Department of Electrical Engineering and Computer Science

University of Central Florida

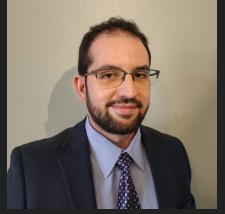
Dr. Lei Wei

“Lab Tool Kit Data Gathering for Lake Studies”

Group 07

Ali Ahmed Al Khusaibi	Electrical Engineer
Homero Rodriguez	Electrical Engineer
Mina Younes	Computer Engineer
Ross Springstead	Computer Engineer
Zeid Haddadin	Electrical Engineer

Motivation & Background

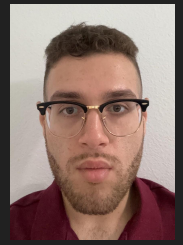


Homero Rodriguez EE

- To produce a low cost but effective tool that provides reliable and significant data from Lakes. Which could be used to better understand lake's health and to predict unwanted phenomenons.

- Toxic Algae Blooms
- Hazardous Bacteria colonies
- Mosquito larvae and other insects
- Analize Bio - chemical composition

Goals Defined During SD1



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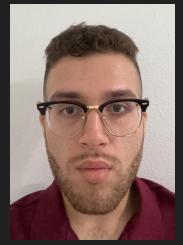
- Build a project to monitor, research, and understand lakes
- Project will contain sensors for air and water data
- Collect data on lakes and store them
- Have a functioning floating device (controlled by remote control)
- It will contain solar panels

- Update: Goals were successfully achieved (7/15/2023)

Goals Revisited for SD2



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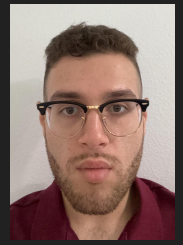
- Discussions with experts like a biologist helped us add another goal
  - Creating a low-cost project that can do multiple readings
  - (Previous goals all remain valid)

- Update: Goals were successfully achieved (7/15/2023)

Objectives



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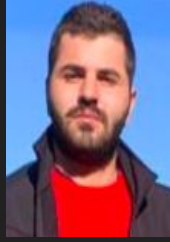
CpE

- Completion in allowed time frame
  - 150 pages for Spring 2023 semester
  - Project completed for Summer 2023 semester
- Fully functional
  - All described features are implemented & working (Summer 2023)
- Not exceed $1,000 in material cost
  - Low-cost solution
  - Cost split between team members
  - Not sponsored

Update: Objectives were successfully achieved

Requirement Specifications

No	Requirements	Units
1	The system shall measure the water's pH and other factors using sensors	1x per 2 minutes*
2	The system shall transmit the readings to the cloud	1x per 2 minutes*
3	The system shall collect bugs in the water	1 min minimum
4	The system shall detect the water's temperature	1x per hour*
5	The system shall detect the outside temperature	1x per hour*
6	The system shall have solar panels that charge rechargeable batteries	1-2 solar panels,
7	The system shall be waterproof	IP67
8	The system shall be moved with a remote controller	Response time < 2s

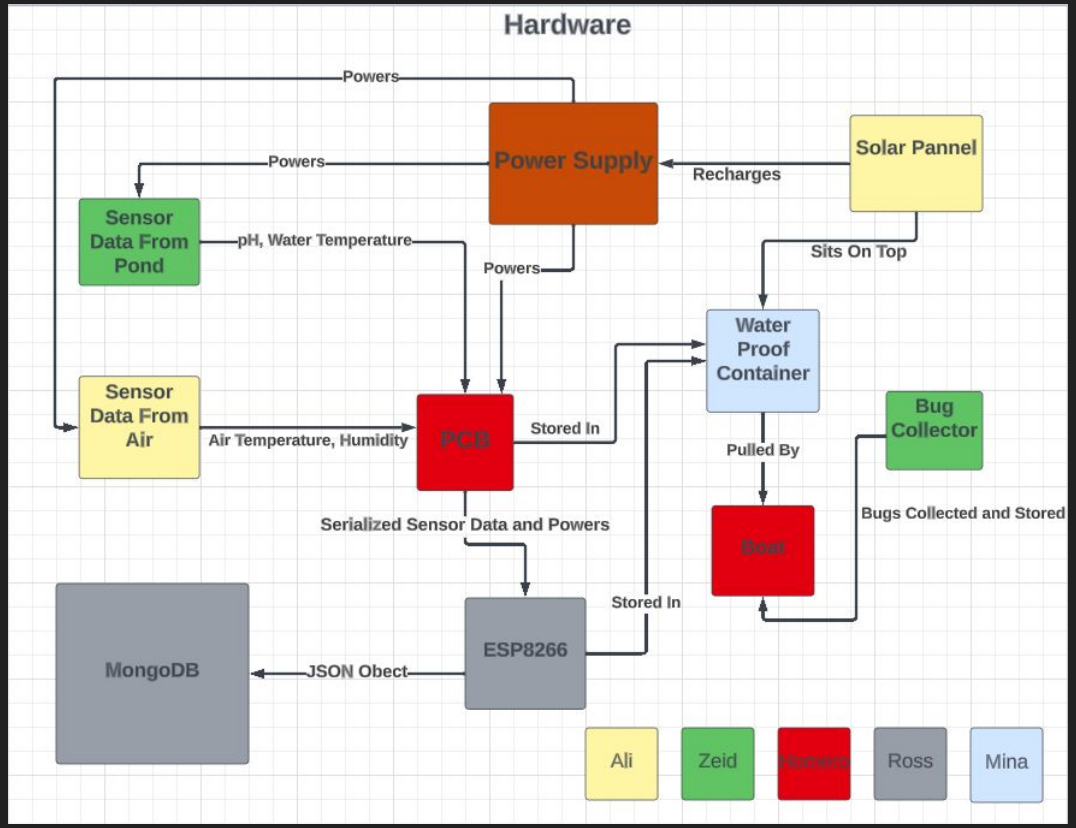


Zeid Haddadin, EE

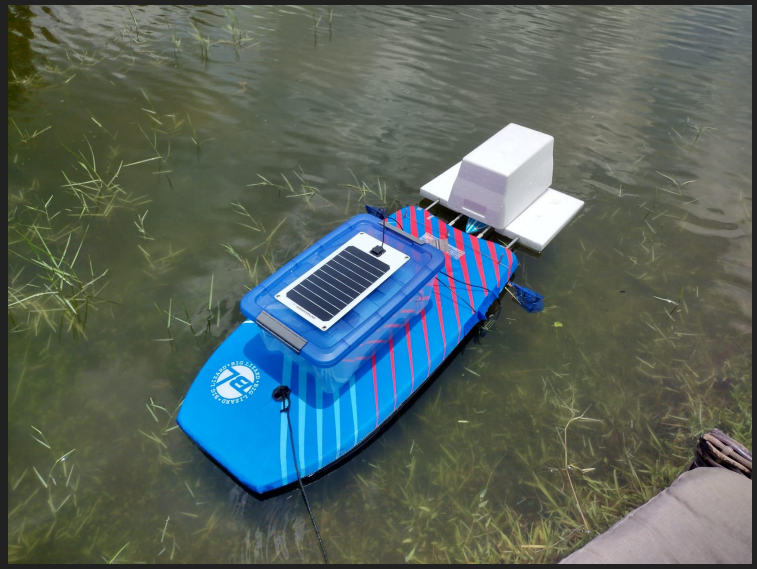
The units with a star (*) are subject to change after consulting with research experts.

The highlighted requirements specifications are the ones that will be demonstrated.

