

Smart Water Leak Shut Off Valve



Team Email: sdmay21-11@iastate.edu

Website: <https://sdmay21-11.sd.ece.iastate.edu/>

Advisor & Client: Cheng Huang

chengh@iastate.edu

Overview

- 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

	
<p>Flo by Moen \$486.57</p>	<p><u>Phyn</u> Plus Smart Water Assistant \$699.99</p>

Requirements

Functional

- Hardware monitors and sends water flow data to app
- Users can view their water usage history
- Users can remotely turn the valve on/off and monitor their water flow in real time
- The shut-off valve can automatically open and close according to a schedule entered by the user

Non-Functional

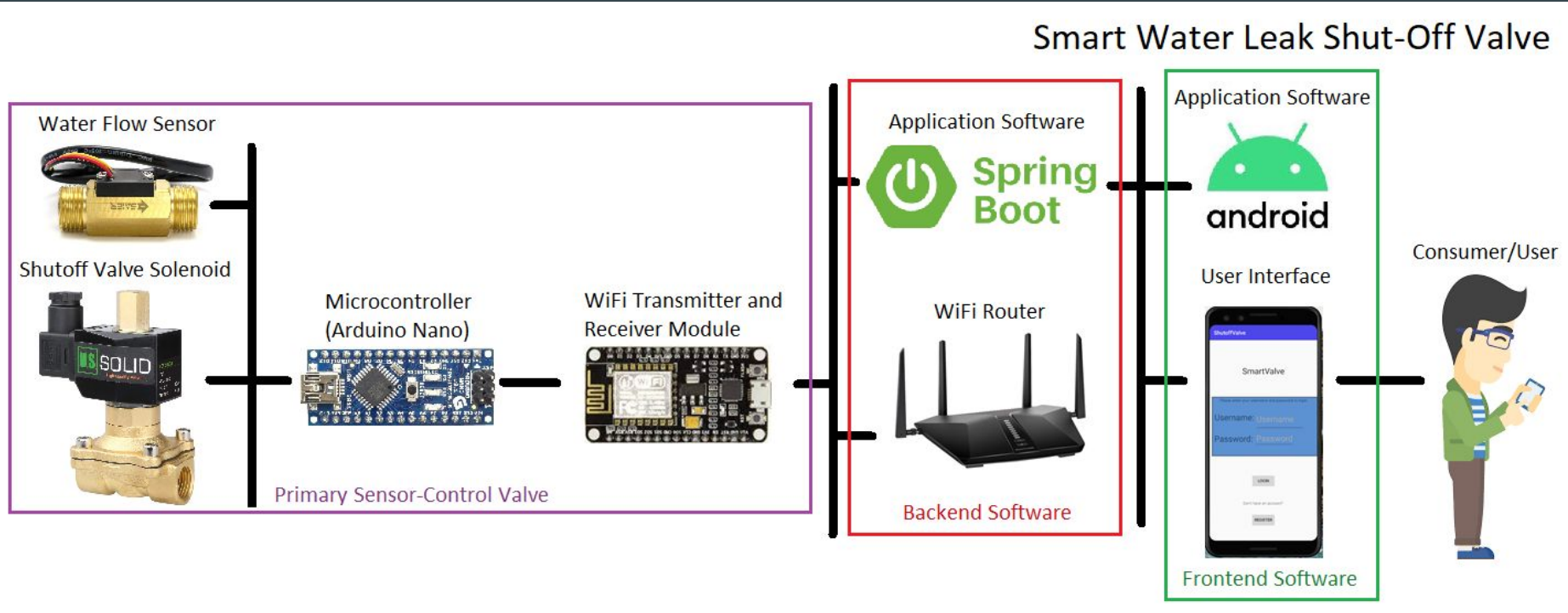
- Hardware expected cost less than \$200
- Measure water flow within 5% accuracy of actual flow rate
 - Final Set Accuracy: 1%
- Hardware is easily integratable into a piping system

