# Team A1 | plant Health

## PROJECT PROPOSAL

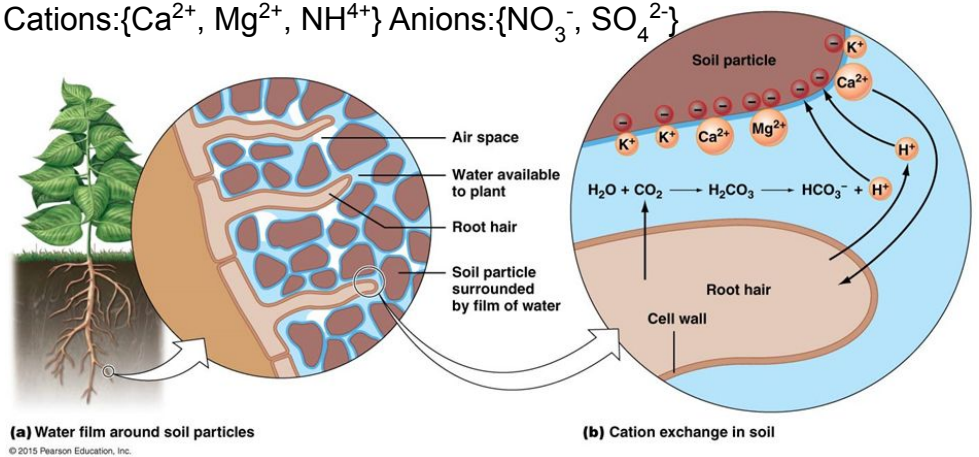
Karen Abruzzo, Ankita Bhanjois, Arden Diakhate-Palme

# Use Case

- Target audience: ecological and environmental scientists, pharmaceutical botanists
  - precise control of a plant's environment in a research setting or for pharmaceutical plants
- Measuring soil pH/moisture and adjust parameters accordingly
- Goal of project: managing (1) soil moisture and (2) soil pH

Areas covered: Software, Hardware


Cations:{$Ca^{2+}$, $Mg^{2+}$, $NH^{4+}$} Anions:{$NO_3^-$, $SO_4^{2-}$}



# Use Case Requirements

- Pick up soil sample and deposit in container
  - **Motivation**: Soil sample is used to measure soil pH
  - **Metrics**: sample placed in 1:1 ratio of soil and deionized water; 14g sample gathered from soil of 0.5g/$cm^3$ volume

- Test the pH and moisture of soil
  - **Motivation**: Want to get measurements to create ideal solution to make plant soil either more basic or more acidic

- Make an ideal mixture from pipe system with “fixed” aqueous solution
  - **Motivation**: Plant will have soil pH adjusted to ideal conditions