Hardware Block Diagram



Ross Springstead, CpE



Hardware Comparison & Selection:
“Project Brain”

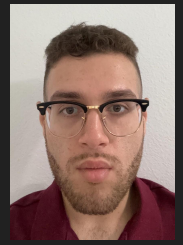


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Table: Project Brain Technologies

	Microcontroller	**PCB**
Advantage(s)	Fully functional, libraries, fast prototyping	Flexibility from custom design
Disadvantage(s)	Some have limited processing power	Long design process to receive final product

Hardware Comparison & Selection:
Development board (Arduino UNO)

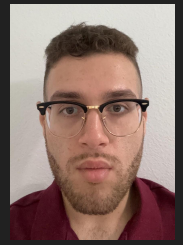

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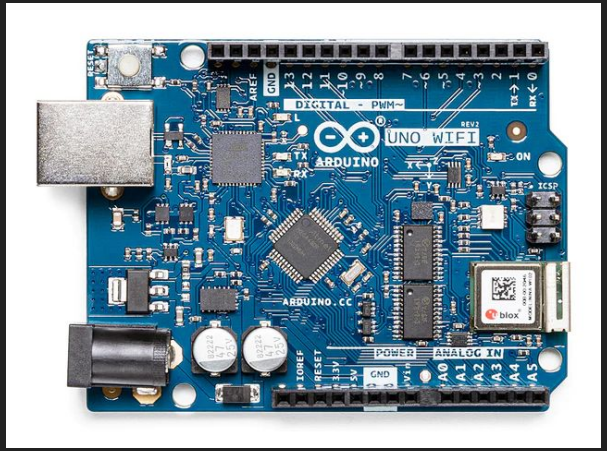
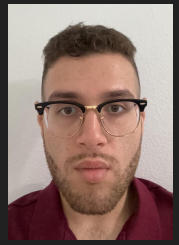
Table 6: Microcontroller Boards Comparison

	MSP430G2ET	MSP430FR6989	Arduino UNO Rev3	Arduino UNO WiFi REV2
Operation Voltage	1.8 to 3.6V	1.8 to 3.6V	5V	5V
System Clock	Up to 16MHz	Up to 16MHz	16 MHz	16MHz
Memory	-16KB Flash memory -512 Bytes SRAM	-8MHz FRAM access -128KB non volatile FRAM	-32KB Flash memory -2KB SRAM -1KB EEPROM	-48KB Flash memory -6 Bytes SRAM -256 Bytes EEPROM
Communication	UART, IrDA, SPI, I2C	UART, I2C, SPI	UART, I2C, SPI	UART, I2C, SPI
LCD Display	No	Yes (320 segments)	No	No
Manufacturer	Texas Instruments	Texas Instruments	Arduino	Arduino
Price	$10.00	$20.00	$27.60	$53.80
Size (Length x Width)	N/A	76.2 mm x 50.8 mm	68.6 mm x 53.4 mm	68.6 mm x 53.4 mm
Weight	N/A	28g	25g	26g



Arduino UNO WiFi Rev2
(Arduino website)

Hardware Comparison & Selection: PCB



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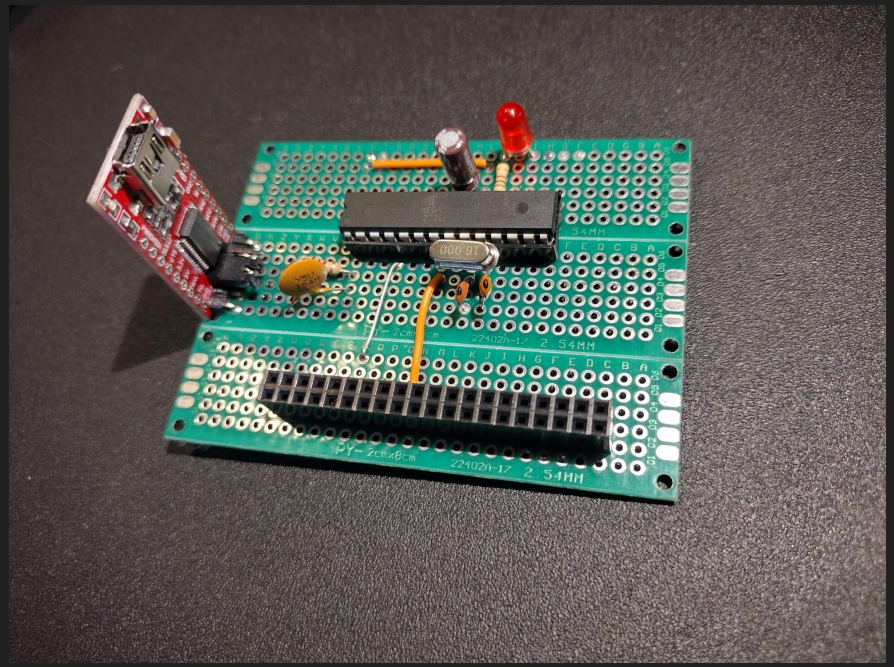
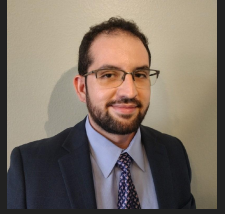


PCB Design Process



Homero Rodriguez EE

- Significant PCB design will be done using Flux design software.

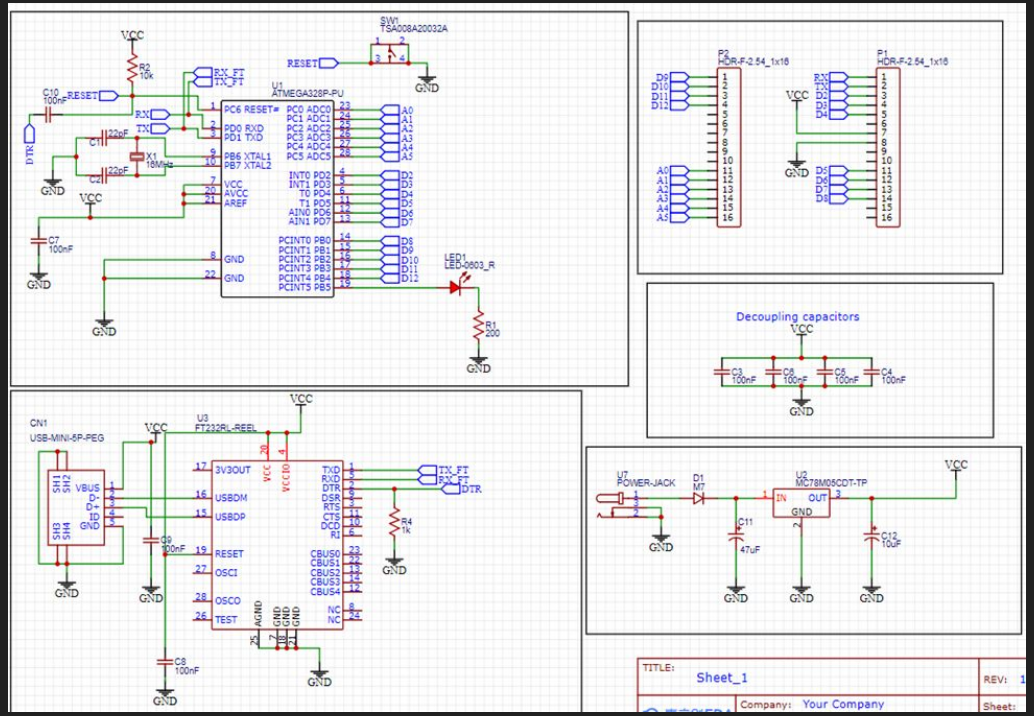
- At least temperature sensor, pH sensor, Air Quality sensor and the ESP Wi-Fi module will be integrated into the PCB.

- Biggest challenge is the time constraint in between the cycles of the design iteration process.

