Smart Water Leak Shut Off Valve

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sdmay21-11

https://sdmay21-11.sd.ece.iastate.edu/
Advisor & Client: Cheng Huang

Project Vision

- Problem Statement
  - To develop a low-cost water shutoff valve with the ability to remotely monitor and control water flow.

- Purpose
  - Mitigate unwanted water usage/leaks to prevent water damage.

- Main Goal
  - Develop a mobile application and water valve that can communicate with each other to control and report the flow of water through a pipe. The valve can also be automatically shut off when abnormal water usage is detected.

Constraints

- Affordability
  - Total cost of parts: <$150
- Accessibility
  - Reasonable size for easy integration
  - Run on common household voltages
  - Some plumbing knowledge may be required
- Technology
  - Requires a WiFi connection
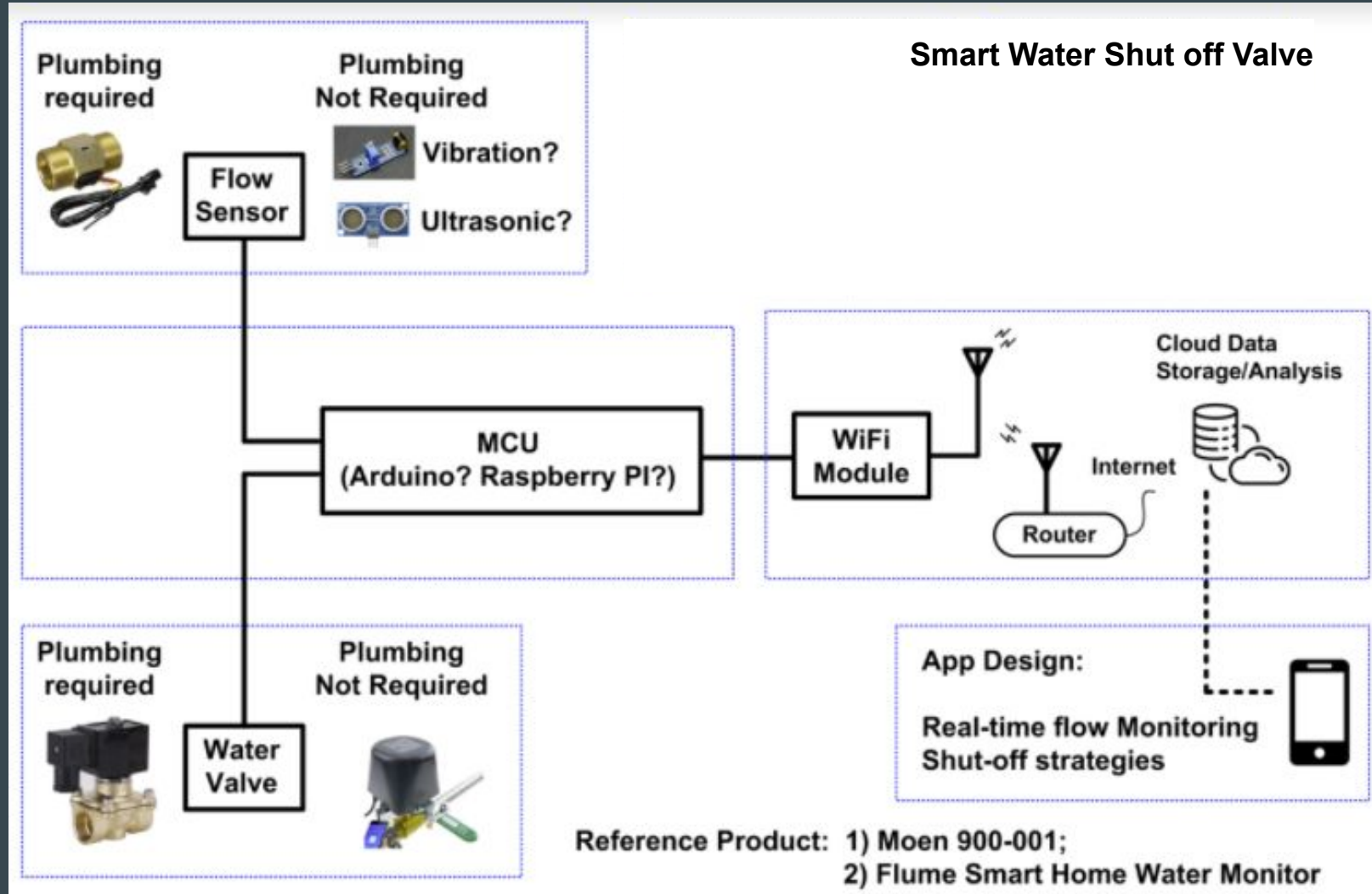 - Mobile device for application