# Technical Challenges

- Sensor readings are accurate and gathered quickly
  - Component: STM + Sensor

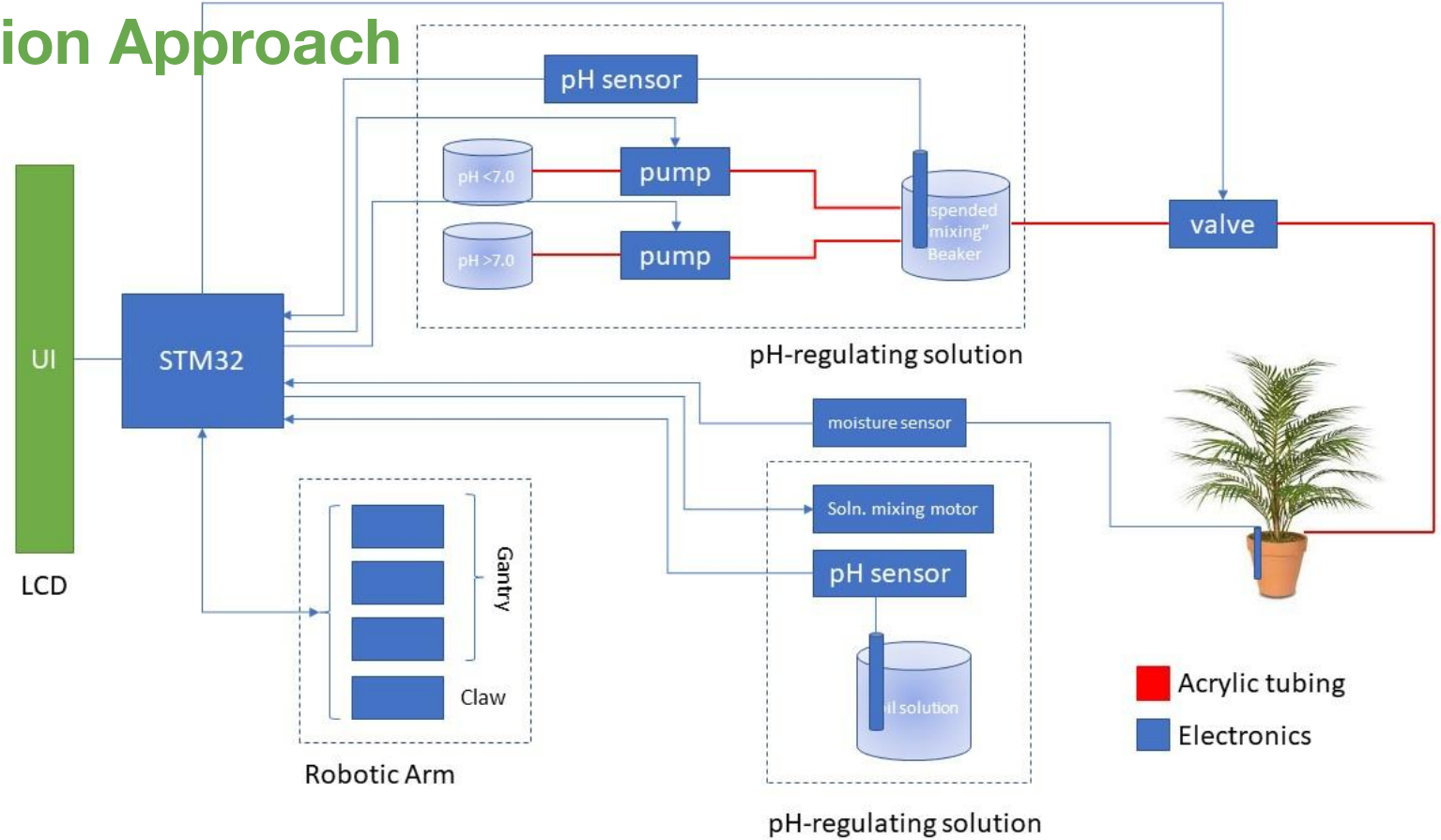
- Taking a soil sample of consistent volume from potted plant
  - Component: Gantry system & real-time control

- Pump an acidic/basic solution of appropriate volume based on pH/moisture measurements
  - Component: Pump system & pH sensing feedback loop

# Technical Challenges (cont.)

- Waiting to remeasure soil sample after new solution added
- Maintain controlled environment
  - Temperature may cause fluctuations in sensor readings
- Timing of all components are maximally parallelized to save time

# Solution Approach



# Solution Approach (cont.)

1. Vertical XY Gantry system with claw transports soil from plant to beaker
   a. (in parallel) Soil moisture sensor takes measurement
2. STM calculates total volume of liquid necessary for intermediate soln.
3. Soil solution mixed with magnetic stirrer
4. pH sensor measures the acidity of the soil solution
5. STM calculates necessary the pH of the final aqueous solution to reach the optimal soil pH level
6. Two pumps: one connected to an acidic solution, another to a basic one are used to create an optimum pH in an intermediate beaker
7. A third pump adds enough water to the intermediate beaker to reach the predetermined volume of water the plant requires (from (2))
8. The plant is watered with the relatively acidic or basic solution (from (6))

# Testing, Verification, and Metrics

| Functionality | Testing Strategy | Metrics |
|---|---|---|
| Soil Sample | Record mass of samples collected by the gantry system | Sample is 14 +/- 2 grams |
| Soil Moisture | Test system on soil with varying moisture levels | Maintain desired moisture within 1 level of ideal moisture (of 4 levels) |
| Soil pH | test pH of secondary soil sample after one cycle | Able to *increase* or *decrease* pH level from measured baseline |
| Gantry Timing | Record time for gantry system to take and deposit sample | Sample is picked up and deposited in 15 +/- 5 seconds |

