

Department of Electrical Engineering and Computer Science

University of Central Florida

Dr. Lei Wei

“Lab Tool-kit Data Gathering for Lake Studies”

Group 07

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Electrical Engineer
Electrical Engineer
Electrical Engineer
Computer Engineer
Computer Engineer



Homero Rodriguez EE

Motivation & Background

- To produce a tool that benefits scientific research & the public health system.
- Highly precise & specialized tool **Vs** Low cost & less precise tool for the use of general public.
- The benefit of getting information from lakes where the State currently has no reach for research or monitoring. (Lakes privately owned by landlords or small communities)

Administrative Content: Budget

- Money spent to date: \$599.98
 - Lower than the \$1,000 limit predetermined
- Estimated money spent at the end: \$800.00
 - Unexpected expenses
 - Still under predetermined limit

Table 21: Bill of Materials

Item Description	Vendor	Quantity	Price Unit	Per	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, CO2, & 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	AliiExpress	2	\$7.64		\$15.28
MicroSD, 32 GB	Amazon	1	\$10.00		\$10.00
Total Cost:					\$599.98



Mina Younes,
CpE

Goals Defined During SD1

- 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



Mina Younes,
CpE

Goals Revisited for SD2

- 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)



Mina Younes,
CpE

Objectives

- Completion in allowed timeframe
 - 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



Mina Younes,
CpE

Requirement Specifications (Zeid)



Zeid Haddadin,
EE

No	Requirements	Units
1	The system shall measure the water's pH	1x per hour*
2	The system shall transmit the readings to the cloud	1x per hour*
3	The system shall collect samples of water	≥ 30 mL
4	The system shall collect bugs in the water	1 min minimum
5	The system shall detect the water's temperature	1x per hour*
6	The system shall detect the outside temperature	1x per hour*
7	The system shall have solar panels that charge rechargeable batteries	1-2 solar panels,
8	The system shall be waterproof	IP67
9	The system shall be moved with a remote controller	Response time < 2s

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.

House of Quality:



Ali AL Khusaibi, EIT

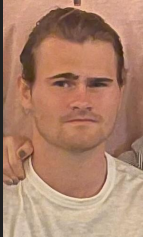
Correlations	
Positive	+
Negative	-
No Correlation	

Relationships	
Strong	●
Moderate	○
Weak	▽

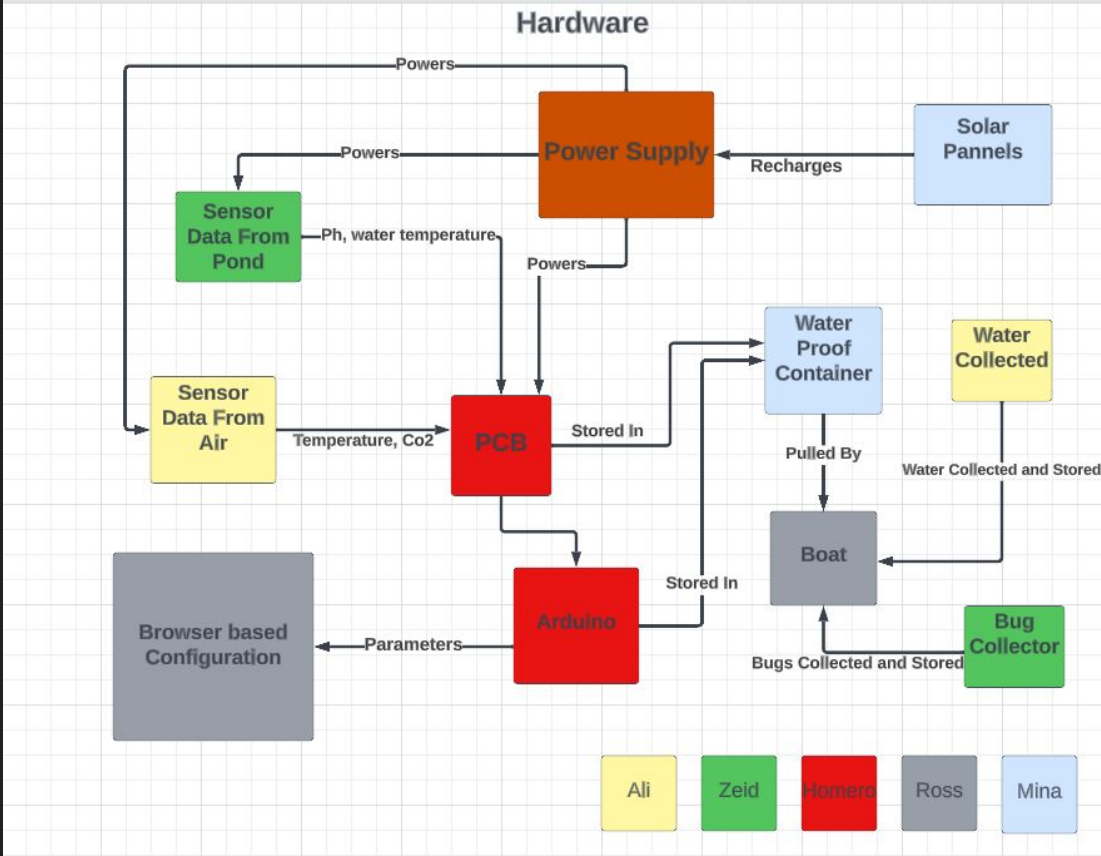
Direction of Improvement	
Maximize	▲
Target	◇
Minimize	▼

