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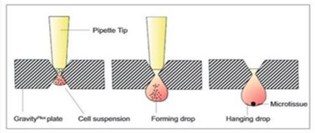
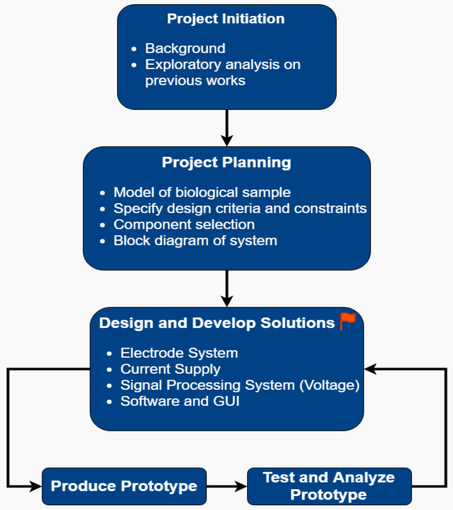
Impedance Spectroscopy of Epithelial Cell Tissue

Introduction

- Certain types of chemotherapy cause sores do develop in the mouth and throat of some patients.
- Dr. Leung's research aims to determine whether damaged cells in the lower layers of the skin are responsible for causing the sores.
- The cell cultures are 150µm to 300µm in diameter.
- Impedance spectroscopy is used to determine if the sample has been compromised.
- Compromised samples will have a lower impedance.

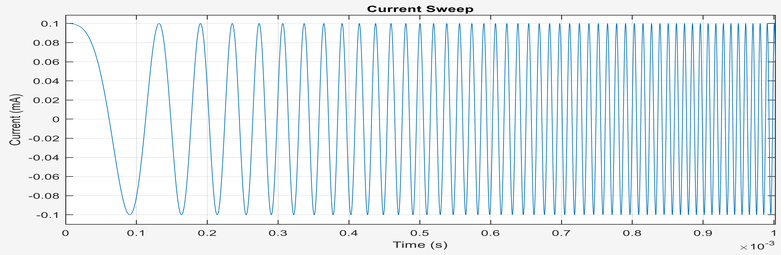


Design Process



Details of Design

Input Current Source
(1kHz to 10MHz)

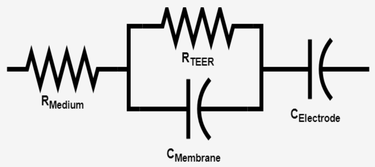


The AD9959 development board will be used to drive an AC current through the tissue culture.

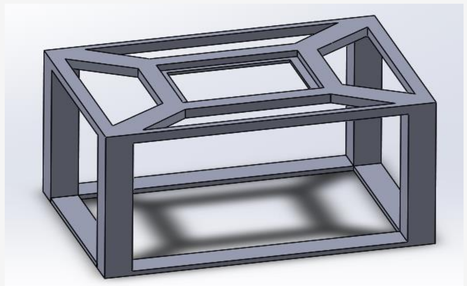
Electrodes

Tissue Sample Module

Electrical Model of Tissue Sample



Precision Apparatus



Because of the small scale of the samples and the high level of precision required, a measurement apparatus is being designed to ensure the precise placement of the electrodes is repeatable. The first draft of this stand can be seen above. The tray with the hanging droplets will sit on top and be held in place while the electrodes are inserted into the droplets from bellow.

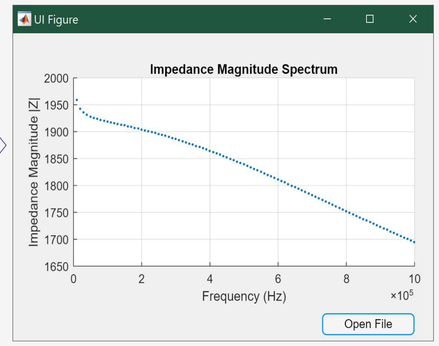
Software Module

Micro-controller

Device must accommodate provided AD9959 board
Parallel/peripherals interface
USB 2.0
Built in debugger
Development software

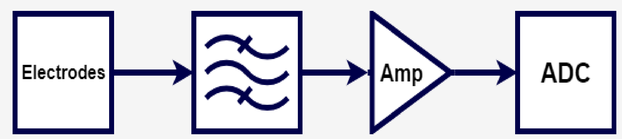
USB

Computer (GUI)



Electrodes

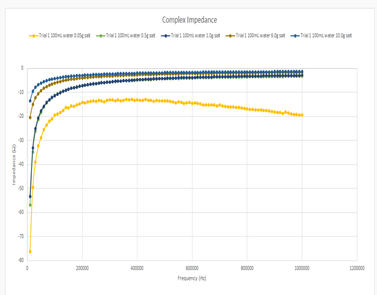
Voltage Measurement Module



Signal processing. A buffer and filter are to be place before the amplifier to avoid loading the sample and amplifying unnecessary signals. An ADC with greater than 20MHz sampling rate will be utilized to sample signals that ranges from 1kHz to 10MHz.

Preliminary Experiment

- A preliminary experiment was done using an Agilent 4294A Precision Impedance Analyzer.
- The impedance of the water was measured as table salt was added.
- The change in impedance was recorded as the concentration changed.
- These preliminary results are an indication of what we can expect to see from our device as well as provide some test data that will be invaluable for the design of the software and GUI.



Initial Conclusion and Future Works

- **Goal:** Design a device to measure the impedance of epithelial cell tissues that allows Dr. Leung to identify the abnormal tissues.
- **Project Progress:** The overall project is on schedule following the plan; project Initiation and project planning are completed.
- **Achievement:** The hardware components of the project are selected; hardware design has taken on experiments on the simple model of tissues; GUI is ready for the first demo.
- **Future works:**
  - Configure the selected microcontroller and design hardware components.
  - Optimize GUI base on the feedback from the first demo.
  - Integrate and test the systems.

Reference

[1] Douville, N.J., Tung, Y., Li, R., Wang, J., El-Sayed, M.E.H., Takayama, S. (2010). Fabrication of Two-Layered Channel System with Embedded Electrodes to Measure Resistance Across Epithelial and Endothelial Barriers. *Analytical Chemistry, 82(6),* 2505-2511.

[2] Srinivasan, B., Kolli, A.R., Esch,. M.B., Abaci, H.E., Shuler, M.L., Hickman, J.J. (2015) TEER Measurement Techniques for In Vitro Barrier Model Systems. *Journal of Laboratory Automation, 1 (20).* DOI: 10.1177/2211068214561025

[3] Schmid, Y.R.F., Burgel, S.C., Misun, P.M., Hierlemann, A., Frey, O. (2016). Electrical Impedance Spectroscopy for Microtissue Spheroid Analysis in Hanging-Drop Networks, *ACS Sensors, 1,* 1028-1035, DOI: 10.1021/acssensors.6b00272