Electric Motor Monitoring

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What’s covered

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- Overview
- Big Picture Vision & PDS
- Project Scope for This Semester
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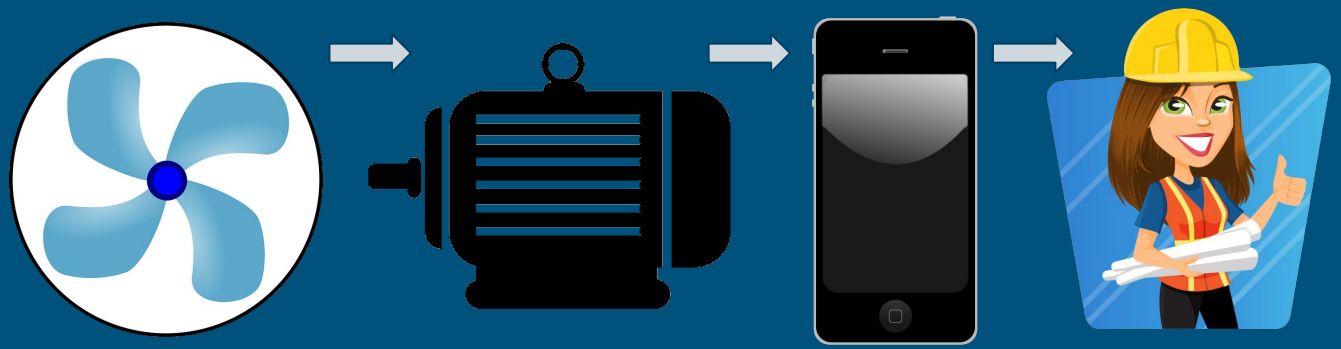
The Problem & Background

- Preventative maintenance can waste money by replacing parts that are still usable
- Machine failure can cause down time of a machine at very unpredictable times and can damage other parts that would otherwise remain healthy.
- Monitoring machine components through electric motors and a mobile app can inform engineers and technicians as to which parts are likely to fail first and when they must be replaced.

Overview

We want to use an electric motor to gain insights on whatever it is driving (fan, pump, pulley, etc.)



Product Design Specifications

Our product should be able to

- Transduce multiple thermophysical parameters using sensors installed on the motor
- Record and make available both past and real-time data for review
- Display the data and analysis in a user-friendly interface
- Compare baseline reference data with a machine’s performance in order to predict a problem with the mechanism being driven by the motor

Big Picture Vision

Give building managers the ability to prioritize procedures like bearing or belt replacements based on the motors attached to them using data about temperature, duty cycle, noise level and quality, vibration, voltage, and current analyzed and displayed by a mobile app.

Project Scope for This Semester

- Build mobile platform to interface with Raspberry Pi, analyzing and displaying data from sensors
- Outfit donated small-scale motor and pump with sensors
- Obtain baseline data for regular operation of pump
- Intentionally hinder operation of pump and observe the effects on measured motor parameters, building model for anomalous and damaging pump behavior

Measurements and Sensors

Temperature	→	Thermocouple
Vibration	→	Accelerometer
Voltage	→	Voltage divider, analog input
Current	→	Inductive current sensor
Noise level and quality	→	Microphone

Design Criteria and Alternatives

- Arduino
- Raspberry Pi
- TI LaunchPad

Criteria	**Weight (%)**
Cost	5
Communication ability	25
Durability	5
Programming ease	15
Computing power	15
Accessories availability	15
Product support, community forums	10
Physical size	10

Alternatives and Design Matrix

	Arduino		Raspberry Pi		TI Launchpad	
Cost (5)	**2.5/5**	**2.5**	**4/5**	**4**	**4.5/5**	**4.5**
Communications (25)	**4/5**	**20**	**5/5**	**25**	**2/5**	**10**
Durability (5)	**3/5**	**3**	**3/5**	**3**	**3.5/5**	**3.5**
Programming ease (15)	**4.5/5**	**13.5**	**4.5/5**	**13.5**	**3/5**	**9**
Computing power (15)	**2.5/5**	**7.5**	**4/5**	**12**	**4/5**	**12**
Accessories availability (15)	**5/5**	**15**	**3/5**	**9**	**3/5**	**9**
Product support, community forums (10)	**5/5**	**10**	**5/5**	**10**	**3/5**	**6**
Physical size (10)	**3.5/5**	**7**	**4/5**	**8**	**5/5**	**10**
Total	**-**	**78.5**	**-**	**84.5**	**-**	**64**

