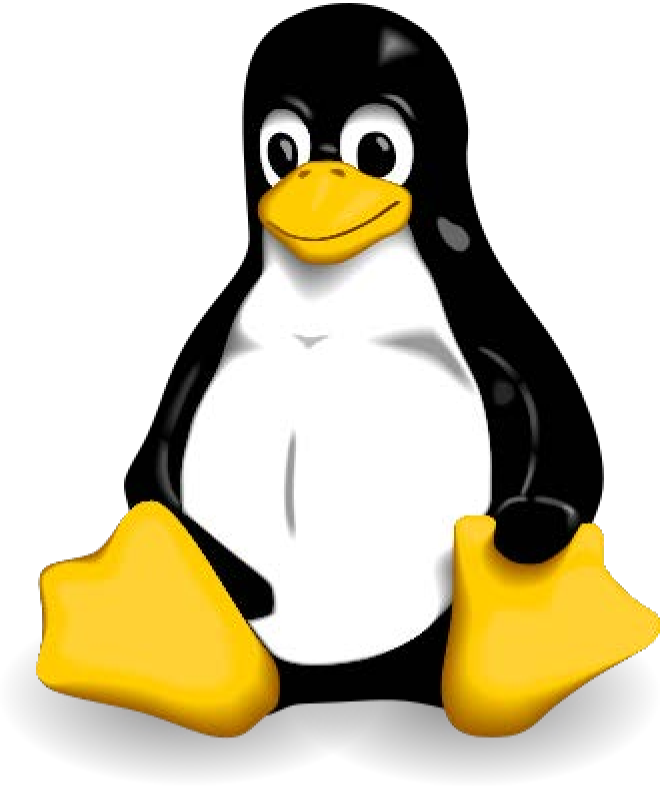
- Any USB dongle will work
- Can be 2.4 or 5 GHz

SOFTWARE design

SOFTWARE design



OPERATING system



- Custom Linux OS made with Buildroot
- Based on kernel version 3.12.17.
- Will have the bare minimum we need
    - USB
    - GPIO
    - Networking/WPA supplicant
    - QT and python libraries