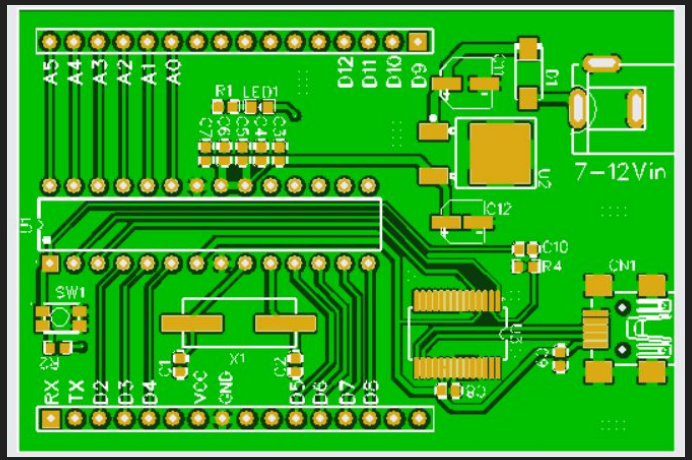
PCB Design

Ali AL khusaibi,
EE

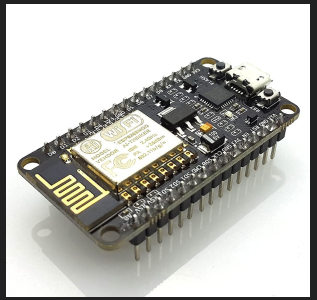
PCB Schematic



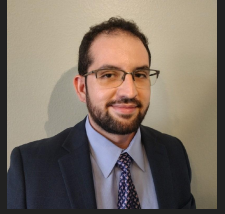
PCB layout



ESP12E Wifi module



PCB Fast Development Method (Maximising Success Rate by increasing independent tries per cycle)



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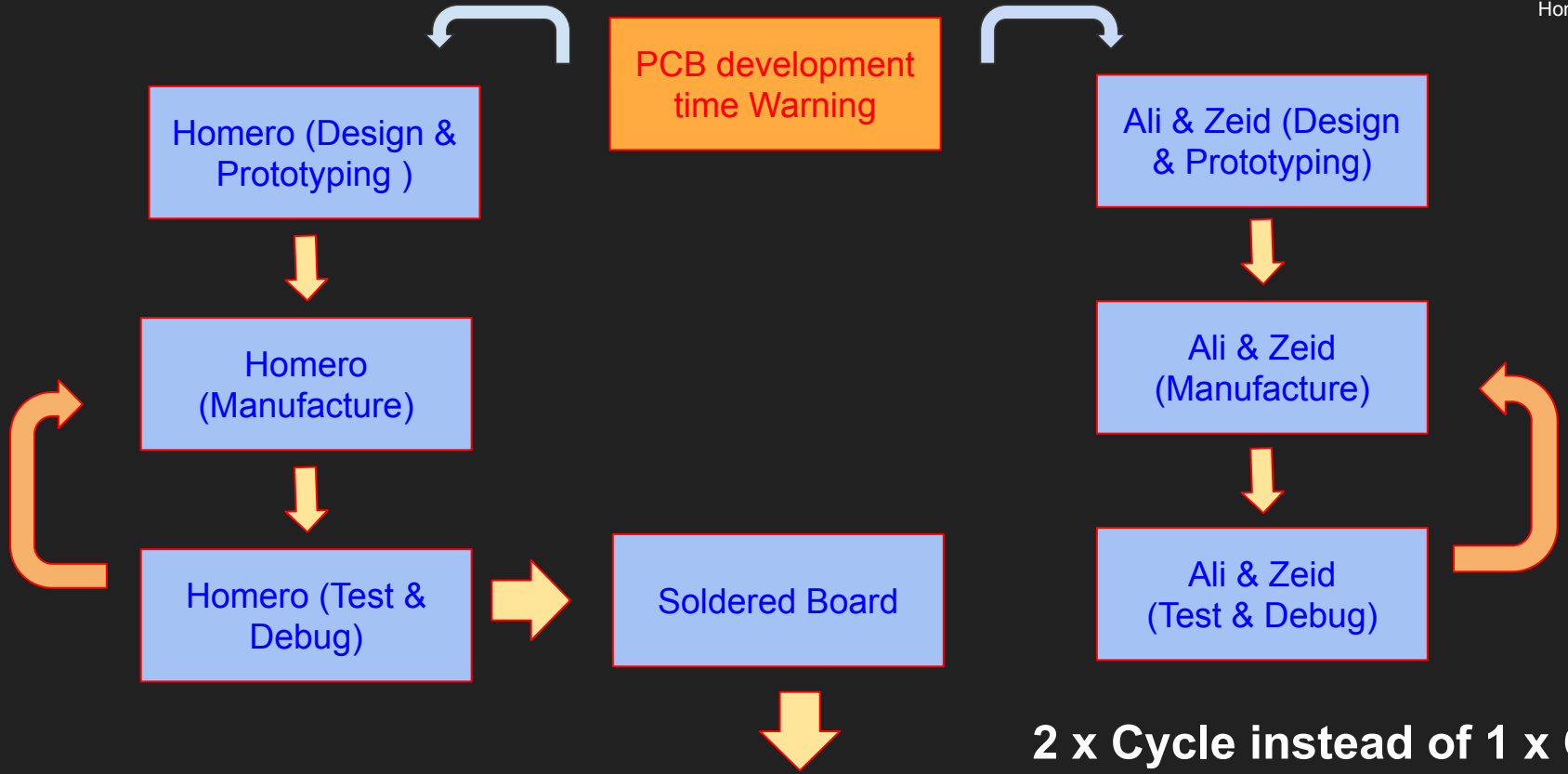
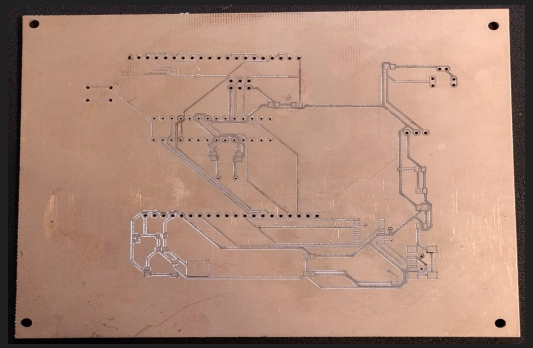


2 x Cycle instead of 1 x Cycle

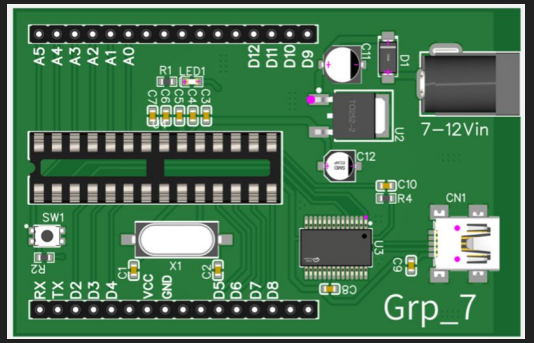
PCB Versions

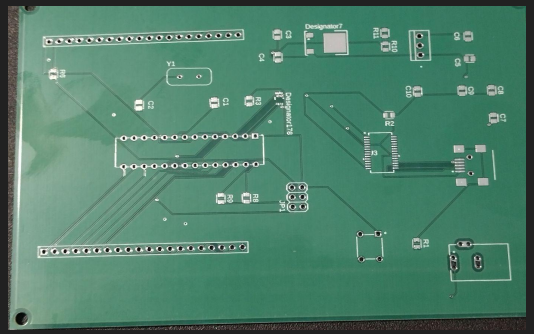
Homero
(Manufacture)

Ali & Zeid
(Manufacture)

