EE 1.7 – Actively Conserve Water

Sponsored by SENSCO Solutions

Created by:
David Talley, Eltayib Bahar, John Carroll, Lynn Vu
Ingram School of Engineering
Texas State University

ABOUT SENIOR DESIGN

- Senior Design I & II are a series of classes which provide the students with a comprehensive design experience, which introduces each member to the systematic design process.
- This process requires the participants to brainstorm, design, construct, and test a system or component in a team-based environment.
- A sponsor is provided to each group that is responsible for funding and setting guidelines for the system or component they want created.
- At the end of the final semester, each team will present their final product to their respective sponsor during Senior Design Day.

ABOUT SENSCO

- SENSCO is a startup devoted to leaving the world better than we found it by tackling important social issues.
- Whether through, conserving water, preventing hearing loss, or empowering the visually impaired, SENSCO is looking for creative sensing solutions that improve our quality of life.
- Their passion is to use technology to enact meaningful and positive change on a large scale.
- Designing, building and integrating the right components, software, and connectivity.

PURPOSE

- Clean, drinkable water is unquestionably our most precious resource.
- By 2025, 48 nations with a combined population of 2.8 million are expected to experience freshwater scarcity.
- Majority of current residential irrigation systems are timed and a broken sprinkler head or a cracked pipe can waste water.
- Problem may go undetected for weeks or months depending on when the system is set to run.
- Current leak detection /prevention systems are either inadequate or too expensive to be widely adopted.
- We believe we can empower individuals to make a contribution towards solving the leakage and water loss problem.