Constraints

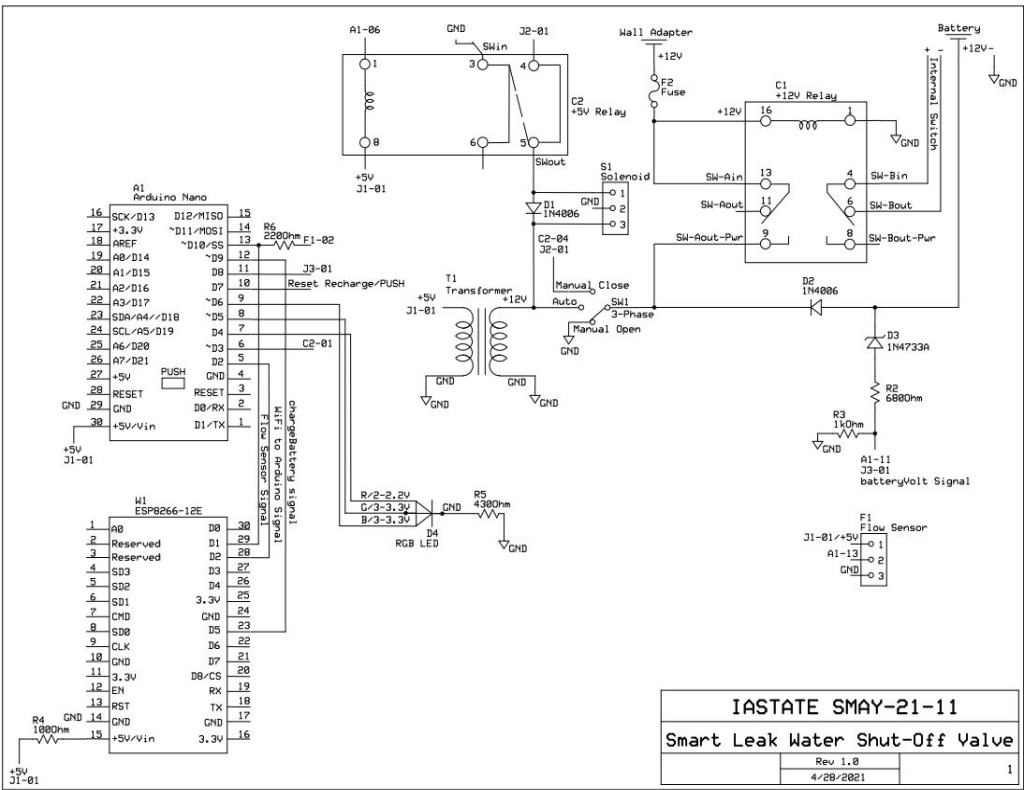
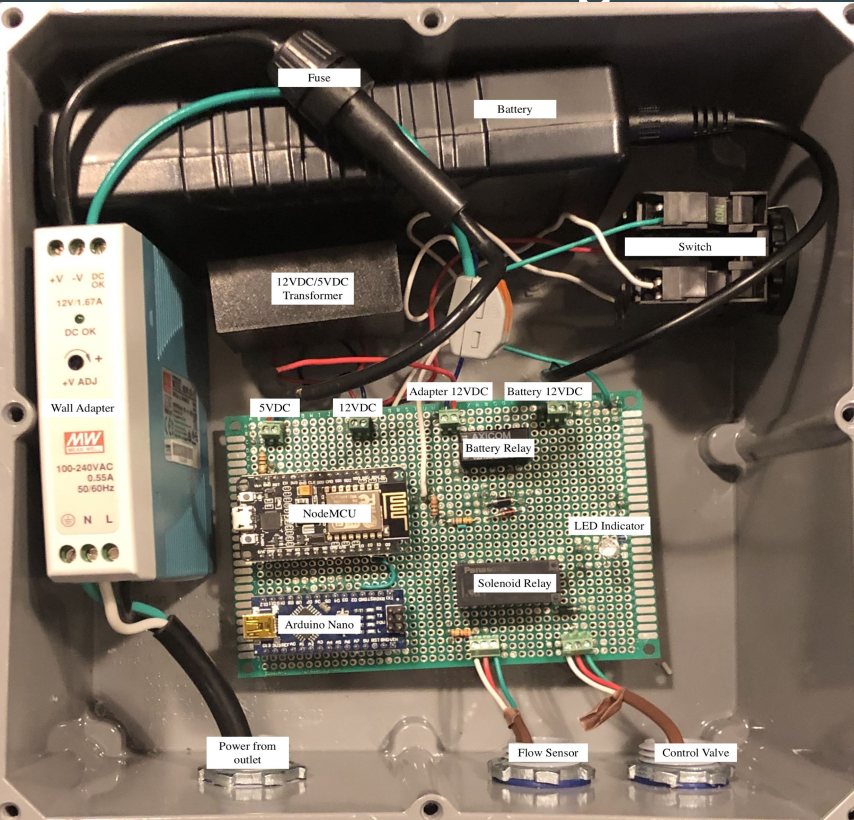
- **Affordability**
 - Total expected cost of parts: <\$200
- **Accessibility**
 - Reasonable size for easy integration
 - Run on common household voltages
 - Some plumbing knowledge may be required
- **Technology**
 - Requires a WiFi connection
 - Mobile device for application

