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Embedded Control of a Compact Gas Chromatography System

Introduction

Marimetrics is an SME that is actively developing products which dramatically increases our ability to access an untapped wealth of information residing in the ocean. One such product uses gas chromatography to determine chemical component concentrations over time in various water bodies. This product has excellent applications in the aquaculture industry as chemical compounds concentrations can act as indicators of fish health.

Gas Chromatography

Gas chromatography is the process of separating, identifying and quantifying various compositional elements of a compound.
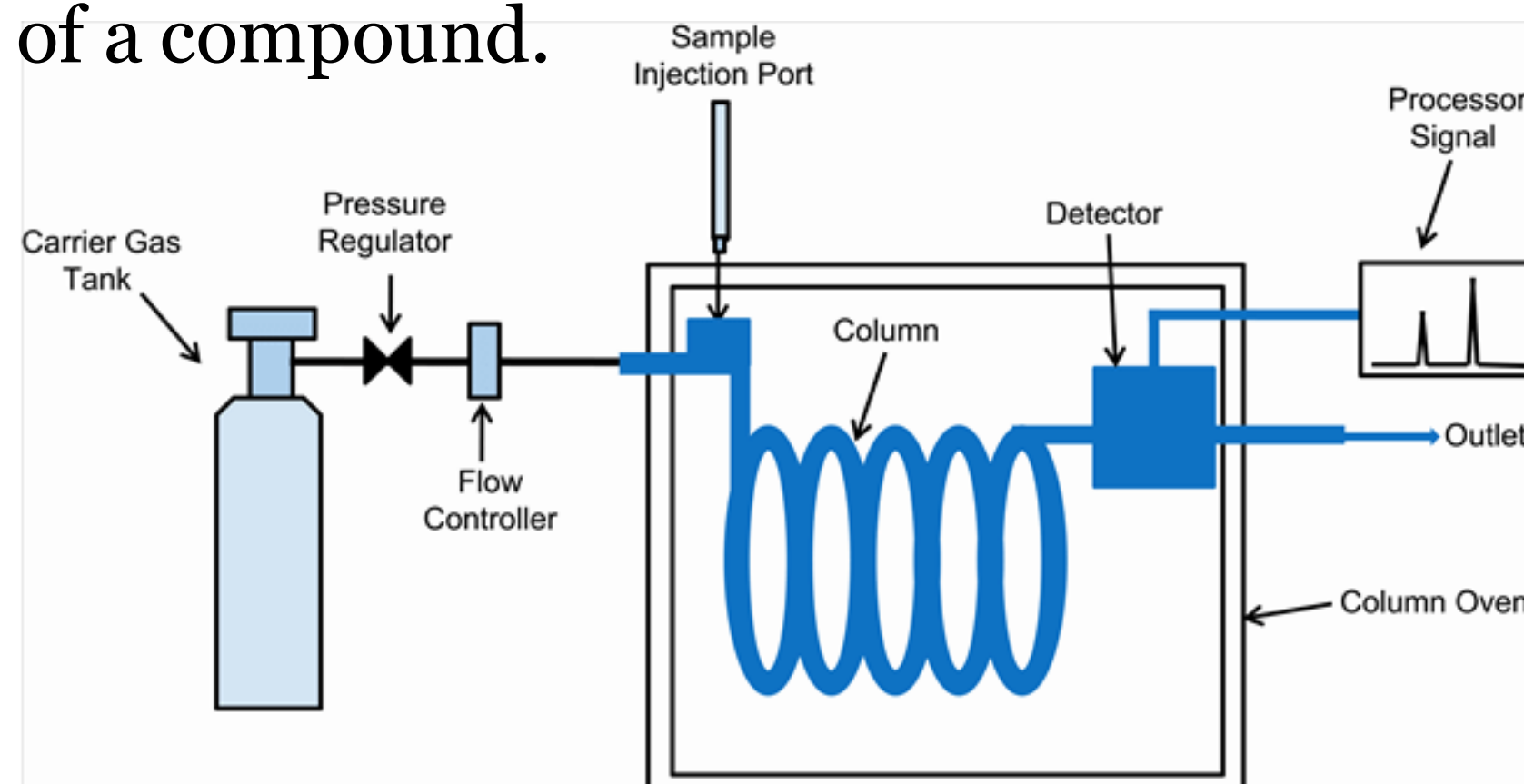
Figure 1: Gas Chromatography Equipment [1]

Previous Work

This project is a continuation from previous Capstone groups. Past contributions include:
- Microcontroller Selection (SAME70)
- nRF Connect for Cloud
- ADC Board Modifications
- FreeRTOS OS selection

Figure 2: Free RTOS and nRF Connect Icons [2, 3]