BACKEND

Flask
web development,
one drop at a time

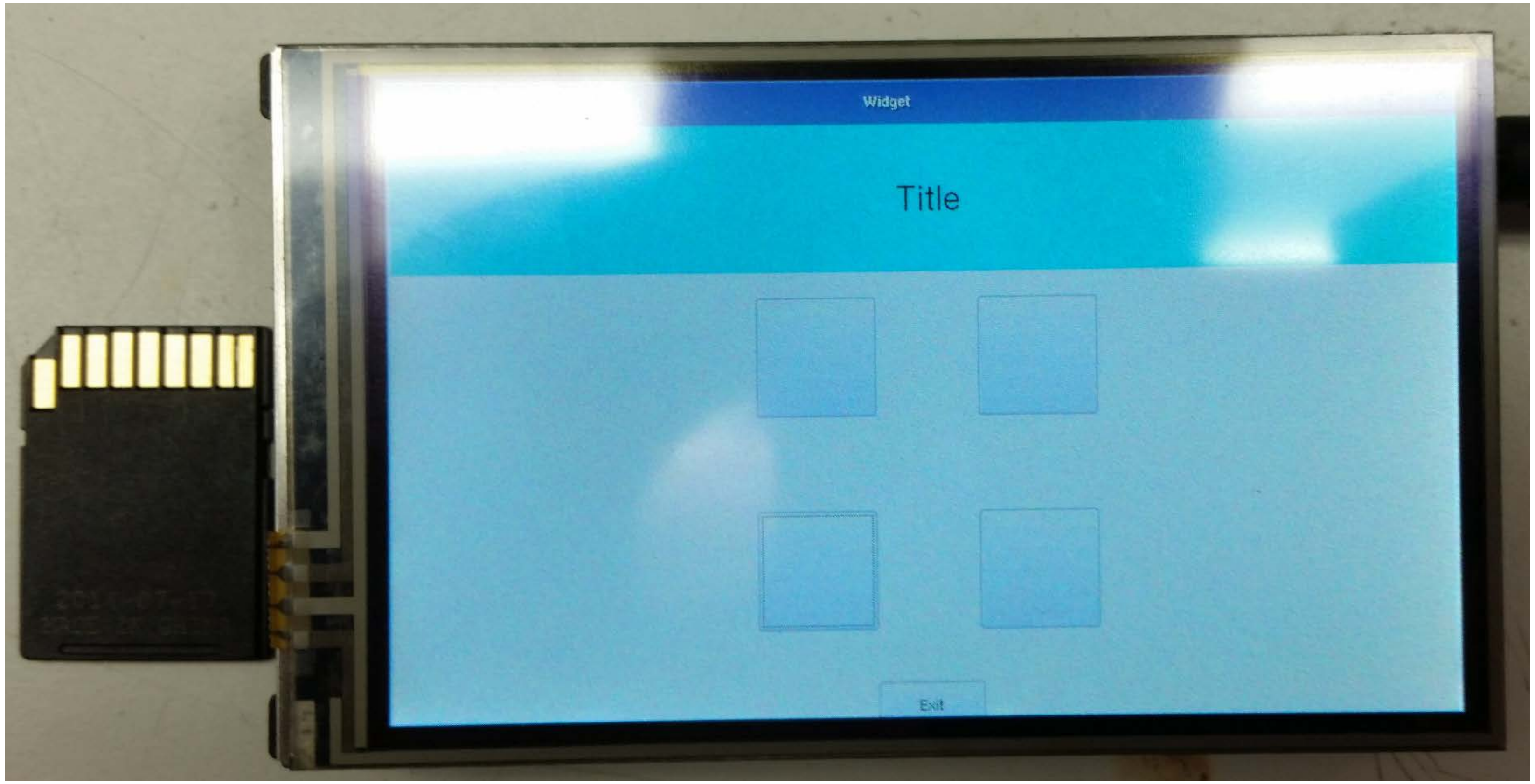
SQLite

- Flask as a webserver/application framework
  - Python-based
  - API to communicate with android app
- SQLite Database
  - Perfect for single applications and embedded systems
  - Can be created from directly within Flask