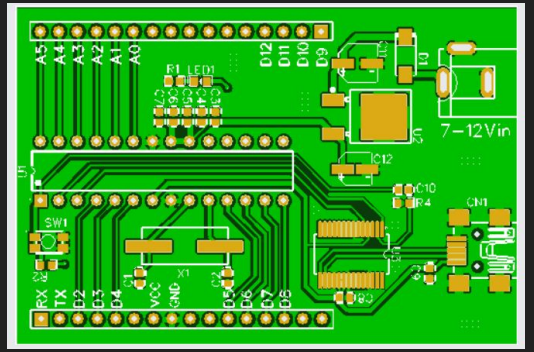


First Cycle

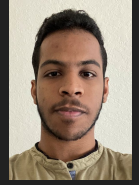




Second Cycle



PCB testing & Debugging



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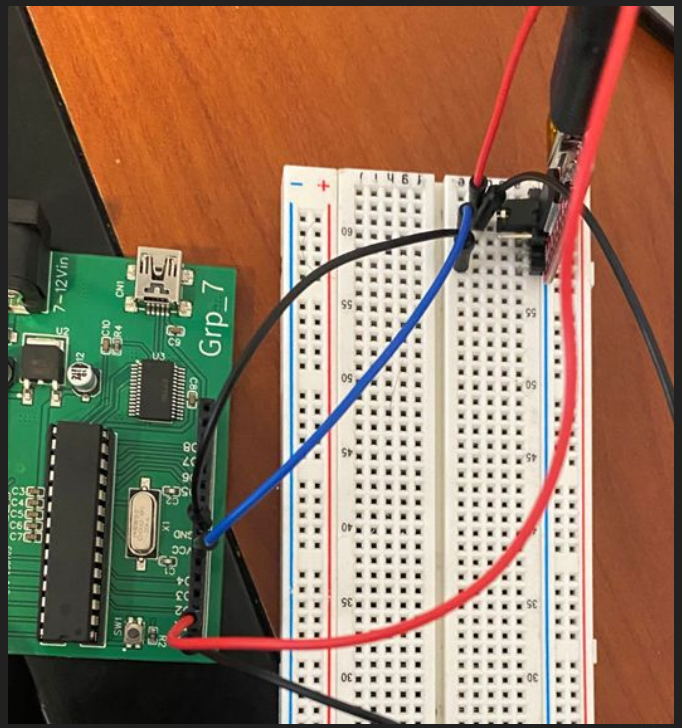
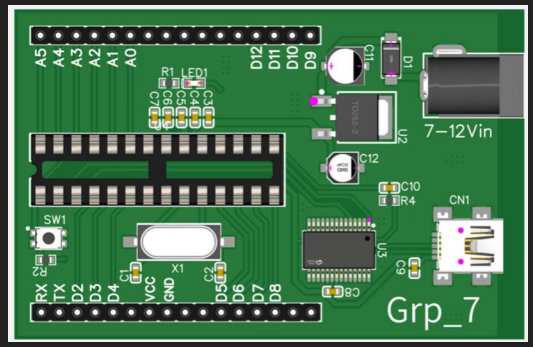
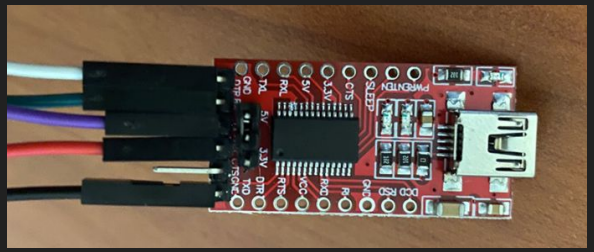
EE



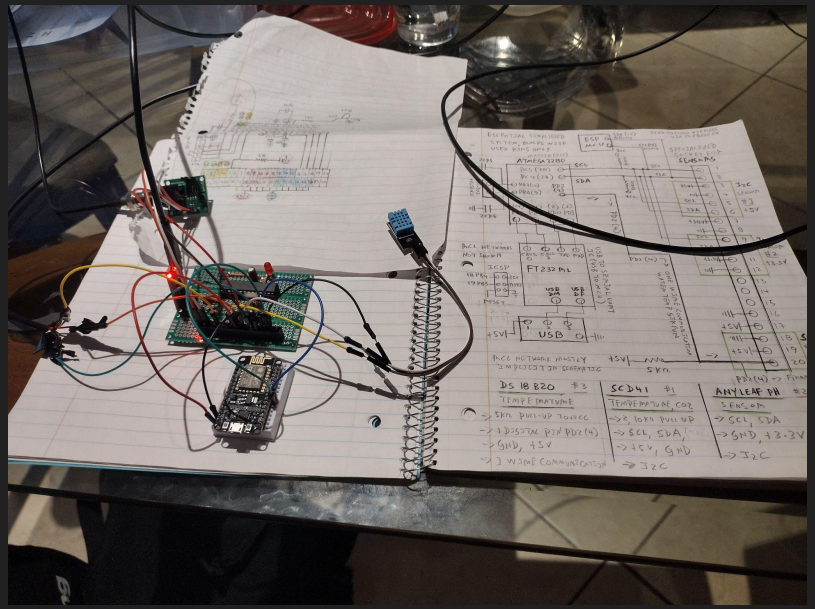
PCB debugging and testing

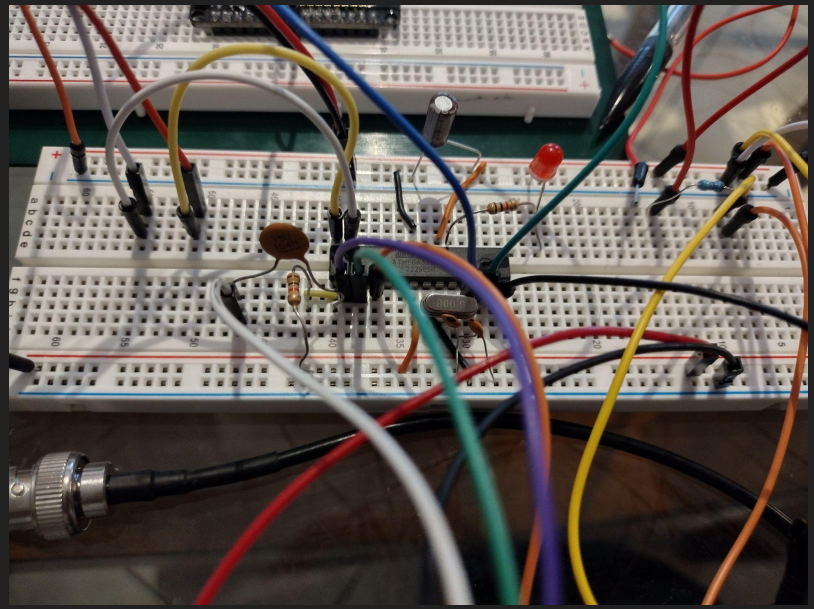




FT232RL Mini USB Programmer module

Hardware Explanation

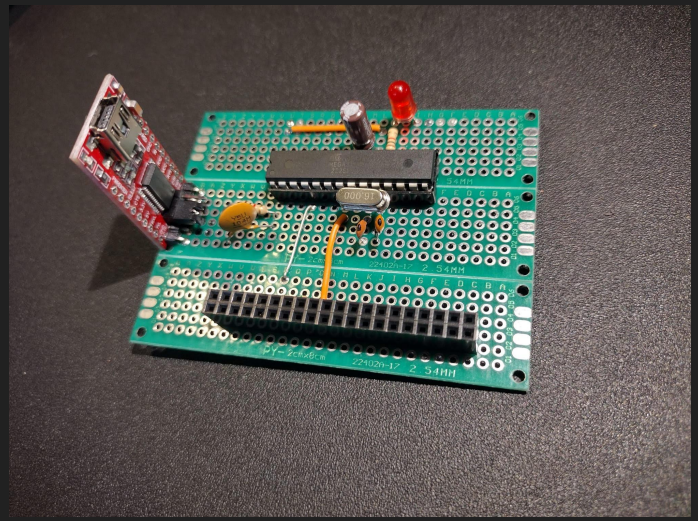


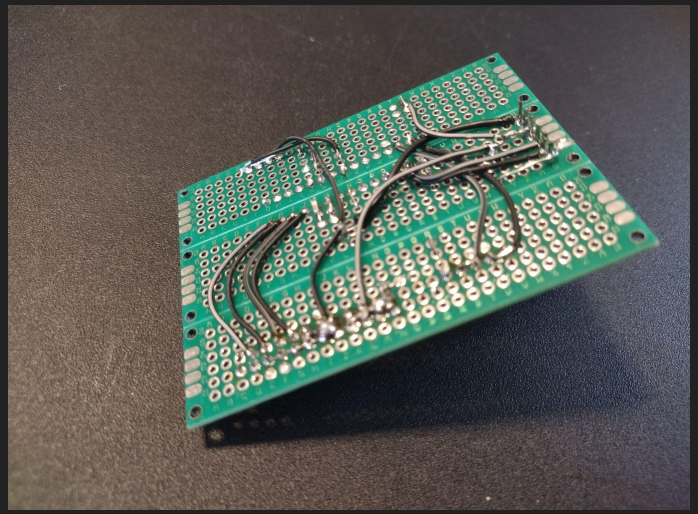


Homero Rodriguez EE

From drawing schematics in design table to breadboard, then Soldered Board and finally transfer successfully proven circuit to PCB.

