Home Hydroponic System

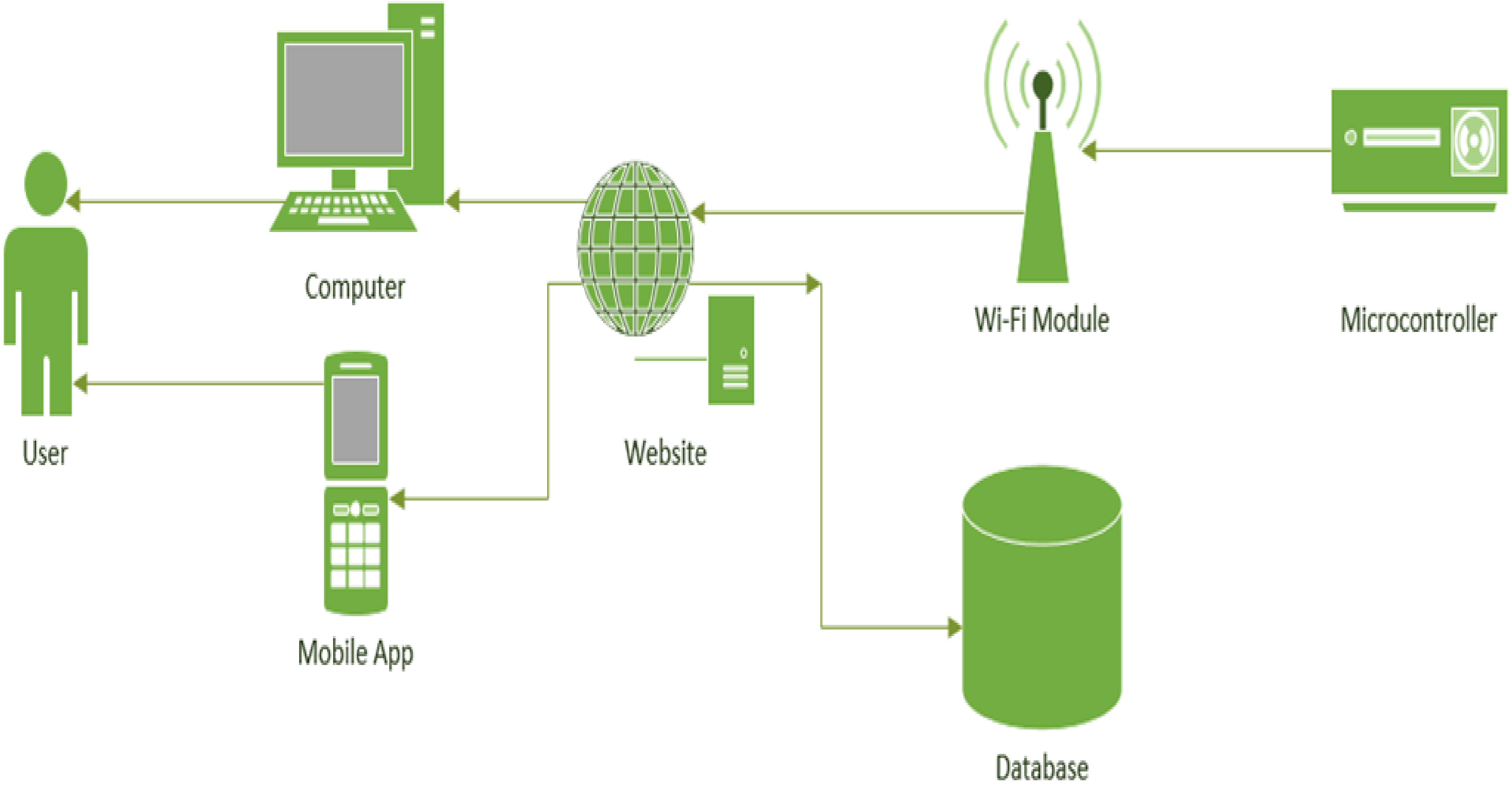
Senior Design Spring 2017

Group 18

Group Members:

Joshua Casserino	Computer Engineering - Document Manager
Richard Charmbury	Electrical Engineering - Budget Manager
Alexander Costello	Computer Engineering - Component Manager
Ernest Inman	Electrical Engineering - Project Manager

User Interface Flowchart



Introduction
►Project Description
Motivation
Current Hydroponic Systems
System Break Down
User Interface
Administration

Project Description

- **To create a home hydroponic system**
    - **Easy to use**
    - **Fits in a usual home**
    - **Can be easily moved**

Motivation

- **Make the growing of home produce easier**
- **Aid individuals to become more independent**
- **Aid in a healthier lifestyle**
- **Help lower the current waste of the modern farming practices**
- **Help make the growing of personal produce more affordable**

Current Hydroponic Systems

Issues with current hydroponic systems

- Too large for household use
- Stationary

Home Hydroponic System

Current Hydroponic Systems

Issues with current hydroponic systems

- **Too complicated for a beginner**

Home Hydroponic System

Requirement and Specifications of Hydroponic System

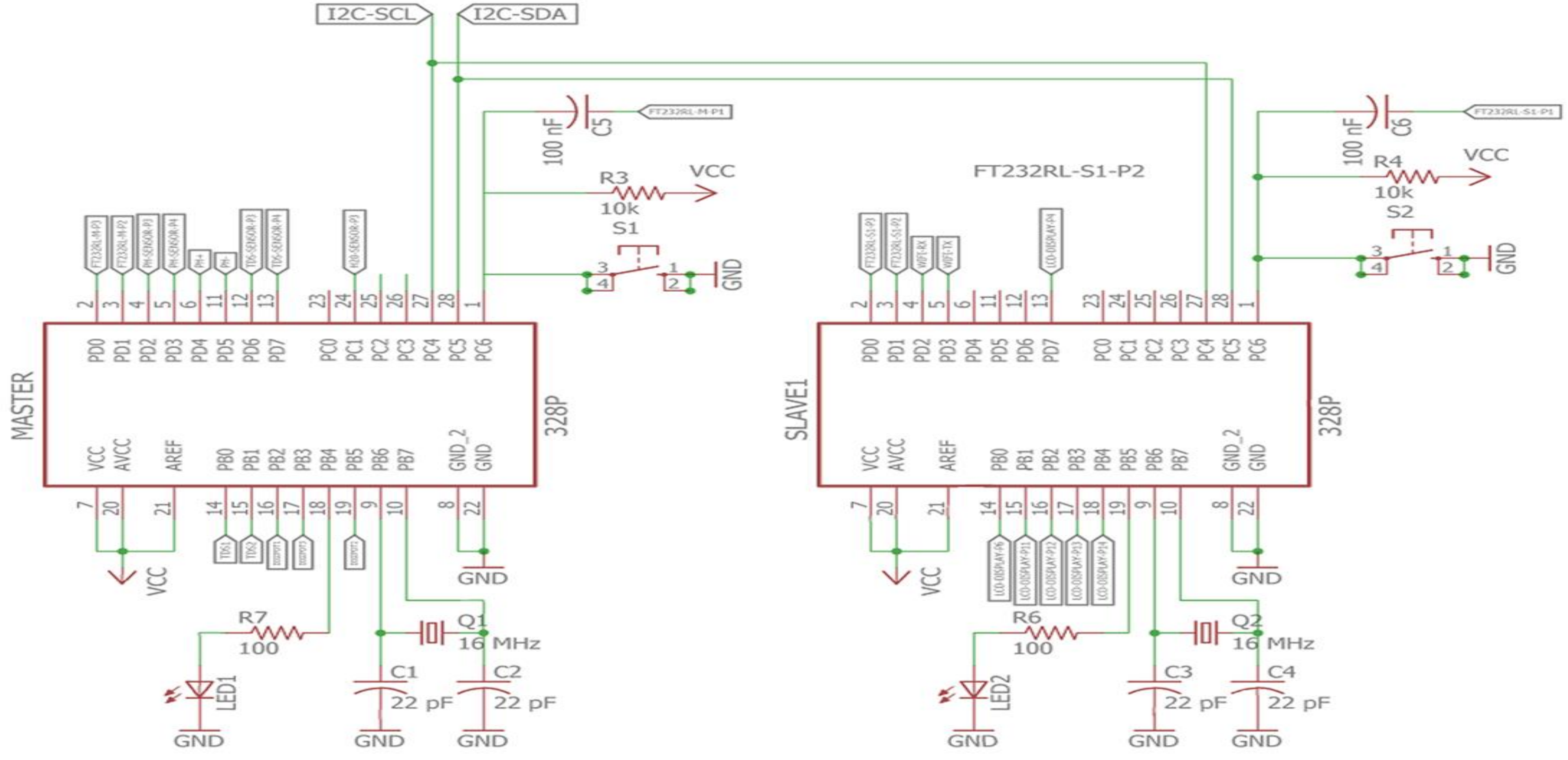
Requirement Specification	Value
Reservoir Capacity	5 Gallons
Power Supply	120V AC to 12/5/3.3 Volts DC
LED Array	6000 Lumens per Square Foot
pH Sensor	0 - 14 pH Reading w 0.1 Increment Accuracy
TDS Sensor	Accurate to Within 20 (S/m)
Light Sensor	Up to 188 uLux Sensitivity I2C Interface
Water Level Sensor	0 - 8 Inches w 0.1 Increment Accuracy
Microprocessor Speed	16 MHz 8-bit
Peristaltic Pumps	0 – 100 (mL / min)
Wi-Fi Data Connection Rate	Once per 5 minutes

Microcontroller Selection

Microcontrollers			
Manufacturer	TI	Atmel	Atmel
Part Number	MSP430G2553	ATmega328P	ATmega2560
SRAM	0.5 kB	2 kB	8 kB
Flash Memory	16 kB	32 kB	256 kB
Clock Speed	16 MHz	16 MHz	16 MHz
Number I/O Pins	24	32	54
Cost	$5.55	$1.55	$9.99