Column #	1	2	3	4	5	6	7
Direction of Improvement	▼	▲	▼	▲	▼	◇	◇
Engineering Requirements	Part Dimensions	Power Reliability	Weight	Data Throughput	Cost of Materials	Collection of Water Samples	Device Mobility
Customer Requirements (Explicit and Implicit)							
Cost	▽	●	▽	○	●	●	○
Ease of Use	▽	▽	○	○	○	●	○
Durable	▽	●	○	▽	●	▽	▽
Small Form Factor	●	○	○	▽	○	○	▽
Device Longevity	○	●	▽	○	●	○	▽
Target	< 5 x 5 feet	Above 95% of Time	< 15 lbs	1 set of readings per hour	<\$1000	≥ 30 mL	Maneuverable from at least 500ft

Hardware Block Diagram



Ross Springstead, CpE



Hardware Comparison & Selection: “Project Brain”



Mina Younes,
CpE

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

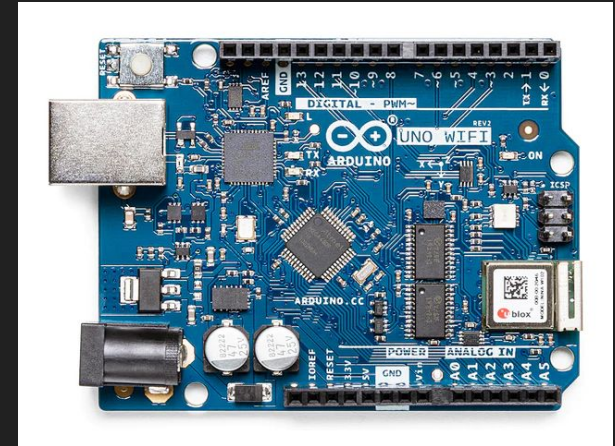
Hardware Comparison & Selection: Microcontroller



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CpE

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: Recharging Power Supply (Batteries)



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CpE

Table: Recharging Power Supply Technologies

	Manually with Charger	Solar Panel
Advantage(s)	Does not depend on the weather	Product stays in water, renewable energy source
Disadvantage(s)	Take out product from water to take out batteries (inconvenient)	Weather dependent

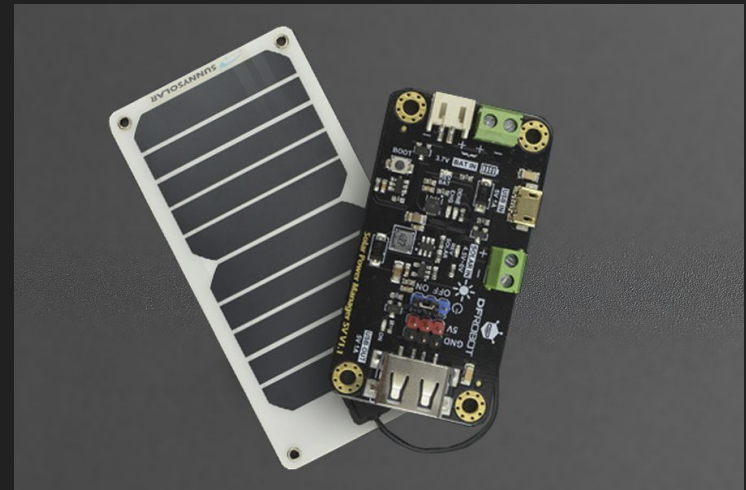
Hardware Comparison & Selection: Solar Panel