Hardware Explanation

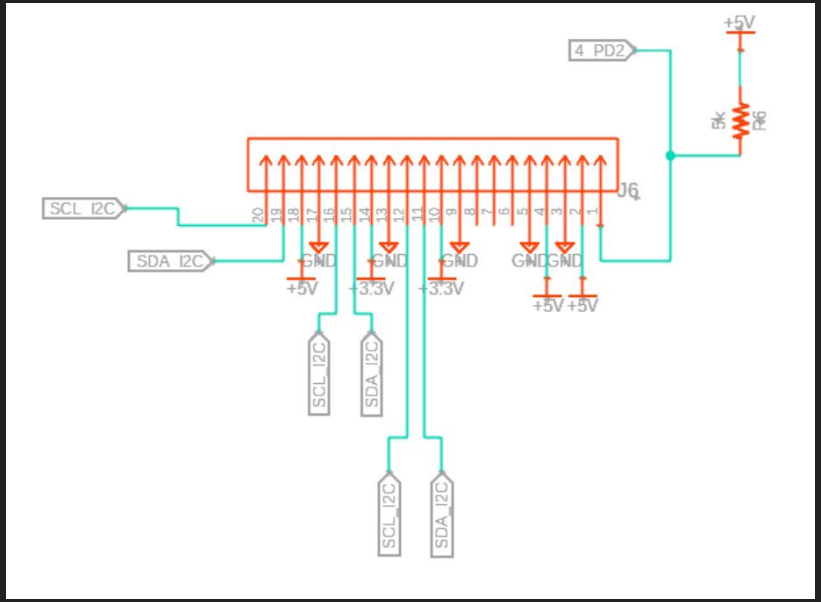


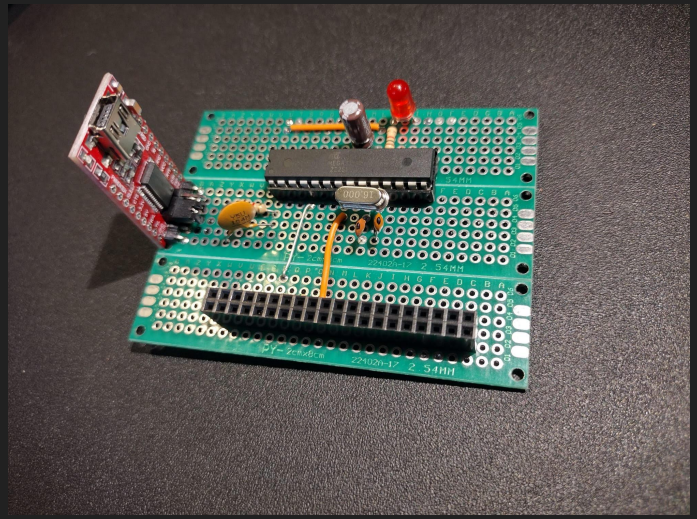


Homero Rodriguez EE

The Soldered Board is currently running the project to a 100% of its expected functionality.

Hardware Explanation





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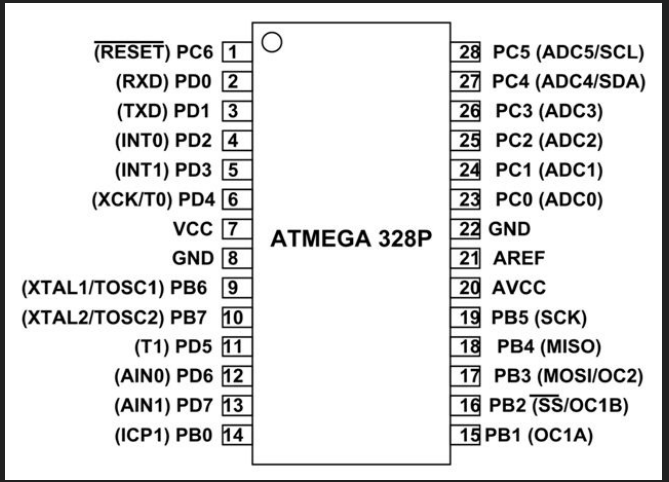
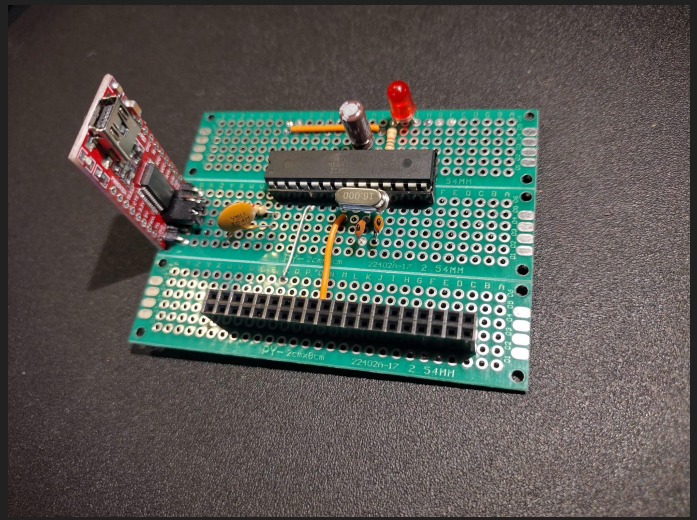
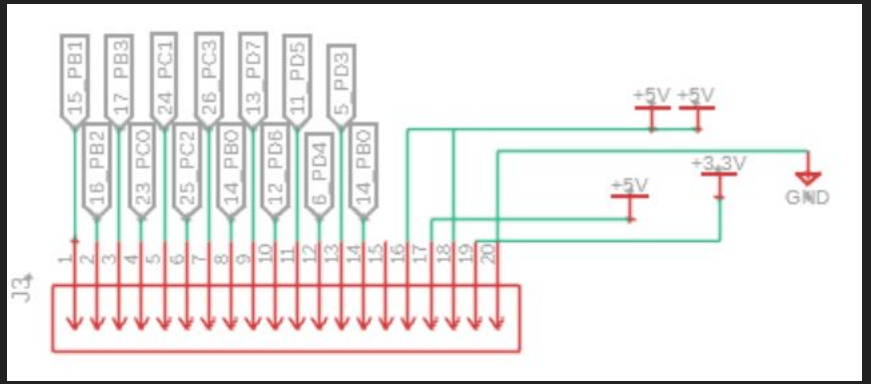
Customized designed Pin Socket for Sensors in PCB. It can manage two I2C sensors and one Single Wire Communication.



ATmega328 Chip Pin-out from the Data-sheet

Hardware Explanation





Design in PCB

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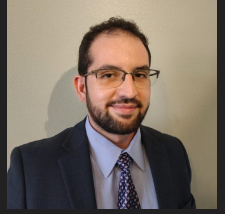
All other pins of ATmega accessible from Pin Sockets in the case are needed, plus additional power 5V, 3V and ground Pins available for other devices. (Using jumping wires)

Hardware Explanation (Net sampling organic Material and species from lake)



Homero Rodriguez EE

The Nets successfully sampled organic material, small insects and animals from the lake which is important information to understand lake composition. (Biochemical , bacteria and more)

Hardware Comparison & Selection:
Recharging Power Supply (Batteries)

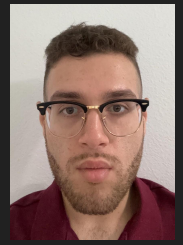


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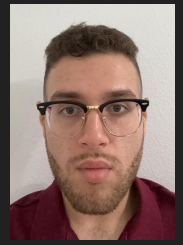
Table: Recharging Power Supply Technologies

	Manually with Charger	**Solar Panel**
Advantage(s)	Does not depend on the weather	Renewable energy source
Disadvantage(s)	Take out product from water to take out batteries (inconvenient)	Slower charge time

