System Integration of BioHaptix System for Tissue Impedance Measurement

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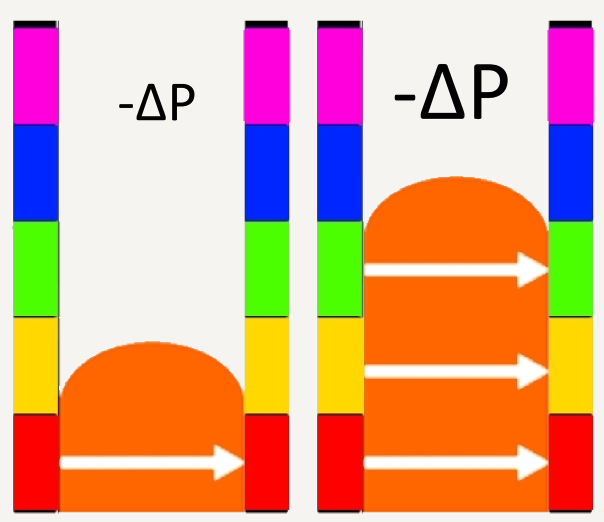
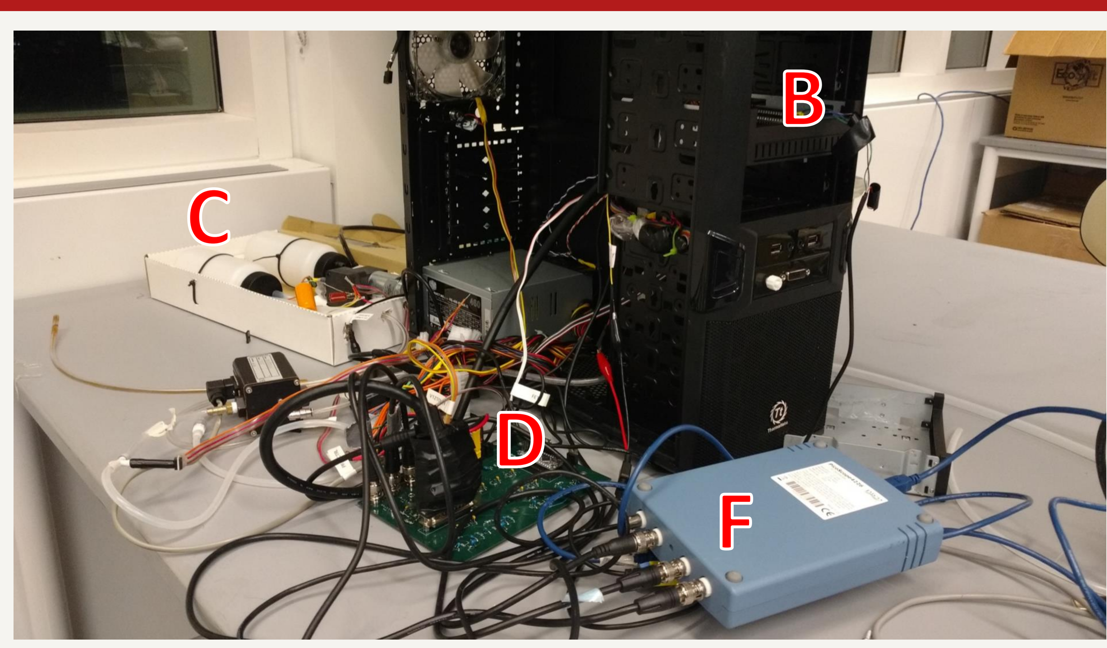
Soft Tissue Impedance