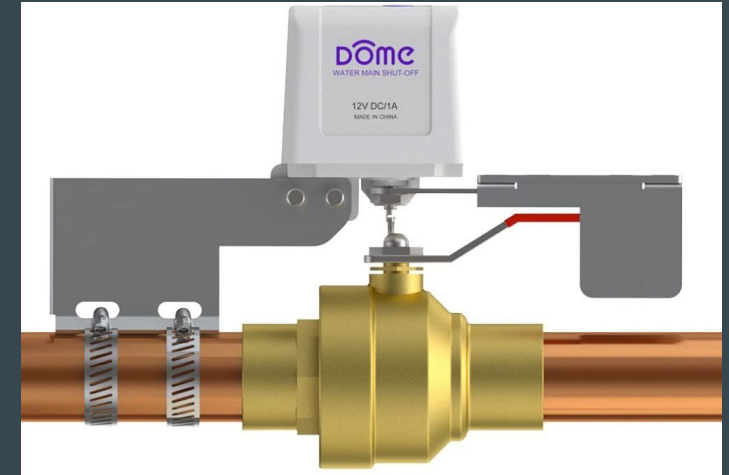Flo by Moen $486.57

Phyn Plus Smart Water Assistant $699.99

Conceptual Sketch
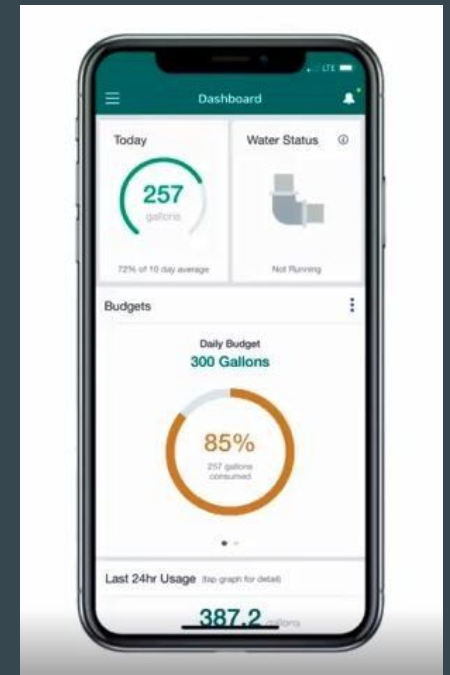
Functional Requirements

Hardware:

- Detect water flow through pipes
- Communicate with the software
- Change state of shutoff valve

Software:

- Notify user of unwanted water usage in real time
- Allow user to turn water off/on remotely
- Allow user to input schedule to automatically turn water off when detected
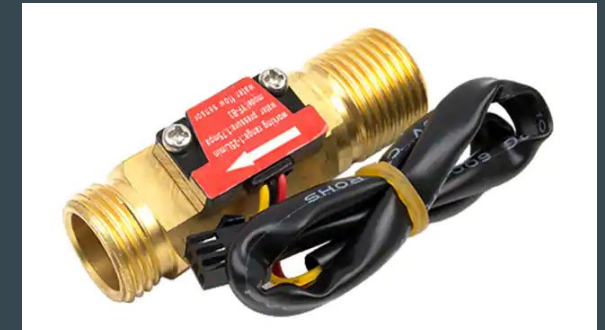
Qualitative Assessment
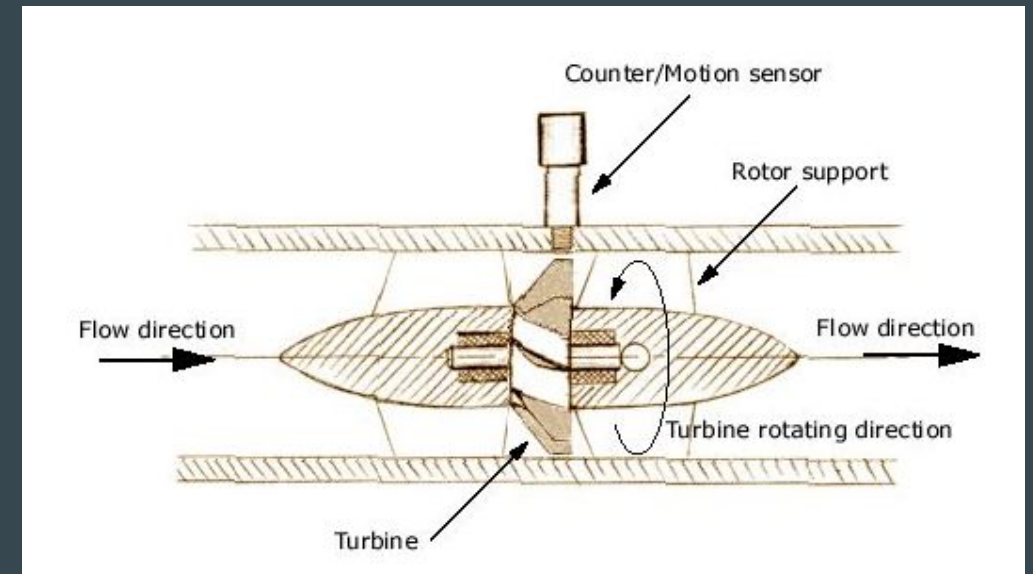
Sonic Sensor:

Flow Sensor:

Considerations:

- Cost
- Effectiveness
- Compatibility
- Component specific risks

Risk Management

- Short Circuiting: Waterproof enclosure
- Loss of Internet Connection: Notify user when wifi connection is lost
- Lost data: Backup data buffer
- Software Compatibility: Android only
- App Crashing: Thorough software testing, ability to report a crash

Schedule

| Task	Time (weeks)
Initial Brainstorming/Creating a schedule	4
Researching Sensors/Parts	2
Research ESP8266 Wifi Module Compatability	3
Hardware Design	2
Software Design	2
Finalizing Designs	1
Ordering and Receiving Parts	4
Frontend Basic UI Development	2
Backend Setup and Login Screen	2
Bug Testing	7+
Hardware Individual Testing	2+
Prototype Construction	2+
Prototype Software Integration	2+
Functional Requirement Testing	2+

Development Framework

- We decided to use the Agile Framework
  - Promotes communication between teammates
  - Consistently receive feedback after each sprint
  - Continuous implementation of features
- Git and Trello
  - Easily share progress
  - Review code before pushing to production
  - Update tasks and goals
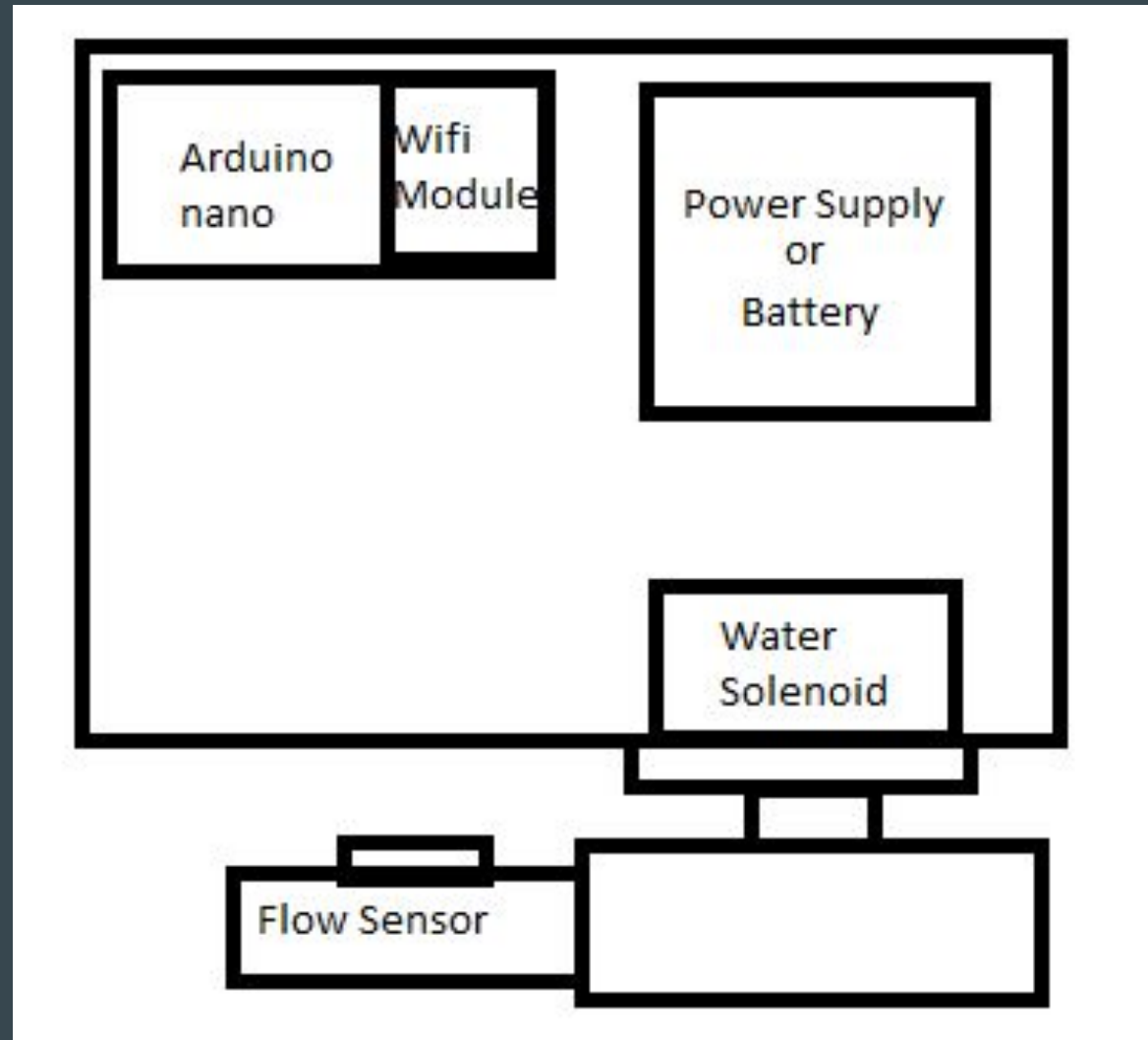- Discord as means of communication