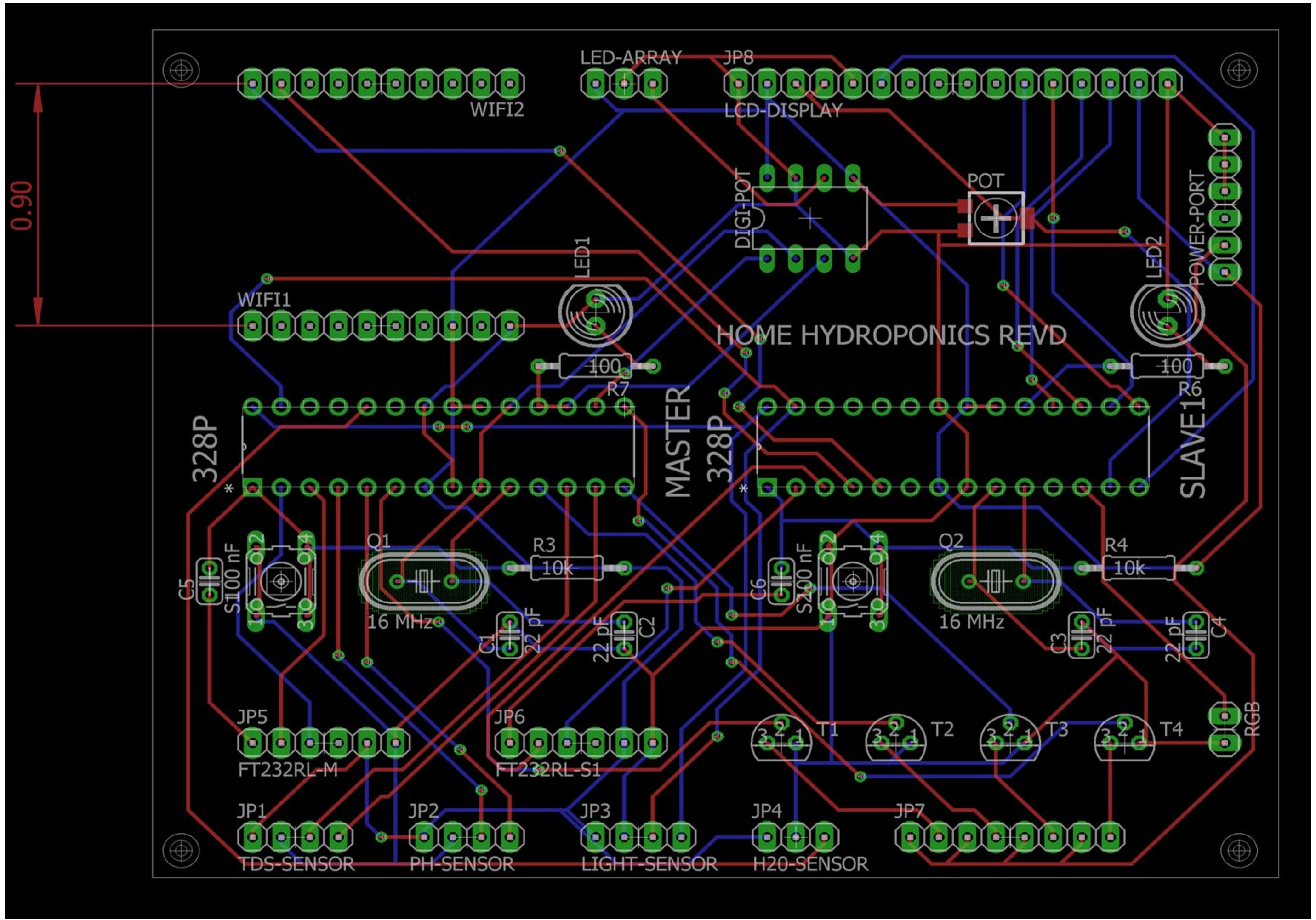
PCB

Master/Slave Configuration



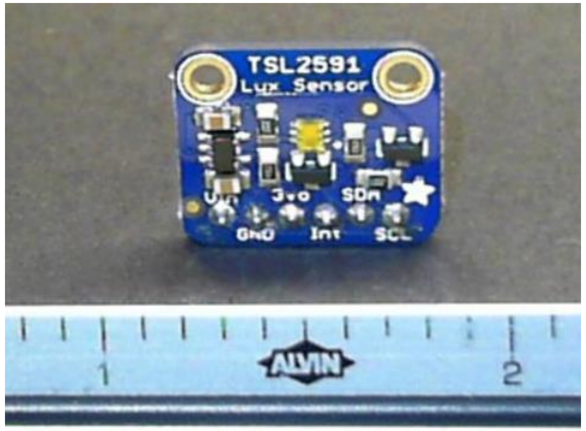
PCB

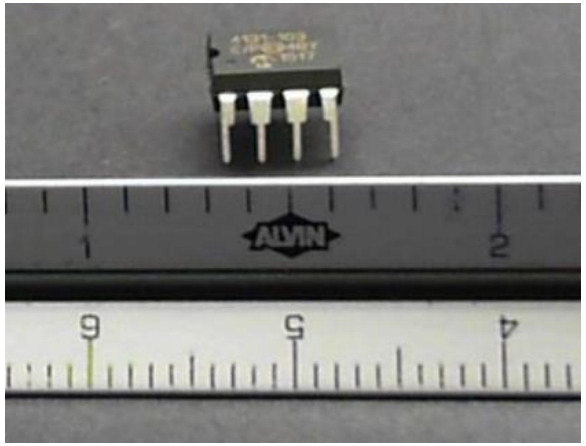
REVD Home Hydroponics Change the color (no Black)



Master / Lighting System

- **Purpose of the lighting control**
  - **Save energy**
  - **Control how long the plants receive lighting**
  - **Monitor light intensity the plants receive**
  - **Control intensity of light emitted through dimming circuit**





Master / Lighting System

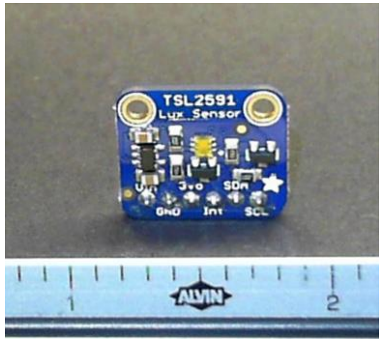
Light Sensor

The light sensor needs to perform the following:

- **Read intensity of light**
- **Distinguish between Sunlight and artificial light**
- **Efficiently help control artificial lights**

The 2 sensors that were considered:

- **The Adafruit GA1A12S202**
- **The Adafruit TSL 2561**



Master / Lighting System

Light Sensor

The GA1A12S202

- Low power consumption 3.3mW
- Analog Output easy to control with code
- Dynamic reading range between 3 to 55,000 LUX
- Can be used indoors or outdoors
- Cost is $3.95

The TSL 2561

- Low power .75mW
- 16 bit output and can utilize I^2C saves pins
- Reads lumens/lux, full spectrum, infrared, and visible light
- Cost $5.95

TSL 2561 was chosen

Master / Lighting System

Dimming control

Options to control lighting intensity

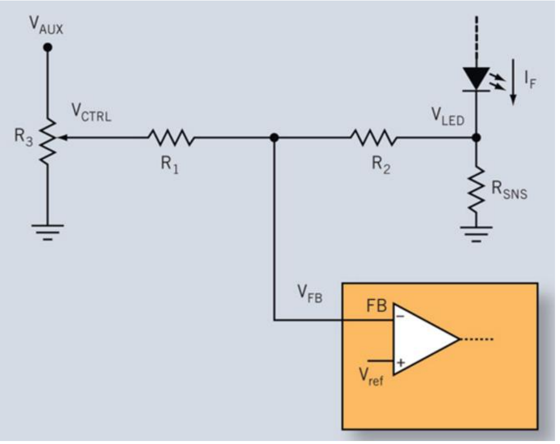
- **MCP4131 Analog to Digital Integrated Circuit**
- **Op amps**

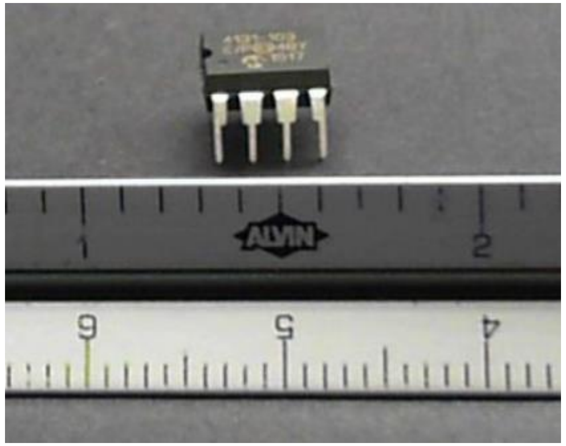
Analog to Digital IC

- **Small footprint**
- **Power efficient .025 A**

Op amp Circuit

- **Utilizes low efficient resistors**
- **Not power efficient .7 A**
- **Need an LED driver to provide constant current**





