Group 8:

LetitGrow! : Autonomous Hydroponic Garden

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- ❏ Web Implementation
- ❏ System Assembly

Danny Nguyen (**EE**)

- ❏ PCB Design
- ❏ Hardware troubleshooting

Edwin Rivera (**EE**)

- ❏ Parts and Budget
- ❏ PCB Manufacturing

Nathan To (**CpE**)

- ❏ Software Implementation
- ❏ Sensor Troubleshooting

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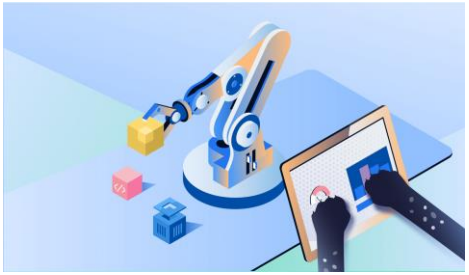
Our Solution: **LetitGrow!** A smart hydroponic system

- **Deep Water Culture Hydroponic**

- **Automatic Plant Care**



- **Web App Integrated**

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Motivations

- **Food Insecurity**
  - Rising temperatures due to climate change
  - Population outgrowing agricultural output

- **COVID-19**
  - Supply chain issues
  - Scarcity due to panic buyers
  - People acquiring new hobbies

- **Rising popularity of Hydroponics**
  - Uses 70% to 90% less water
  - Faster growing speed
  - Cleaner experience for indoors

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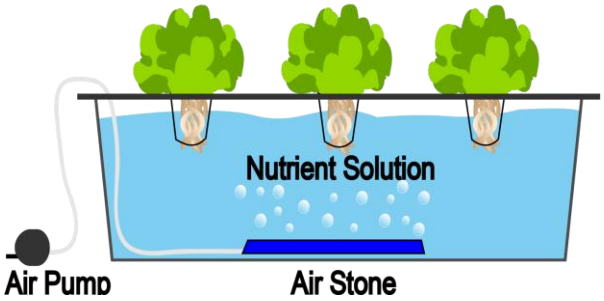
Why Deep Water Culture (DWC) Hydroponics?

➢ **What is it?**

Hydroponics is an agricultural technique that only uses water to grow plants, completely getting rid of soil.



DWC is a specific type of hydroponics where the roots are directly submerged in a water reservoir with oxygen and nutrients.

➢ **Advantages**

- Fast growth
- Simple setup
- Clean

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Goals and Objectives

- **Garden Autonomy**
  - Achieve a minimal amount of time needed for plant care from the user: 2 weeks without any care needed
- **Beginner user friendly experience**
  - Require no plant maintenance experience
- **Total feedback of the plant environment**
  - Use the plant's pH, nutrients, water level, air and water temperature data to achieve plant growth
- **Monitor and control the system remotely from the web**
  - Receive live feed from your plant and modify parameters on the browser

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Requirements and Specifications

Requirement	Specification
Compact Tank Size	< 36” x 24” x 20”
Power self-sufficiency	Direct connection to US outlet
Water capacity for 12 plants	23 gallons
Sensor monitoring	Minimum 12 GPIO pins
Affordable cost	< $400
Accessible User Interface	Web app

Plant Requirements

Plant Parameter	Specification
Water Temperature	[65-80]° F
Total Dissolved Solids (TDS)	[600-1000] ppm
Water pH level	[5.0 , 7.0]
Air Quality	[800-1000] ppm of CO_2
Air Temperature	[60-90]° F
Humidity	[50-70]%
Light	LED Lights | 14 to 16 hours | Everyday

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Current Solutions

- **Home Hydroponics**
  - For beginners
  - Small capacity
  - Automatic lights
  - Small water pump to oxygenate water
  - Cheap ($50-$80)

- **Hybriponics**
  - Vertical garden
  - Large capacity
  - Costly ($800+)
  - App connectivity

- **Farm.bot**
  - Robotic arm
  - Multiple arm tips for functionalities
  - Soil based garden
  - Scalable
  - Expert level install
  - Expensive ($1700)