TEAM MEMBERS


David Talley
Project Manager

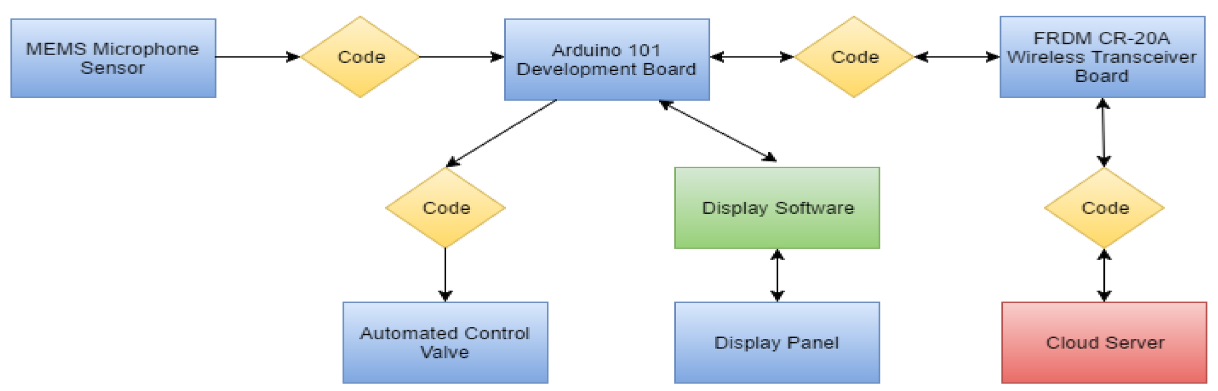

Eltayib Bahar


John Carroll


Lynn Vu

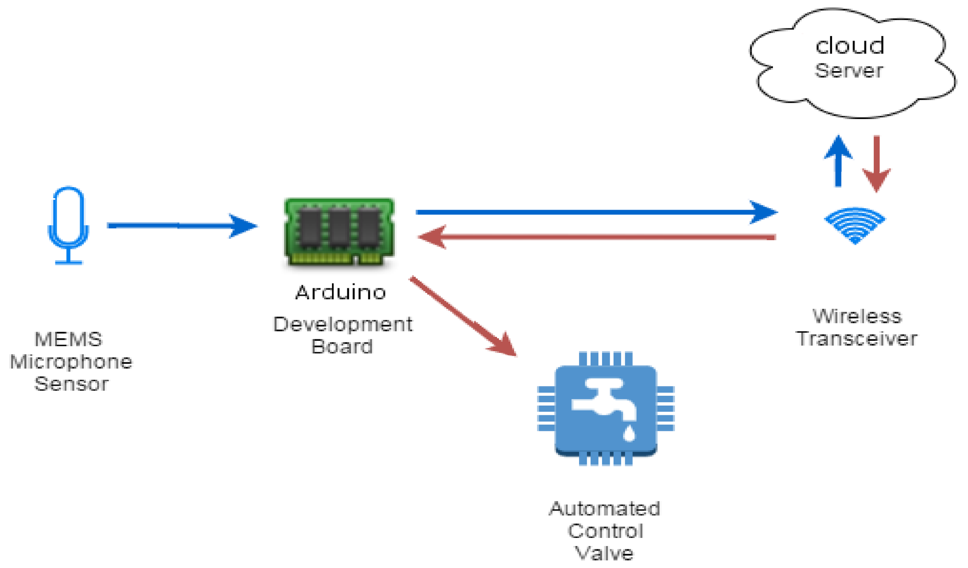
OUR APPROACH

- Our team is proposing a Smart Irrigation System that will be capable of:
  - detecting a leak in a residential irrigation system.
  - Shutting off water to the irrigation system, preventing further loss.
  - Notifying the homeowner so repairs can take place.
- The Smart Irrigation System will use data from a MEMS microphone sensor to determine if a leak is present in an irrigation network.
- We will have three different approaches towards developing this system.
- **Approach 1: Single MEMS Microphone sensor**
  - One microphone sensor will be placed at the main irrigation line. This sensor will record data about the activity of the entire Irrigation Network.
- **Approach 2: Multiple MEMS Microphone sensors**
  - This approach involves placing multiple sensors in different locations in the irrigation network. Possibly one sensor at each sprinkler head. Data from multiple sources will be analyzed to determine the status of the system.
- **Approach 3: In-line flow rate sensor**
  - If we are unable to produce an accurate interpretation of the flow rate from data produced by the MEMS microphones we will implement an in-line flow rate sensor to measure water flow.
  - This approach will be a last resort as our main goal for this project is to collect meaningful flow rate data from the MEMS microphone sensors.



FUNCTIONALITY

- Water flowing through the irrigation lines will produce vibrations and other inaudible noises as it flows through sprinkler heads
- MEMS microphone sensors attached to the sprinkler lines or the sprinkler heads themselves will detect these vibrations and sounds
- Data from the sensors will be continuously analyzed by the Arduino 101 development board. If the data meets certain criteria indicative of a leak, the system will turn a control valve to shut off water to the system
- Periodic status updates will be communicated wirelessly, notifying the homeowner when a leak is detected



ACTION CRITERIA

Hardware Performance Parameters					
Parameter	Test Conditions	Min	Max	Units	How Tested
No Flow Rate Detected	No Sound Profile	0	0.1	GPM	Shut water to system off and measure microphone output
Minimum Flow Rate Detected	Sound Profile Recognized	0.1	0.5	GPM	Slowly Increase water flow until microphone outputs recognizable sound profile.
Acceptable Flow Rate	Sound Profile Recognized	0.5	3.5	GPM	Set water flow to typical sprinkler flow rate
High Flow Rate	Sound Profile Recognized	3.5	10	GPM	Water flow exceeded typical sprinkler flow rate
Shut off Rate	No Sound Profile found	Variable	Variable	GPM	Add obstruction or open pipe to create abnormal flow rate, allow system to shut off water automatically

STRETCH GOALS

- The functionality can be expanded to Incorporate data from different inputs including:
  - Moisture sensors placed in the soil.
  - Weather forecast information.
  - These inputs will help the Smart Irrigation System to conserve water. by determining if watering the law is even necessary.
- The scale of the Smart Irrigation System can also be expanded for application towards larger irrigation systems, like those used by Golf Courses and municipal parks.

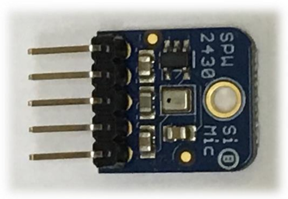
CONSTRAINTS

- Environmental Constraints
  - Our system will be calibrated specifically to our prototype, therefore it may not be universal.
- Sensitivity Constraints
  - It is not yet known what flow rates the MEMS microphone sensors will be capable of detecting. This will have an impact on which Approach our team will ultimately rely on.
- Communication Constraints
  - It may be determined that using multiple sensors, spread throughout the irrigation network is a more effective for sensing leaks. However the Arduino 101 board must be able to interpret data from multiple sensors simultaneously.
- Budgetary Constraints
  - SENSCO has provided MEMS microphone sensors and development boards. However all other necessary components must fit within our budget of $500.

HARDWARE

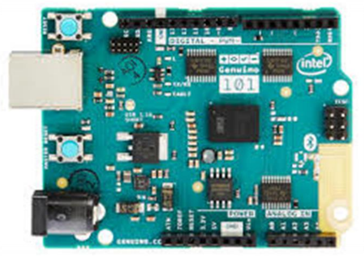
- Adafruit SPW2430 Mems Microphone Sensor

Value	Min	Max	Unit
Operating Voltage	-	3.3	V
Frequency	100	10,000	Hz
Output Voltage	-	0.67	V



- Arduino Board 101

Value	Min	Max	Unit
Operating Voltage	-	3.3	V
Input Voltage	7	12	V
DC Current per I/O Pin	-	20	mA



- FRDM CR20A Wireless Transceiver

Value	Min	Max	Unit
Input Voltage	+3.3	+5	V
Output Power	-32	+8	dBm
Frequency Range	2360	2480	MHz
Temperature	-40	+70	°C

1st SEMESTER PROGRESS

- Research Completed for the following areas:
  - **Irrigation system market analysis** – Revealed that current smart irrigation systems are too expensive or are unable to provide any automated action.
  - **Hardware selection** – Revealed the most appropriate hardware to achieve interface between sensors, wireless network and control valve would be:
    - Arduino Board 101
    - FRDM CR-20A Wireless Transceiver Board
  - **Programming languages** most appropriate for hardware components would be a combination of C and assembly language.

2nd SEMESTER GOALS

Tasks planned for the Completion of the project:

- Determine Sensor Capabilities
- Develop Code for interfacing between components
- Successful Wireless Communication of System Status updates
- Construction of prototype irrigation system
- Perform testing with prototype to demonstrate proof of concept

Acknowledgements
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