The Analog to digital IC was utilized

Master / Lighting System

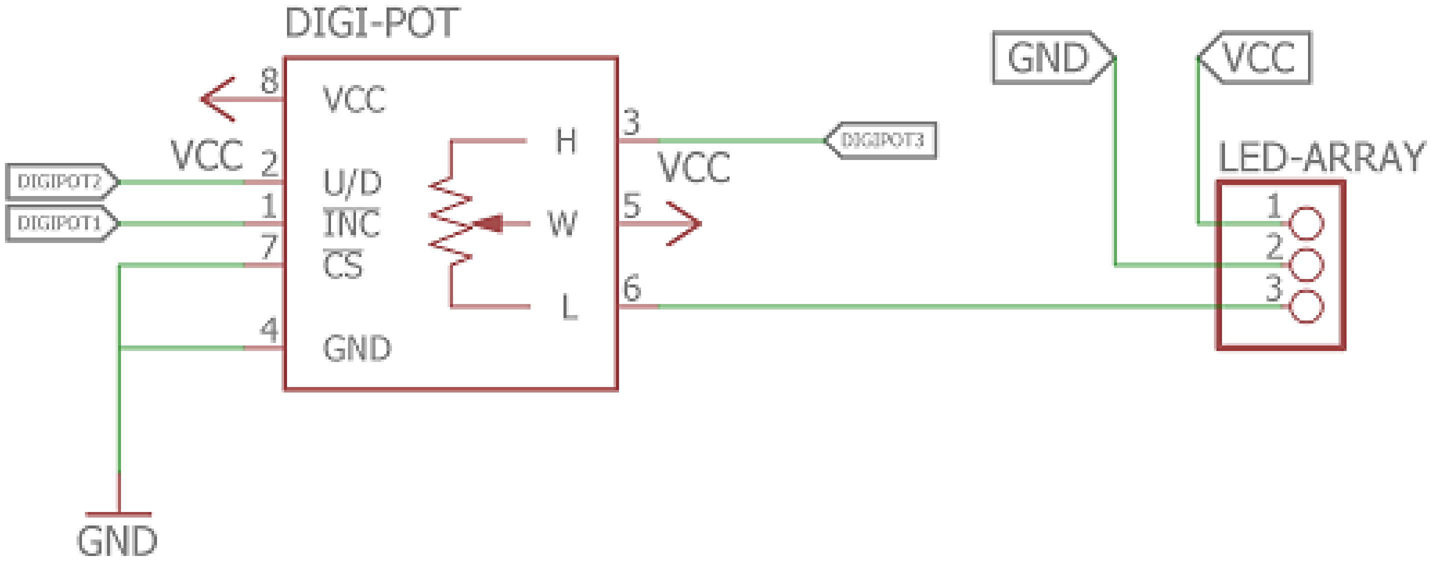
Dimming control

LED Dimmer Control

- Using the digital to analog converter allowed us to have full control
- Low power 25mA
- The MCU will receive information from sensor and decide the setting
- 128 bits can be utilizes to control the brightness of the lights

Master / Lighting System

Digital Potentiometer – Digital to Analog Converter



Master / Lighting System

Light Sensor & Dimmer Testing

Testing Lighting for

- Sensitivity of light sensor
- How to distinguish between sunlight and artificial lighting
- Distance the sensor needs to be from lighting

Results

- We found the sensor to be very sensitive
- Needs to be 7 inches from the LED array
- The sensor will provide full spectrum readings
- LED does not produce full spectrum

Master / Water Treatment System

Pump Control

Options to control pumps considered

- Mechanical Relays
- Transistor Circuit control

Mechanical Relays

- Easy to Control
- Easy to implement
- Not Power efficient
- Caused problems with MCU

Introduction
System Break Down
Requirements/Specifications
Main Schematic
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PCBs
► Master
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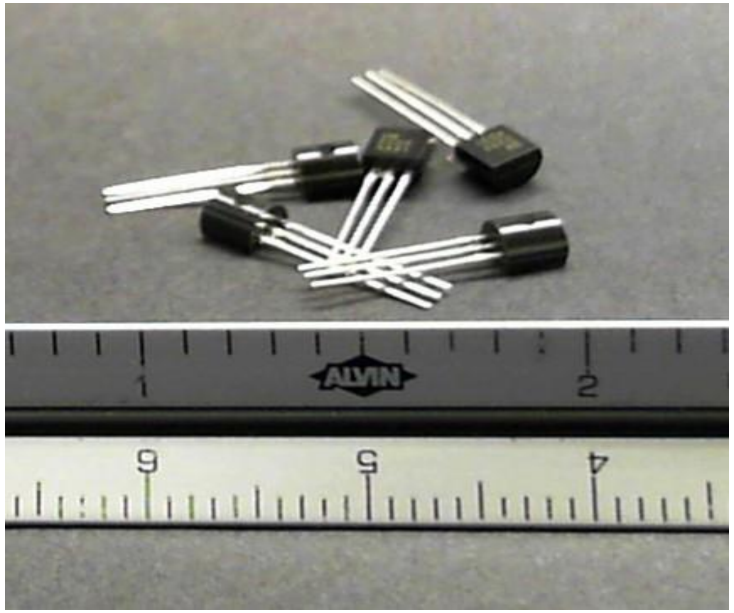
Master / Water Treatment System

Pump Control

Transistor Circuit control

- **Utilizing BJT and Diode circuit power efficient**
- **Small footprint**
- **Efficient coding**



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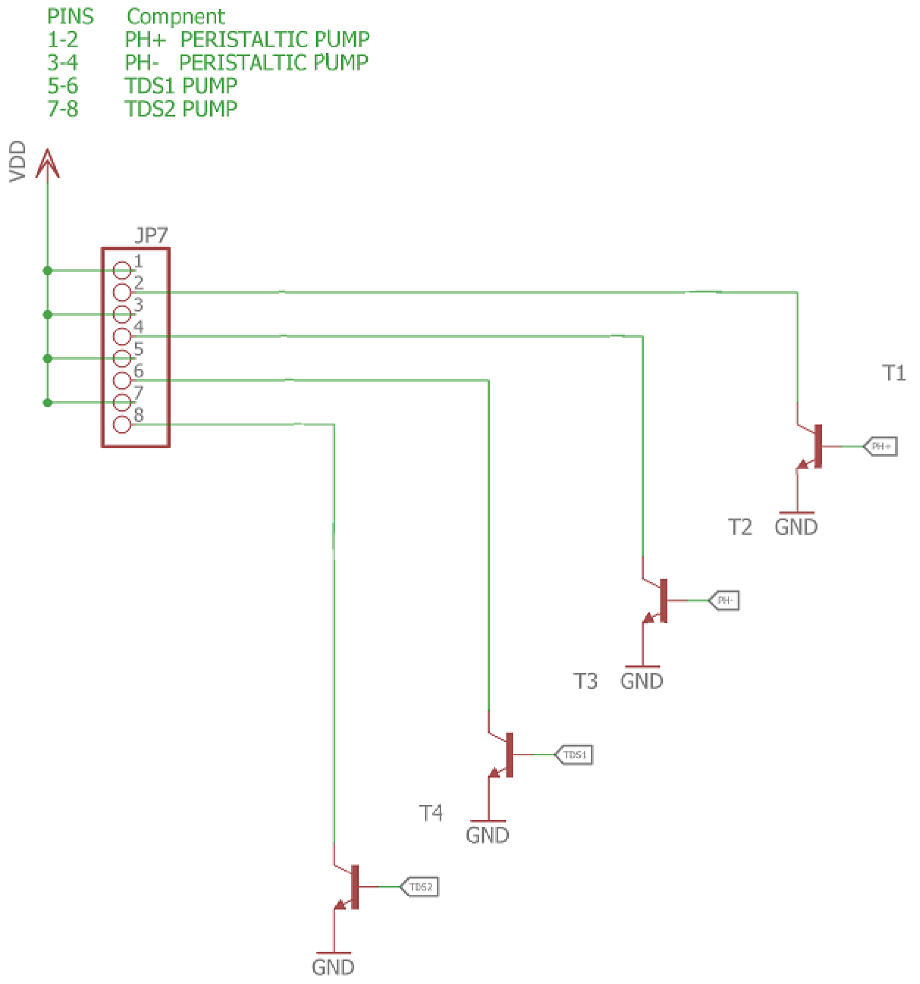
Master / Water Treatment System

Transistor Array to Control Peristaltic pH and TDS Pumps



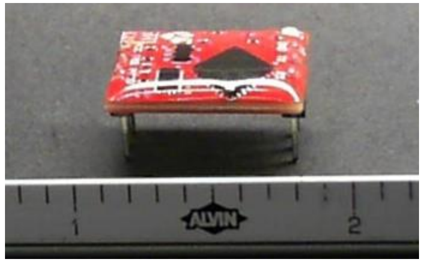
Master / Water Treatment System

pH Subsystem Add a comparison

- **pH Sensor**
  - **Monitors solutions for proper pH**

- **Peristaltic Pumps**
  - **Raise pH Levels to Required pH of Plants**
  - **Lower pH Levels to Required pH of Plants**

- **EZO pH Module Circuit**
  - **Converts the measurements to useable data**



Master / Water Treatment System

pH Subsystem – pH Sensor Add a comparison

- **Female BNC Connector to EZO pH Module Circuit**
- **Fully Submergible up to BNC Connector**
- **Proper pH for Optimal Nutrient Absorption**
- **Generates a Analog Voltage that Corresponds to pH**

Master / Water Treatment System

pH Subsystem – pH Peristaltic Pumps Add a comparison

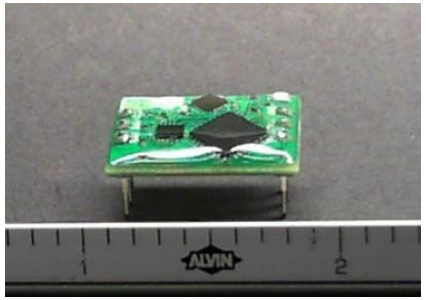
- 2 Pumps One Each for pH+ & pH-
- 12 Volts DC Operation
- 80 mA Operating Current
- 0 – 100 (mL / minute) Flow Rate
- Silicone Tubing
  - 4mm Outer Diameter
  - 2mm Inner Diameter

Master / Water Treatment System

TDS Subsystem Add a comparison

- **TDS Sensor**
  - **Monitors solutions for proper nutrients**

- **Peristaltic Pumps**
  - **1 Pump for Growth Nutrients**
  - **1 Pump for Flowering Nutrients**