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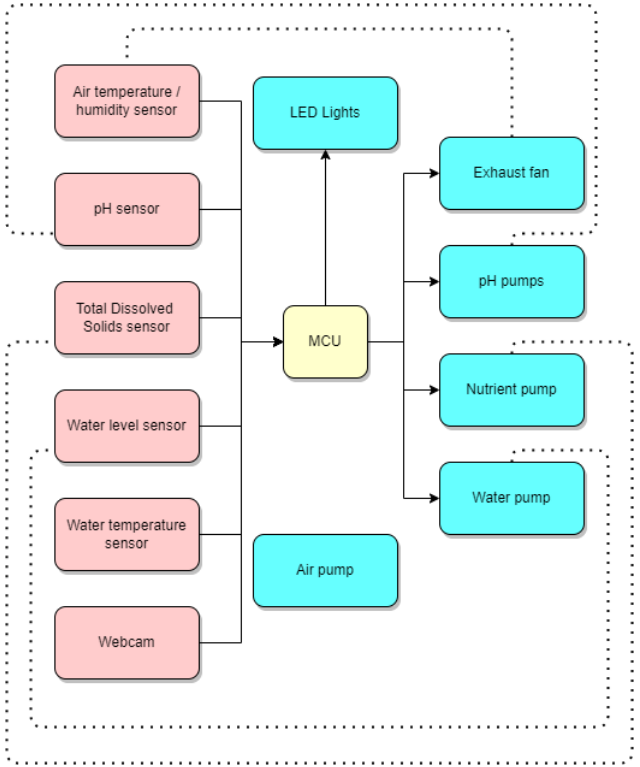
Product Comparison

	Home Hydroponics	Hybriponic	Farm.bot	Our Solution
Easy to use	✓	✓	✓	✓
Easy to install	✓	✓	×	✓
Scalability	×	✓	✓	×
Compact size	✓	✓	✓	✓
App integration	×	✓	✓	✓
Water level sensing	✓	✓	✓	✓
Air temperature/Humidity	×	✓	✓	✓
pH sensing	×	×	×	✓
Nutrient sensing	×	×	×	✓
Image monitoring	×	×	✓	✓
Affordable	✓	×	×	✓

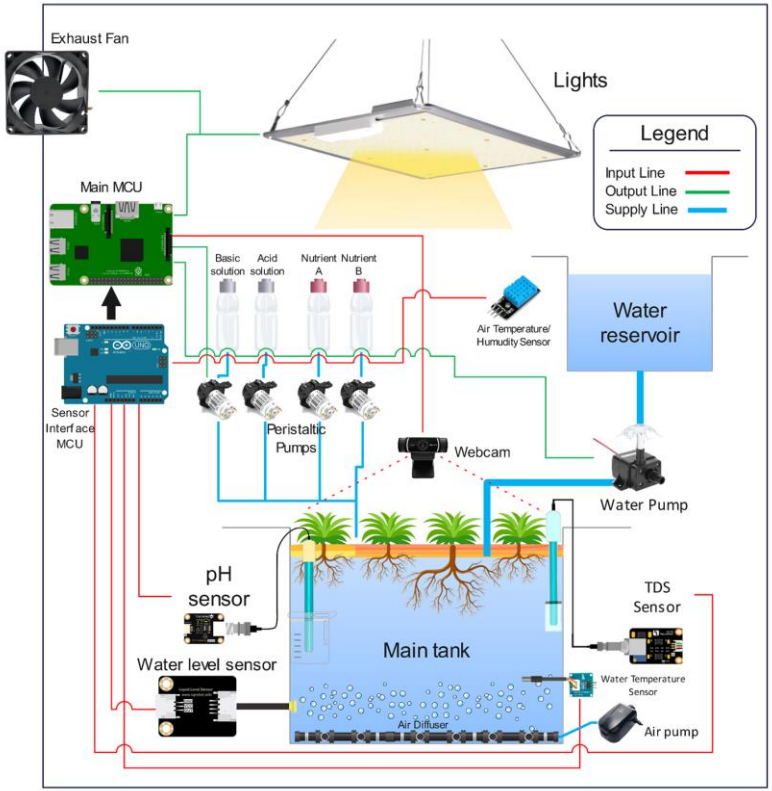
System Design Diagram

- **Input blocks (red)**
  - Turn output components On/Off
  - Data is collected every 1 hour under normal levels
  - If system needs calibration, data is actively sampled in a feedback loop every 10 seconds