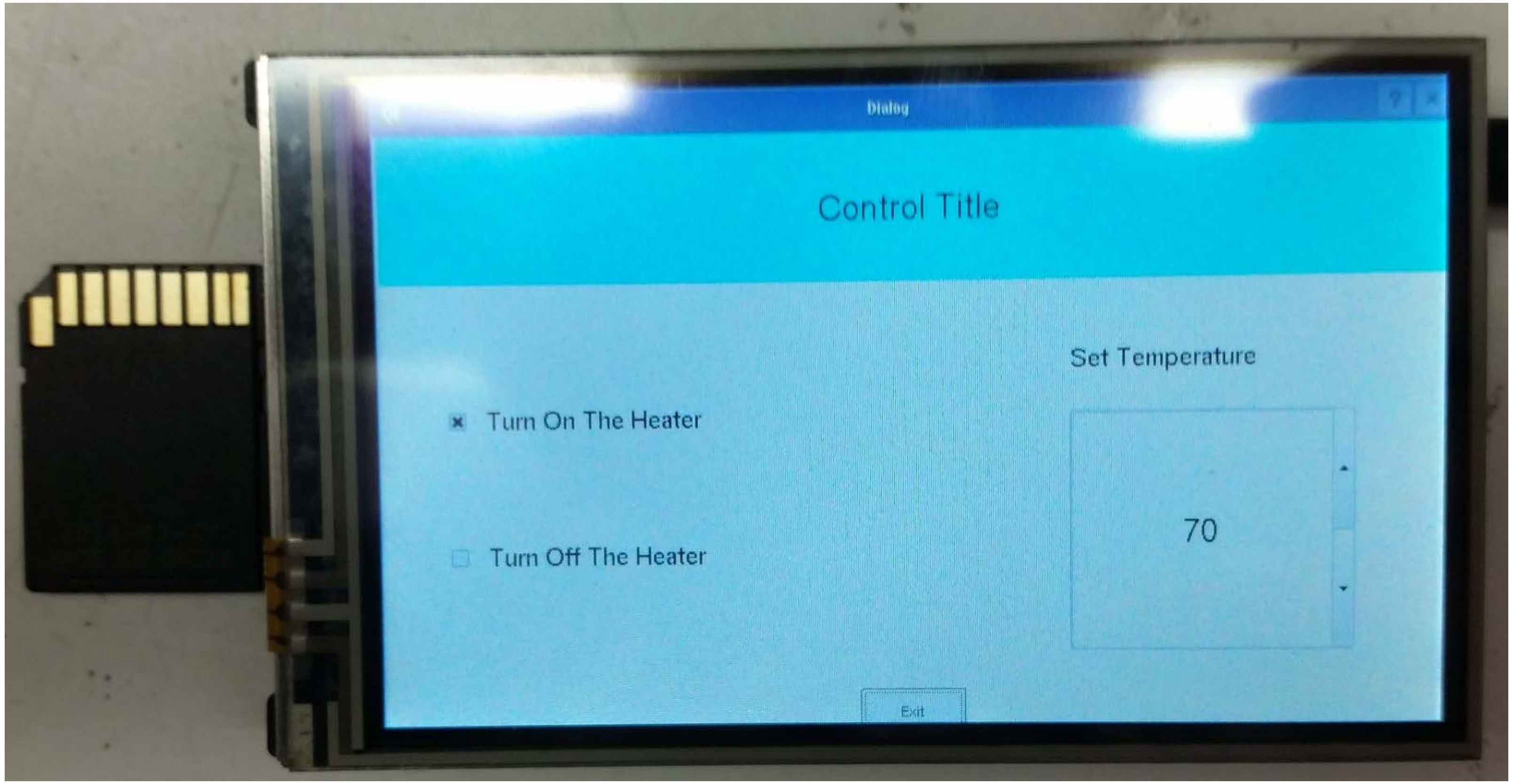
FRONTEND

- QT application framework for UI development
  - Cross platform
  - It can output to our frame buffer without a window manager
  - It can interface with SQLite database created in flask

NATIVE app



NATIVE app



☒ Turn On The Heater

□ Turn Off The Heater

Set Temperature

70

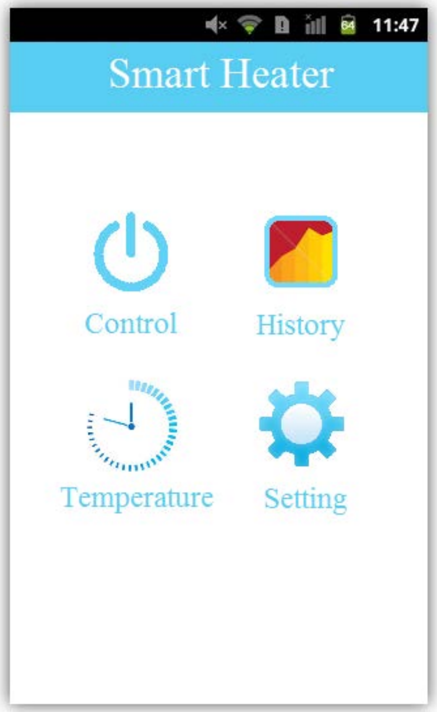
PATTERN recognition

- Store data as an image
- Sample data every 5 minutes
    - Each sample represented as a pixel
- Image processing to find the pattern
- Calculate threshold
- Use thresh hold to separate the data

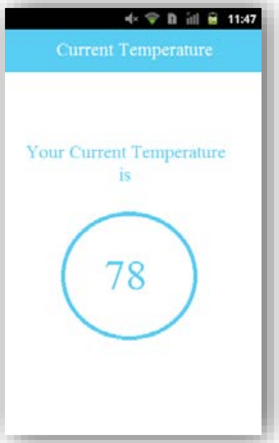
MOBILE application

- Android App to communicate with water heater remotely
- Uses RESTful API
  - HTTP requests
  - JSON

APPLICATION features



- Displays
  - Statistical data
  - History of usage
    - Temperature
    - Energy usage
- Controls
  - Temperature
  - Turn on/off