Objectives

The main objective is to reduce the size, cost and power consumption of the current system while also improving the computational power by converting the older LabVIEW based system to a much smaller microcontroller based embedded system. This allows for wider applications for the product. The detailed objectives are:

1. Compact GC Electrical Development
2. Product Enhancement
3. Data Acquisition Development
4. Cloud Connectivity Capabilities
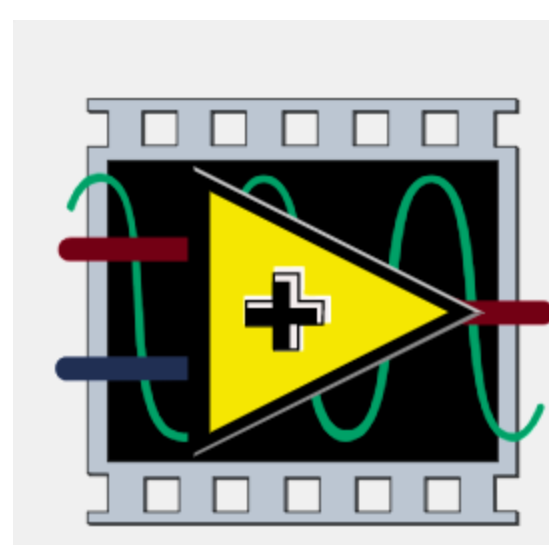5. UI Development
6. Testing

Figure 3: LabVIEW Icon [4]

Design Details

A comparison between the proposed microcontroller system and current National Instruments System was conducted to justify the decision to port all functionalities. This comparison can be viewed in the corresponding table.

As can be seen from the table, the benefit to the product enhancements outweigh cost of the work required to change the system to microcontroller based.

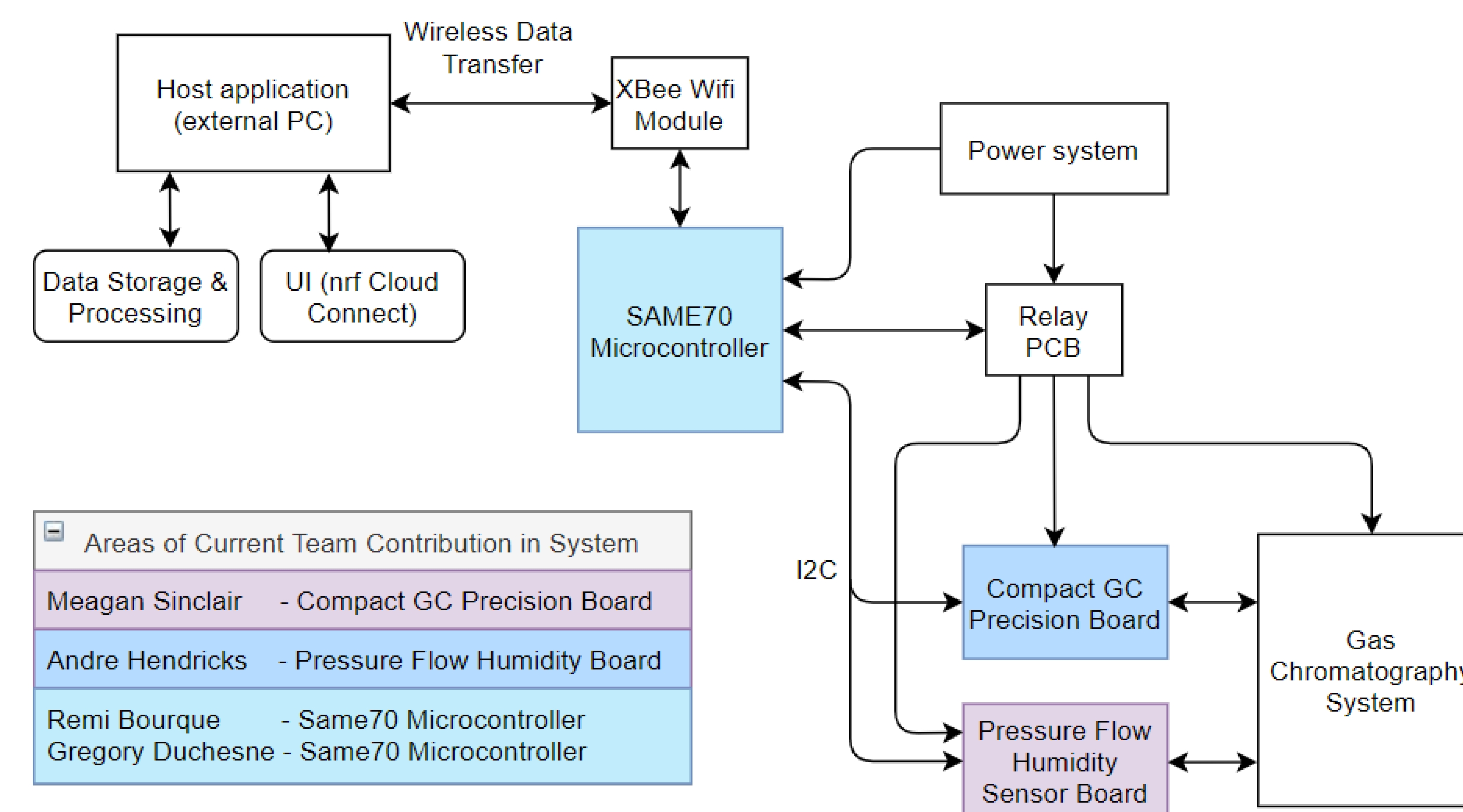| Microcontroller	National Instruments System
Low cost ~$50	Expensive ~$1200
Low power	High power
C/C++ (Free)	Proprietary programming language, LabVIEW (~$1000)
Requires extensive programming knowledge	Beginner friendly
Customizable housing	Standard package size
Longer time to market	Short time to market