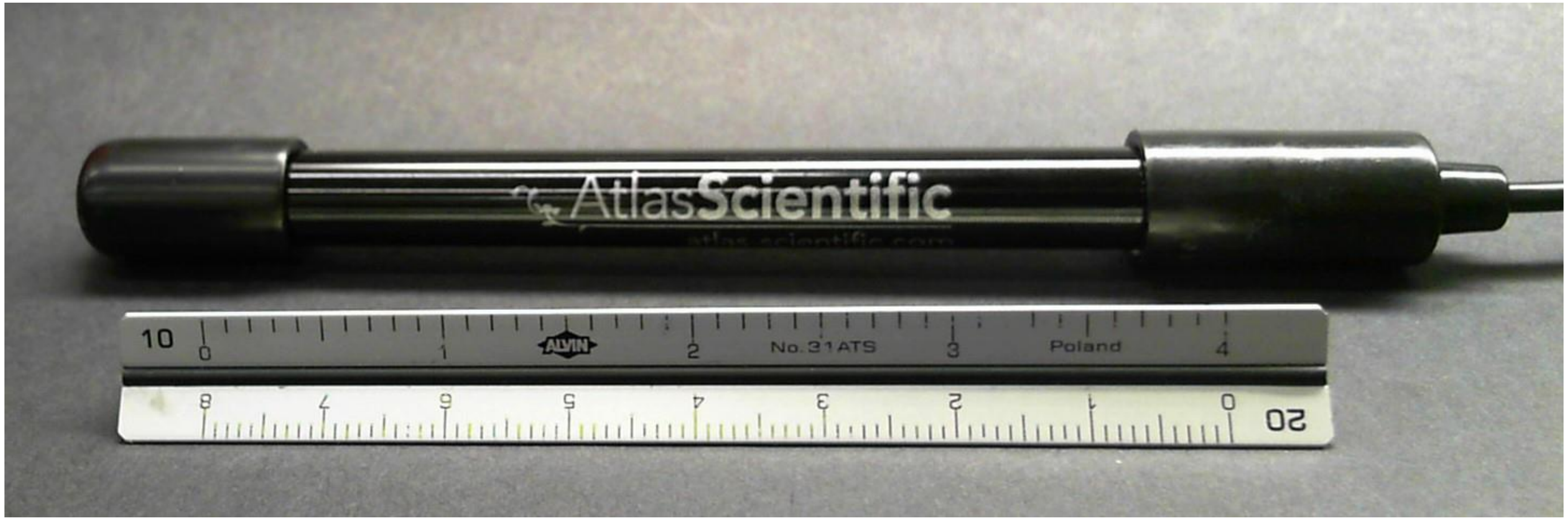


- **EZO TDS Module Circuit**
  - **Converts the measurements to useable data**

Master / Water Treatment System

TDS Sensor Add a comparison

- Female BNC Connector to EZO TDS Module Circuit
- Fully Submergible up to BNC Connector
- Reads Nutrients in Solution by Reading Total Dissolved Solids in Solution
- Generates a Analog Voltage that Corresponds to TDS



Master / Water Treatment System

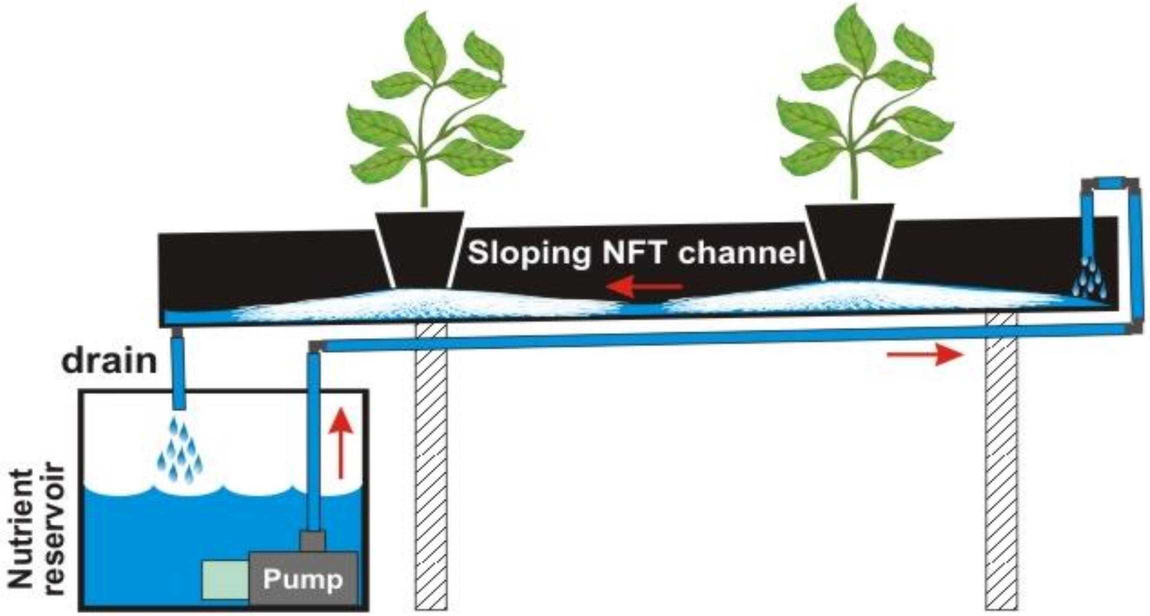
TDS Peristaltic Pumps

- **2 Pumps for Growth and Flowering Nutrients**
- **12 Volts DC Operation**
- **80 mA Operating Current**
- **0 – 100 (mL / minute) Flow Rate**
- **Silicone Tubing**
  - **4mm Outer Diameter**
  - **2mm Inner Diameter**

Master / Water Tank Subsystem

Reservoir Tank

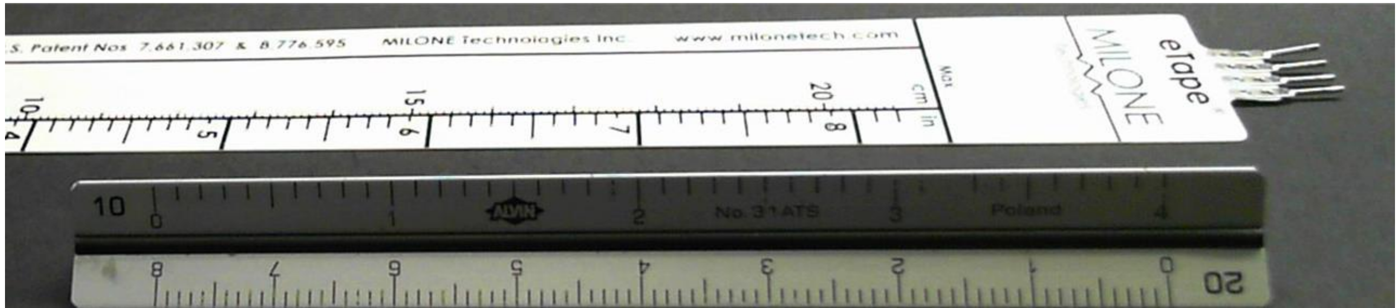
- **Dark / Light Blocking Water-Proof Container**
- **Contain a Minimum of 2 Gallons* of Liquid**
- **eTape Water Level Sensor**
- **Continuous Water Pump for Nutrient Circulation**
- **Continuous Air Pump w Air Stone**



Master / Water Tank Subsystem

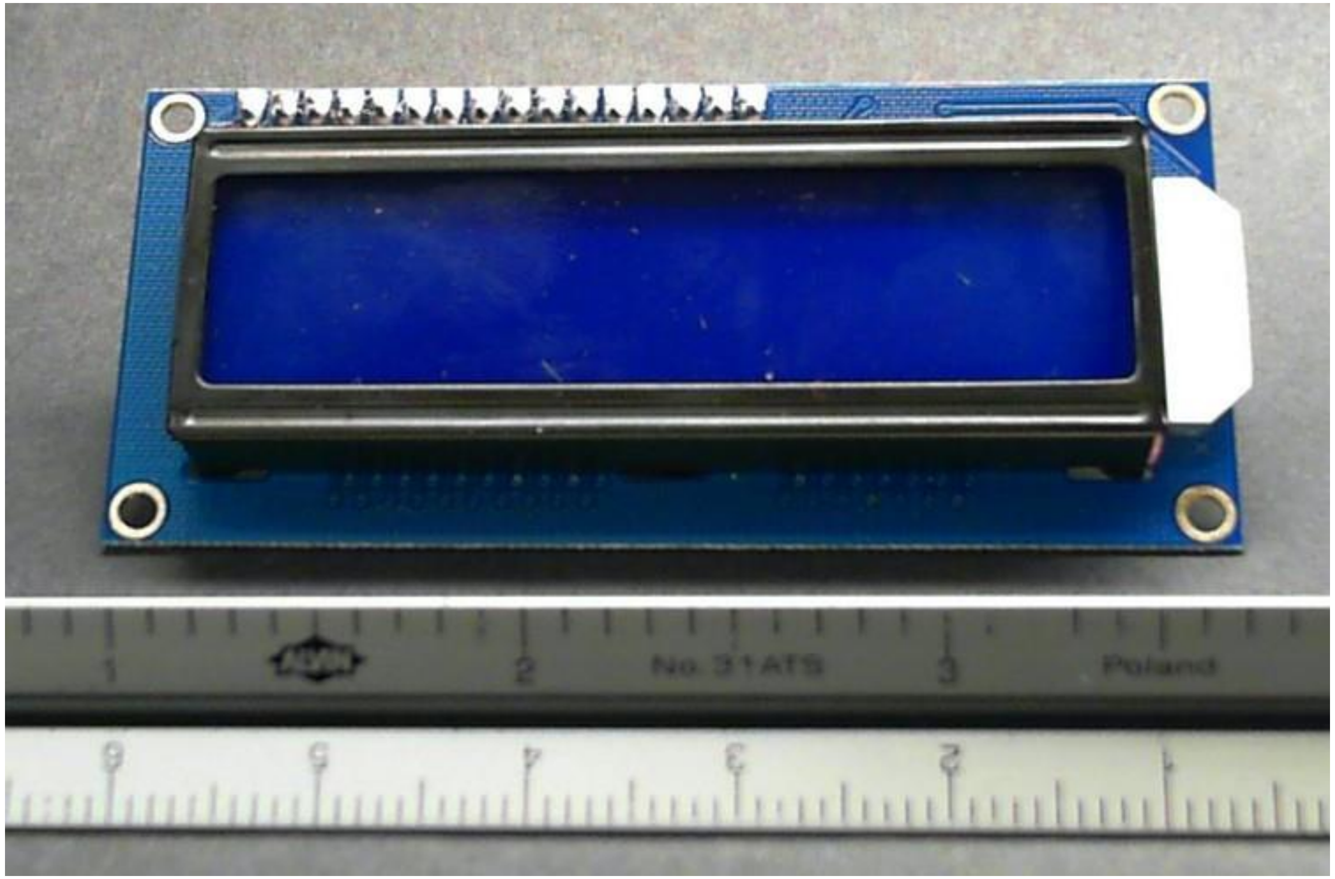
Water Sensor

- **eTape Continuous Liquid Sensor**
  - **8” eTape**
  - **Resistive Analog Output**
    - **1500 Ω (Empty Reading)**
    - **400 Ω (Full Reading)**
  - **Accuracy to 0.01 Inch**
  - **0.5 W Power Rating**
  - **Actuation Depth: Nominal 1 Inch**
  - **Temperature Range 15 ˚ to 140˚ F**



