# Project Review: Noise Control in Beard Trimmer

**Course**: ME5650 ENC 2020

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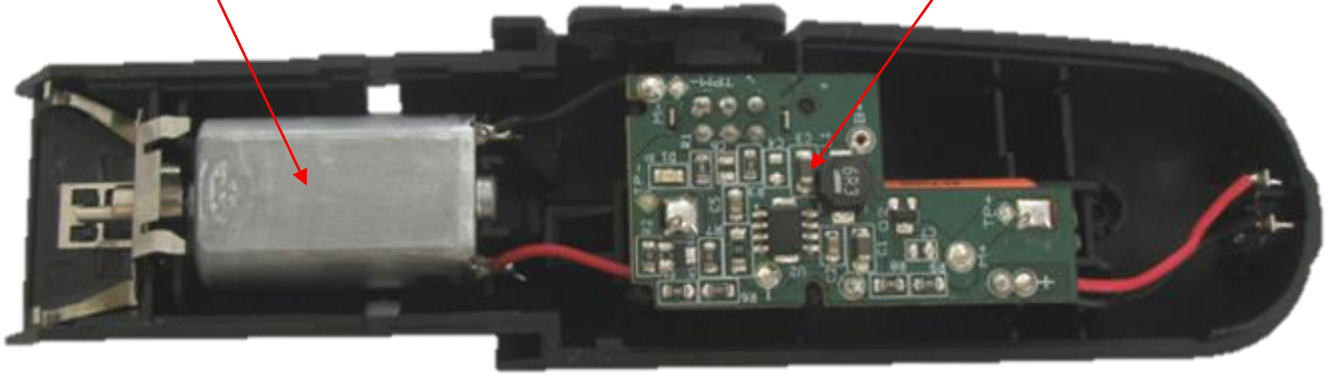
# Contents

Contents:

# Product Description

LD-180FF Metal Brush Motor

USB rechargeable battery mounted on PCB



Internal Circuitry

Durable plastic casing

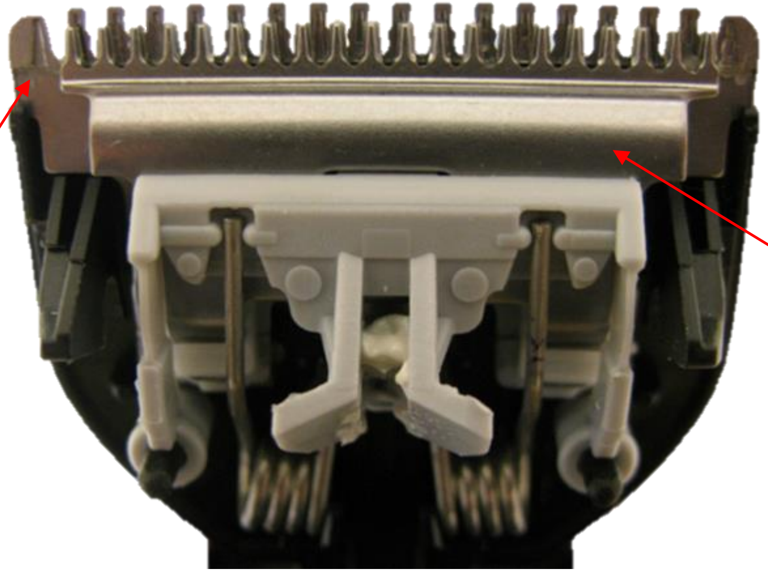
Model: Philips BT1212

# Product Description:

Shaft Mounted on Cam of DC Motor
Produces elliptical Motion

Rechargeable battery

External Stationary Blade



Internal Movable Blade

Blades made of Stainless steel

# Product Description: Working Principle

- When the coil of the DC motor is powered, magnetic field is generated around the armature causing the motor to rotate.
- DC motor makes the movable blade oscillate in fast pace.
- The trimming takes place when the movable and stationary blades overlap each other pinching the hair off the skin.
- Hence one cut per oscillation.