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CpE

Table 8: Solar Panel Comparison

	Semi Flexible Monocrystalline	FelIDen 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

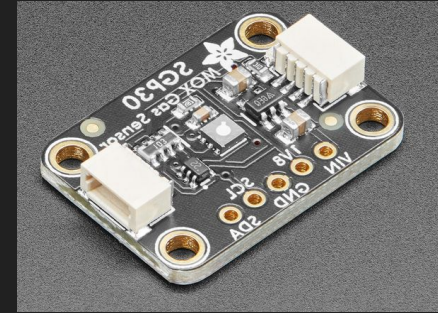


Homero Rodriguez EE

Table 17: Air Quality Sensor Selection

	MQ - 135 Gas Sensor	Adafruit SGP30 TVOC Sensor	Digilent AQS, Sensor	Pmod Digital	MIKROE 1630 Digital Sensor
Operating Voltage	3.3V to 5V ± 0.1	3.3V to 5V ± 0.1	1.8 V to 3.3 V ± 0.1		3.3V to 5V ± 0.1
Operating Current LPM	N/A	0.05 mA	2.5 mA		N/A
Operating Current CM	160 mA	4.5 mA	6 mA		200 mA
Power	< 800 mW	< 225 mW	< 198 mW		< 1 W
Weight grams	11 g	1.3 g	9.07 g		3 g
Working Temperature	-10 °C to 45 °C	-40 °C to 85 °C	-40 °C to 85 °C		-10 °C to 50 °C
Manufacturer	Winsen Electronics Technology Co, Ltd	Adafruits, Sensirion AG	Digilent		MikroElektronika
Dimension	32 mm x 22 mm x 30 mm	20 mm x 20 mm x 4 mm	31.75 mm x 20.32 mm x 25.4 mm		25.5 mm x 20.0 mm x 4 mm
Cost	\$3.00 - \$5.89	\$17.50 - \$22.00	\$26.00 - \$30.00		\$16.50 - \$20.00
Gasses detected	NH3, NOx, Benzene, smoke, CO2, more	(TVOC) eCO2, CO, Ethanol, Butane, Acetone, more	(VOCs) CO, NO2, PM2.5, more		CO, NO2, NH3, H2, CH4, C3H8, C4H10, more
Parts per Million (ppm)	10 to 1000 varies per gas	0 to 60,000 varies per gas	1 to 1000 varies per gas		10 to 1000 varies per gas

Adafruit SGP30 Air Quality Sensor



First Option ->

MQ - 135 Gas Sensor



Second Option ->

Container Comparison



Zeid Haddadin,
EE

	ML-58F	UNO R3 Case	IP67
Material	ABS plastic	ABS plastic	ABS Plastic
Dimensions	8.75 x 5.25 x 3.30 in / 222.25 x 133.35 x 83.82 mm.	Case Size: 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	1.3 ounces	7.7 ounces
Waterproof	yes	yes	no
Color	Clear ; Gray	Black	Gray
Price	\$36	\$5	\$31



UNO R3 Case

Water temperature sensor comparison - Zeid



Zeid Haddadin,
EE

	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

Power Supply Comparison and selection:



Ali AL khusaibi, E.

	REACELL lithium-ion 3.7v battery	Tenergy(NiMH) battery pack	SHENZ 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



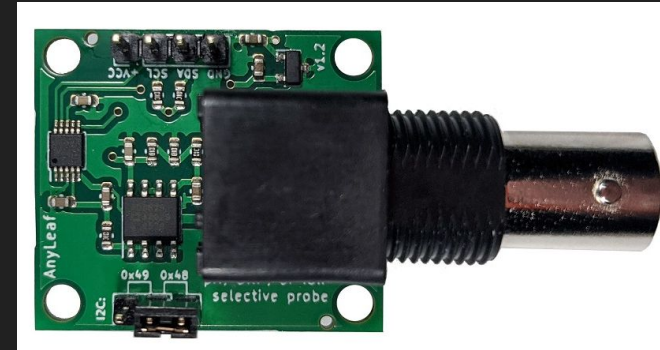
Tenergy(NiMH) battery pack

Hardware Comparison & Selection: pH Sensor



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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