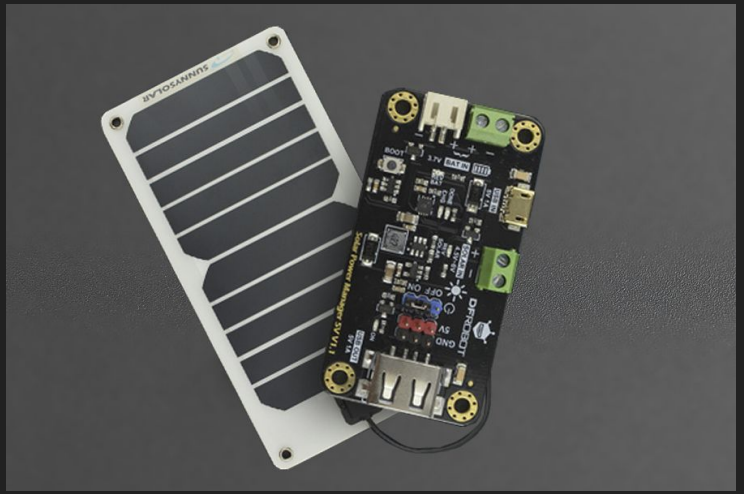
Hardware Comparison & Selection: Solar Panel



Mina Younes,
CpE

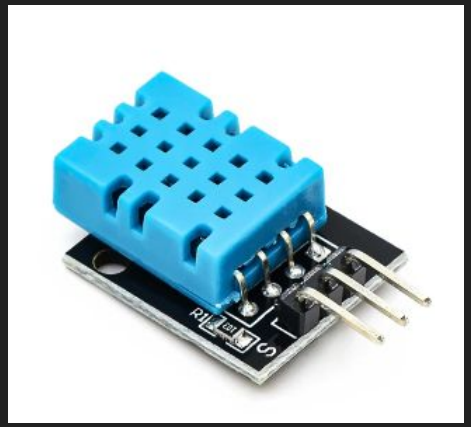
Table 8: Solar Panel Comparison

	Semi Flexible Monocrystalline	FellDen Micro	Treedix Polysilicon
Operating Voltage	5V	5V	5.5V
Operating Current	1A	200 mA	181 mA
Power	5W	1W	1W
Weight	87g	277.8g	99.7g
Working Temperature	-4 °F to 140 °F	N/A	14 °F to 140 °F
Manufacturer	DFRobot	SuniAde	Treedix
Dimension	289.8 mm x 149.86 mm x 1.27 mm	110 mm x 60 mm x 2.5 mm	95 mm x 95 mm x 3.05 mm
Pieces Included	1	10	3
Cost	$25.40	$21.00	$14.00

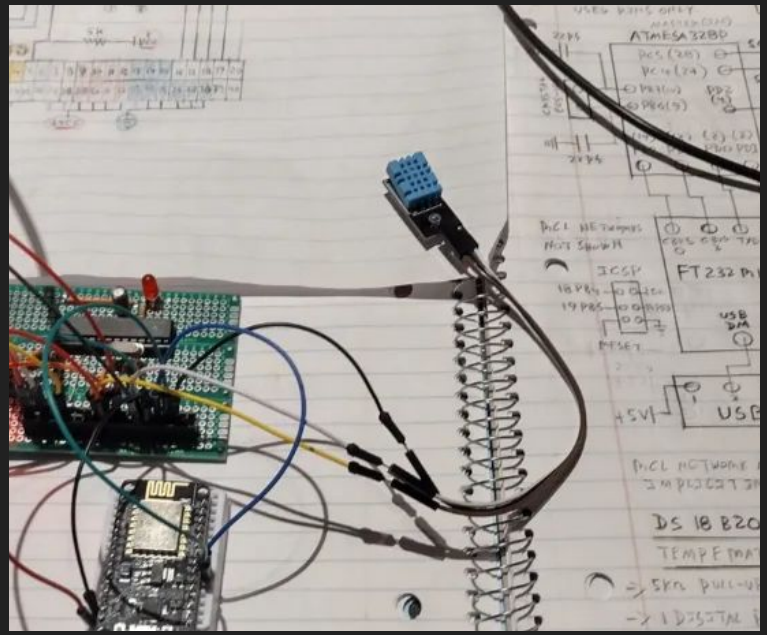


Semi Flexible Monocrystalline
(DFRobot)

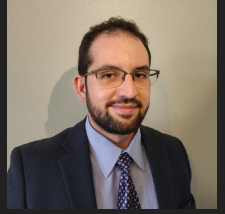
Hardware Comparison & Selection:
Air Quality Sensor



DHT11
Temperature - humidity sensor.



DHT11 Installed and working on Soldered Board.

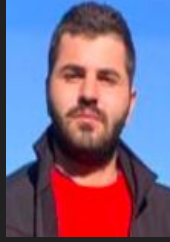


Homero Rodriguez EE

Container Comparison

	ML-58F	Foam	IP67
Material	ABS plastic	polyethylene	ABS Plastic
Dimensions	8.75 x 5.25 x 3.30 in / 222.25 x 133.35 x 83.82 mm.	7.5cm x 6cm x 2cm (2.95inch x 2.36inch x 0.78inch)	290×190×140mm (11.4"×7.5"×5.5")
Weight	6.4 ounces	0.5 ounces	7.7 ounces
Waterproof	yes	yes	no
Color	Clear ; Gray	White	Gray
Price	$36	$5	$31

Foam

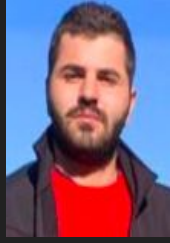


Zeid Haddadin, EE

Water Temperature Sensor Comparison

	Gikfun DS18B20	KOOKYE TMP36	HiLetgo MAX6675	LMT86LPM
Power supply range	3.0V to 5.5V DC	2.7V to 5.5V DC	3.0V to 5.5V DC	2.2V to 5.5V DC
Dimensions	5.8 x 0.6 x 3.9 inches	2.1 x 2 x 0.5 inches	4.5 x 2.5 x 0.3 inches	3 x 1.6 x 1.15 inches
Weight	2.4 Ounces	0.634 ounces	0.71 Ounces	0.4
Temperature range	-55°C to +125°C (-67°F to +257°F	-40°C to 150°C / -40F to 302F 2°C accuracy	C20Degrees Celsius ¨C 85Degrees Celsius	-50°C ~ 150°C
Accuracy over the range	: ±0.5°C	±2°C	±2°C	±0.4°C
waterproof	yes	yes	no	yes
Price	$12	$10	$8	2$

Gikfun DS18B20



Zeid Haddadin, EE

Power Supply Comparison and selection:

Ali AL khusaibi, E

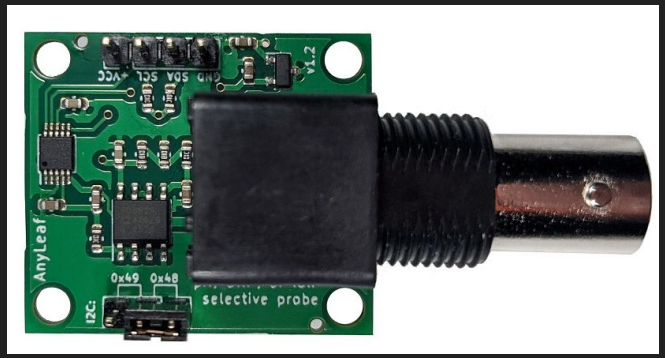
	REACELL lithium-ion 3.7v battery	Tenergy(NiMH) battery pack	SHENMZ lithium ion battery (Li-Ion)	Swanlake (NiMH) rechargeable battery
Voltage	3.7v	12v	3.7v	3.6v
Capacity	3000mAh	2000mAh	3400mAh	2500mAh
Chemistry	lithium ion	NiMH	lithium ion	NiMH
Weight (one battery)	0.7ounce (20g)	7.9ounce (225g)	0.7ounce (20g)	1.58 ounce (45g)
Size(height x width)	(67x18.67mm)	(5.36 x 7.3cm)	(2.2 x 7.2cm)	(65 x 18mm)
Top	Button type	Flat top	Flat top	Flat top
Brand	N/A	Tenergy	N/A	PUNILM
Number of batteries included	4	10	4	4
Protection	No	Yes	No	No
Manufacturer	REACELL	Tenergy	AexPower	Swanlake