The diagram to the left shows the System Architecture of the proposed Compact Gas Chromatography System.

The diagram is color coded to show the current work being done by each group member.

When the project is fully completed all sections of this diagram should be color coded.

Areas of Current Team Contribution in System

Meagan Sinclair	- Compact GC Precision Board
Andre Hendricks	- Pressure Flow Humidity Board
Remi Bourque	- Same70 Microcontroller
Gregory Duchesne	- Same70 Microcontroller

Figure 4: System Architecture

Current Work

The team has been working towards the completion of the electrical development objective, which includes:

1. PCB alterations on the SAME70 Microcontroller
2. Sensor PCB Modifications
3. ADC PCB Modifications
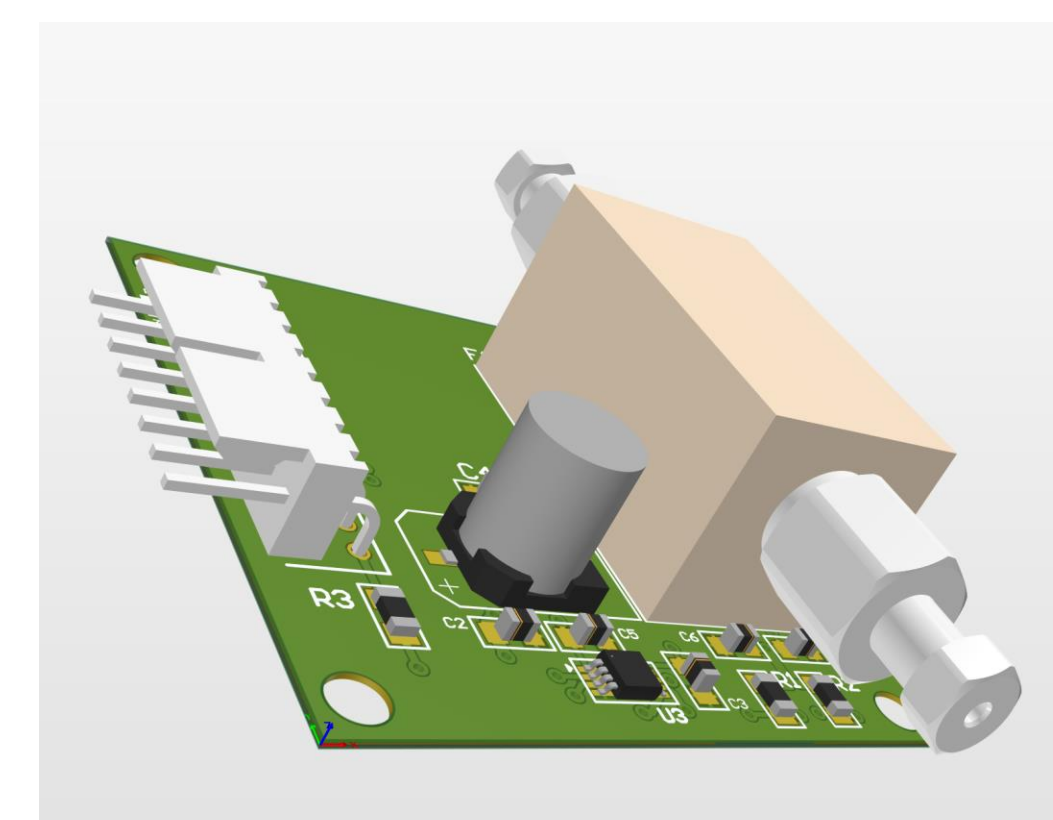
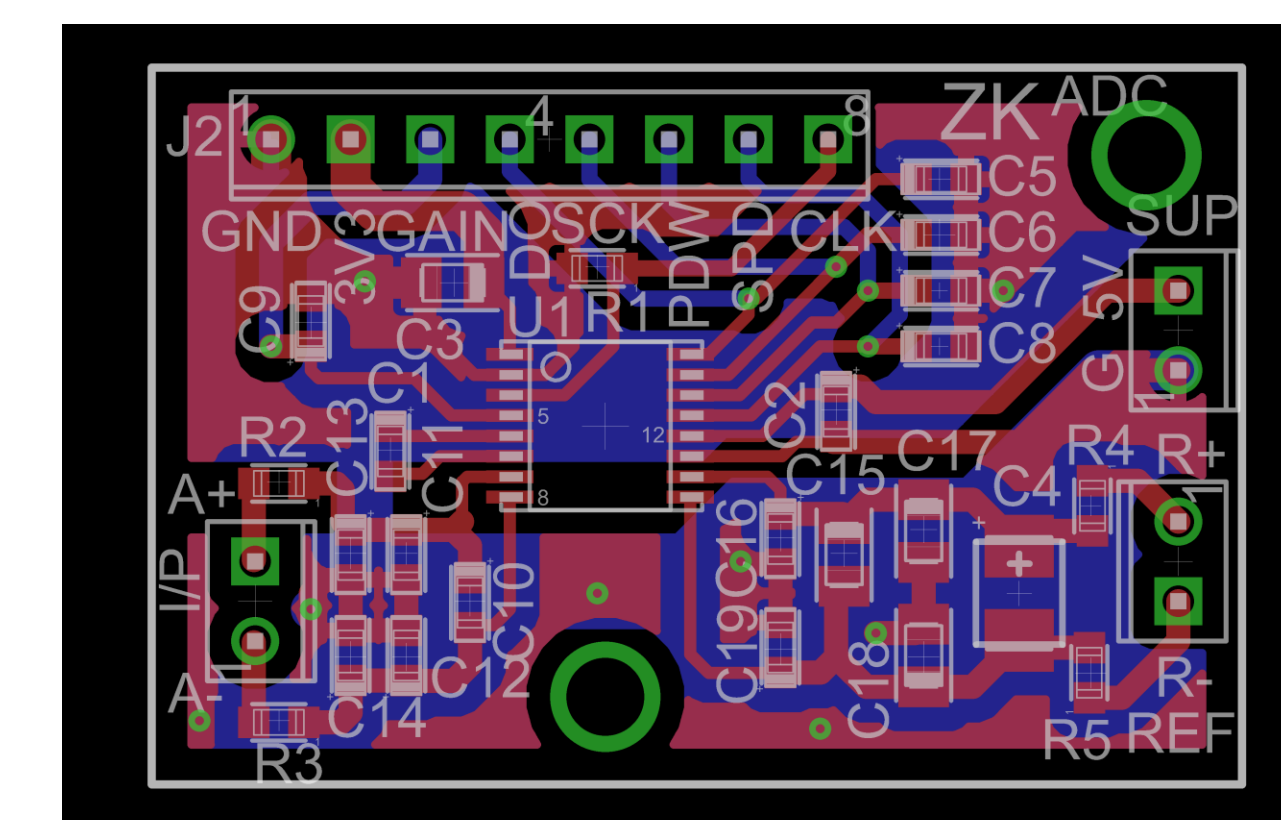Figure 5: SAME70 microcontroller [5]
Figure 6: 3D Rendering Sensor Board
Figure 7: Example of an ADC PCB [6]

Future Work

The team will continue to work towards the objectives outline in the Objectives section. Challenges may include time limitations and lack of human resources as the group has decided on ambitious goals.

Pictured is a render of the final product that the team is working toward.

Figure 8: Final Product

Summary

- Gas chromatography allows access to a wealth of knowledge by analyzing chemical compounds in fluid.
- The sponsor company wants to modify an existing system to be more compact, not reliant on LabVIEW, and more power efficient.
- The solution is to implement an embedded microcontroller-based system.
- Microcontroller provides a cheaper and more power efficient design when compared to NI systems.

Acknowledgements

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Image Sources

[1] https://www.researchgate.net/figure/Schematic-diagram-of-the-main-components-of-a-gas-chromatography-system-Philadelphia_fig3_273134301

[2] https://upload.wikimedia.org/wikipedia/fr/e/ee/FreeRTOSLogo.jpg

[3] https://www.nordicsemi.com/Software-and-tools/Development-Tools/nRF-Connect-for-Cloud

[4] https://vecta.io/symbols/87/brands-la-lz/73/labview-icon

[5] https://www.microchip.com/DevelopmentTools/ProductDetails/PartNO/ATSAME70-XPLD

[6] https://e2e.ti.com/support/data-converters/f/73/t/311196