- **Output blocks (cyan)**
  - Dependent on the input sensors
  - LED lights directly controlled by MCU by regular scheduling
  - Air pump is completely independent as is always On



System Prototype



Growing Tent

- **Inputs (red)**
  - Sensors data is received and transmitted to the main MCU
  - Webcam directly connects to main MCU for computer vision testing
- **Output (green)**
  - 4 peristaltic pumps supply pH and Nutrients
  - Lights are automatically on/off
  - Exhaust fan helps regulate temperature and humidity when lights are on
  - Water pump refills the main tank
- **Supply Lines (blue)**
  - Tubing connects to the main tank for pH and Nutrient delivery
  - Air pump delivers oxygen to the roots via and air diffuser placed in the bottom of the tank
  - Tubes deliver water from the reservoir tank to the main tank

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Microcontroller

Raspberry Pi 4	
Processor:	Broadcom BCM2711 Quad core Cortex-A72 1.5GHz
Memory:	8GB LPDDR4 SDRAM
Connectivity:	X4 USBs, Ethernet, Bluetooth, x2 micro HDMI, 40 pin GPIO header
Power:	5V DC via USB-C & 5V DC via GPIO header (500mA)

BeagleBone Black	
Processor:	AM335x 1GHz ARM Cortex A8
Memory:	512MB DDR3 RAM
Connectivity:	x2 USBs, Ethernet, HDMI, 2x 46 pin header
Power:	5V DC via USB (210mA)

Grow Tent

Manufacturer:	YITAHOME
Cost:	$63.99
Size:	36” x 36” x 72”
Canvas Thickness:	1680D
Support Weight:	Up to 120 lbs

Manufacturer:	MELONFARM
Cost:	$89.99
Size:	36” x 36” x 72”
Canvas Thickness:	600D
Support Weight:	Up to 110 lbs

pH Sensor

Manufacturer:	GAOHOU
Cost:	$35.88
Measurement Range:	0pH - 14pH
Accuracy:	+/- 0.25pH
Operating Temperature:	0°C - 60°C
Size:	42 x 32 x 20mm

Manufacturer:	OCESTORE
Cost:	$34.99
Measurement Range:	0pH - 14pH
Accuracy:	+/- 0.25pH
Operating Temperature:	0°C - 60°C
Size:	42 x 32 x 20mm

TDS Sensor

Manufacturer:	PUSOKEI
Cost:	$14.89
Measurement Range:	0ppm - 1000ppm
Accuracy:	+/- 10%
Working Voltage:	3.3~5.5V
Size:	42 x 33mm

Manufacturer:	KUIDAMOS
Cost:	$17.09
Measurement Range:	0ppm - 1000ppm
Accuracy:	+/- 10%
Working Voltage:	3.3~5.5V
Size:	42 x 33mm

Water Level Sensor

Manufacturer:	CQRobot
Cost:	$8.99
Working Voltage:	5V
Operating Temperature:	-25°C to 105°C
Size:	35 x 36 x 3mm

Manufacturer:	Elegoo
Cost:	Owned
Working Voltage:	3~5V
Operating Temperature:	10°C to 30°C
Size:	62 x 20 x 8mm

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Air Temp/Humidity Sensor

Manufacturer:	Elegoo (DHT11)
Cost:	Owned
Temperature Range:	0°C to 50°C (+/-2°)
Humidity Range:	20% - 90% RH (+/-5%)
Size:	28 x 12 x 7.2mm

Manufacturer:	HiLetgo (DHT22)
Cost:	$8.49
Temperature Range:	-40°C to 80°C (+/-0.5°)
Humidity Range:	0% - 100% RH (+/-2%)
Size:	28 x 12 x 10mm