Parts	Cost
Solenoid	\$42.80
Power Supply	\$13.50
Arduino Nano	\$4.66
Flow Sensor	\$10.49
Wifi Module	\$4.66
Housing	\$28.45
PCB	\$51.00
Transformer	\$8.98
Fuse	\$2.59
Resistors	\$0.50
1n4006 Diode	\$0.14
1N4733A	\$0.12
5V Relay Switch	\$2.76
12V Relay Switch	\$3.66
Rechargeable Battery	\$37.99
RGB LED	\$0.09
Total Expected Cost:	\$212.39
Without PCB	\$161.39

Conceptual Sketch



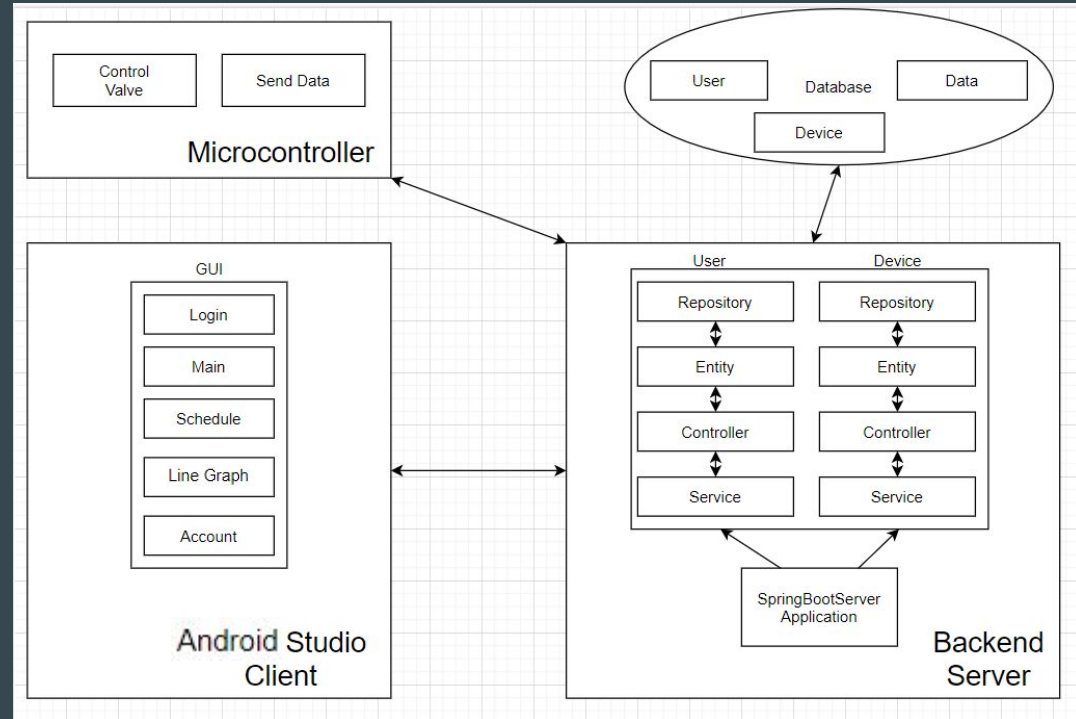
Final Circuit Design



IASTATE SMAY-21-11	
Smart Leak Water Shut-Off Valve	
Rev 1.0	
4/28/2021	1

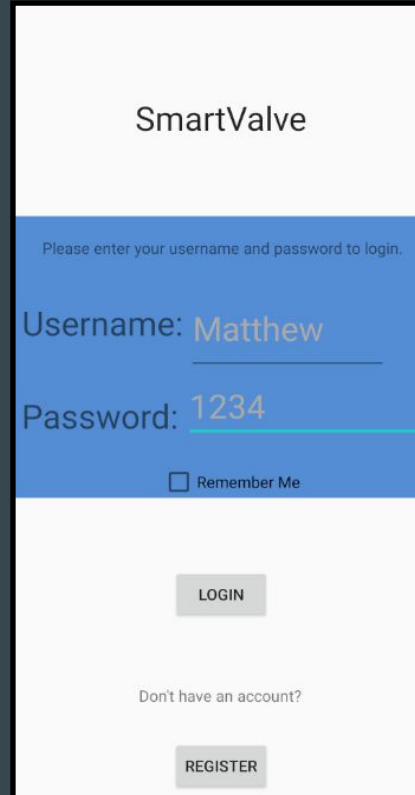
Software Implementation

- Spring Boot application connected to MySQL database
- Android Application using Android Studio
- Shut Off Valve communicates using ESP8266-12E NodeMCU



Account Setup

- Account creation
- Device management
- Setting up the Shut Off Valve



SmartValve

Please enter your username and password to login.

