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# Using Emitted Vibrational Frequencies to Determine Watermelon Sweetness

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## Introduction

The current focus of this project is to gather audio signals from thumping watermelon to determine if there is any correlation between the sound produced and the sugar concentration of the watermelon. The audio signals are converted to harmonic frequencies using the FFT and then compared to the sweetness of the watermelon. The ultimate goal of this long-term project is to create a mobile app to be used by consumers when determining which watermelon they should buy at the store.

## Data Collection and Analysis

Visual watermelon characteristics and weight are recorded before recording the thump signal. After the thump audio is recorded, then the signal is then run through a previously developed program to determine the Fast Fourier Transform (FFT) of the thump. The FFT converts the audio signal to discrete harmonic frequencies. The watermelon is then cut open long-ways and the visual characteristics of the inside of the watermelon are recorded and a core is taken from the center of the watermelon. This core is then juiced and a drop is placed on a brix meter which determines the sweetness of the watermelon. On the brix scale, the higher the number, the greater the sweetness.

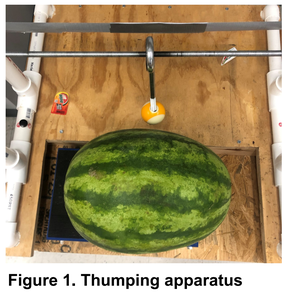

Figure 1. Thumping apparatus


Figure 2. Brix meter used to determine sweetness on the brix scale

This summer, a relationship between the two is believed to have been found with the location of the main peak in the FFT and the sweetness. As the main peak moves toward 150 Hz, the watermelon has been determined to be sweeter than a watermelon with a peak frequency closer to 100 Hz. Looking at the FFT frequency output to the right, is this a watermelon you would purchase?

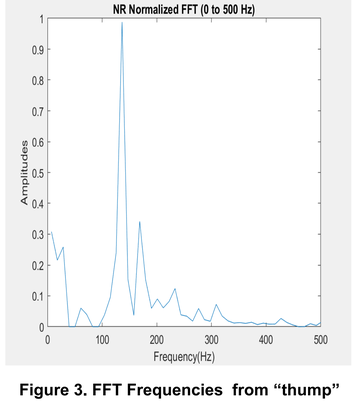


Figure 3. FFT Frequencies from "thump"

## Results

This summer, data was collected from 60 watermelons and combined with audio signal data recorded from previous years. The FFT's from all the signals were collected based on the brix reading of each watermelon and averaged, giving an expectancy of where the max peak should be for a specific brix level. The results for specific brix values are shown below in figure 4.

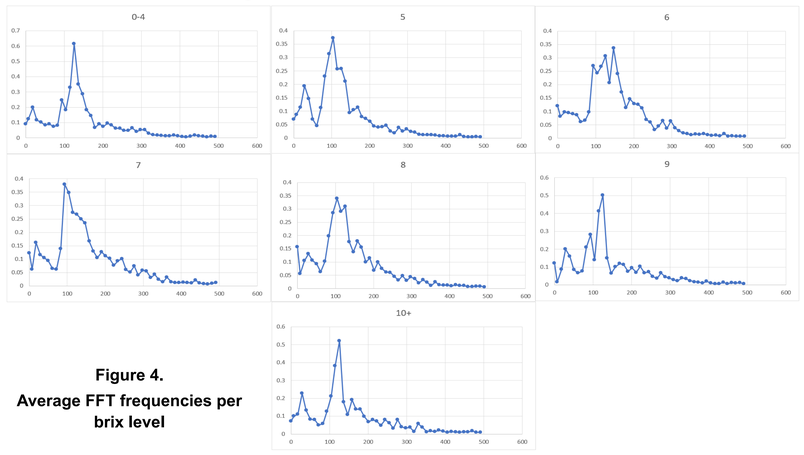


Figure 4.
Average FFT frequencies per brix level

## App Development

Work on an app that could be used in the field began by choosing to develop on an Apple device. We used the free programing language Xcode that is used to run on all Apple devices. This meant previously developed code in MATLAB could not be copied over as is, since Xcode is C based while MATLAB uses a variety of languages. We used SwiftUI for the interface of the app which allowed for an easier time in editing objects within the code. Multiple files within the project were required to streamline app development. This would allow for easier changes to the code in the event of a variable that needed to added or changed when calculating the sweetness of a watermelon.

```
Group{
//need to add code to make the options and everything scale smaller for smaller screens which means ratioing it to the screen size possible

// .zIndex() makes sure that options are always the top item when they come up
// default setting is 0 on order

// start->options of shine
VStack{ ...          }.offset(y: UIScreen.main.bounds.height * 0.25)

VStack{ ...          }.background(Color(UIColor.label.withAlphaComponent(self.Shine ? 0.2 : 0)).edgesIgnoringSafeArea(.all)).zIndex(1)
// end options of shine

// start->options of field spot color
VStack{ ...          }.offset(y: (UIScreen.main.bounds.height * 0.1))

VStack{ ...          }.background(Color(UIColor.label.withAlphaComponent(self.FieldSpot ? 0.2 : 0)).edgesIgnoringSafeArea(.all)).zIndex(1)
// end->options of field spot color

// start->options of stem color
VStack{ ...          }.offset(y: -(UIScreen.main.bounds.height * 0.05))

VStack{ ...          }.background(Color(UIColor.label.withAlphaComponent(self.StemColor ? 0.2 : 0)).edgesIgnoringSafeArea(.all)).zIndex(1)
// end->options of stem color

// start->options of seed
VStack{ ...          }.offset(y:-(UIScreen.main.bounds.height * 0.2))

VStack{ ...          }.background(Color(UIColor.label.withAlphaComponent(self.Seeded ? 0.2 : 0)).edgesIgnoringSafeArea(.all)).zIndex(1)
// end->options of seed

// start->options of watermelon color
VStack{ ...          }.offset(y: -(UIScreen.main.bounds.height * 0.35))

VStack{ ...          }.background(Color(UIColor.label.withAlphaComponent(self.WatermelonColor ? 0.2 : 0)).edgesIgnoringSafeArea(.all)).zIndex(1)
// end->options of watermelon color
```

Figure 5. Code for the Selection Page options


Figure 6. Selection Page to input data for variables

Figure 7. Analysis Page to show the results of the sound file

Currently in the project we have several screens developed for use by consumers. In figure 6, for example, it shows the various watermelon parameters that may affect sweetness. In figure 7, this will display the analysis of the thump signal and what the consumer can expect from that watermelon if purchased.

## Conclusion and Future Work

In order to be more confident in the relationship between the frequency and sweetness, more watermelons will need to be processed as well as seeing if the frequency is affected by various other watermelon characteristics, such as size. Further analysis of the audio signal should continue in the event additional frequencies in the FFT can be related to the watermelon's sweetness. The more parameters that can be used to determine the sweetness, the more accurate the final predicted value will be.

A completed app was not finished this summer, but the frame work is in place for future development and additions. Working on the app for this project has shown how vastly different it can be when trying to create programs for various jobs not to mention working with different languages. Development on the app has helped with new ideas that have made the MATLAB program more efficient.

## Acknowledgements

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