Detecticav(ity)



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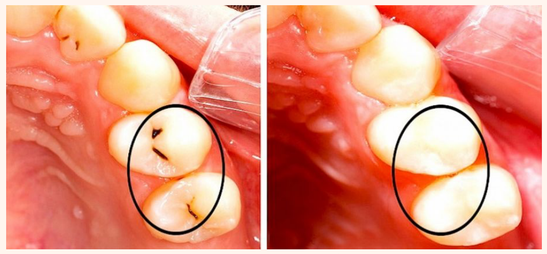
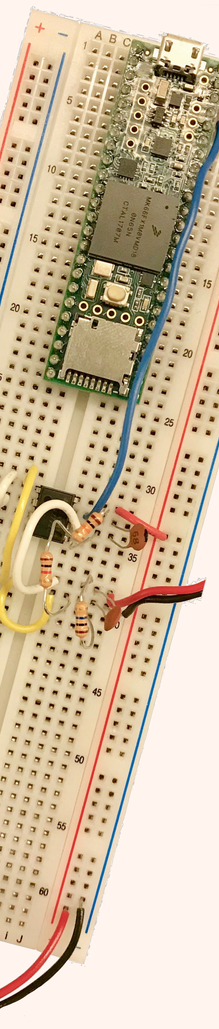
A low-cost ubiquitous sensing tool to detect cavities in teeth using a new technique called *acoustic echodentography*.





Research

Background

Ubiquitous computing sensing has been applied to convert many everyday artifacts to generate data and make predictions using AI. This is part of larger trend towards generating ubiquitous sensing platforms in which low-cost, decentralized devices communicate with one another. Furthermore, the Quantified-Self movement encourages people to track numerous facets of their daily routines and health. We intend to apply these trends toward improving user's oral hygiene.

Motivation

According to the CDC, 18.6% of children aged 5-19 years have untreated dental caries. However, that percentage significantly increases for adults aged 20-64. Approximately 91% of adults have untreated dental caries, according to the NIH. Because of this, we wanted to research a potential solution that would decrease the high percentage and promote better oral healthcare habits.

Goal

The goal of Detecticav(ity) is to do a Spectral Chirp analysis of teeth to determine whether or not there is a cavity. This will be done by generating sine waves of various frequencies to find a frequency that resonates well with an artificial tooth. We can determine the density of the tooth via frequencies, and we are hoping that a distortion in a sine wave will classify whether or not a tooth has a cavity.

References

Centers for Disease Control and Prevention. (2017). Oral and Dental Health . Retrieved from http://www.cdc.gov/nchs/fastats/dental.htm.

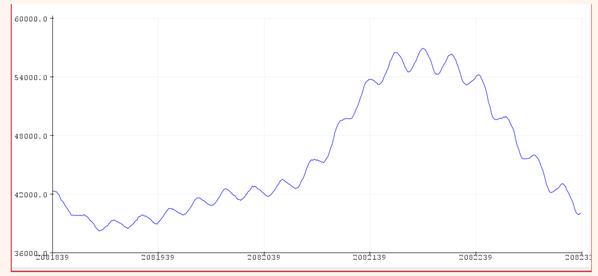
Dental Caries (Tooth Decay) in Adults (Age 20 to 64). (2018, July). Retrieved November 28, 2018, from https://www.nidcr.nih.gov/research/data-statistics/dental-caries/adults

Ghorayeb, S. R., & Valle, T. (2002). Experimental evaluation of human teeth using noninvasive ultrasound: echodentography. IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, 49(10), 1437–1443.

Methodology

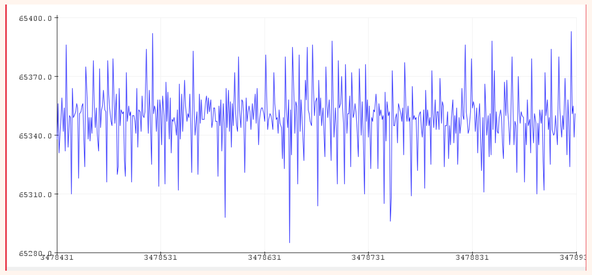
The process of building Detecticav(ity) is 3-part process:

1. Building the frequency (chirp) sweep generator and frequency signal receiver using a Teensy 3.6 microcontroller.
2. Data collection of artificial teeth with 1.6 mm drill bit to simulate dental caries.
3. SVM machine learning to classify and detect whether or not the tooth has a cavity.



No Cavity Sound Wave

Cavity Sound Wave



Findings

We used a C-Support Vector Classification Model to classify the collected data with binary labels (i.e. Cavity vs. No Cavity). The model predicted a 42% success rate based on a 33% train-test split of our data set.

Conclusion

Based on our preliminary analysis, we determined that the combination of acoustic echodentography and a SVM machine learning algorithm can possibly classify dental caries. For future considerations of this work, we would like to increase the sample size, use human teeth, use more sophisticated instruments and potentially build a low-cost consumer product which would promote better oral hygeine - especially in low-income communities.