# Possible Mechanical Sources

There are various possible mechanical sources:

1. Noise due to brushes of the motor:
   - As the brushes rub against the commutator, they create  mechanical and electrical noise.
2. Vibrations due to motion of shaft of Motor:
   - As the shaft is mounted on a cam rotates, the vibration of the casing is possible which may produce noise.
3. Vibrations due to motion of blades:
   - As the blades oscillate, the entire casing also vibrates which may produce noise.

As we can see all of the above sources lead to structure borne noise.

# Measurements and Interpretation: Measuring RPM

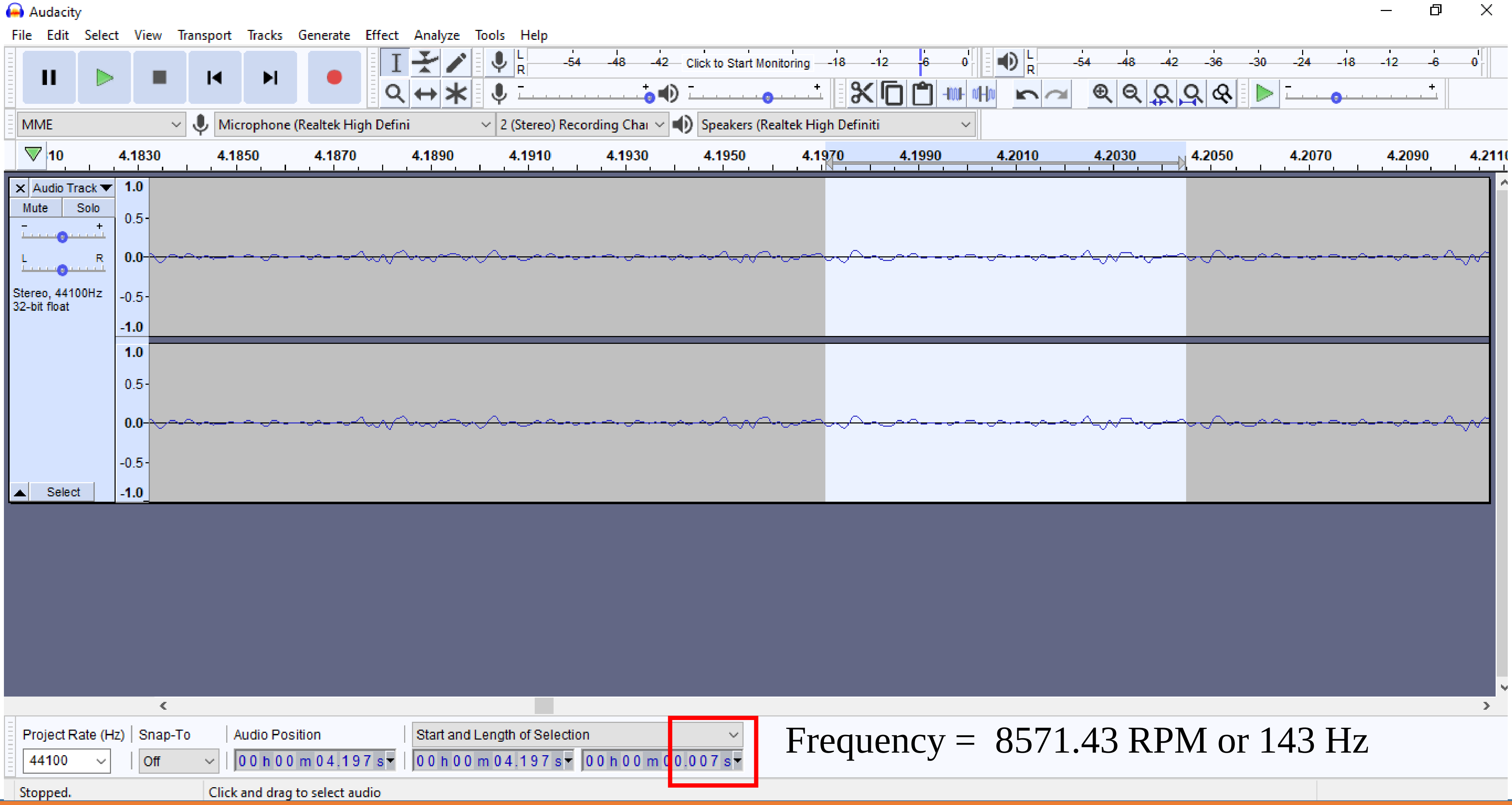
RPM of the motor can be easily measured without sophisticated tools using audacity software