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Water Temperature Sensor

Manufacturer:	GAOHOU
Cost:	$13.99 (x2 Sensors)
Measuring Range:	-55°C to 110°C (+/-2°)
Working Voltage:	3.2 ~ 5.25V
Size:	7 x 26mm

Manufacturer:	Low Voltage Labs
Cost:	$8.99 (x1 Sensor)
Measuring Range:	-55°C to 125°C (+/-2°)
Working Voltage:	3.0 ~ 5.25V
Size:	7 x 26mm

Budget

Item	Quantity	Estimated Cost
Grow Tent	1	$64
Plastic Tote (Reservoir)	1	$12
Plant Growth Nutrients	1	$39
pH Solutions	1	$21
Raspberry Pi 4	1	Owned
Custom PCB	2	$170
Air Temp/Humidity Sensor	1	Owned
pH Sensor	1	$37
TDS Sensor	1	$16
Water Level Sensor	1	$9
Water Temperature Sensor	2	$14
Peristaltic Pump	4	$52
Air Pump	1	$16
Water Pump	1	$12
Webcam	1	Owned
Total:		$462

- Initial estimated budget was between $410 - $530
- Largest expense attributed to the custom PCB
- Other minor components not listed are also already owned
- Total cost is approximately $462

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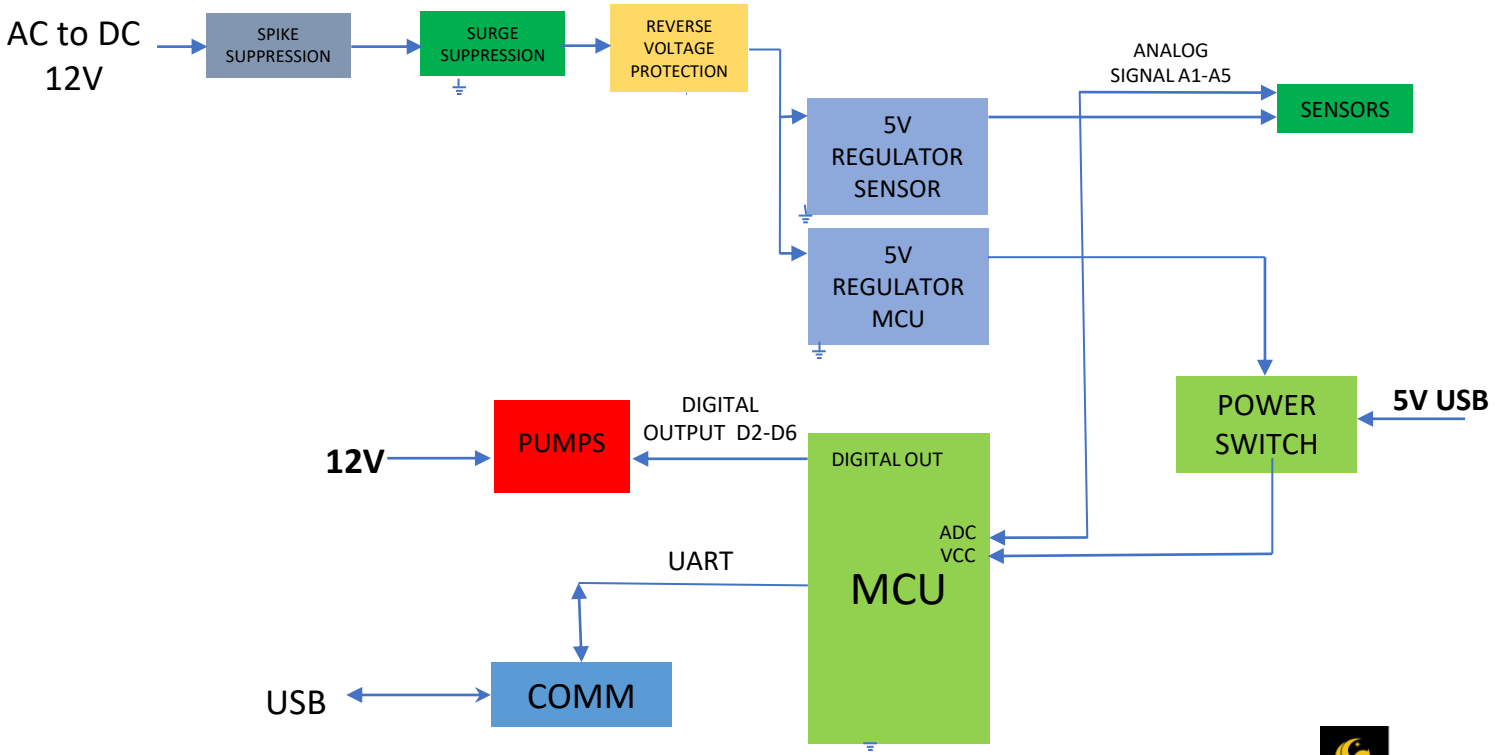
Power Block Diagram