ADMINISTRATIVE content

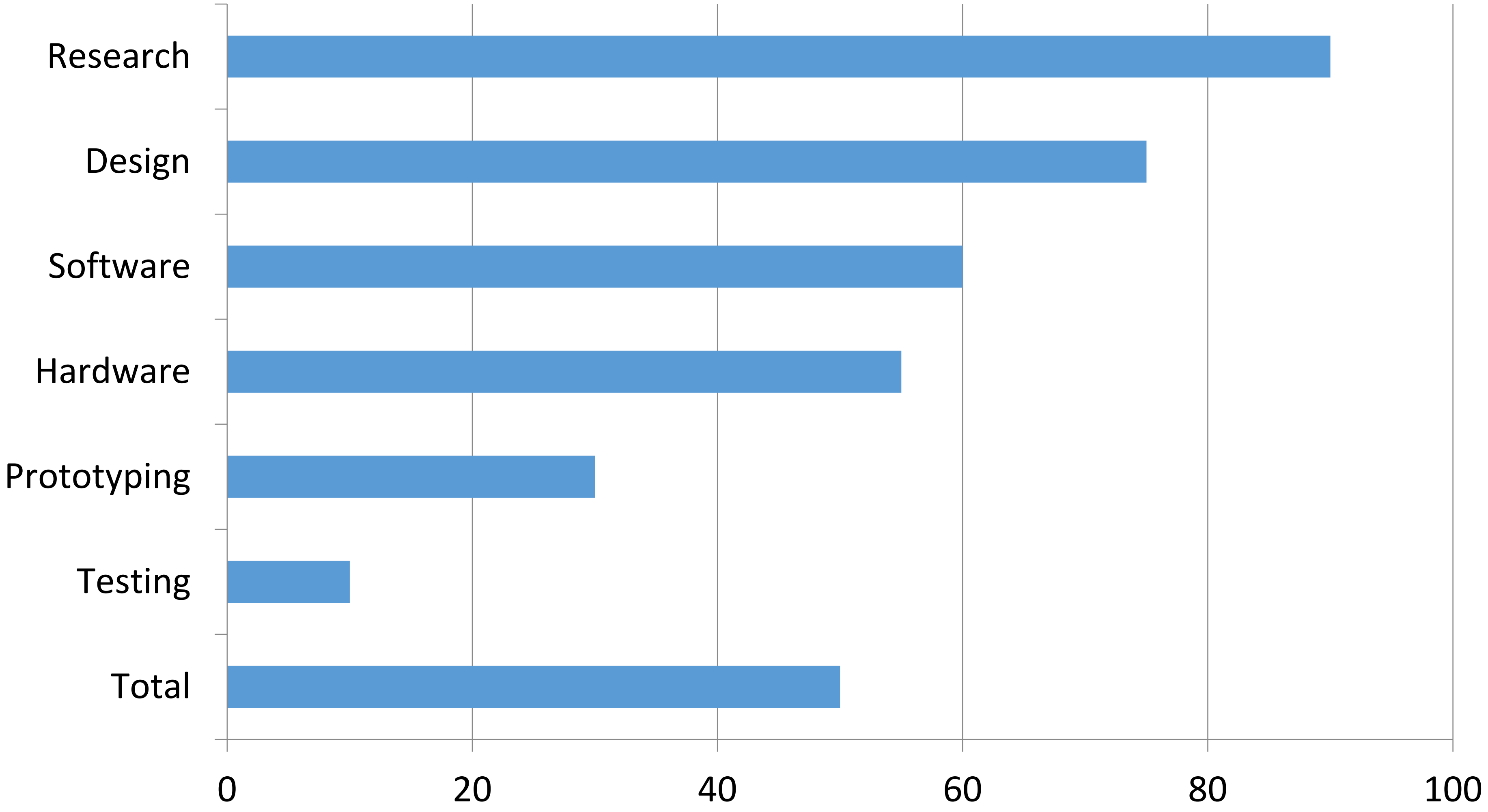
WORK distributions

	Hardware	Software backend	Software frontend
Mauro		X	
Bryan	X		
Vipol			X

BUDGET

	Quantity	Price	Extended	Cost
CFA920-TS	1	187	187	0
WiFi adapter	1	5	5	0
Temperature sensor	2	10	20	20
Flow meter	1	10	10	10
Current sensor	1	10	10	10
PIR sensor	1	7	7	0
Relays	3	12	36	36
PCB	1	30	30	30
Miscellaneous components	1	40	40	40
		Total	345	146

PROGRESS


Research
Design
Software
Hardware
Prototyping
Testing
Total
0
20
40
60
80
100

QUESTIONS?