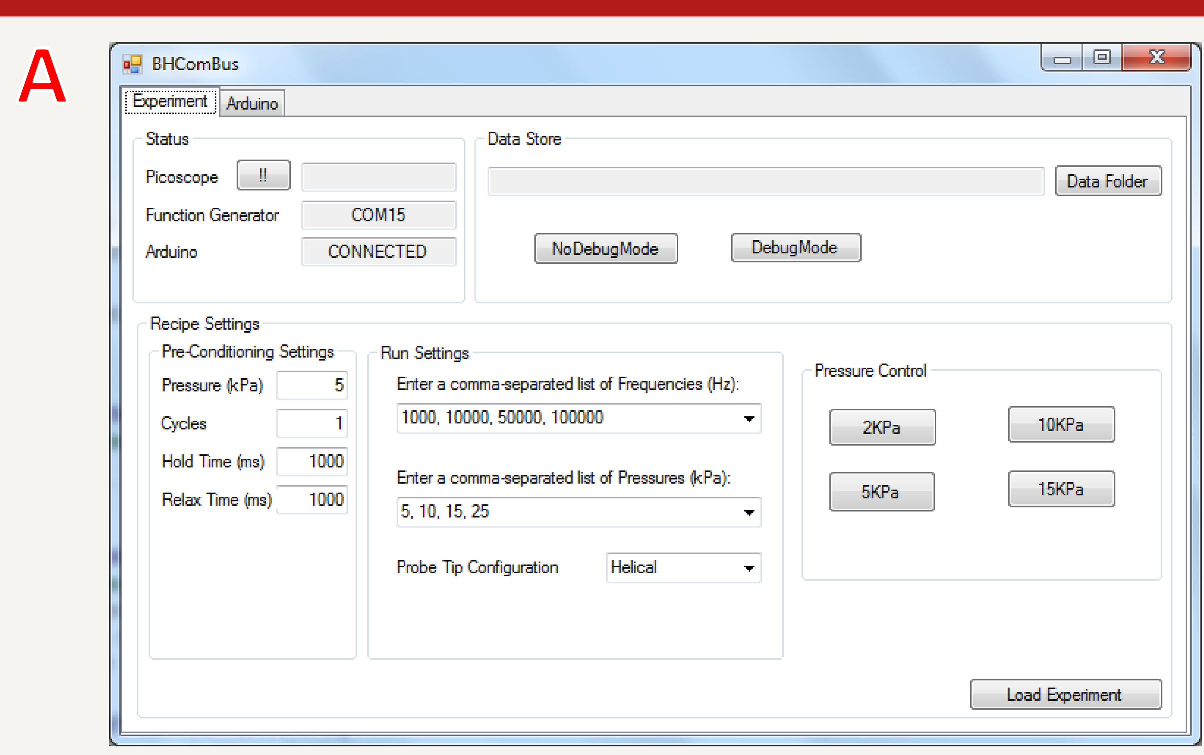
Soft tissues are complex materials whose mechanical stiffness and electrical impedance are extremely useful in a variety of ways, some of which include measuring the likelihood pre-term birth and cancer diagnosis. Dr. Jonathan Butcher, along with previous students, has developed a device for mechanical and electrical impedance measurement, using a single device that can vary pressure while sending a variable-frequency signal through the tissue (visualized below). This device can be used for nondestructive, fast, quantitative measurement of soft tissue, which can be used for diagnostic purposes. This product would also be far cheaper than other solutions for soft-tissue characterization.