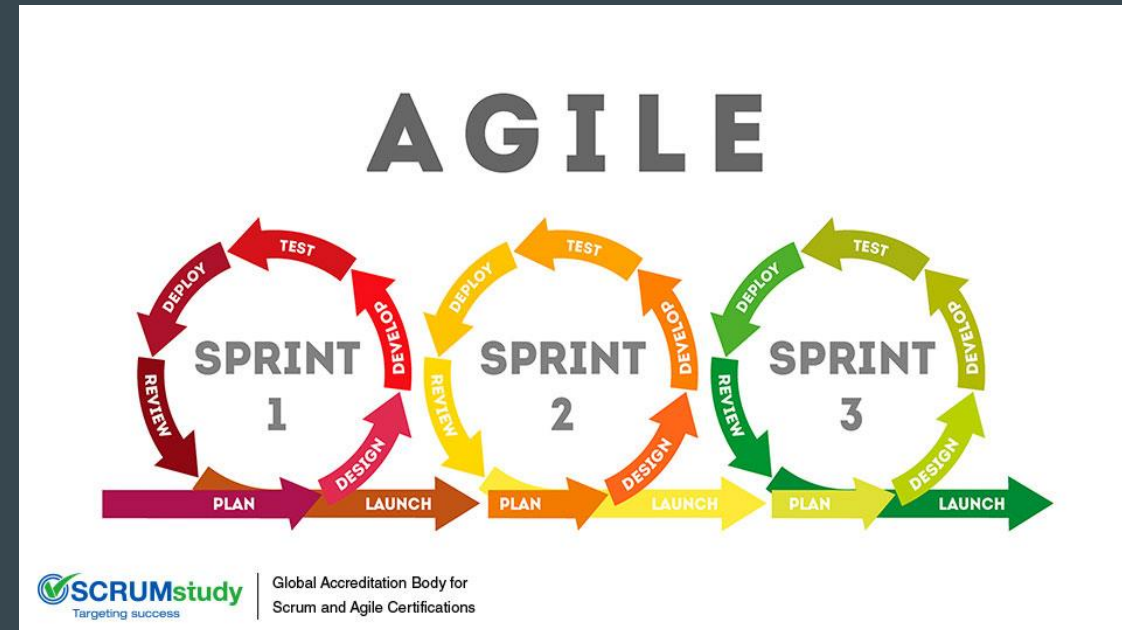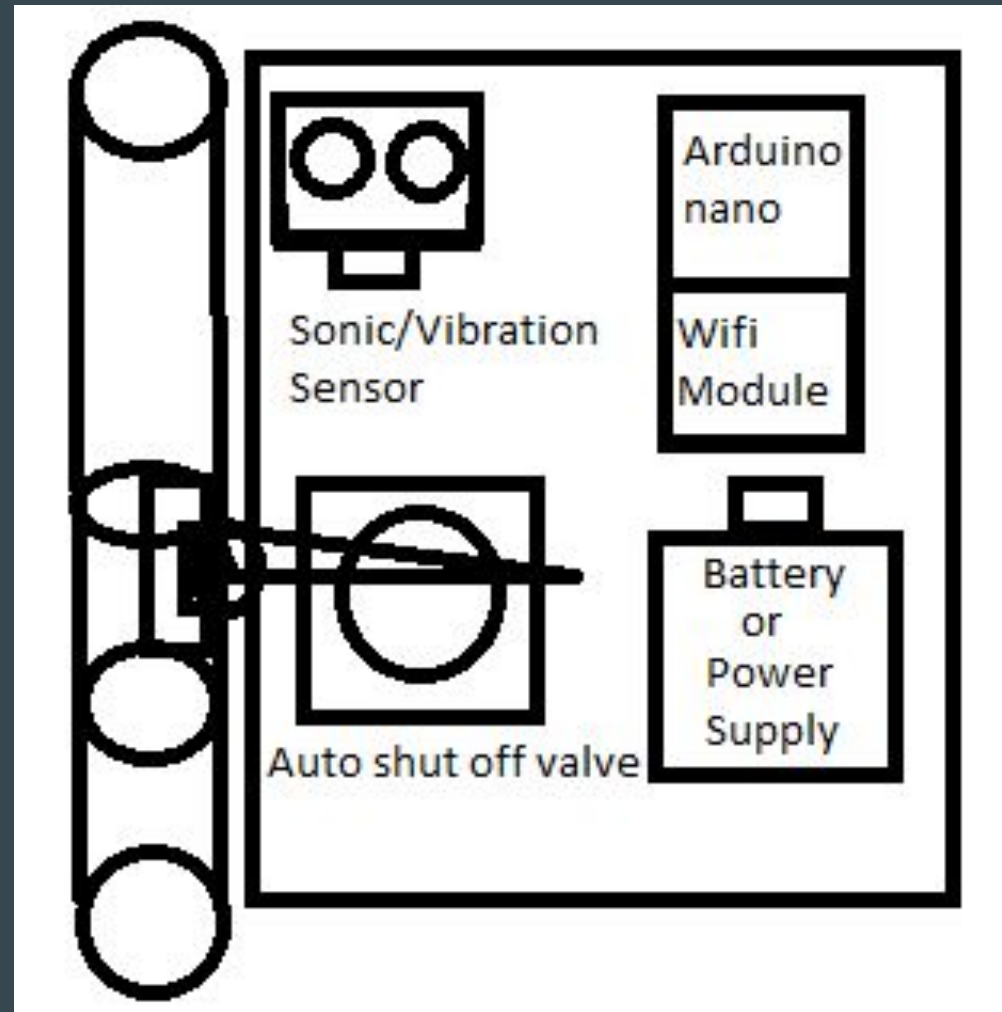
Entity-Relationship Diagram
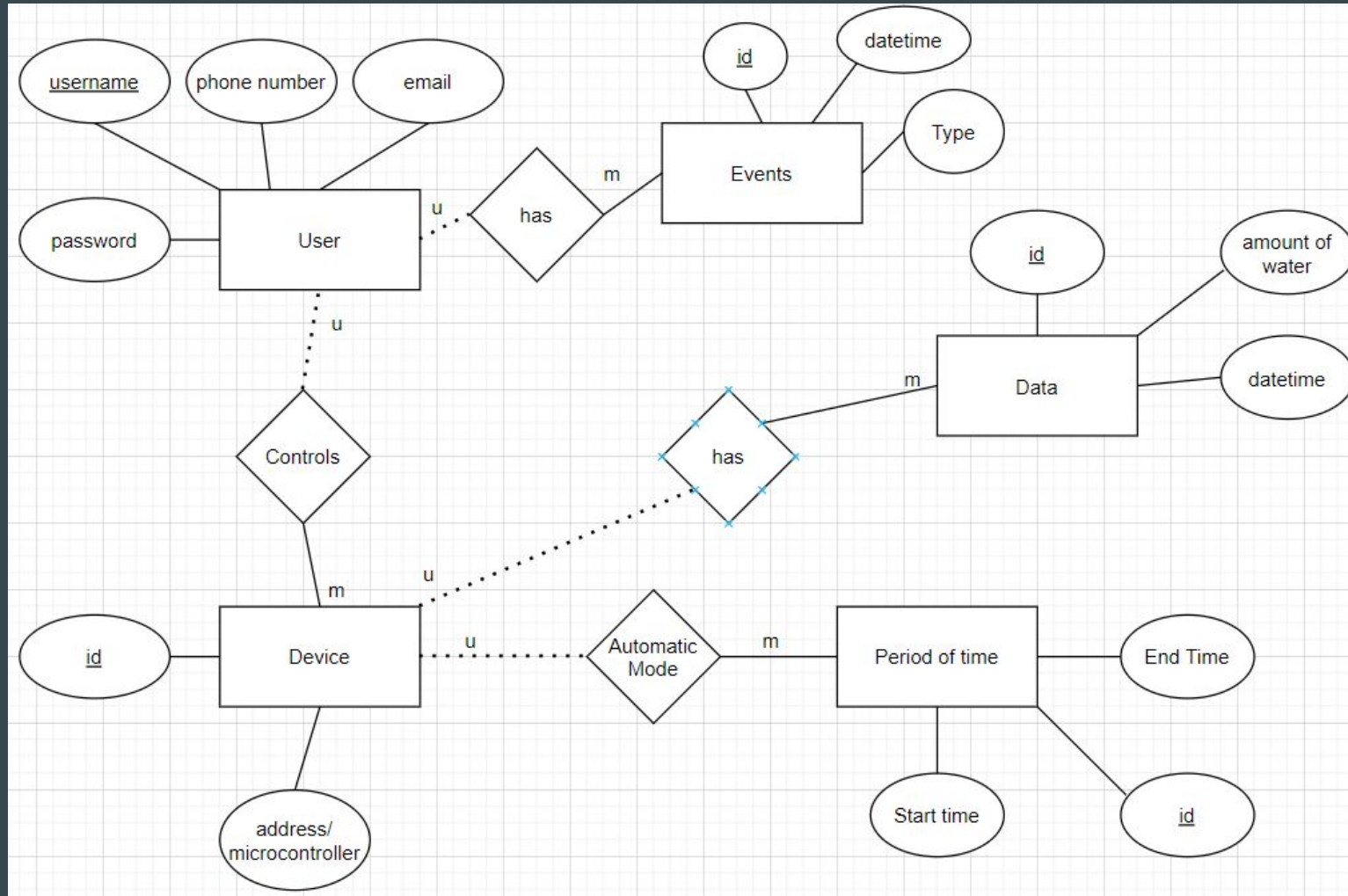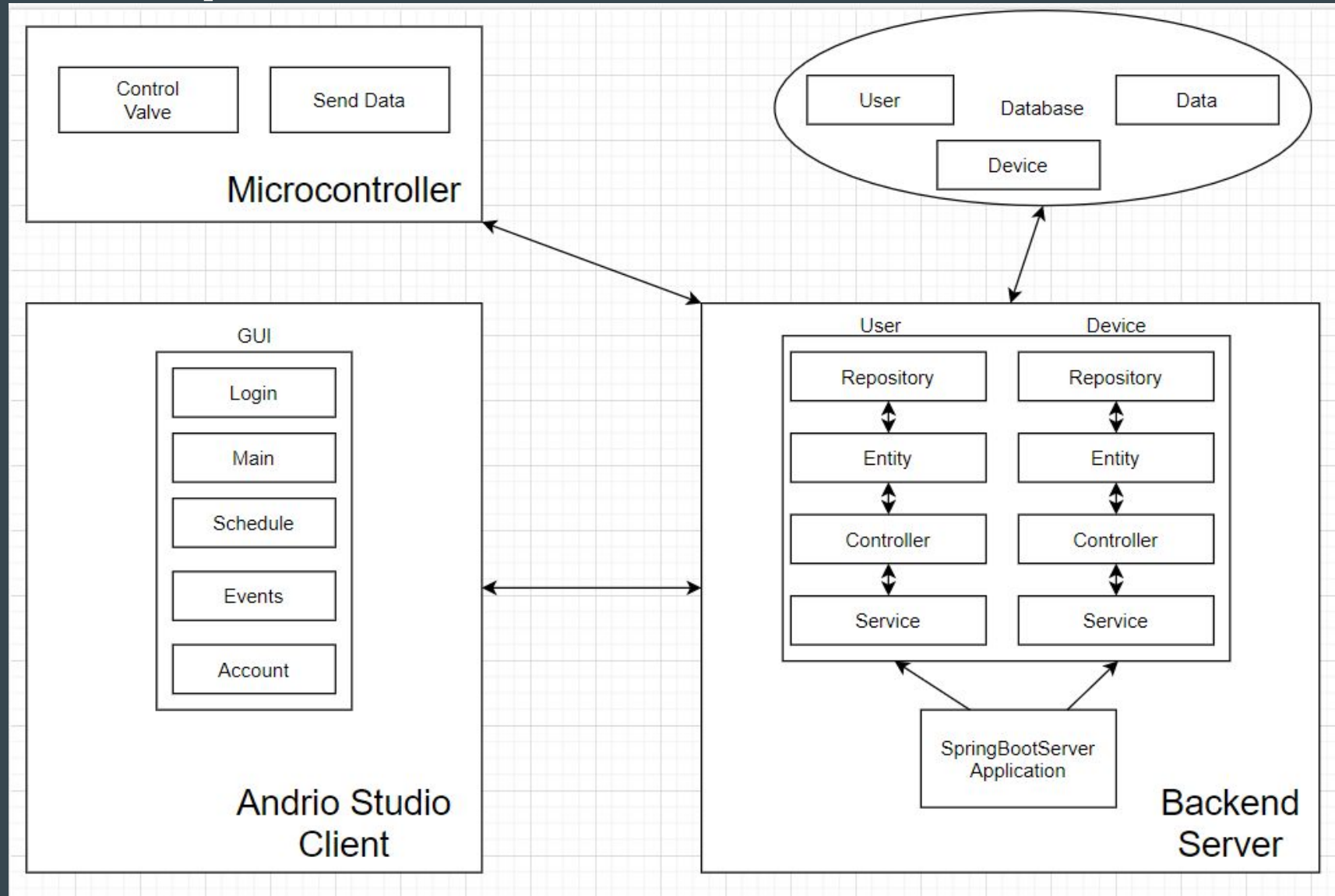
Screen Sketches
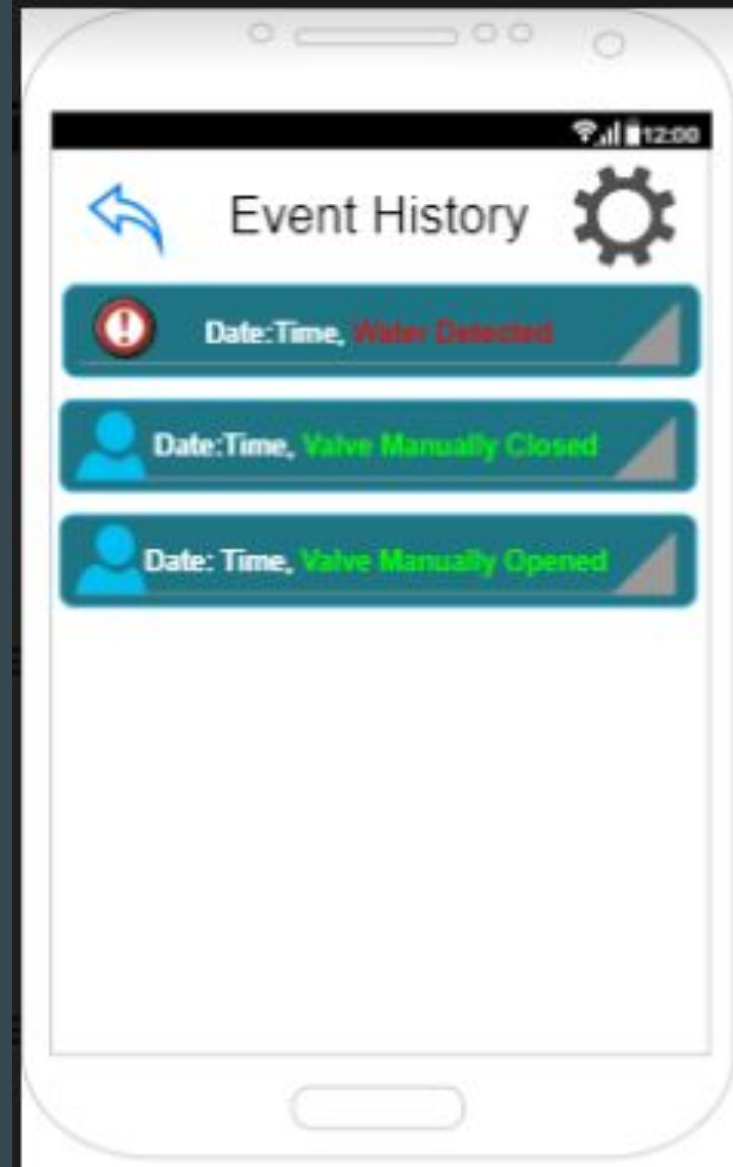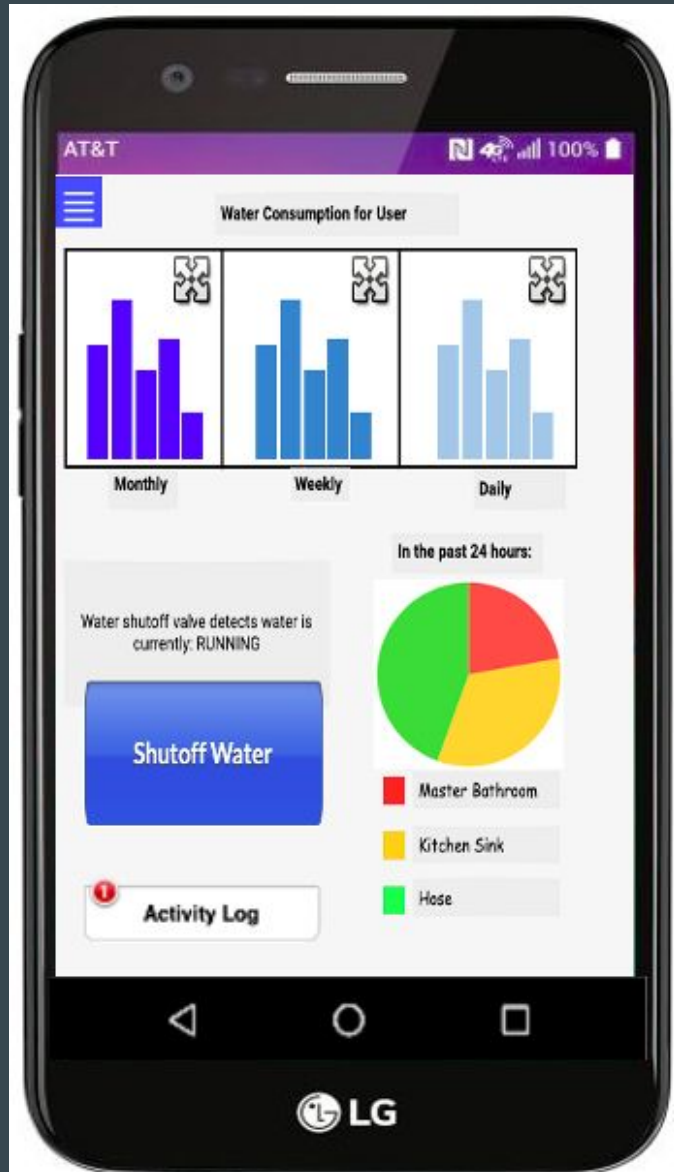
Hardware Prototype - Plumbing

