

Home Hydroponic System Senior Design Spring 2017 Group 18



Group Members:

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| Electrical Engineering - Budget Manager
| Computer Engineering - Component Manager
| Electrical Engineering - Project Manager



Administration

User Interface

Administration

Website

Database

App

Introduction









Current Hydroponic Systems

System Break Down

Introduction

Motivation

► Project Description

User Interface

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Project Description

- To create a home hydroponic system
 - \circ Easy to use
 - $\circ~$ Fits in a usual home
 - \circ Can be easily moved



Current Hydroponic Systems

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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



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► Current Hydroponic Systems

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Current Hydroponic Systems

- Issues with current hydroponic systems
- Too large for household use
- Stationary









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► Current Hydroponic Systems

Home Hydroponic

System

Current Hydroponic Systems
Member Work break down
System Break Down

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System Break Down





Current Hydroponic Systems

- Issues with current hydroponic systems
- Too complicated for a beginner







Home Hydroponic System



Introduction

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Requirements/Specifications
 Main Schematic
 Microcontroller Selection

PCBs

- Master
- Slave
- Power-supply
- MCU Code Flow Chart
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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

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PCB

Master/Slave Configuration



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PCB

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REVD Home Hydroponics Change the color (no Black)









Master / Lighting System

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







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Master / Lighting System Light Sensor

Requirements/Specifications

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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

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Microcontroller Selection

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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







Microcontroller Selection

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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



Microcontroller Selection

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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

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Home Hydroponic System



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



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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





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Master / Water Treatment System pH Subsystem Add a comparison

- pH Sensor
 - Monitors solutions for proper pH
- Peristaltic Pumps
 - $\circ~$ 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



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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
 - o 2mm Inner Diameter





Microcontroller Selection

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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



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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
 - o 4mm Outer Diameter
 - o 2mm Inner Diameter





Requirements/Specifications





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



Microcontroller Selection PCBs

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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
 - o 0.5 W Power Rating
 - Actuation Depth: Nominal 1 Inch
 - Temperature Range 15 ° to 140° F



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Slave / LCD Screen

• We wanted a way to see data without having to look online



Adafruit 16x2 character LCD

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Slave / LCD Screen

Pros

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

Cons

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







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)

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Microcontroller Selection

Requirements/Specifications





Slave / WiFi Module





Adafruit HUZZAH ESP8266 Breakout

ESP8266-12f Module

► Slave

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Slave / WiFi Module

- Requirements/Specifications Main Schematic
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- 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
 - o Bluetooth
 - Why we chose WiFi
 - **o** Using Bluetooth would require close proximity when using the app
 - We wanted our data available online

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Home Hydroponic System



Power Supply

System needs

- The total power needs of the system is about 2.0 watts
- 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

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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
 - \circ Low noise
 - Inexpensive Cost \$0.60
- Switching
 - Slower switching speeds
 - $\circ~$ Creates noise that would need to be filtered out
 - Cost around \$ 2.00



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Power Supply / System Design Add final view of board









MCU Code Flow Chart



Introduction System Break Down





► Requirements/Specifications

User Interface Flowchart

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Website App

Database





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







Requirements and Specifications

Languages used;

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

System Break Down

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App Flow Chart



System Break Down User Interface

Requirements/Specifications Website

►App

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Home Hydroponic System



46 7 11:49

Introduction **App Screen Flow** System Break Down ⁴⁶ 7 11:48 ⁴⁶ 7 11:49 **User Interface** Home Hydroponics System W Home Equipment History Requirements/Specifications Website Garage System ► App Garage System INFO Equipment ID: 0001 Database 2017-02-11 15:46:47 Username pH: 6.82 Lux: 28309 **User Interface Flowchart** pH: 9.00 TDS: -7 2017-02-09 15:49:17 TDS: 845 Water Level: 3.00 Administration Lux: 9090 0002 2016-01-30 23:59:00 Password INFO Equipment ID: 0002 pH: 6.82 TDS: 845 pH: 7.50 Lux: 31876 Water Level: 3.00 Lux: 28309 TDS: 829 2017-02-09 06:16:14 2016-01-30 23:52:00 LOGIN 0003 pH: 6.55 TDS: 788 Water Level: 3.00 Equipment ID: 0003 Lux: 30888 INFO pH: 7.29 Lux: 28846 2016-01-30 23:50:00 TDS: 832 2017-02-09 06:16:53 Haven't registered yet? pH: 7.38 TDS: 870 Water Level: 3.00 0004 Lux: 29468 NEW USER REGISTRATION 2016-01-30 23:44:00 Equipment ID: 0004 INFO pH: 7.64 TDS: 881 pH: 7.24 Lux: 29442 Water Level: 3.00 Lux: 30580 2017-02-09 14:09:02 TDS: 748 2016-01-30 23:34:00 0007 pH: 6.72 TDS: 798 Equipment ID: 0007 INFO Water Level: 3.00 Lux: 27927 pH: 7.87 Lux: 30903 2016-01-30 23:26:00 TDS: 867 2017-02-09 06:40:04 ~~~~ \triangleleft Ο \triangleleft Ο \triangleleft Ο







Introduction **App Screen Flow** System Break Down 46 7 11:49 **User Interface** Equipment ID Management Requirements/Specifications Website ► App Database ADD Enter Equipment ID User Interface Flowchart Administration Garage System DELETE •

 \triangleleft





Requirements/Specifications

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Website





Database / Break Down

🔽 🐟 id587274_homehydroponicsystem equi	ipmentid 🔽 💿 id587274_homehydroponicsystem users
userName : varchar(16)	userName : varchar(16)
🛿 equipmentID : varchar(4)	userPassword : varchar(16)
# currentTDS : int(11)	🔽 👝 id587274_homehydroponicsystem presets
# currentPH : decimal(4,2)	👔 plantType : varchar(255)
# currentLUX : int(11)	<pre># settingTdsHigh : int(11)</pre>
currentWaterLevel : decimal(4,2)	# settingTdsLow : int(11)
<pre># settingTdsHigh : int(11)</pre>	# settingPhHigh : decimal(5,3)
<pre># settingTdsLow : int(11)</pre>	<pre># settingPhLow : decimal(5,3)</pre>
# settingPhHigh : decimal(4,2)	lightOnTime : time
# settingPhLow : decimal(4,2)	lightOffTime : time
# counterTDS : int(11)	# flowering : tinyint(1)
# counterPHUp : int(11)	id587274_homehydroponicsystem equipmenthis
counterPHDown : int(11)	<pre>a oguipmontID : varshar(4)</pre>
counterFlowering : int(11)	TDS : int(11)
🗉 lightOnTime : time	# TDS . Int(TT)
🗉 lightOffTime : time	# PH : decimal(4,2)
# led : tinyint(1)	# LOA : Int(11) # Meterl evel: desimpl(4.2)
# flowering : tinyint(1)	<pre># vvalerLever. decimal(4,2)</pre>
currentTimestamp : datetime	The stamp . dateume
nickname : varchar(16)	
IdatePlanted : text	

plants : text



Current Hydroponic Systems

System Break Down

Member Work break down

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Home Hydroponic System



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







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- Current Problems and Concerns
- ► Budget
 - **Current Progress**
 - Future Upgrades
 - Questions?

Budget





Current Problems and Concerns

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Current Progress Future Upgrades Questions?

Budget





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







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- Current Progress
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Questions?