Steps:

- Place a small insulation tape around the shaft of the motor as shown in figure
- As the motor rotates place your finger in close to tape to produce buzz noise.
- Find out the time interval using audacity.
- RPM = 60/T.

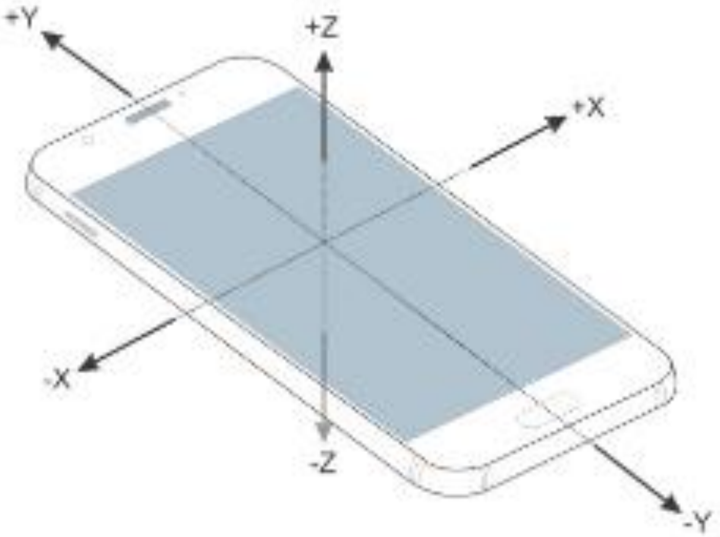
Insulation tape attached to shaft

# Measurements and Interpretation: Measuring RPM




Frequency = 8571.43 RPM or 143 Hz

- We used iDynamics mobile  application developed by University of Kaiserslautern for Vibrational analysis .
- The application uses inbuilt accelerometer sensor of the mobile phones.