REACELL Lithium-ion battery pack

Hardware Comparison & Selection: pH Sensor

Ross Springstead, CpE

	Gravity: Analog pH Sensor	AnyLeaf
Range	0-14	0-14
Accuracy	< 0.2pH	<.01ph
Communication	I2C	I2C
Dimensions	43mm×32mm	60 x 27 x 17 (height)
Weight	15 grams	14 grams
Input Voltage	3.3-5.5 V	2-5 V
Response Time	<2 Minutes	N/A
Price	$39.50	$70



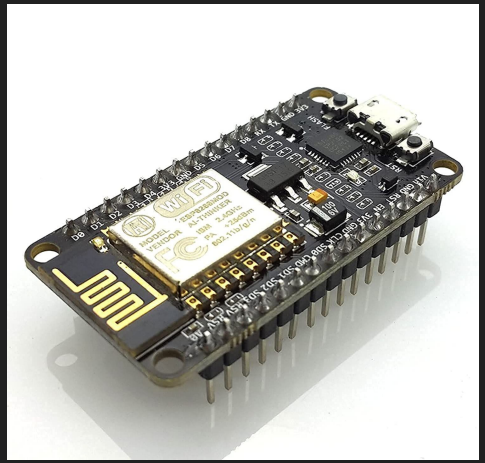
AnyLeaf pH Module

Hardware Comparison & Selection: Data Transmission

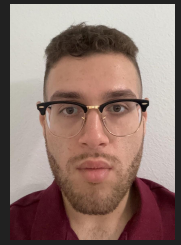
Ross Springstead, CpE

	ESP8266 WiFi Module	2.4G Zigbee CC2530 Core Development Board	SparkFun LTE CAT M1/NB-Iot Shield	Speed RF Transmitter and Receiver Link Kit
Method	WiFi	ZigBee	4G LTE cellular	Radio Waves
Frequency Range	2400-2484 MHz	2400 MHz	698 MHz - 960 MHz or 1.7 GHz - 2.7GHz	200 KHZ
Distance of Signal	30-100 Meters	10 - 30 Meters	Global	2 KM
Input Voltage	3.3V	3.3V	3.3 V	3.3V - 9V (Transmitter) 3V - 5V (Receiver)
Intended Use	Internet Cellular Connections	Home Automation	Internet Cellular Connections	Transmitting Data Locally
Price	$7.50	$8.11	$96.50	$17.00

WiFi Module - NodeMCU ESP8266



Software & Hardware Integration: NodeMCU code



Mina Younes, CpE

sketch_jul17a | Arduino IDE 2.1.1

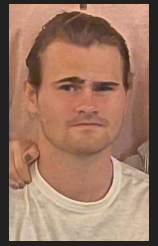
File Edit Sketch Tools Help

Select Board

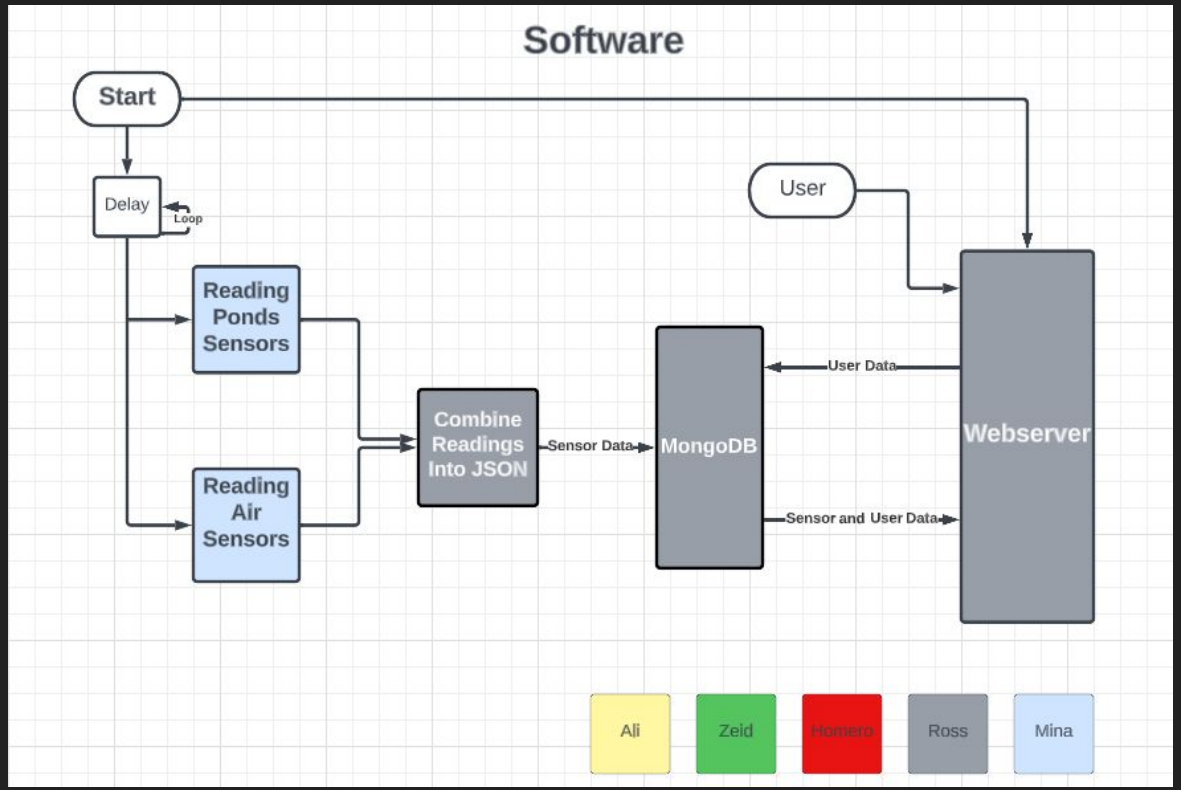
sketch_jul17a.ino

```ino
#include <Arduino.h>
#include <ESP8266WiFi.h>
#include <ESP8266HTTPClient.h>
#include <WiFiClientSecureBearSSL.h>
#include <ArduinoJson.h>
#include <SoftwareSerial.h>

// Replace with your network credentials
// const char* ssid = "SpectrumSetup-33";
// const char* password = "inputreason953";

const char* ssid = "Test";
const char* password = "minamina";

// NodeMCU pins
#define NODEMCU_RX D6
#define NODEMCU_TX D5

// Initialize NodeMCU software serial
SoftwareSerial nodemcu(NODEMCU_RX, NODEMCU_TX);

void setup() {
  Serial.begin(115200);
  //Serial.setDebugOutput(true);

  Serial.println();
  Serial.println();
  Serial.println();

  // Connect to Wi-Fi
  WiFi.mode(WIFI_STA);
  WiFi.begin(ssid, password);
  Serial.print("ssid: ");
  Serial.println(ssid);
  Serial.print("password: ");
  Serial.println(password);

  Serial.print("Connecting to WiFi ..");
  while (WiFi.status() != WL_CONNECTED) {
    Serial.print('.');
    delay(1000);
  }

  // Initialize NodeMCU serial communication
  nodemcu.begin(9600);
  delay(1000);
}

void loop() {
  // Wait for WiFi connection
  if (WiFi.status() == WL_CONNECTED) {
    std::unique_ptr<BearSSL::WiFiClientSecure> client(new BearSSL::WiFiClientSecure);

    // Ignore SSL certificate validation
    client->setInsecure();

    // Create an HTTPClient instance
    HTTPClient https;

    // Initializing an HTTPS communication using the secure client
    Serial.println("[HTTPS] begin...");
    if (https.begin(*client, "https://us-east-1.aws.data.mongodb-api.com/app/test-sending-data-rovkb/endpoint/createData")) {  // HTTPS
      https.addHeader("Content-Type", "application/json");

      // Read JSON data from NodeMCU
      if (nodemcu.available()) {
        String jsonStr;
        while (nodemcu.available()) {
          jsonStr += nodemcu.readString();
        }

        StaticJsonDocument<200> jsonDocument;
        DeserializationError error = deserializeJson(jsonDocument, jsonStr);
        if (!error) {
          JsonObject data = jsonDocument.as<JsonObject>();

          // Send JSON data to MongoDB
          String output;
          serializeJson(data, output);
          int httpResponseCode = https.POST(output);
          Serial.println(httpResponseCode);
        }
      }

      https.end();
    } else {
      Serial.println("fail");
    }
  }
  Serial.println();
  Serial.println("Waiting 2min before the next round...");
  delay(60000);
}
```

