CF Scanner: A Cost-Effective Screening Device for Cystic Fibrosis in Developing Countries

Johnny Chou, Bradley Dalrymple, Christopher Le, Ted Lee, Jae Min Song, Winston Ye

Supervisor: Dr. Rodney Vaughan

Simon Fraser University

Introduction

Cystic fibrosis (CF) is the most common fatal genetic disease affecting children and young adults. There is no cure for CF at the moment, whereas, the outlook and life span of patients with the disease can be significantly improved by early diagnosis. The diagnosis of CF is usually done by a screening sweat test followed by a genetic testing if the screening result is confirmed to be positive.

The sweat test is considered the gold standard for screening CF due to its distinct symptom of substantially excessive amount of salt in patient's sweat.

CF, earlier believed to be non existent in non Caucasian, is now being reported in developing countries.

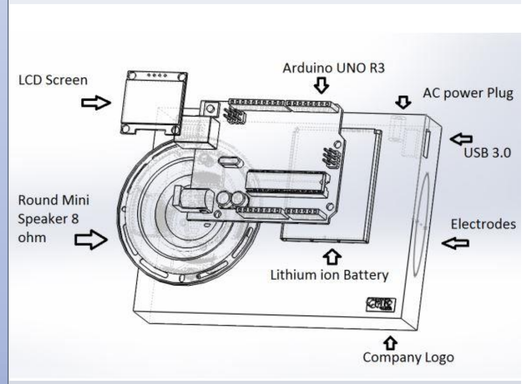
The current screening method requires a lot of train medical professionals and infrastructure that developing countries are short of. Besides, false results caused by human error can be fatal to patients and be expensive to the health care system($400 per time in Canada). Therefore, having an alternative which is reliable and cost effective for screening CF is needed in order to further improve the current CF diagnosis and treatment in developing countries.

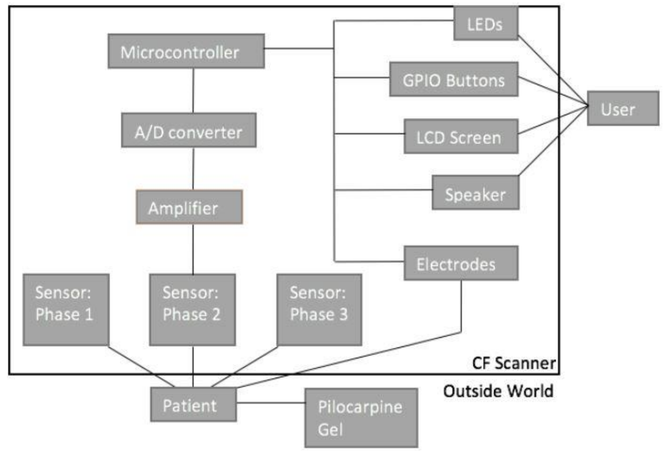
Objective

As mentioned in introduction, developing countries are lack of resources to screen CF using traditional sweat test. In order to address the issue, CF Solutions is currently developing a reliable and cost effective device that is designed to a point where a non-medical professional can operate the device and observe results easily.

The objective of CF Scanner is to advance Cystic Fibrosis detection in developing countries.

CF Scanner System Overview





CF Scanner Stage 1 Testing

Testing Method:

The stage 1 testing is aim to prove the concept that the excessive salt content in CF patients' sweat can be detected by our device through measuring conductivity and resistance.

Phantoms are frequently used in medical testing. For our stage 1 testing, skin phantoms were made of deionized water, sodium chloride, and agar to mimic human skin with sweat. Three different concentrations were made to match the chloride(salt) threshold for traditional sweat test.

The CF Scanner was used to test the each phantom's resistance.

Testing Result:

Salt Concentration	0.2 g in 100mL dH_2O	1.0 g in 100mL dH_2O	2.0 g in 100mL dH_2O
Trial #1	26.82 kΩ	20.34 kΩ	15.65 kΩ
Trial #2	25.67 kΩ	20.77 kΩ	15.74 kΩ
Trial #3	26.25 kΩ	20.11 kΩ	14.86 kΩ

Conclusions

For the preliminary testing result, we can see that increase in salt concentration does decrease the resistance; that is, increase in conductivity.

However, the difference between different concentration is not as significant as we expected.

Therefore, for the second stage, we will be looking into our own Ion Selective Electrode sensor to improve the accuracy.

Future Work

Over the next four months, we will be developing our own sensor to improve the accuracy of our sensor. Currently we are measuring the resistance by putting electrodes on the surface of our skin phantom but we will change this in our second prototype by creating an Ion Selective Electrode sensor (ISE sensor). This sensor will target specific ions, i.e. chloride, and determine their concentration. These sensors measure the ions of the solution instead of the electrons. This sensor functions by comparing a solution to a controlled galvanic cell or membrane to determine the unknown solutions concentrations. For our project we will use a glass membrane as this concept is optimized for single charge cation. We will then calculate the concentration using Nernst equation.

References

[1] About Cystic Fibrosis | CF Foundation", *Cff.org*, 2017. [Online]. Available: https://www.cff.org/What-is-CF/About-Cystic-Fibrosis/. [Accessed: 25- Mar- 2017].

[2]"Cystic Fibrosis Canada", *Cysticfibrosis.ca*, 2017. [Online]. Available: http://www.cysticfibrosis.ca/about-cf/what-is-cystic-fibrosis. [Accessed: 31- Jan- 2017].

[3]S. Kabra, M. Kabra, S. Shastri and R. Lodha, "Diagnosing and managing cystic fibrosis in the developing world", *Paediatric Respiratory Reviews*, vol. 7, pp. S147-S150, 2006.

[4]"Diagnosis: Testing: Sweat Test", *Johns Hopkins*, 2017. [Online]. Available: http://www.hopkinscf.org/what-is-cf/diagnosis/testing/sweat-test/. [Accessed: 31- Jan- 2017].

[5] A. M. R. Pinto, P. Bertemes-Filho, and A. S. Paterno, "Gelatin as a Skin Phantom for Bioimpedance Spectroscopy," *VI Latin American Congress on Biomedical Engineering CLAIB 2014, Paraná, Argentina 29, 30 & 31 October 2014 IFMBE Proceedings*, pp. 178–182, 2015.

[6] A. Mattar, C. Leone, J. Rodrigues and F. Adde, "Sweat conductivity: An accurate diagnostic test for cystic fibrosis?", *Journal of Cystic Fibrosis*, vol. 13, no. 5, pp. 528-533, 2014.