# Testing, Verification, and Metrics (cont.)

| Functionality | Testing Strategy | Metrics |
|---|---|---|
| Mixing Timing | Record timing for mixing and measuring sample | Mix soil sample and measure pH in 60 +/- 5 second |
| Intermediate Solution Timing | Record timing for mixing solution and pumping for small and large pH adjustments | Create intermediate solution from pump system within 10 +/- 2 seconds |

# Tasks/Division of Labor

| Karen | Ankita | Arden |
| --- | --- | --- |
| Design and build claw for gantry | Creating the Pipe System | Building the gantry system |
| Reading pH and moisture levels | Re-calibrating the pH level and making fixed solution | Integrating the gantry control with RTOS |
| Mixing soil sample for pH reading | Adding solution into soil and heating system (tentative) | RTOS scheduling and task parallelization |

# Schedule

| Tasks | Week 3 | Week 4 | Week 5 | Week 6 | Week 7 | Fall Break | Week 8 | Week 9 | Week 10 | Week 11 | Week 12 | Week 13 | Week 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 9/12 | 9/17 | 9/26 | 10/2 | 10/10 | 10/17 | 10/24 | 10/31 | 11/7 | 11/14 | 11/21 | 11/28 | 12/4 |
| **Class Assignments** | | | | | | - | | | | | | | |
| Project Proposal Presentation | | DUE | | | | - | | | | | | | |
| Design Presentation | | | | DUE | | - | | | | | | | |
| Design Document | | | | | DUE | - | | | | | | | |
| Ethics Assignment | | | | | | - | DUE | | | | | | |
| Interim Demo | | | | | | - | | | DUE | | | | |
| Final Preentation | | | | | | - | | | | | | | DUE |
| | | | | | | | | | | | | | |
| **Overall Project Work** | | | | | | - | | | | | | | |
| Research Equipment/Materials | | | | | | - | | | | | | | |
| Order/Rent Equipment/Material | | | | | | - | | | | | | | |
| Individual Setup of Equipment | | | | | | - | | | | | | | |
| Individual Testing of Equipment (HW) | | | | | | - | | | | | | | |
| RTOS development (SW integration) | | | | | | - | | | | | | | |
| | | | | | | | | | | | | | |
| **Water Pipe System** | | | | | | - | | | | | | | |
| Research how to control measured system | | | | | | - | | | | | | | |
| Build initial prototype of pump system | | | | | | | | | | | | | |
| Finalize prototype/design of system | | | | | | - | | | | | | | |
| Test if able to test pH levels/set up sensors | | | | | | - | | | | | | | |
| Create pump system to add into plant | | | | | | - | | | | | | | |
| Create heating system? (TBD) | | | | | | - | | | | | | | |
| Combine with rest of system (SW) | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **Soil Sensing** | | | | | | - | | | | | | | |
| Research sensors and mixers | | | | | | - | | | | | | | |
| Connect sensors to STM32 | | | | | | - | | | | | | | |
| Connect mixer to STM32 | | | | | | | | | | | | | |
| Test pH detection with different soil samples | | | | | | - | | | | | | | |
| Test moisture detection | | | | | | - | | | | | | | |
| Combine with rest of system | | | | | | - | | | | | | | |
| | | | | | | | | | | | | | |
| Gantry System | | | | | | - | | | | | | | |
| Research material/retrieve from RoboClub | | | | | | - | | | | | | | |
| Construct gantry support system | | | | | | - | | | | | | | |
| Construct gantry arm and claw system | | | | | | - | | | | | | | |
| Test movement of gantry system (HW) | | | | | | | | | | | | | |
| Test deposition of soil sample in beaker (SW) | | | | | | - | | | | | | | |
| Combine with rest of system (SW) | | | | | | - | | | | | | | |
| | | | | | | | | | | | | | |
| Slack | | | | | | | | | | | | | |

| Division of Taks | |
|---|---|
| Karen | |
| Ankita | |
| Arden | |

# Conclusion

- Want to create a system that monitors plant health to aid environmental biology research and pharmaceutical botany
- Maintain plant soil’s pH and moisture levels
- The intention of this project is to eventually be scaled for multiple plants