Username: Matthew

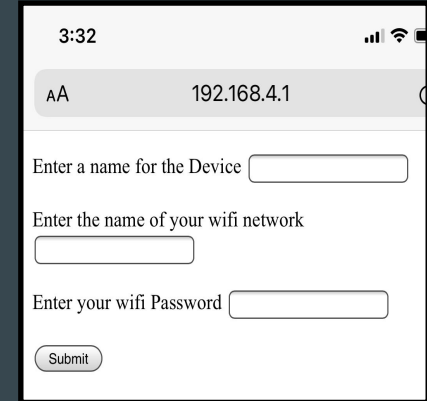
Password: 1234

Remember Me

LOGIN

Don't have an account?

REGISTER



3:32

AA 192.168.4.1

Enter a name for the Device

Enter the name of your wifi network

Enter your wifi Password

Submit



Settings

Devices

Enter a name for your device

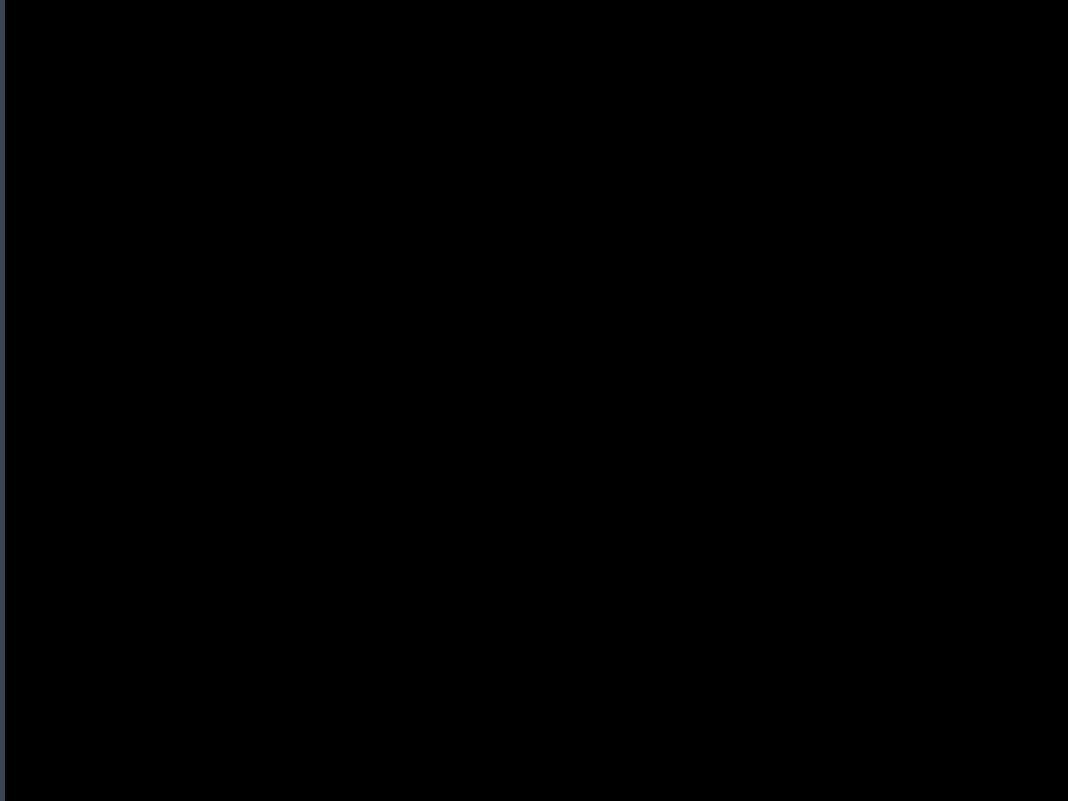
NewDevice + ADD DEVICE

254.254.254.254

4

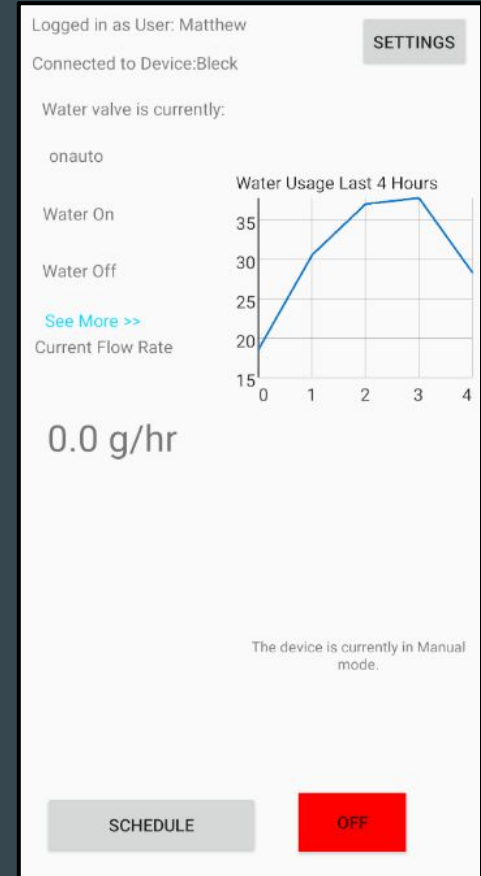
Block

Account Setup: Demo