	Arduino		Raspberry Pi		TI Launchpad	
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Communications (25)	**4/5**	**20**	**5/5**	**25**	**2/5**	**10**
Durability (5)	**3/5**	**3**	**3/5**	**3**	**3.5/5**	**3.5**
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Module Software

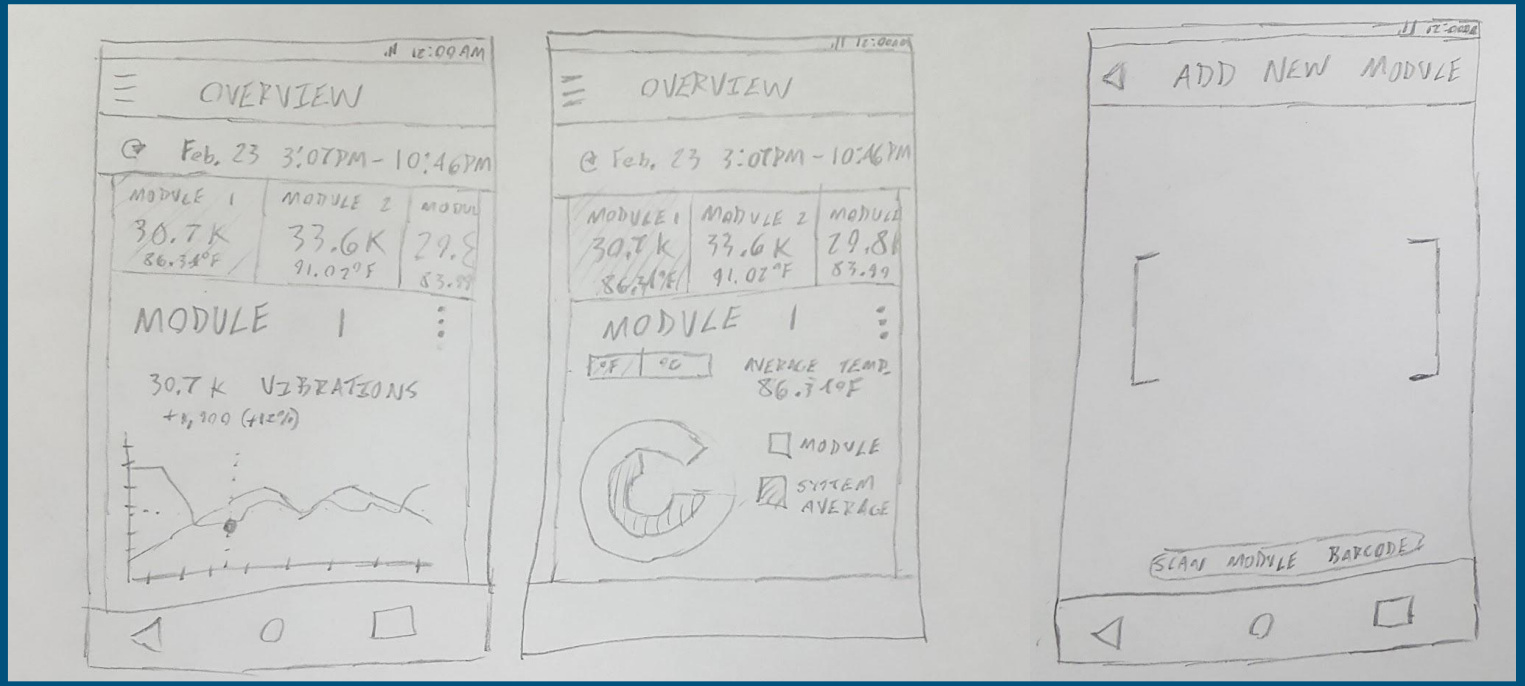
- Raspberry Pi running Python script
- Round Robin Database to store sensor data
- PubNub Framework for SSL encrypted network communication
  - Wrap and send batches of data
  - Live Stream data at network speed