Slave / LCD Screen

- **We wanted a way to see data without having to look online**



Adafruit 16x2 character LCD

Slave / LCD Screen

Pros

- **Small LCD display doesn't use much space**
- **Cheap (~$10)**
- **Besides power and ground, only uses 5 Arduino pins.**

Cons

- **Not touchscreen**
- **Only one color**
- **Manual contrast adjustment via potentiometer**

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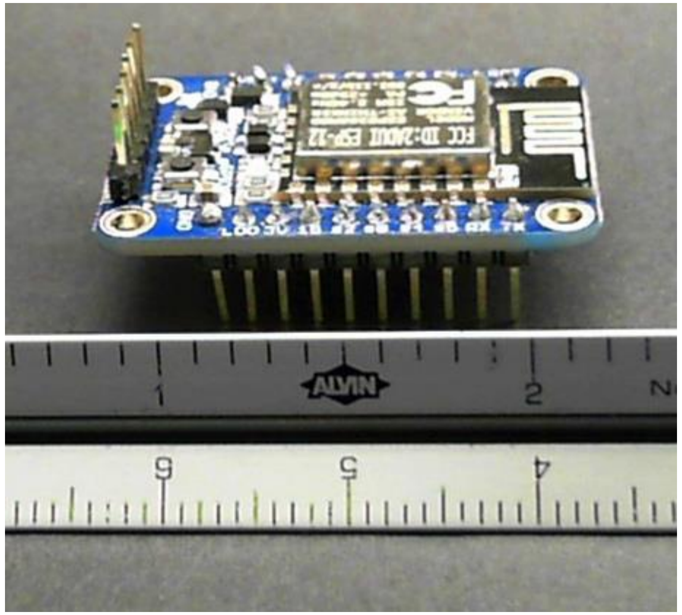
Slave / LCD Screen

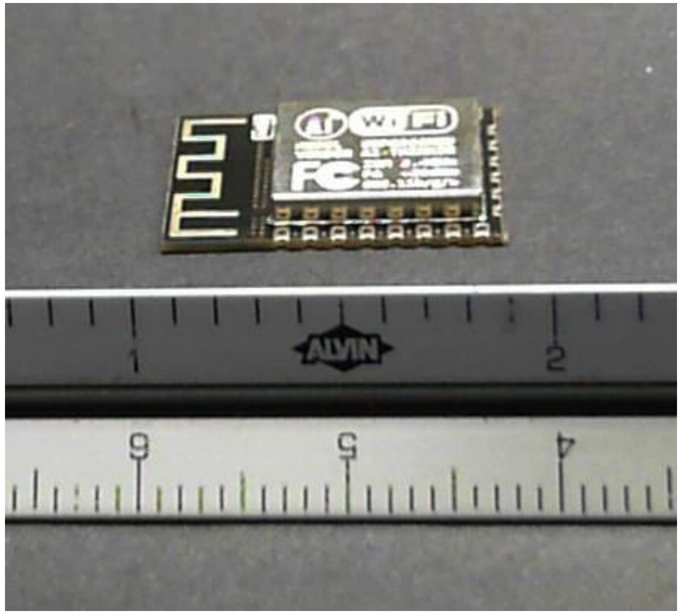
Specifications

- 5v Power and Logic sections
- Standard HD44780 controller/driver
- 0.9" x 2.7“ Screen (24mm x 69mm)
- 1.4" x 3.2" x 0.04“ PCB (36mm x 80.6mm x 1mm)

Slave / WiFi Module



Adafruit HUZZAH ESP8266 Breakout



ESP8266-12f Module

Slave / WiFi Module

- **Can function as both client and access point**
- **802.11 g/b/n functionality**
- **3.3v Power and Logic**
- **Arduino IDE libraries**

Slave / Wireless Communications

- **Options**
  - **WiFi**
  - **Bluetooth**
- **Why we chose WiFi**
  - **Using Bluetooth would require close proximity when using the app**
  - **We wanted our data available online**

Power Supply

System needs

- **The total power needs of the system is about <u>2.0 watts</u>**
- **Total current needs is about <u>1 amp</u>**

Component	Current (ampere)	Voltage (Vdc)	Power (Watts)
MCU	0.05	5	0.25
pH sensor	0.018	5	0.092
TDS sensor	0.023	5	0.113
Control pumps	0.08	12	0.96
Voltage isolation	0.2	5	0.001
Data isolation	0.008	5	0.038
WiFi	0.5	3.3	0.0017
Light sensor	0.0004	5	0.002
DigiPot	0.025	5	0.138
LCD	0.07	5	0.035
Total	**0.9744**		**1.6307**

Power Supply / System Design

Subsystem Current Needs (ampere)		
12 V	5.0 V	3.3 V
0.08	0.3944	0.5

Knowing the current needs of each subsystem we compared regulators
Two options considered:

- **Linear**
  - **Good for low power systems**
  - **Low noise**
  - **Inexpensive Cost $0.60**

- **Switching**
  - **Slower switching speeds**
  - **Creates noise that would need to be filtered out**
  - **Cost around $ 2.00**

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  - Microcontroller Selection
  - PCBs
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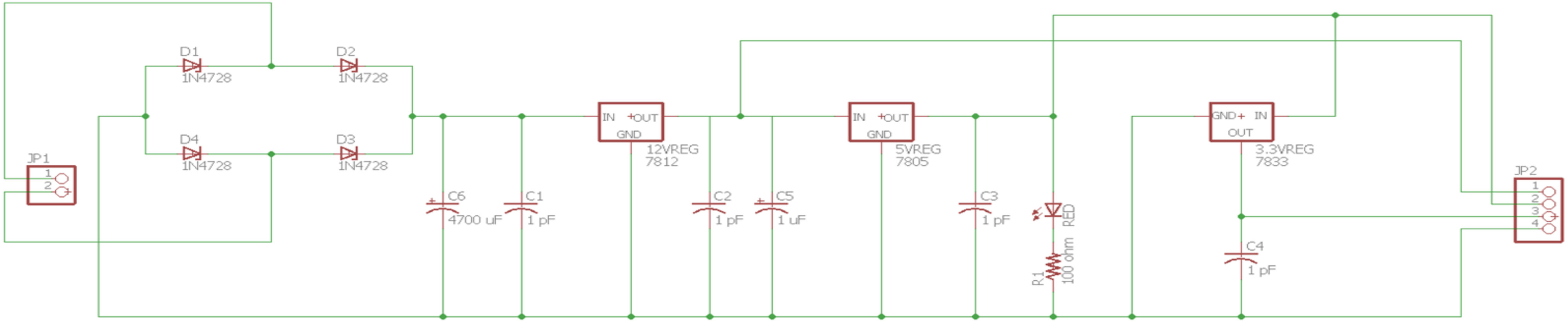
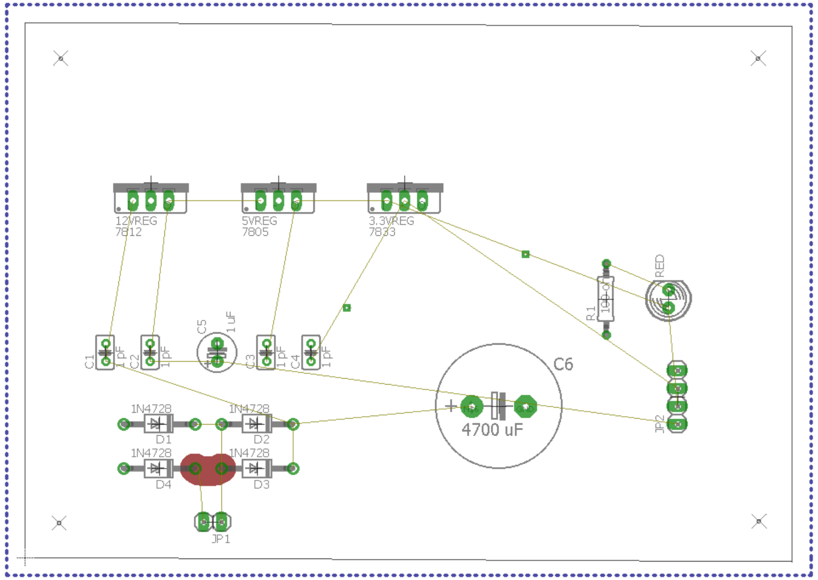
    - Slave
  - ►Power-supply
  - MCU Code Flow Chart
- User Interface
- Administration