V1 System

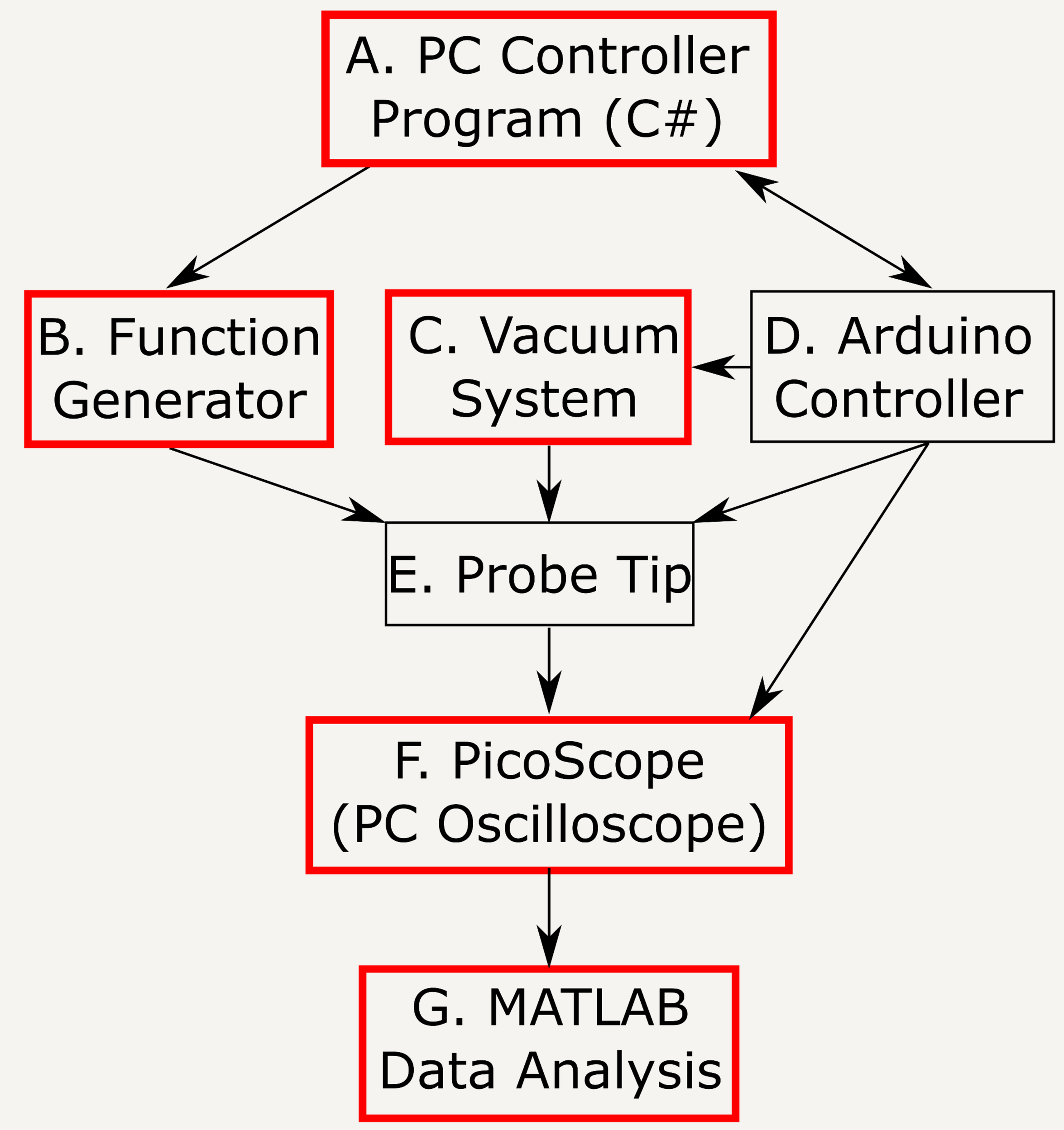


User Interface

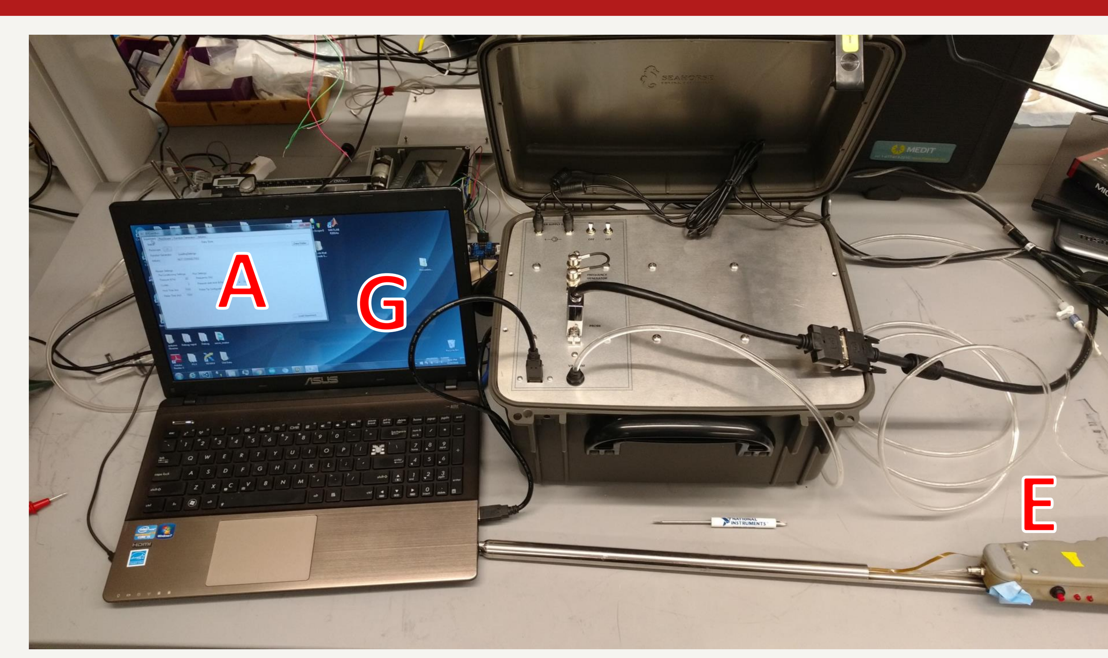


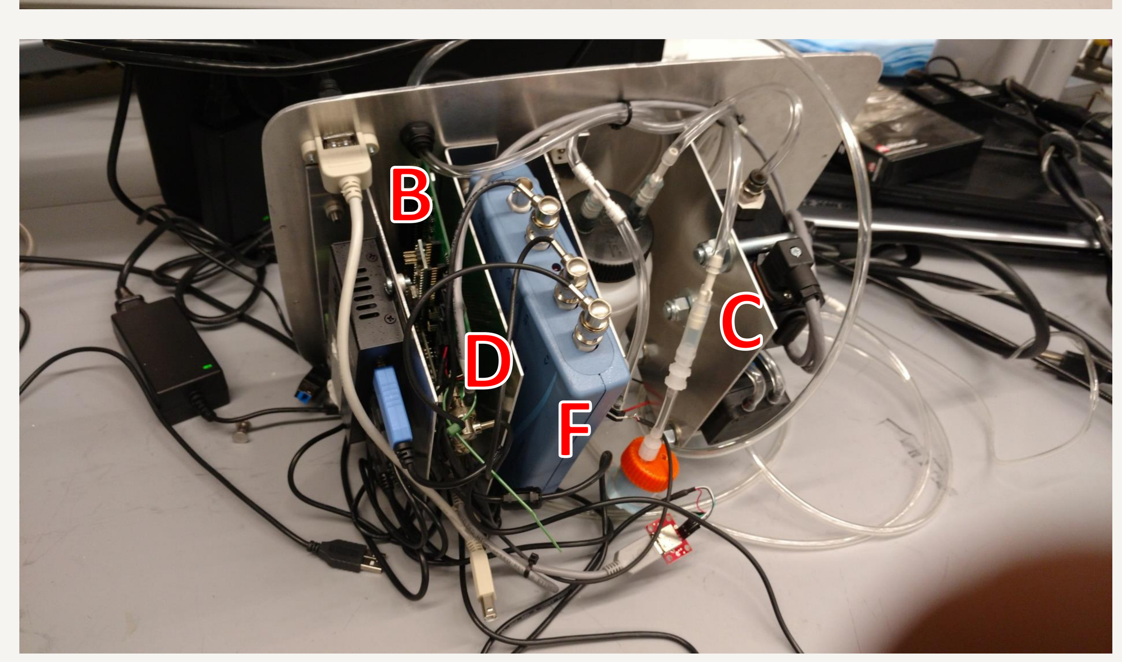
V2 System Block Diagram

This diagram shows the high-level flow of data through the system. The areas of the system that my contributions modified, fixed, or aimed to replace are outlined in red.



V2 System





My Contributions

- **Repaired V1 System:**
  - Fixed old and breaking soldering throughout system, improving reliability
- **Repaired V2 Systems:**
  - Fixed broken/incorrect electrical components, and documented all errors in V2 documentation
  - Fixed vacuum system's mechanical and feedback loop issues
- **Upgraded and Centralized V1/V2 Software:**
  - Removed obsolete code from previous generations
  - Removed all hard-coded parameters so that all parameters were settable at runtime
  - Centralized software from multiple disjoint versions to a single, controlled system
- **Designed New Data Acquisition System:**
  - Researched analog-to-digital converters to interface with a PIC32-based data acquisition system, and began implementation
  - Created an initial design for a data acquisition system that can be used by future students
- **Assisted BME Team Efforts:**
  - Assisted team in understanding existing system and implementation details
  - Helped to create a new vacuum system using embedded software and PWM-driven motors

Conclusions / Future Work

- V1 and V2 systems will serve as a development unit and a reference for a functional system
- The data acquisition system I designed can be included in a future version that could minimize the size of the system. It could also integrate the MATLAB-based data analysis, decreasing complexity and increasing system speed
- The PC-based user interface currently provides little more than a UART interface to the Arduino and Function Generator, and could be replaced by a single embedded controller

References

[1] Tarsi, G.M., et al., Method for non-optical quantification of in situ local soft tissue biomechanics. Journal of Biomechanics (2013).