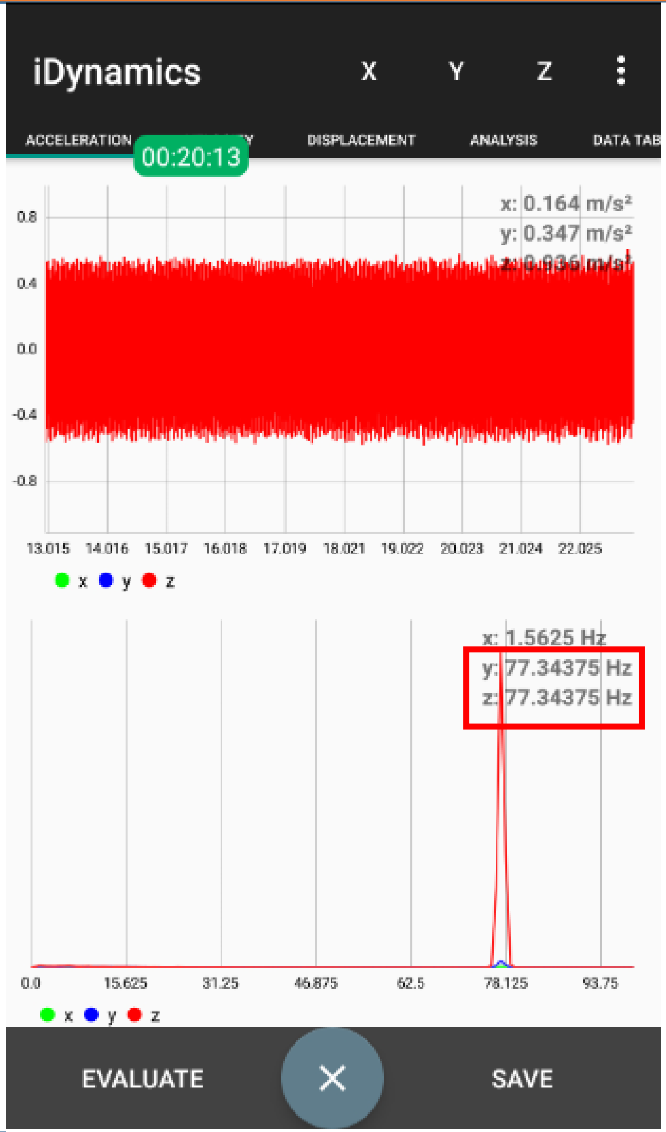

Coordinate axes

# Measurements and Interpretation: Vibration Analysis

Vibration analysis: Without Blades attached
Natural frequency recorded: 77.3437 .

Interpretation:

- Since the RPM of the motor is 143Hz which is close to 2*natural frequency vibration is due to rotation of motor.
- There is not much effect of eccentricity of shaft attached to the motor cam.