Software Design: Block Diagram



Ross Springstead, CpE

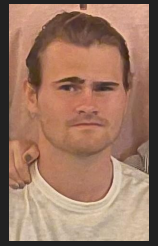


Software Comparison & Selection: Updates to Stack Selection and Hosting

Ross Springstead, CpE

Original Plan	New Plan
Use MERN stack for development	Replacing Express.js and Node.js for Next.js
Use CSS and Bootstap	Switching to CSS and Tailwind
Host our web application on DigitalOcean	Host our web application on Vercel
Using JavaScript and TypeScript	Continuing with only JavaScript

Software Languages Used



Ross Springstead, CpE

	PCB	ESP8266	Website
Integrated Development Environment	Arduino IDE	Arduino IDE	Visual Studio Code
Language	C++	C++	JavaScript
Location of Files	Google Drive	Google Drive	Github

Software Design: Database

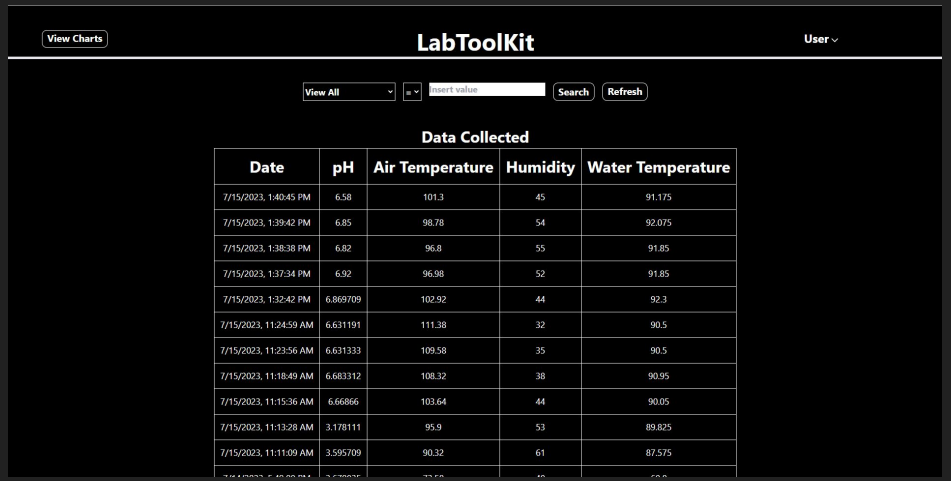
Ross Springstead, CpE

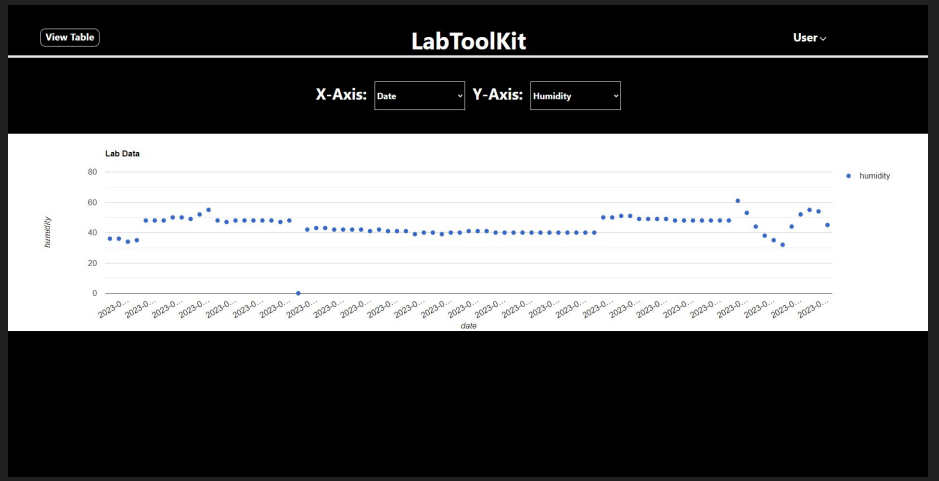
- Our MongoDB Database stores 3 Collections
- **User's Collection:** Email, Hashed Password, Array for Lab Tool Kits
- **Pond Data Collection:** Time Stamp, Humidity, pH, Air Temperature, Water Temperature, and Tool Kit ID
- **Token Collection:** Email and Unique Token

Features of our Website

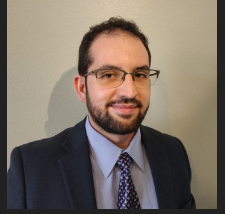
- Can be access from sd2-work.vercel.app

Ross Springstead, CpE





Identifying Needs & Standardizing Data



Homero Rodriguez EE

- Standardized Data Type that contains essential information to optimize efficiency and speed in the industry.

- Data Type (JSON Object)

  -> Time Stamp (Year, month, day, hour, minute)

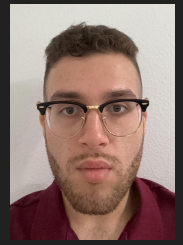
  -> pH

  ->Temperature

  -> Air Quality (Temperature & Humidity)

  -> Other parameters to be determined

Administrative Content: Budget



Mina Younes, CpE

- Money spent at the middle of semester: $599.98
  - Lower than the $1,000 limit predetermined
- Estimated money spent at the end: $800.00
  - Unexpected expenses
  - Still under predetermined limit
- Update:
  - Added $200.00 for 2 PCBs
  - Total new cost: $800.00

Table 21: Bill of Materials

Item Description	Vendor	Quantity	Price Per Unit	Total Estimated Cost
Arduino Microcontroller (Arduino Uno WiFi)	Amazon	1	$54.98	$54.98
Water Temperature Sensor	Amazon	2	$13.66	$27.32
Outside temperature, CO_2, & humidity sensor	Seeedstudio	2	$52.90	$105.80
Net (Mosquito collection)	Amazon	1	$11.99	$11.99
RC Boat	Amazon	1	$50.00	$50.00
Water Holder	Amazon	1	$50.00	$60.00
Solar Panels + Accessories	DFRobot	1	$62.00	$62.00
Batteries	Walmart	1	$20.00	$20.00
pH Sensor	Arduino	2	$35.00	$70.00
GPS Card	Amazon	1	$12.59	$12.59
Lab Container + Accessories (Floater, silicone, etc.)	Amazon	1	$100.00	$100.00
Servo Motors	AliExpress	2	$7.64	$15.28
MicroSD, 32 GB	Amazon	1	$10.00	$10.00
Total Cost:				$599.98

Work Distribution Electronics - Mechanics

Ali AL khusaibi, EE

Team member	PCB design	Prototyping breadboard	Functional Soldered Board	Hardware selection and testing	Floating Lab design and assembly	Sensors selection and testing	Power supply & Solar
Ali	S	S	S	S		S	P
Homero	P	P	P	P	P	S	
Mina		S		S		S	
Ross		S		S	S	S	
Zeid	S	S		S		P	S

P = Primary S = Secondary

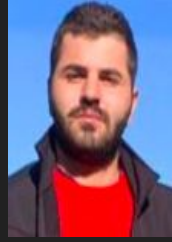
Ali AL khusaibi, EE

Work Distribution Software

Team member	PCB and Esp8266 Software	Web Design (UI and UX)	Account Creation and Management Software	Full Stack Web Application Selection and Implementation	Emotional Support
Ali					
Homero					P
Mina	S	P	P	S	S
Ross	P	S	S	P	
Zeid					

P = Primary S = Secondary

Progress (SD2 Project Milestones)



Zeid Haddadin, EE

May	First day of summer semester goals
May	May goals – Build and test components
June	June goals – Work on software
June	July – work on testing, final paper, and presentation
July	Last Day of Class goals – Presentation of the project
July	Last day of final exams – Submit the final report