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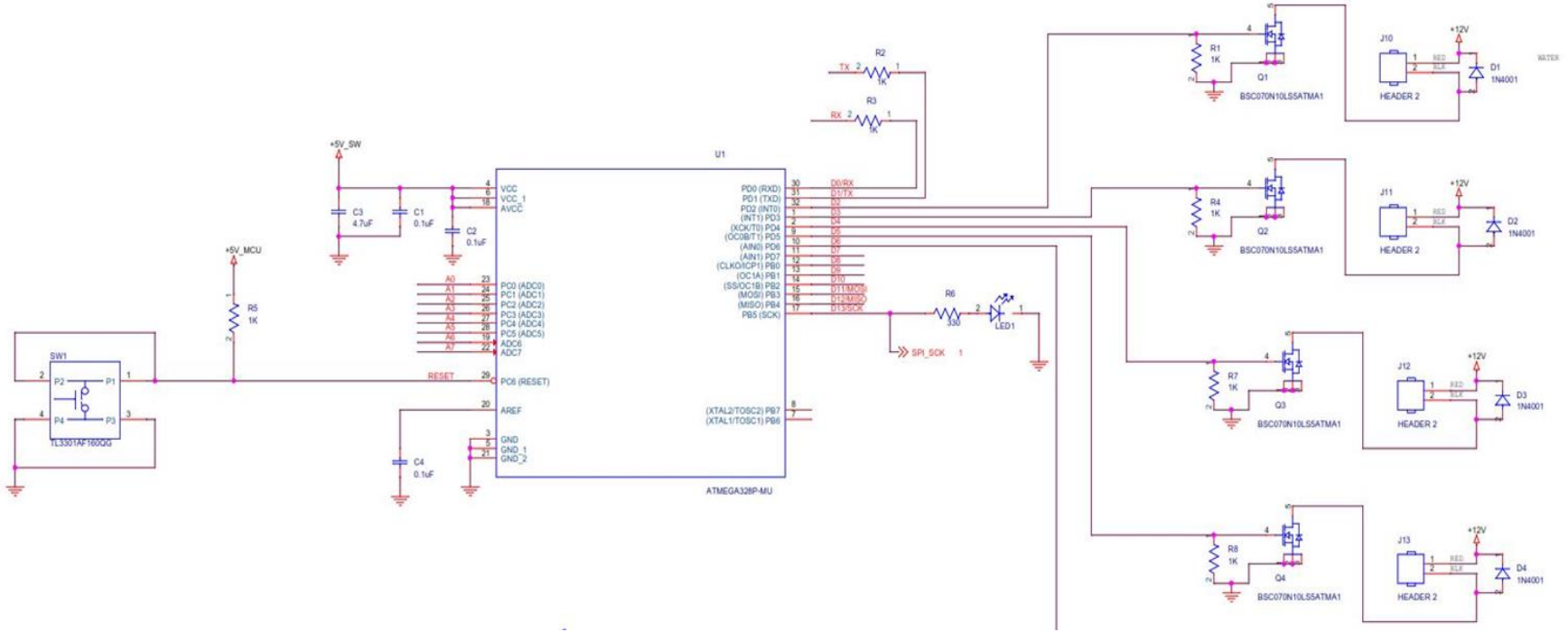
Schematics