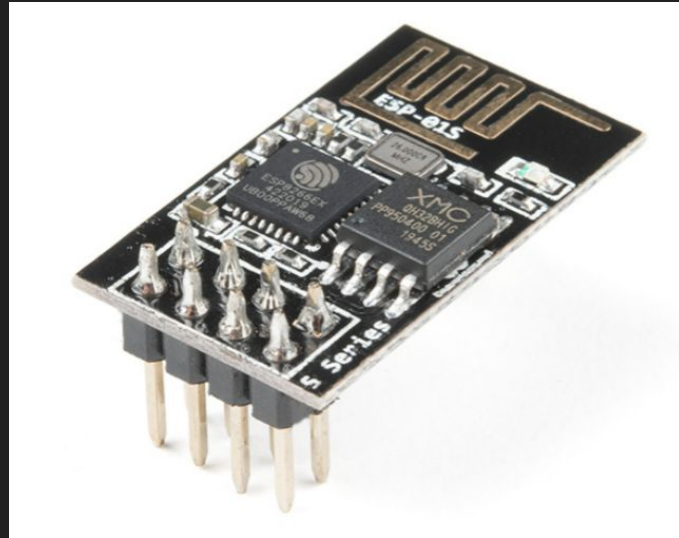
Hardware Comparison & Selection: Data Transmission



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CpE

	ESP8266 WiFi Module	SIM900A GSM Module	SparkFun LTE CAT M1/NB-IoT Shield	Speed RF Transmitter and Receiver Link Kit
Method	WiFi	2G or 3G cellular	4G LTE cellular	Radio Waves
Frequency Range	2400-2484 MHz	900 and 1800 MHz	698 MHz - 960 MHz or 1.7 GHz - 2.7GHz	200 KHZ
Distance of Signal	Global	Global	Global	2 KM
Input Voltage	3.3V	4.5V - 12V	3.3 V	3.3V - 9V (Transmitter) 3V - 5V (Receiver)
Hot Spot Needed	Yes	No	No	No
Communication Method	Data	SMS	Data	Data
Comes Included with Arduino Uno REV2	Yes	No	No	No
Price	\$7.50	\$7.47	\$96.50	\$17.00

WiFi Module - ESP8266 (4MB Flash)





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PCB Design Process

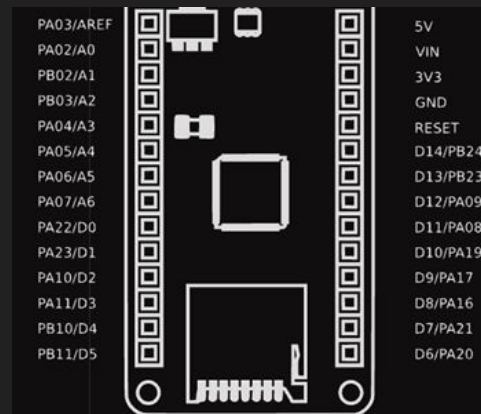
- Significant PCB design will be done using Flux design software.
- At least temperature sensor, pH sensor, Air Quality sensor and the ESP Wi-Fi module will be integrated into the PCB.
- Biggest challenge is the time constraint in between the cycles of the design iteration process.

Design Iteration Process PCB

- Perform Significant PCB design
 - > Revise design.
 - > Send it to the manufacturer. (Gerber file)
 - > Wait and receive the PCB. (Shipping)
 - > Test PCB according to expectations.
 - > Debug & correct the design



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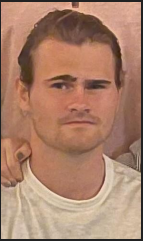
Software Comparison & Selection: Stack Selection and Hosting



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CpE

LAMP Stack	MERN Stack	MEAN Stack
Linux	MongoDB	MongoDB
Apache	Express.js	Express.js
MySQL	React	Angular
PHP	Node.js	Node.js