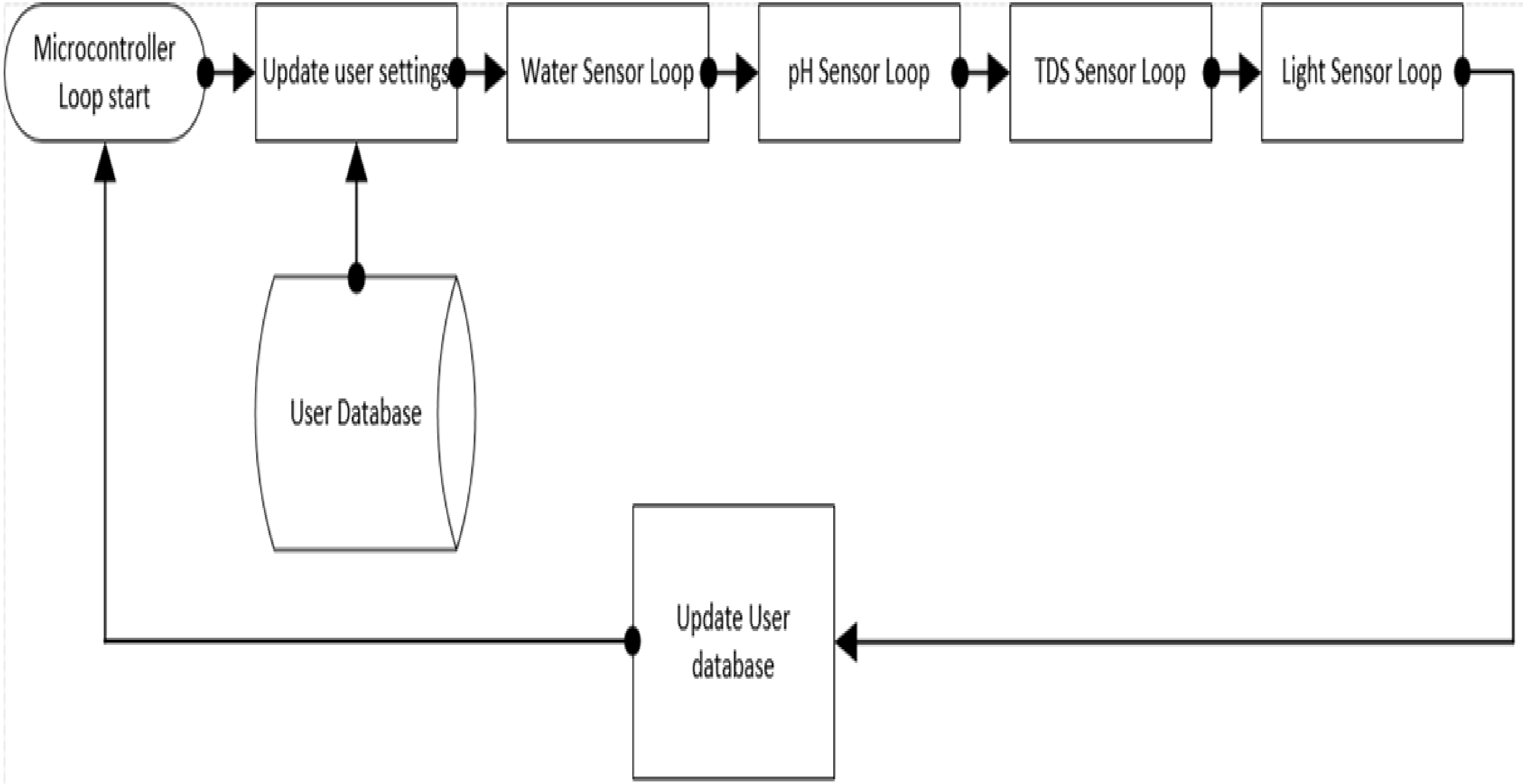
Power Supply / System Design Add final view of board





Home Hydroponic System

MCU Code Flow Chart



Requirements and Specifications

The Home Hydroponics system's user interface requires:

- **Multi-user access**
- **Able to update user settings from the App or Website**
- **Able to alert the user when the system needs maintenance**

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Website
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Requirements and Specifications

Languages used;

- **Programming**
  - **Javascript**
  - **Java (Android Studio)**
  - **PHP**
  - **C/C++ (Arduino IDE)**
- **Markup**
  - **CSS**
  - **HTML**
- **Database Management**
  - **MySQL**

Home Hydroponic System

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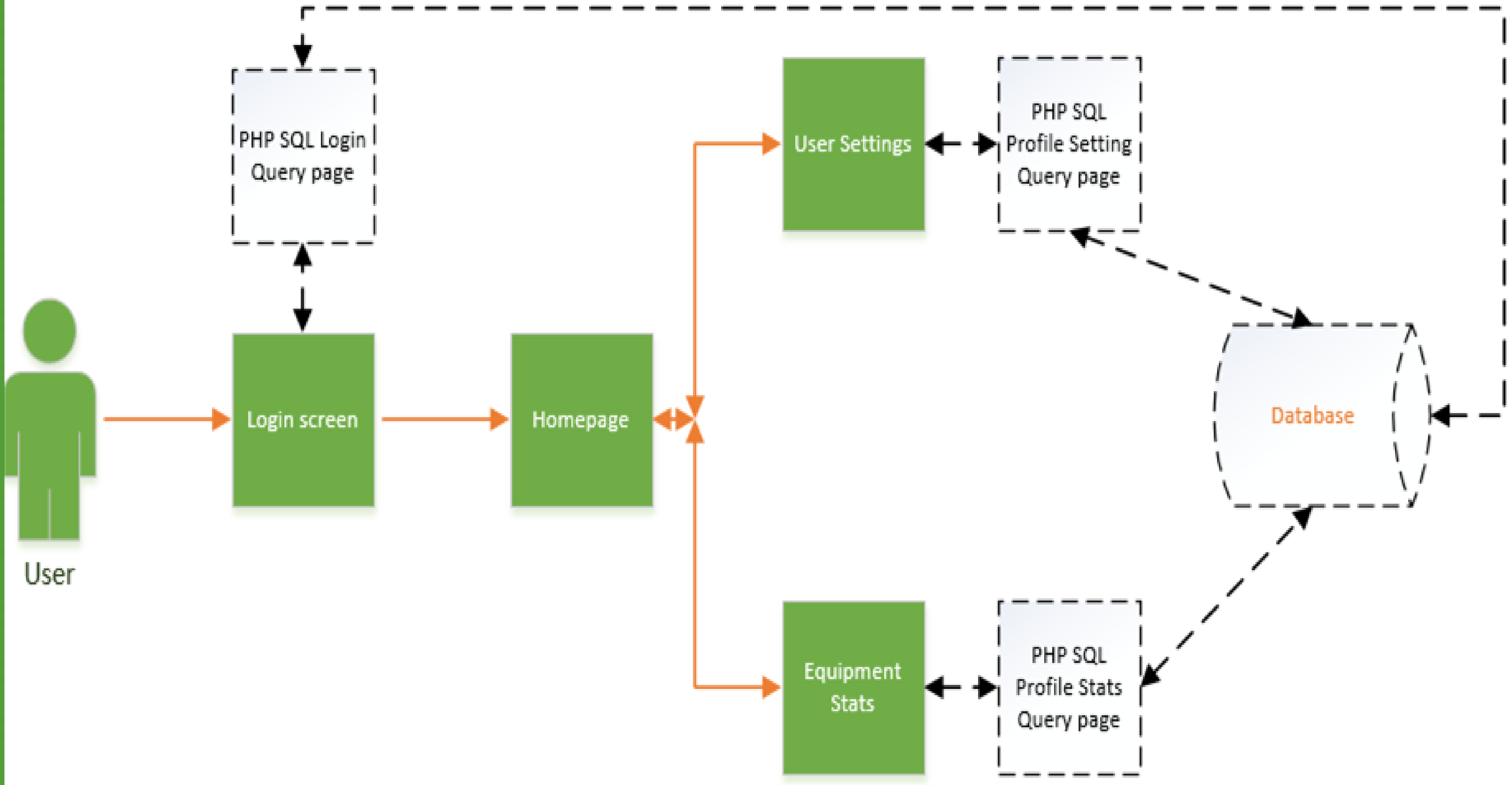
Website Flow Chart



Home Hydroponic System

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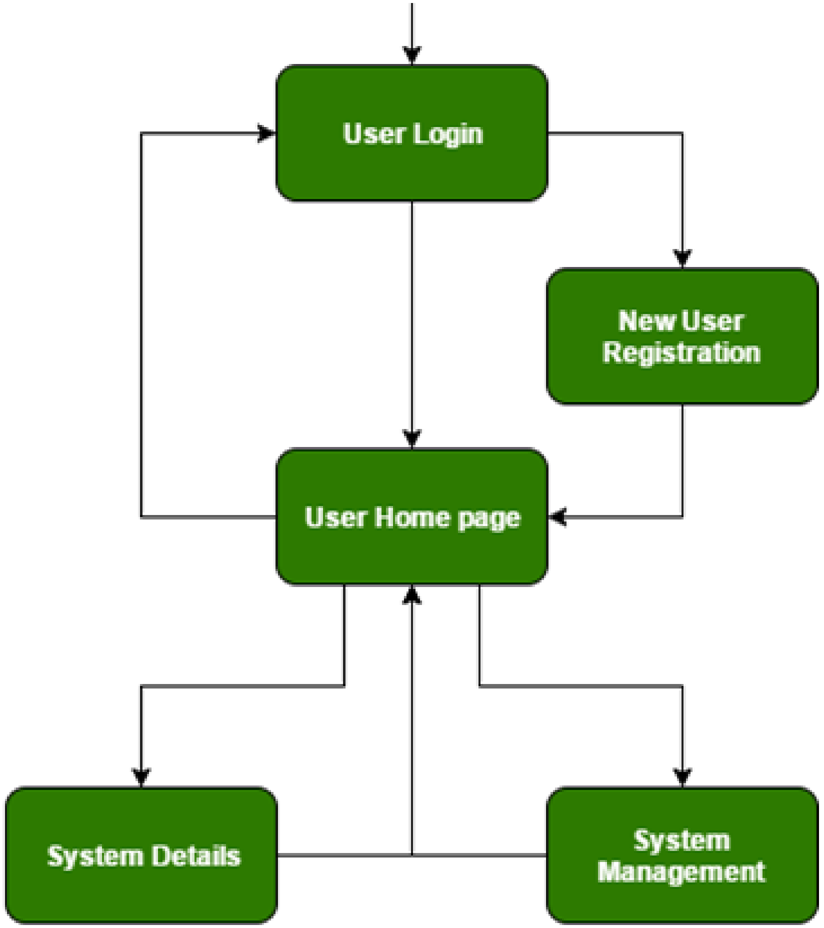
App Flow Chart