ANALYTICS
281
101
321
120
PubNub
Real-Time Network

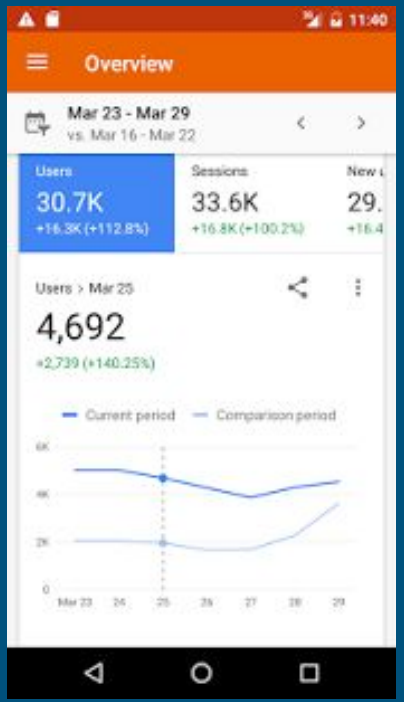
Client Software

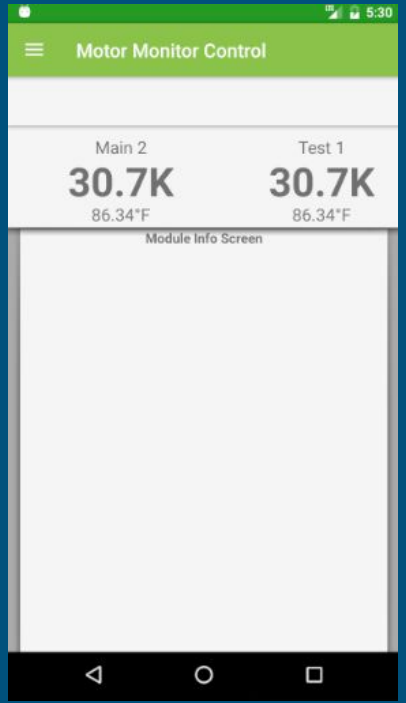
- Android Phone/Tablet Application
- PubNub Framework for SSL encrypted network communication
- GraphView Library to visualize data
- GreenORM for data persistence
- Google Mobile Vision for adding modules by scanning barcodes
- Custom algorithms to detect data irregularities early

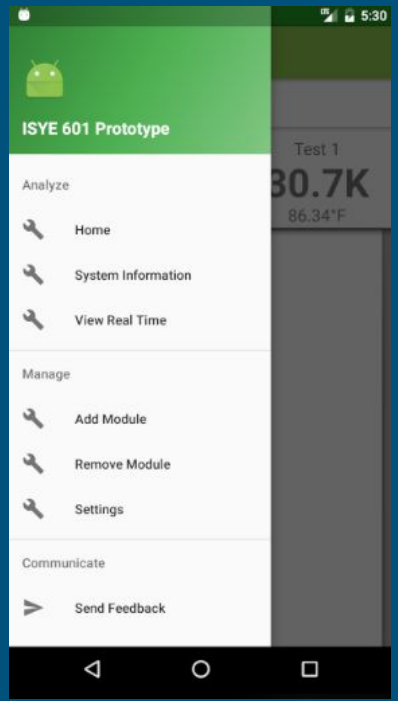
Android Screen Mockups



Android Design Inspiration







Future Work

- Expanding concept to more machines
  - Fans
  - Belt drives
  - hoists
- Implementing our solutions on already-existing equipment on campus
  - HVAC systems on campus
  - Manufacturing equipment in local factory

Acknowledgements

- Regal Beloit, for proposing the idea
- Alfonso Gutierrez, for explaining the concept
- Kurt Kaiser at Pentair, for donating pumps

Sources

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Questions?