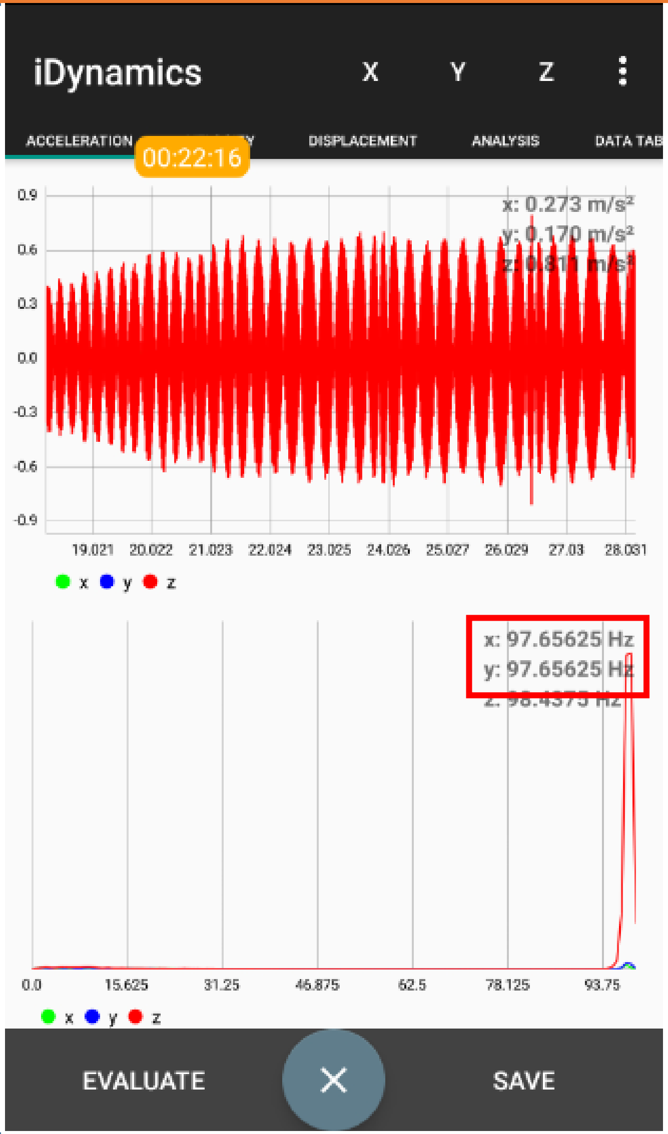


# Measurements and Interpretation: Vibration Analysis

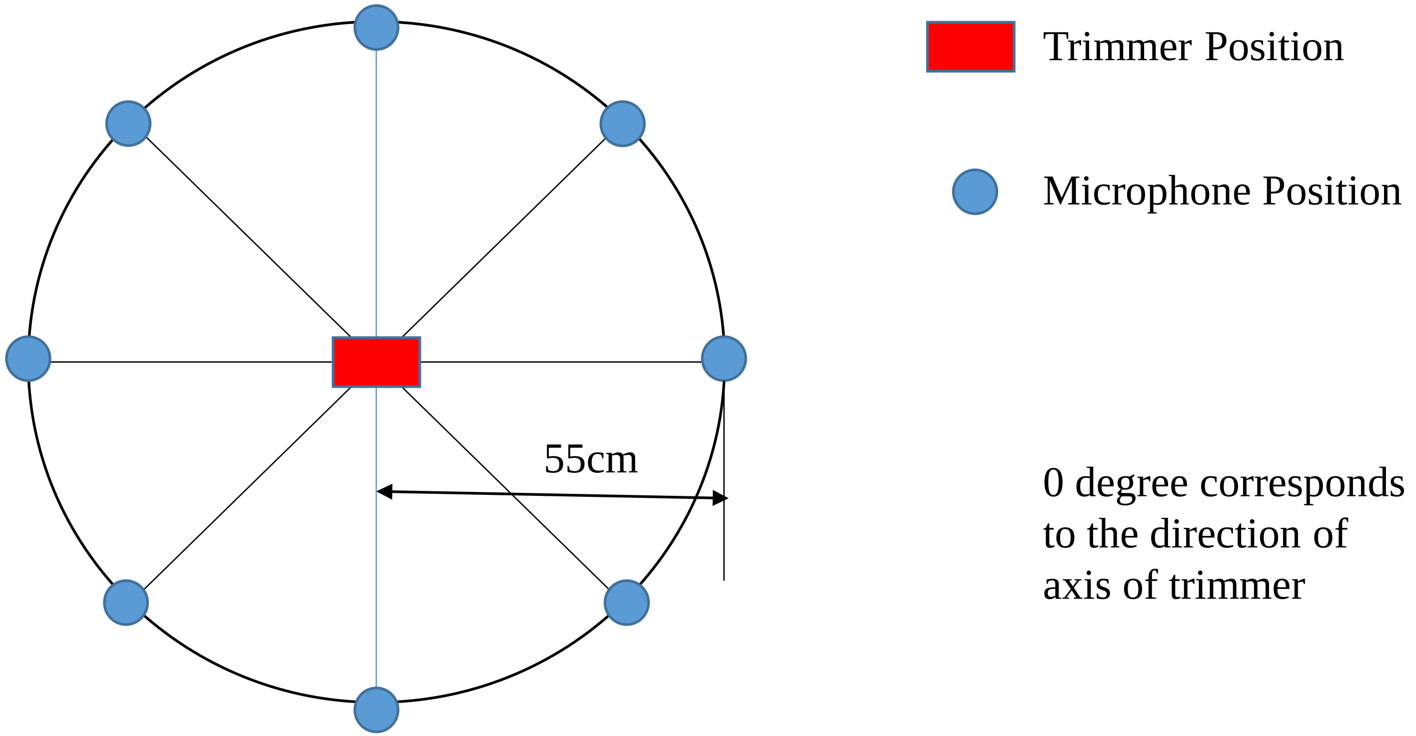
Vibration analysis: With Blades attached
Natural frequency recorded: 97.65 Hz .

Interpretation:

- Though the blades oscillate at frequency equal to that of the motor, there is change in natural frequency
- Hence we can say there is an effect of eccentricity of the shaft and vibrations pass to the structure.