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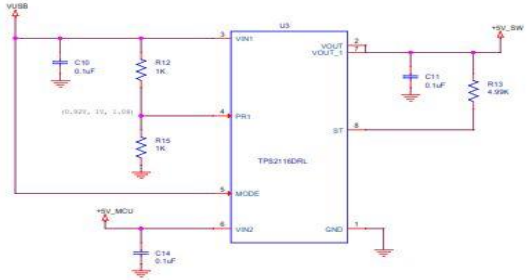
Schematics

POWER SWITCH



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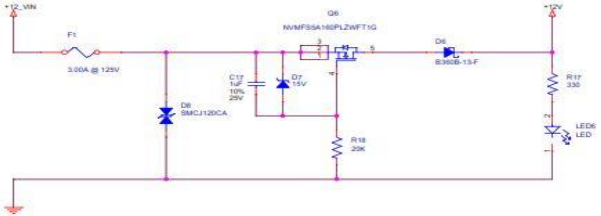
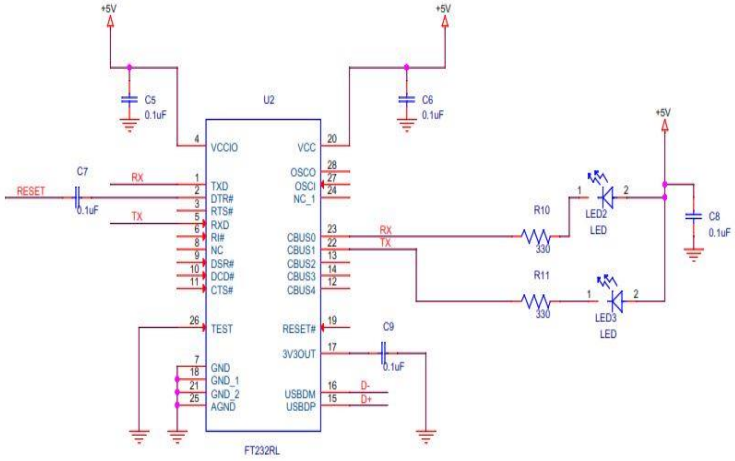


FT232RL/USB-UART



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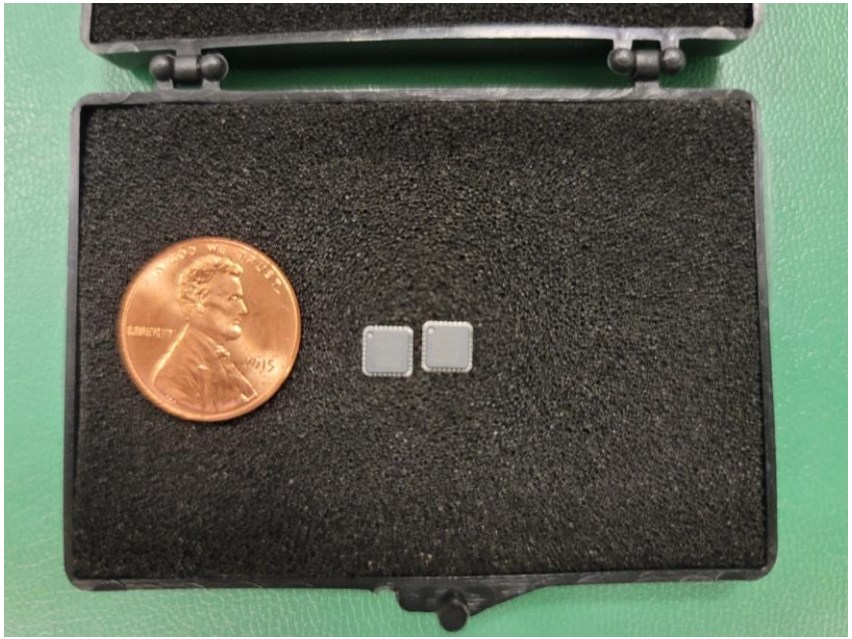
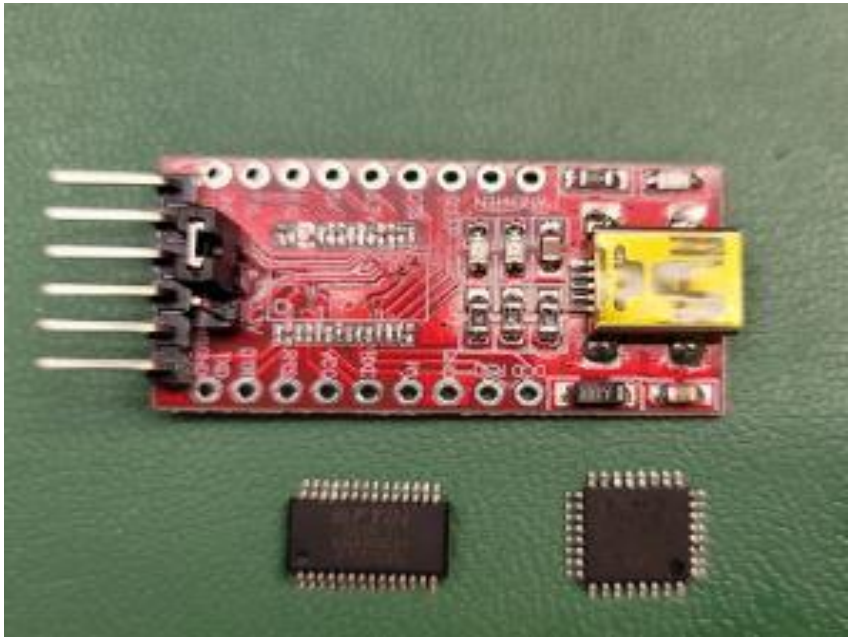