Software Comparison & Selection: Updates to Stack Selection and Hosting



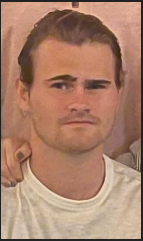
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Original Plan	New Plan
Use MERN stack for development	Replacing Express.js and Node.js for Next.js
Use CSS and Bootstrap	Switching to CSS and Tailwind
Host our web application on DigitalOcean	Host our web application on Vercel
Using JavaScript and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

Software Design: Database

Our MongoDB Database will store

- Ponds sensor data
- Users login and passwords
- Store access code for device

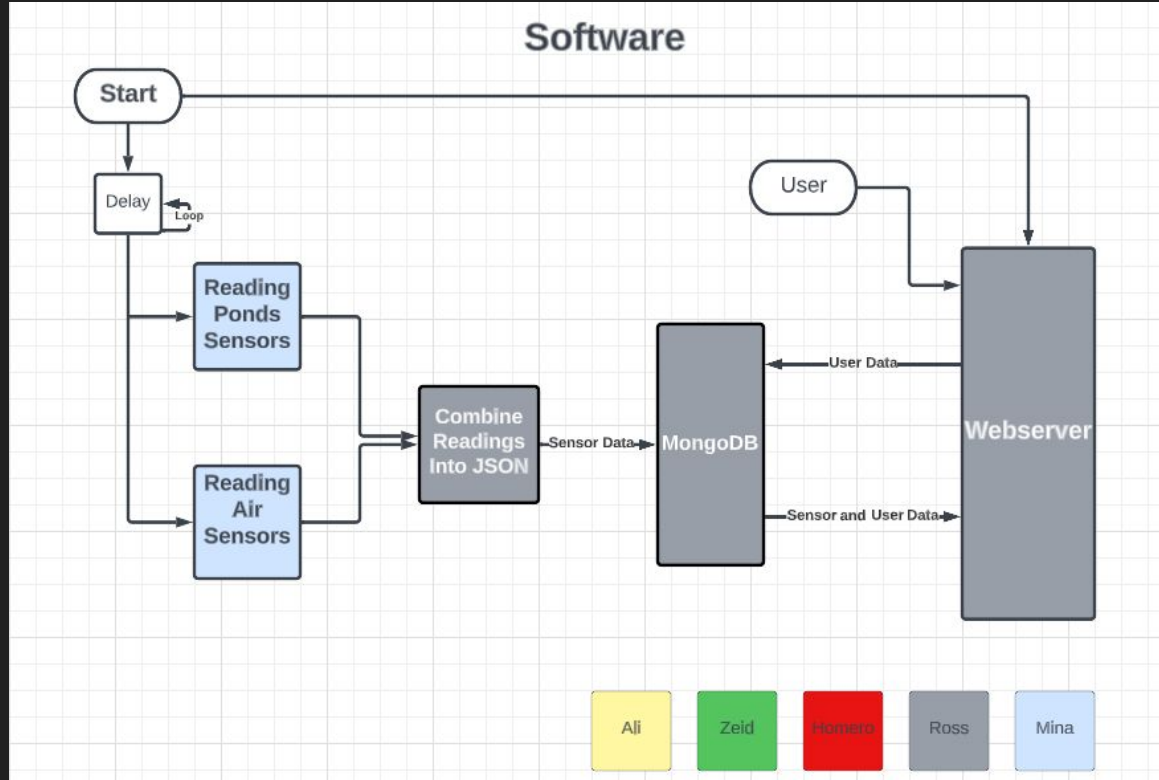


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Software Design: Block Diagram



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CpE





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Identifying needs & standardizing Data

- Standardized Data Type that contains essential information to optimize efficiency and speed in the industry.
- Data Type (Array)
 - > Time Stamp (Year, month, day, hour, minute)
 - > pH
 - > Temperature
 - > Air Quality (CO₂ + other gasses' arrays)
 - > Other parameters to be determined

Work Distribution



Ali AL khusaibi, E

- Ali : Hardware building and testing, PCB design, hardware selection, power supply.
- Mina: Software coding, software testing, User interface design, hardware selection
- Ross: Software design, Software coding, software testing, web application design, Server configuration
- Zeid : PCB design, hardware design microcontroller, hardware testing, sensors selection and testing
- Homero: PCB design, hardware testing, hardware selection, prototyping, video edition, communication RF system development. (Hotspot)

Progress (SD2 Project Milestones) - Zeid



Zeid Haddadin,
EE

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