Home Hydroponic System

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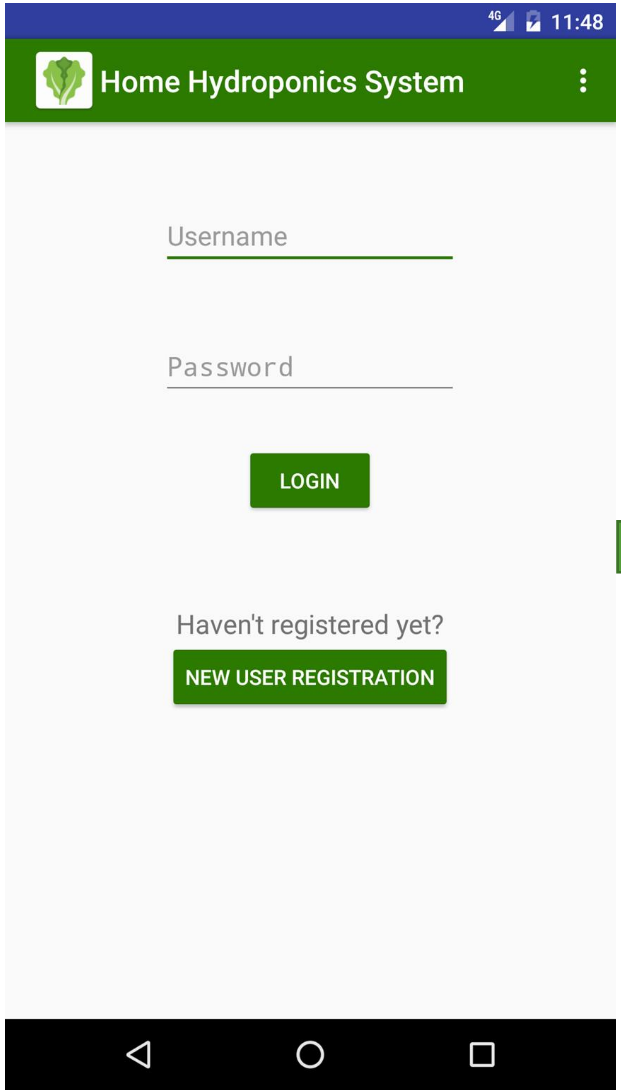
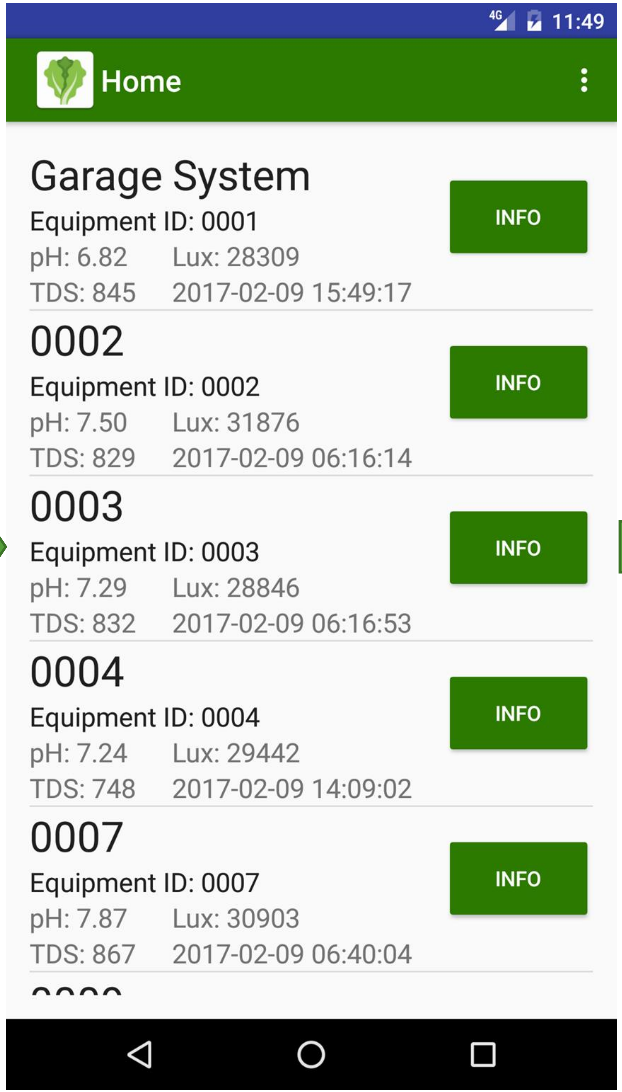
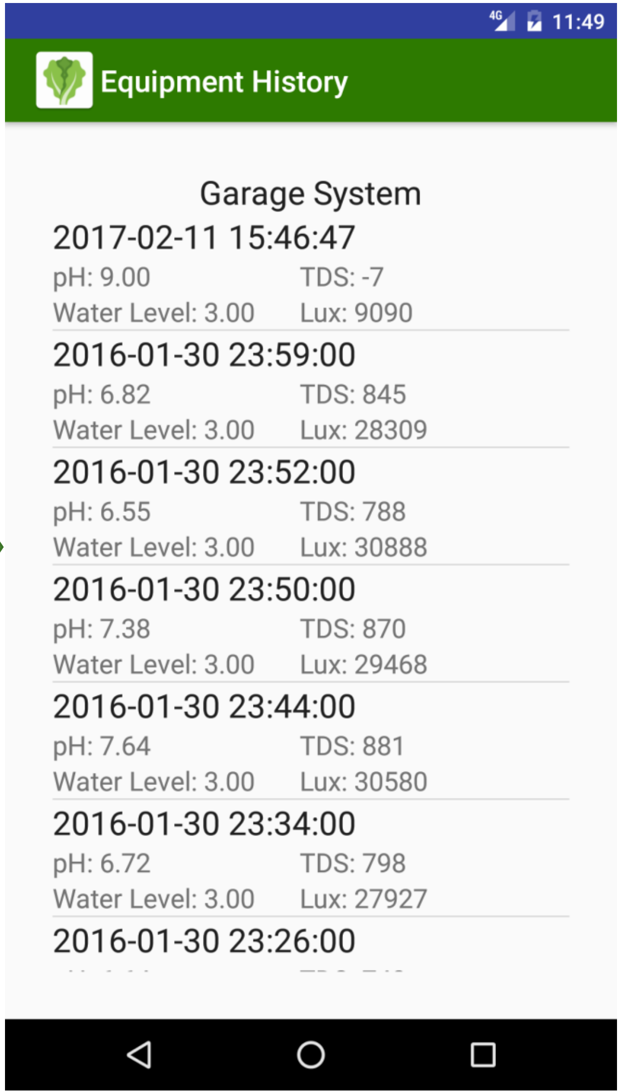
App Screen Flow