- Pandemic component shortage
- Long lead parts, sample part
- 32 VQFN package ATMEGA328P-MU



- Harvesting demo CCA to procure components
- 32 TQFN package ATMEGA328P-AU

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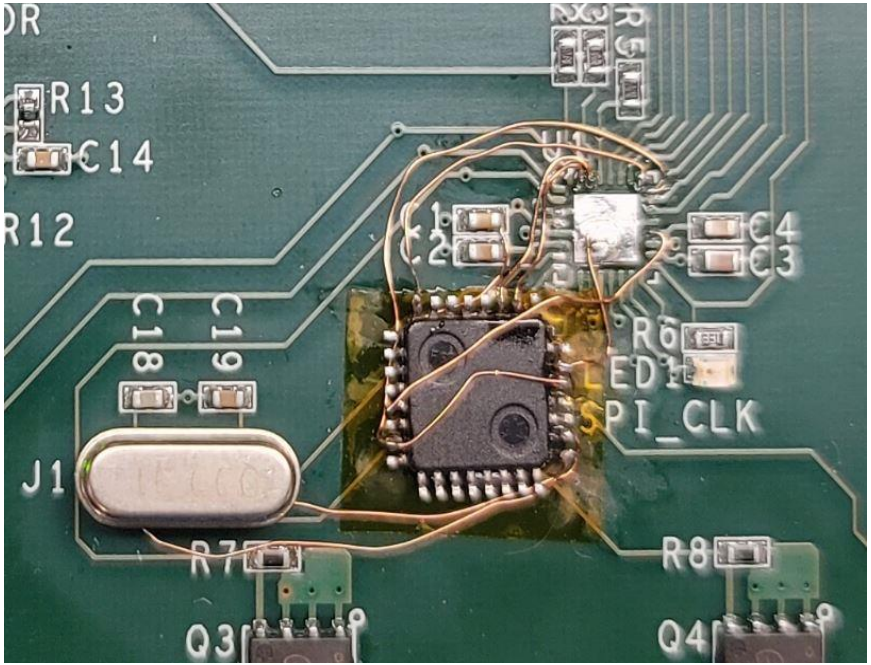