# Measurements and Interpretation: Directivity Test



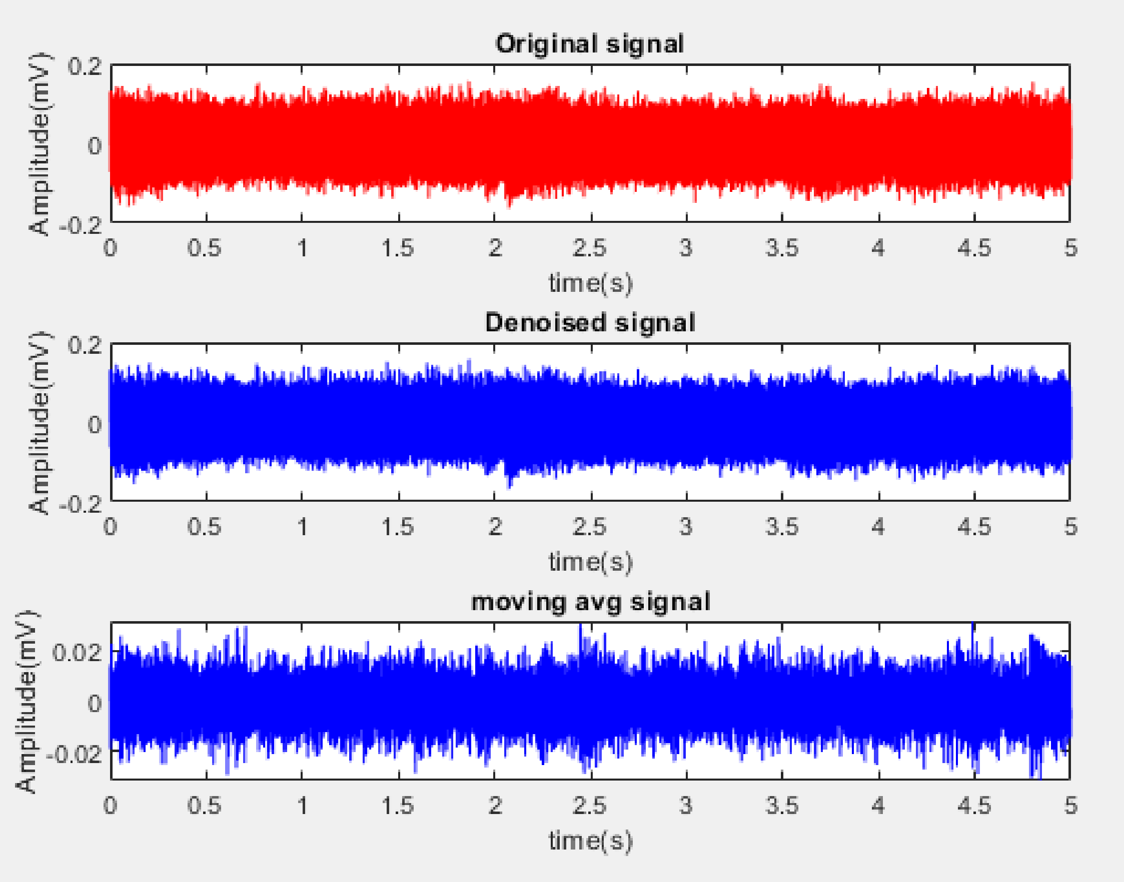

0 degree corresponds to the direction of axis of trimmer

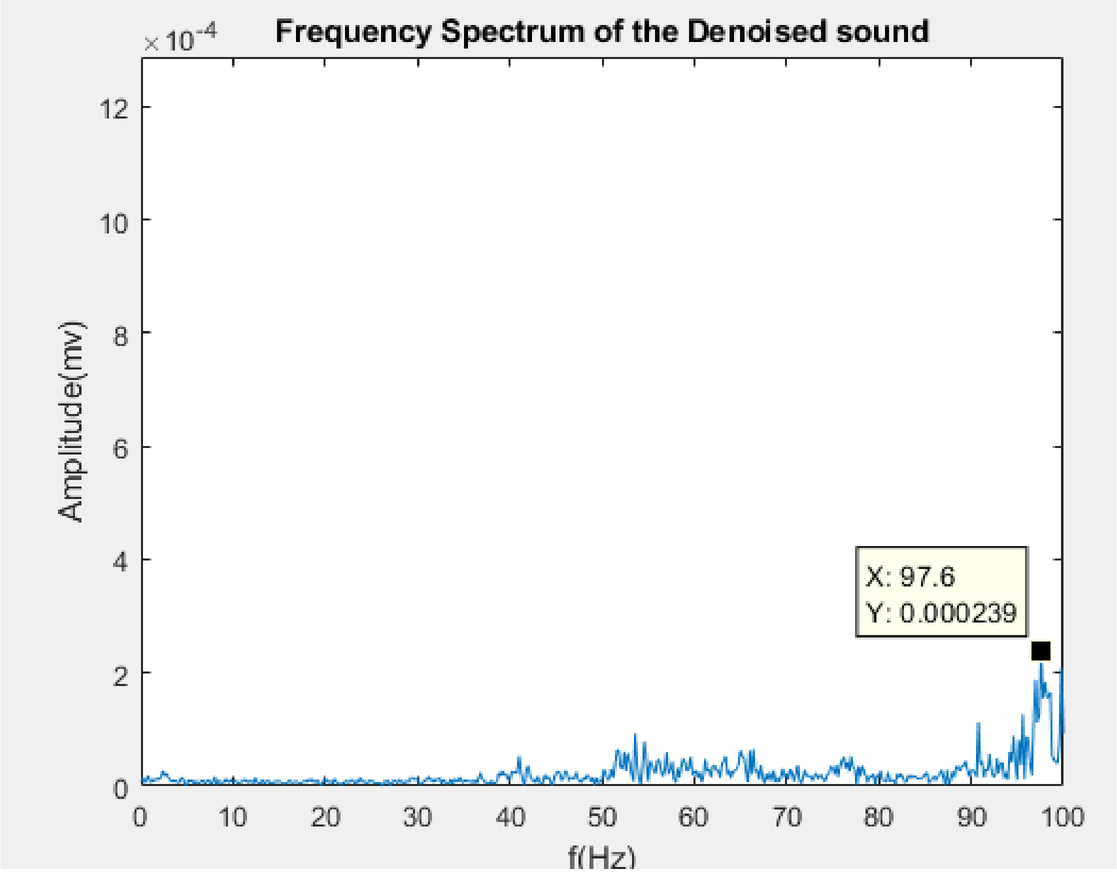
# Measurements and Interpretation: Directivity Test

Directivity Test:

| Angles(in degrees) | SPL(in dB) |
| --- | --- |
| 0 | 48.77 |
| 45 | 49.43 |
| 90 | 51.23 |
| 135 | 51.12 |
| 180 | 51.23 |
| 225 | 52.13 |
| 270 | 54.45 |
| 315 | 49.43 |

Analysis of audio file: Fast Fourier Transform



# Measurements and Interpretation: FFT

Analysis of audio: Interpretation of result:

Since the natural frequency(97.65 Hz) due to vibration analysis by iDynamics is matching with the frequency of the audio we can say the sound generated is mainly due to vibrations caused by the blade which transfer across the casing.

# Noise Source Ranking:

- Frequency corresponding to 97.6 Hz has high amplitude compared with that of 77 Hz and 38.5Hz.
- Hence the source ranking is as follows :

**Vibration due to bade oscillation > Vibration due to rotation of shaft>  noise due to rubbing of brushes**.

# Possible Noise Control Mechanisms:

The noise generated is due to structure borne vibrations, we can possibly reduce the noise two ways

1. Cutting the path of vibration to casing .
    - This includes vibration isolation, avoiding direct contact with casing.
2. Reducing the vibrations of the casing.
    - This includes stiffening of casing, use of damping material around the casing.

# Future Work:

1. Analysis of vibrations and sound levels corresponding to individual component wise.
2. Target reduction of noise level >6dB.
3. Look for alternatives to be implemented in the design stage to reduce noise.

# References:


1. Vibration analysis using mobile devices, A. Feldbush, H. Sadegh, P. Agne
2. Noise and Vibration control, M.L. Munjal
3. Engineering Noise control, Bies and Hanson.

# Thank You