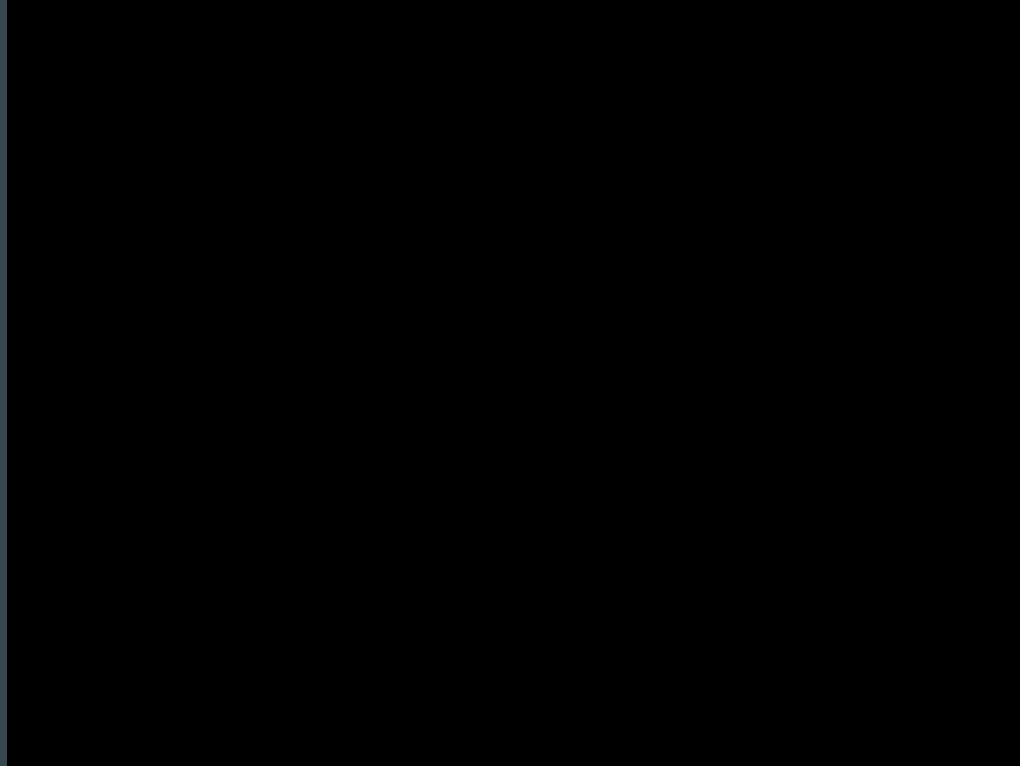


Controlling the Shut Off Valve

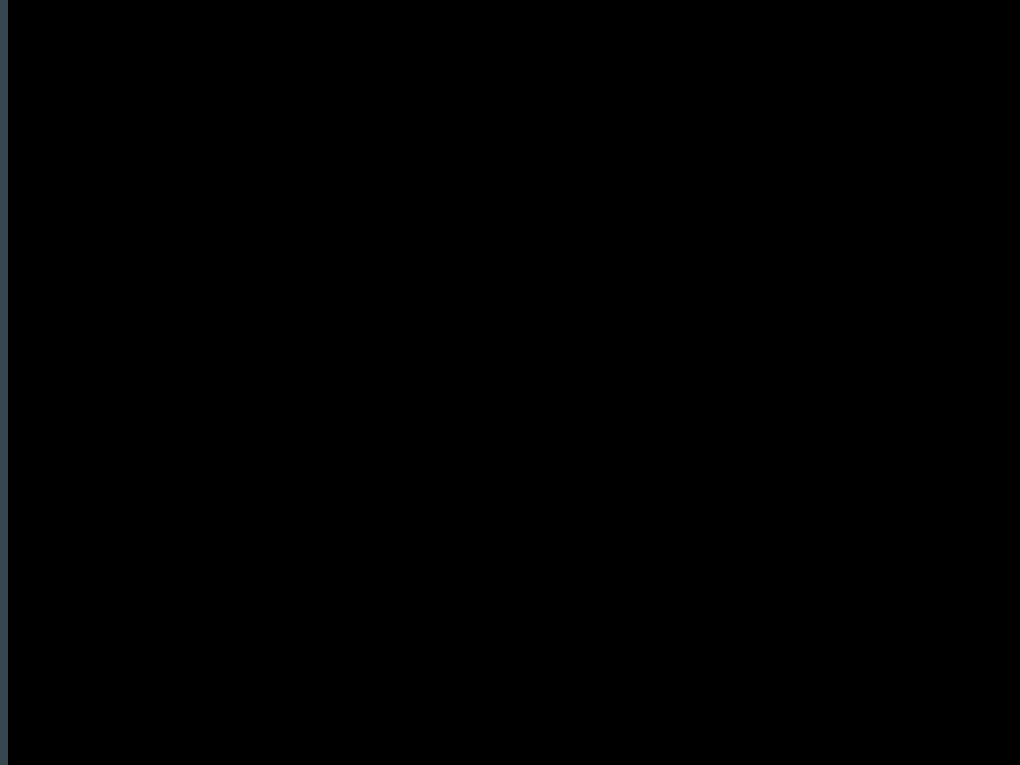
- Users can manually open/close the valve
- Default settings when WiFi connection is lost
- Switch to manually turn device off
- Schedule automatic shut off times



Controlling the Shut Off Valve: Demo

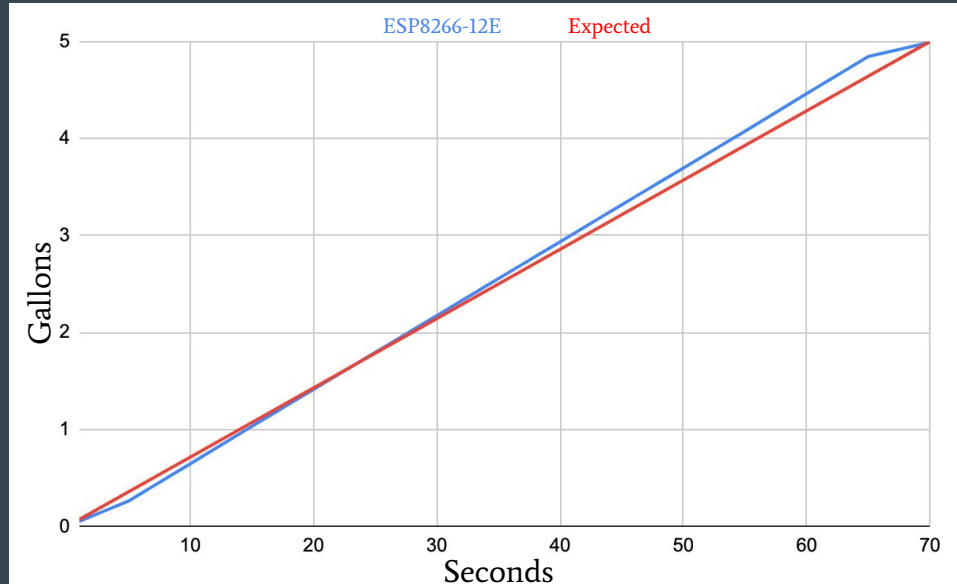


Real-Time Water Usage Updates



Accuracy Testing

- Known Volume testing
- Calculated percent error and made necessary adjustments
- We are currently within 1%



Scheduling for Automatic Mode

- Users can schedule times for the device to automatically shut off
- Options for daily, weekly, or one-time events
- Can view schedule up to a week in advance

Friday, April 23

12 AM 12 PM
1 AM 1 PM
2 AM 2 PM
3 AM 3 PM
4 AM 4 PM
5 AM 5 PM
6 AM 6 PM
7 AM 7 PM
8 AM 8 PM
9 AM 9 PM
10 AM 10 PM
11 AM 11 PM

Sleeping

Dinner

Create a New Event:

Event Name _____

Start Time 1 : 0 AM

End Time 1 : 0 AM

Daily Event Weekly Event

Friday, April 30

12 AM 12 PM
1 AM 1 PM
2 AM 2 PM
3 AM 3 PM
4 AM 4 PM
5 AM 5 PM
6 AM 6 PM
7 AM 7 PM
8 AM 8 PM
9 AM 9 PM
10 AM 10 PM
11 AM 11 PM

Sleeping

Dinner

Concert

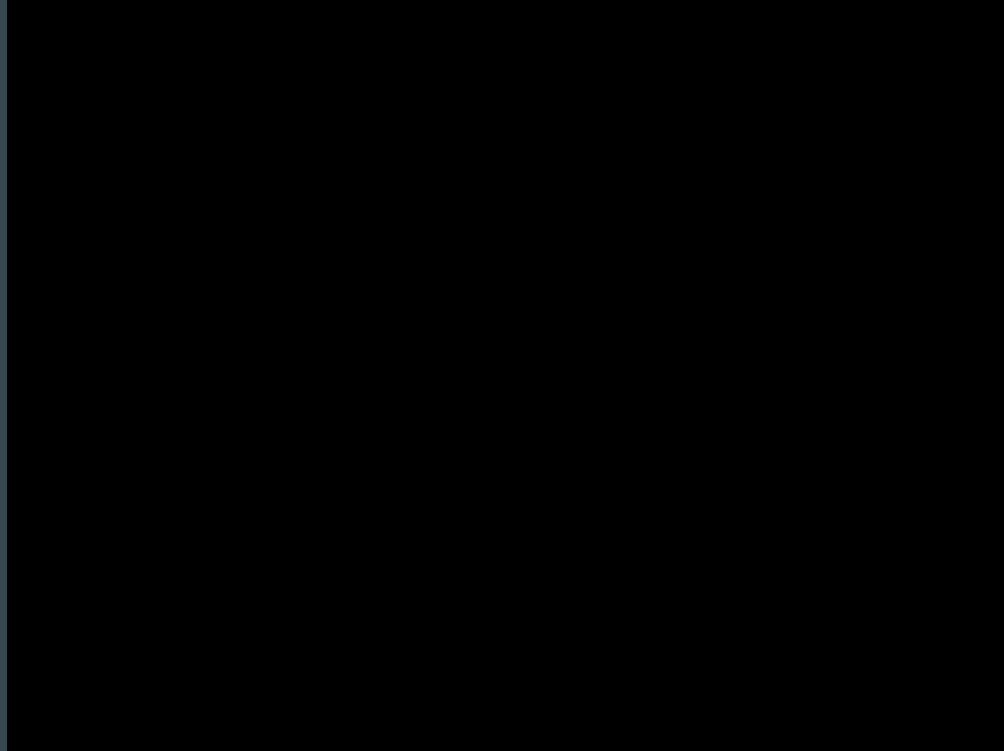
Create a New Event:

Event Name _____

Start Time 4 : 0 PM

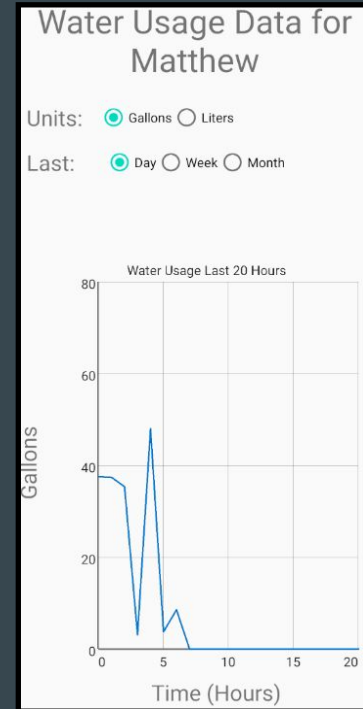
End Time 4 : 30 PM

Scheduling for Automatic Mode: Demo

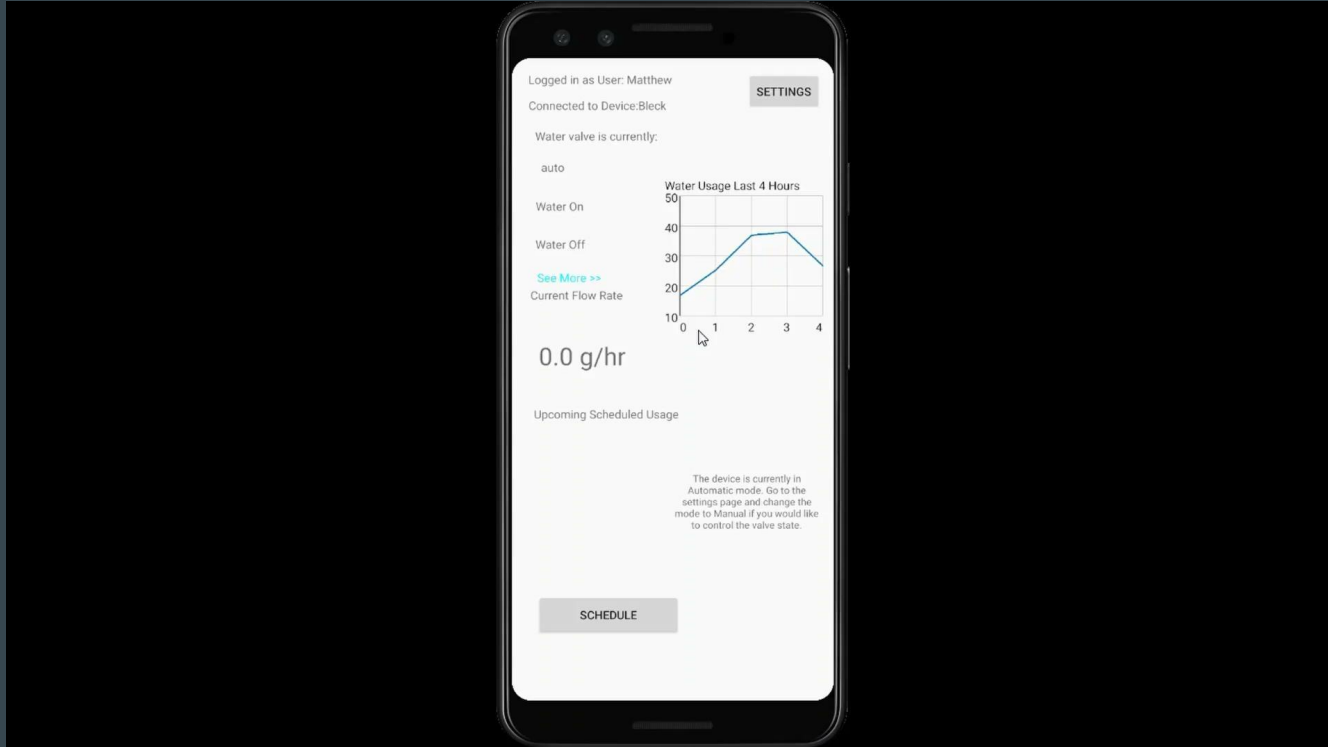


Water Usage Graph

- Users can view previous water usage
- Home screen provides a preview of 4 hours of usage
- Can view daily, weekly, and monthly water usage



Water Usage Graph: Demo



Override Switch w/ Demo

- The switch allows for users to override the application
- Position 1 - “OPEN”
 - Water will flow unrestricted
- Position 2 - “AUTO”
 - Water will follow the application
- Position 3 - “CLOSE”
 - Water will not flow



Backup Battery

- If there is a power failure then the battery backup will kick in and can continue with the set schedule
- Battery has a max capacity of 6000mA-hr
 - The main power consumption would take place when the solenoid is on/closed
 - All other hardware components require almost negligible amperage (mA)
- The battery will last up to 6 hours, indicating it needs to be charged after 5 hours
- The battery can be removed from the system to be recharged

Closing Thoughts

- Product could be improved upon with a machine learning algorithm
- Small quality of life improvements to make the user experience better
- User interface design could be improved
- Installing a timer would make the Shut Off Valve more responsive
- Product could be improved by adding a multi-sensor network

Questions?

Individual Contributions

- Matthew Brandt - Backend Software Developer
 - Backend software development and testing
- Cody Juracek - Hardware Researcher
 - Researching hardware components and design layout
- Curt Kissel - Frontend Software Developer
 - Android Application Frontend Development
- Wolfgang Morton - Hardware Engineer
 - Design testing and prototype development/assembly
- Grace Wilkins - Report Manager
 - Programmed Arduino Nano and assessed testing results

Actual Schedule(Hardware)

- January to mid February - Solenoid circuit testing
 - Performed dry testing of the solenoid circuit
- February to March - Flow sensor circuit testing
 - Started our water testing of the circuit
- March to April - Full circuit testing
 - Full circuit water testing and circuit redesigns
 - Began battery implementation
- April to Current - Hardware and Software integration and accuracy testing
 - Established connection to the application and improved the accuracy of the flow sensor
 - Finished battery testing and implemented into the design