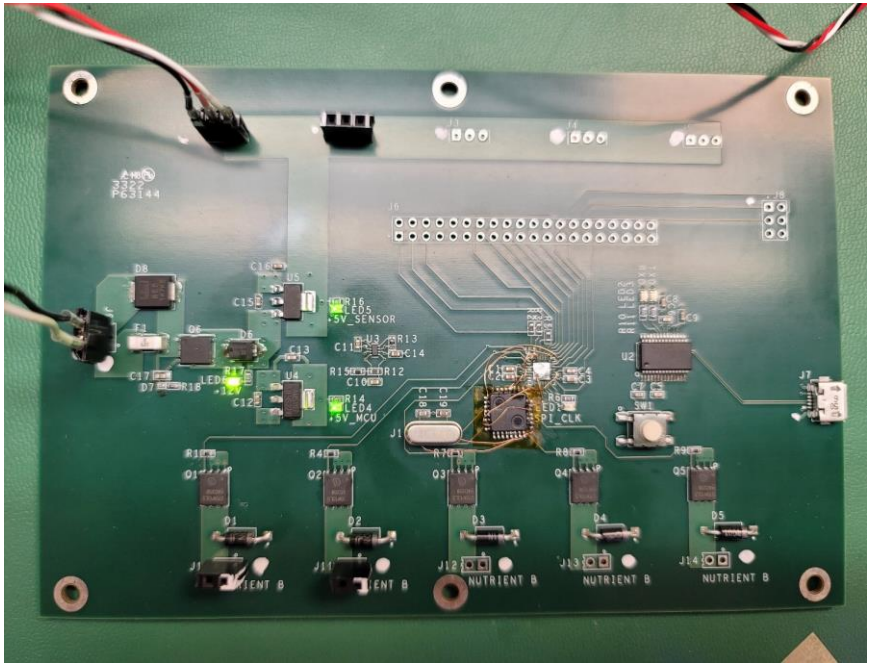

- Dead bug component
- 32 TQFN package ATMEGA328P-AU

- Modified functioning CCA ready for hardware and software integration

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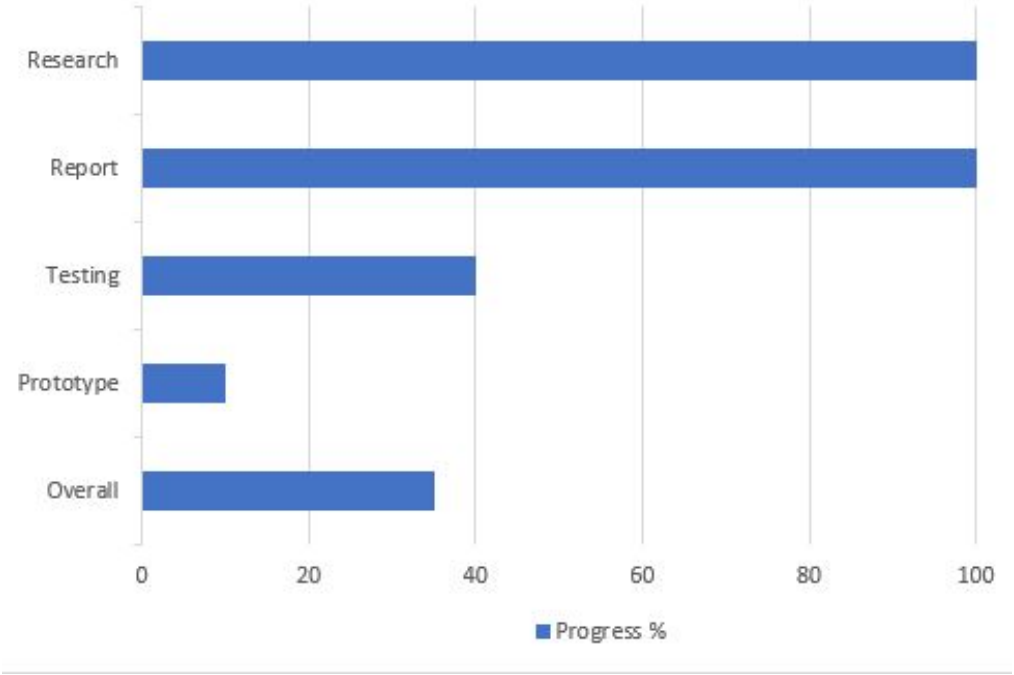
Project Timeline



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