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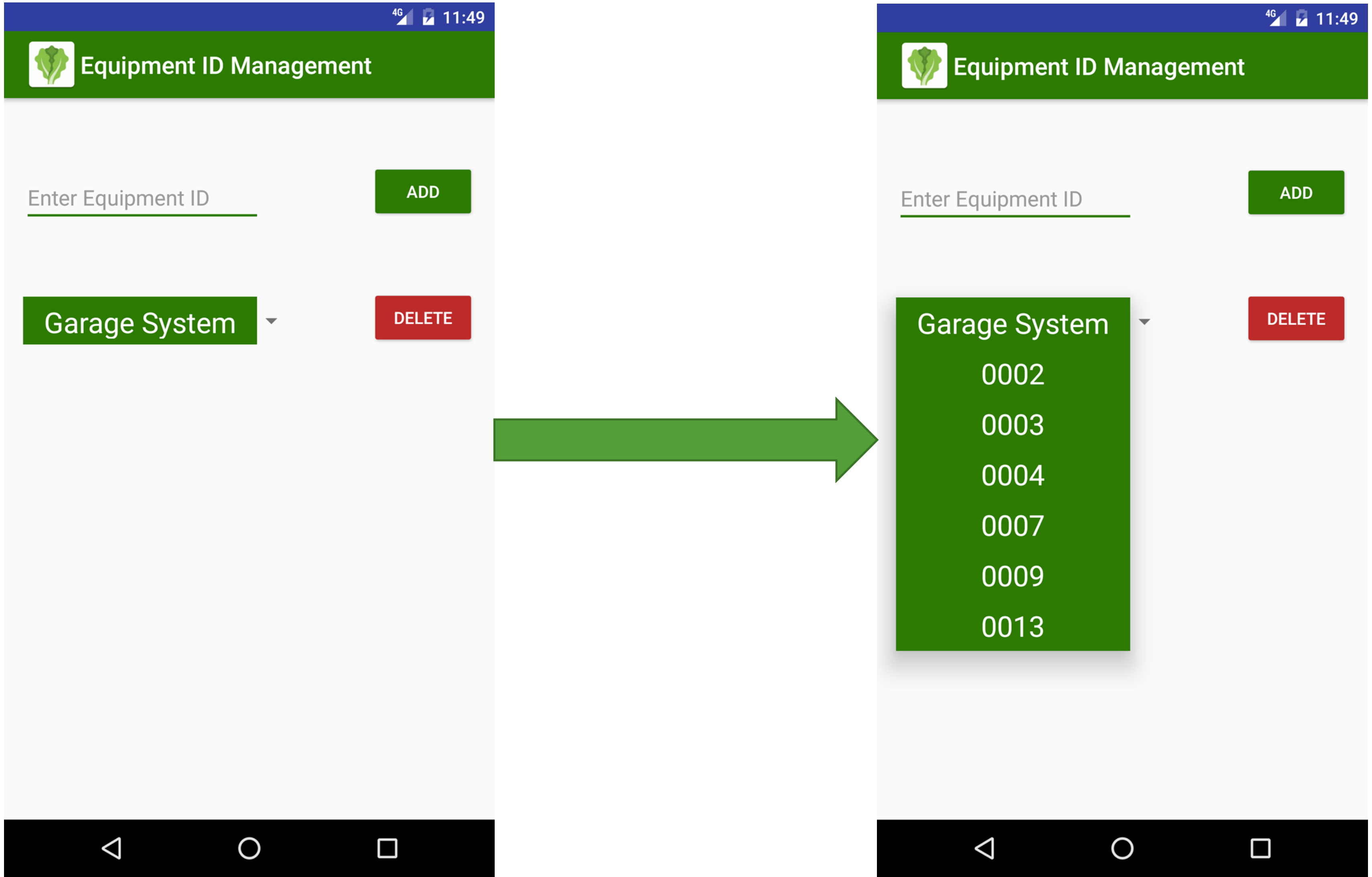
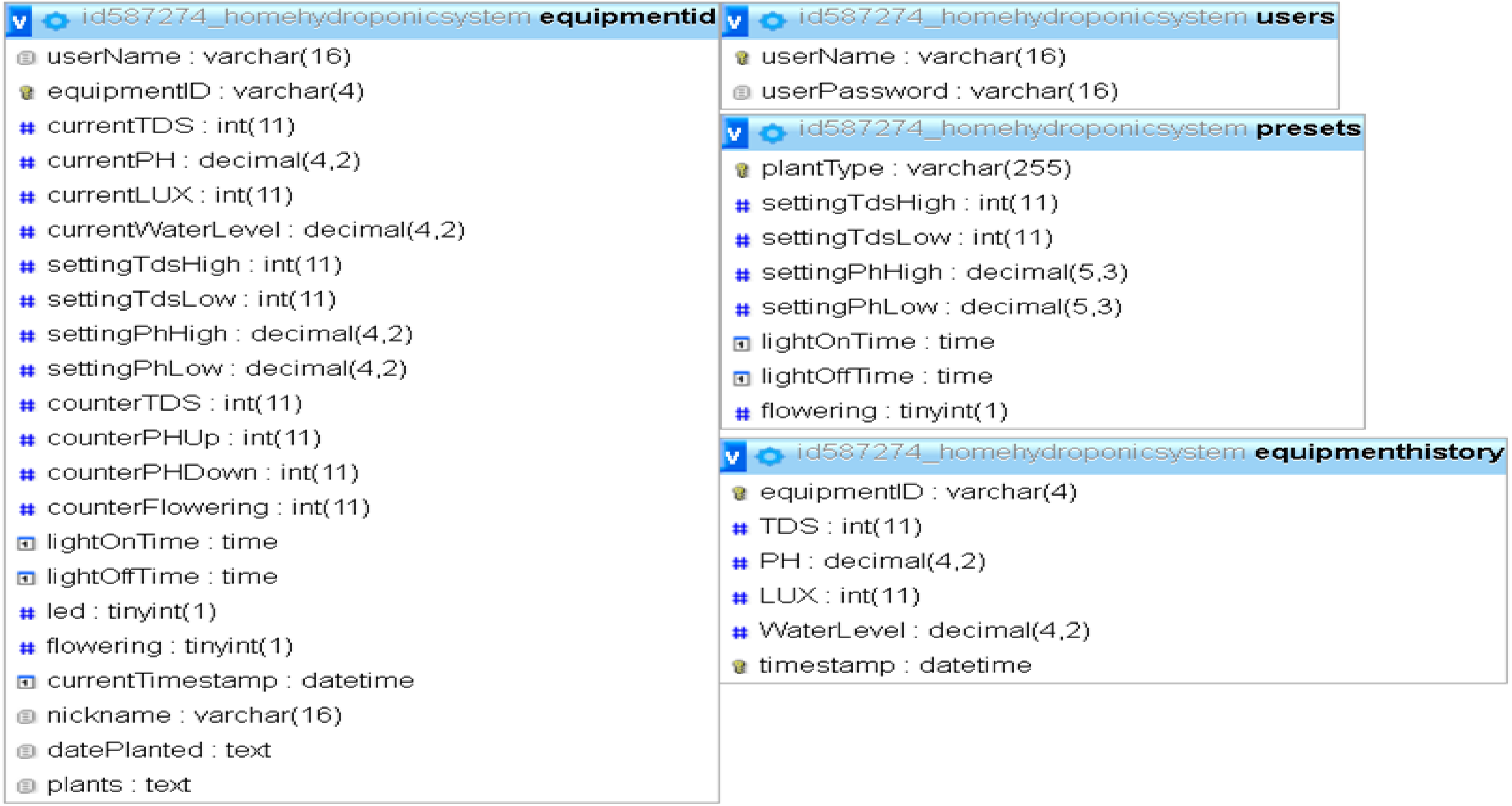
App Screen Flow



Home Hydroponic System

Database / Break Down



Member Work break down Turn this into flow Chart

Hardware

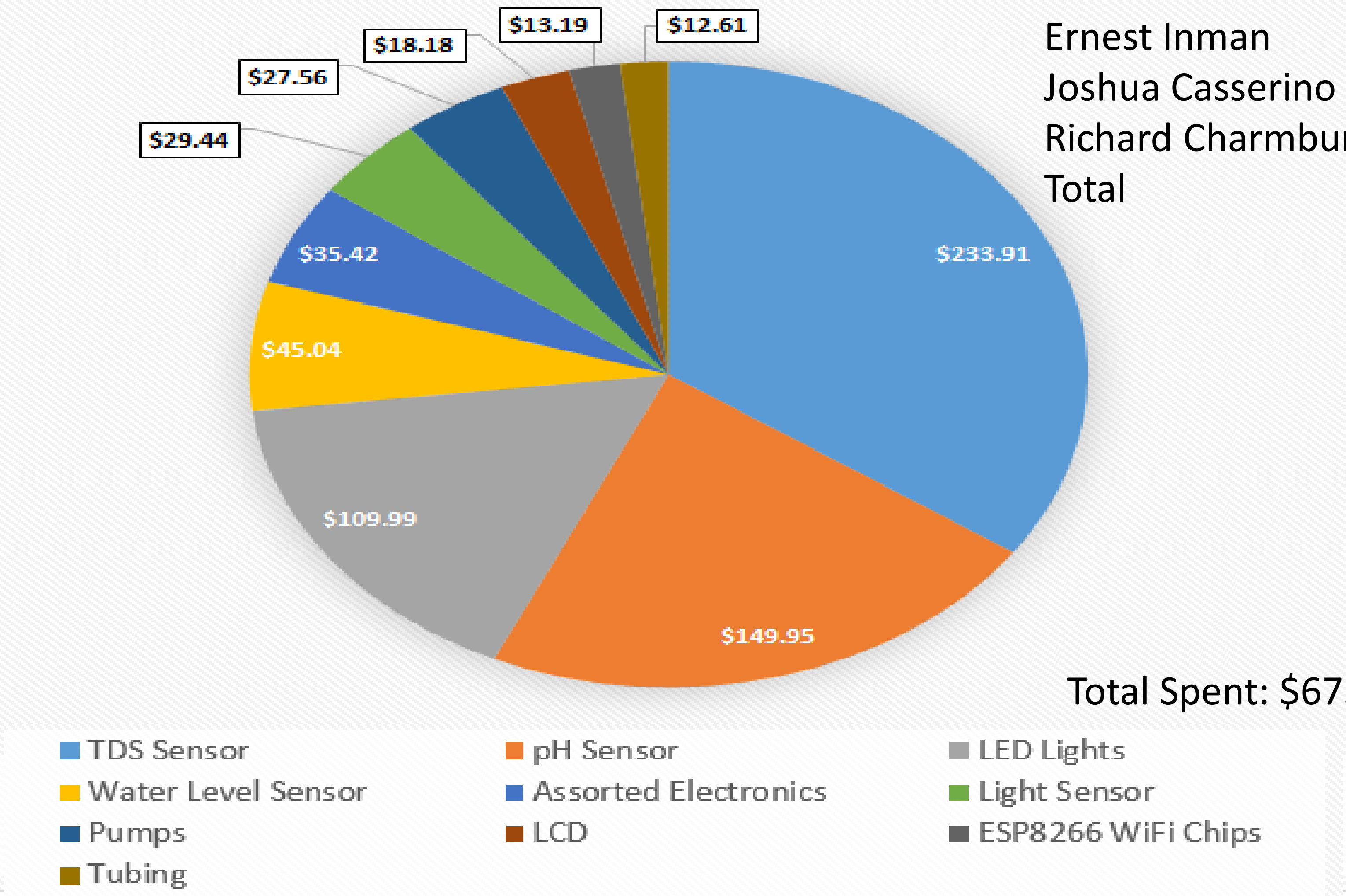
- Bread Board Testing – Ernest Inman/Richard Charmbury
- Bread Board Wiring – Richard Charmbury
- Component Selection – Richard Charmbury
- Light Sensor Testing/Wiring – Ernest Inman/Joshua Casserino
- PCB Design – Richard Charmbury
- pH Sensor Testing/Wiring – Alexander Costello/Richard Charmbury
- Power Supply Design/Creation – Ernest Inman
- Rig Design/Creation – Ernest Inman
- TDS Sensor Testing/Wiring – Ernest Inman/Joshua Casserino
- Water Level Sensor Testing/Wiring - Joshua Casserino/Richard Charmbury
- WiFi Module Testing/Wiring – Alexander Costello/Richard Charmbury

Software

- App Design/Creation – Alexander Costello
- Database Design/Creation – Joshua Casserino
- LCD screen Coding – Alexander Costello
- MCU Coding – Alexander Costello/Joshua Casserino
- Website Design/Creation – Joshua Casserino
- WiFi Module Coding – Alexander Costello/Joshua Casserino

Home Hydroponic System

Budget



Alexander Costello	$250
Ernest Inman	$250
Joshua Casserino	$250
Richard Charmbury	$250
Total	$1000

Total Spent: $675.24

Future Upgrades

- **Install a user interface on the system to increase user's access to system information**
- **Install a modem in the system to increase reliability of database communication**
- **Add catastrophic system failure protection**
- **Improve the systems scalability**

Home Hydroponic System

- Introduction
- System Break Down
- User Interface
- Administration
  - Current Problems and Concerns
  - Budget
  - Current Progress
  - Future Upgrades
  - ►Questions?

Questions?