Hardware Prototype - Non-Plumbing

Software Implementation Plan

Software Test Plan

- JUnit
  - Test individual methods for correctness
  - Narrow down bugs
- Espresso
  - Used to test the interface of the app
- Mockito
  - Test classes and reliance on other classes

Hardware Test Plan

- Data Detection
  - Test known signals through the arduino and wifi module
- Water flow Sensor
  - Alter flow of water through the sensor to ensure it's working properly
  - Leave a constant flow through the sensor for a prolonged time to ensure water is monitored properly over-time
- Valve Shut-off
  - Attach valve shut-off to ensure operation
  - Run operation continuously to determine if there is a breakdown after some number of turns

Completed Milestones

- Hardware
  - Determining best flow sensor component
  - Testing commercially available shut-off valves

- Software
  - Basic GUI
  - Running Spring Application with methods for user creation and authentication

Looking Forward

- Construct plumbing hardware prototype
- Hardware to Software communication
    - Sending and receiving signals
- Non-plumbing option
    - The option that allows the user to just attach the product to the pipe and valve
- Machine learning
    - Analyze existing water usage to automatically detect abnormal water flow

Individual Contributions

- Grace Wilkins - Report Manager
  - Assessing and developing testing framework for hardware components
- Curt Kissel - Frontend Software Developer
  - Front end software development, research, and testing
- Jihun Yoon - Meeting Scribe
  - Front end software development, research, and testing
- Matthew Brandt - Backend Software Developer/ Meeting Planner
  - Back end software development and testing
- Wolfgang Morton - Hardware Engineer
  - Researching hardware components and design layout
- Cody Juracek - Hardware Researcher
  - Researching hardware components and design layout

Questions?

Use Case Diagram

2nd Semester Schedule

Parts List

Device	Part Name	Cost
Water flow sensor G1/2	11499173	$6.02
ultrasonic sensor	Excelity 3pcs Ultrasonic Module HC-SR04 Distance Sensor with 3pcs Mounting Bracket for Arduino	$7.99
Electric rotating motor	290-008	$19.99
Wifi module	Serial Wireless WiFi Transceiver Receiver Module	$12.98
Water ball valve, male, G1/4	Mini Ball Valve, Brass, Inline, 1-Piece, Pipe Size 1/4 in, Connection Type FNPT x MNPT	$8.65
Arduino Nano	Mini Nano V3.0 ATmega328P Microcontroller Board w/USB Cable For Arduino	$13.99

Table 2.7. Parts List