(ME-5650) ENGINEERING NOISE CONTROL

Project report -1

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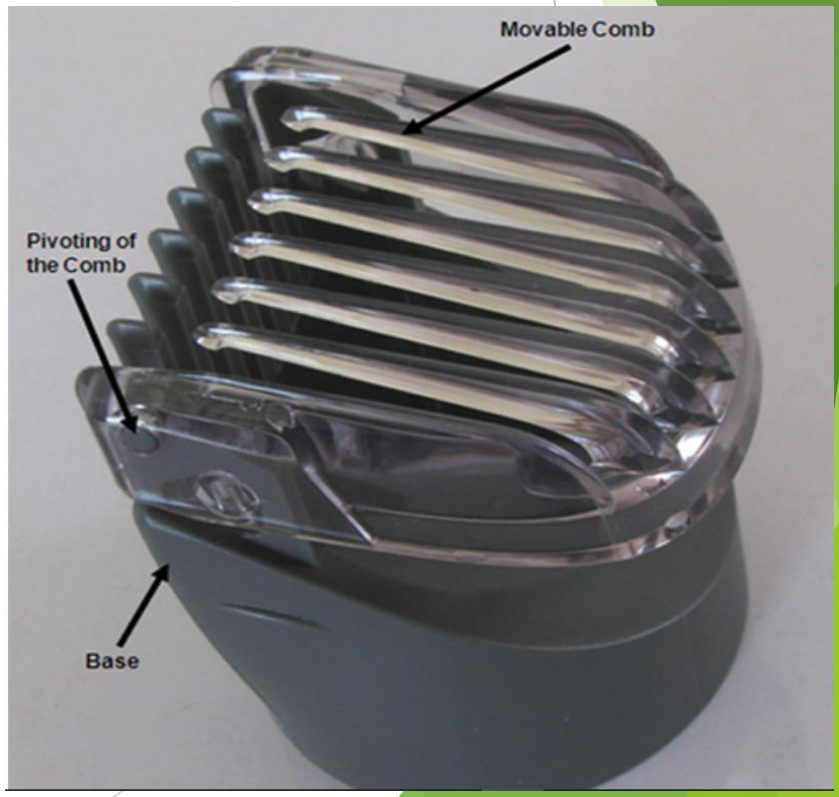
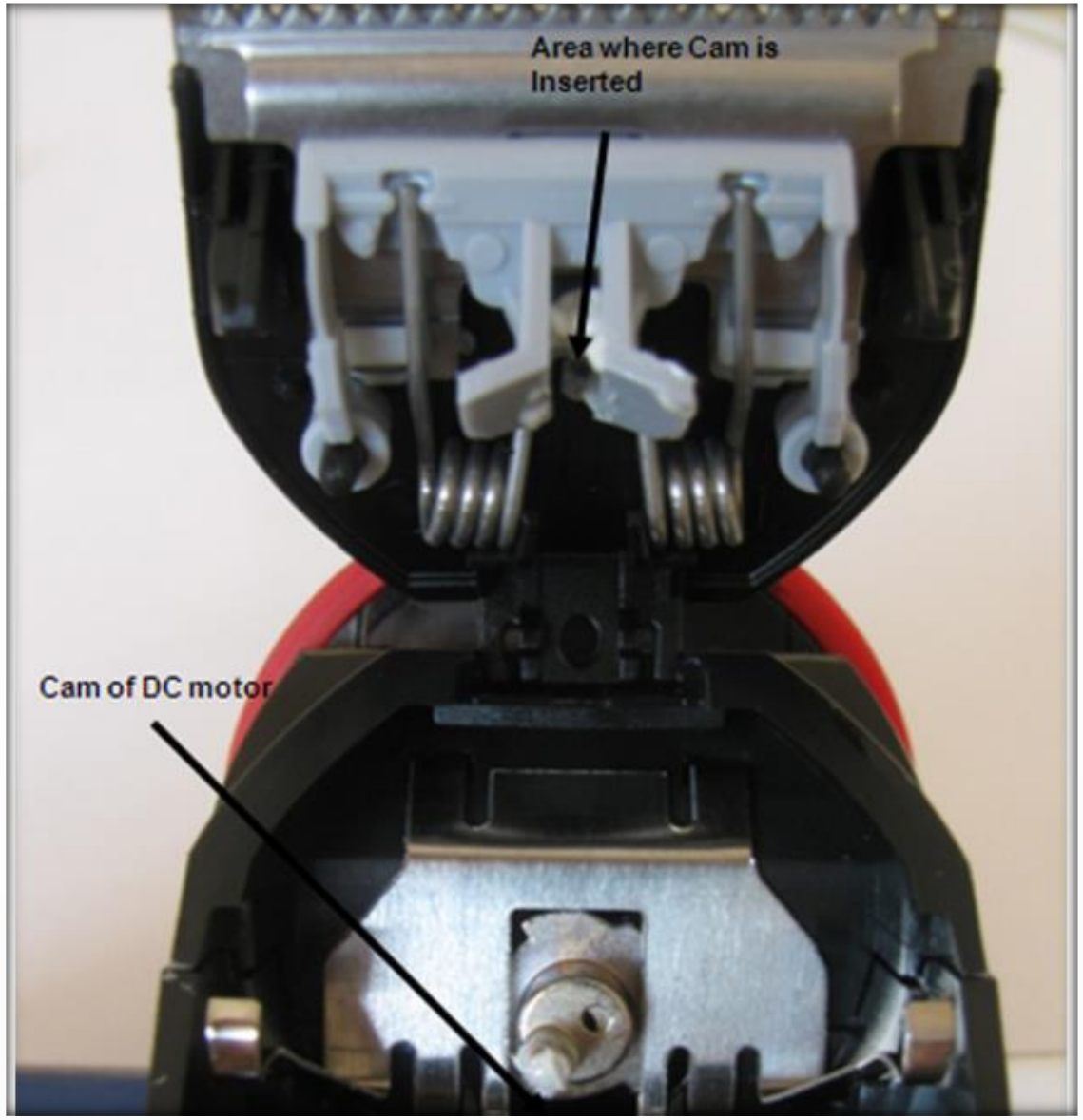
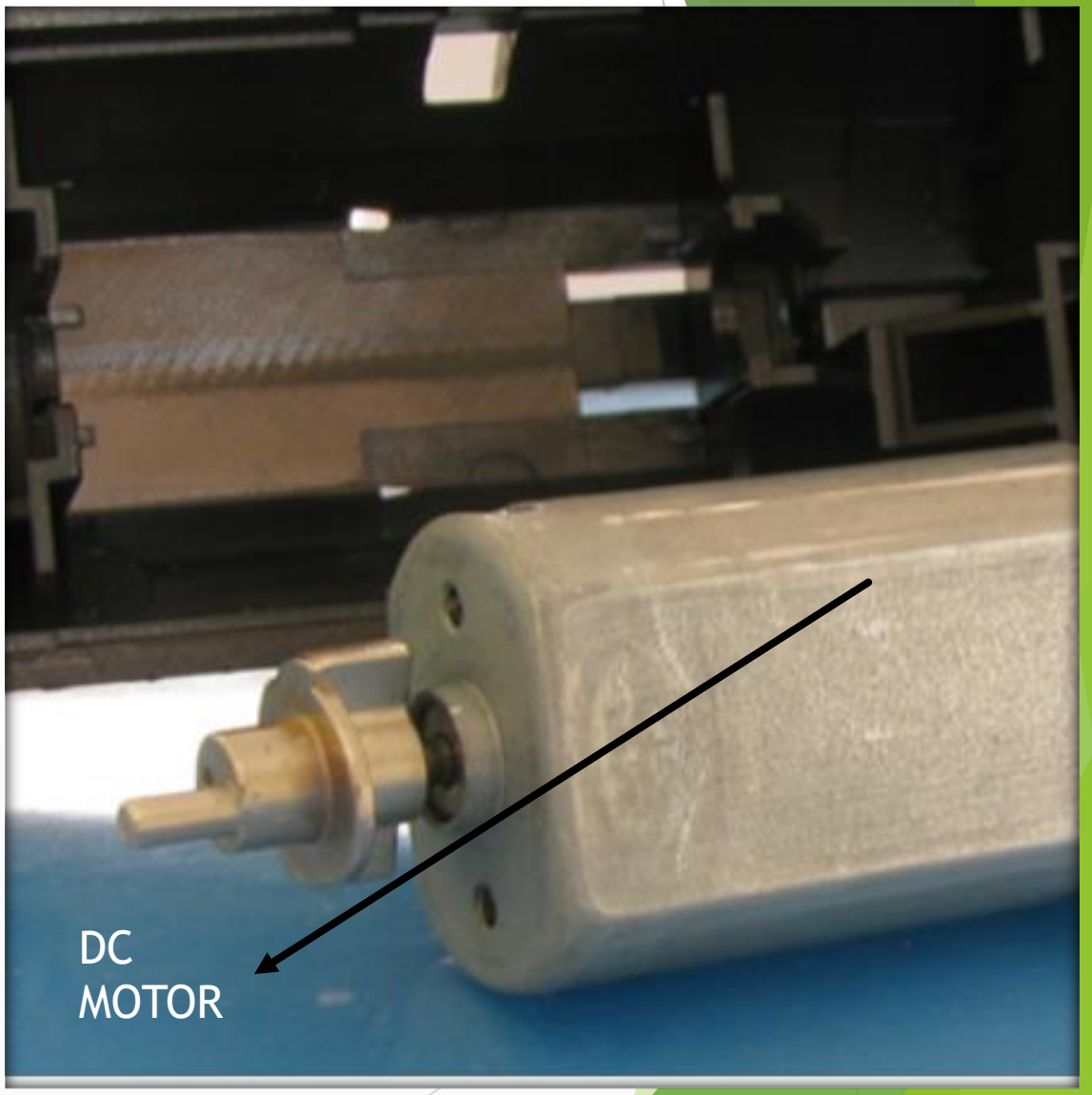
Product: BEARD TRIMMER

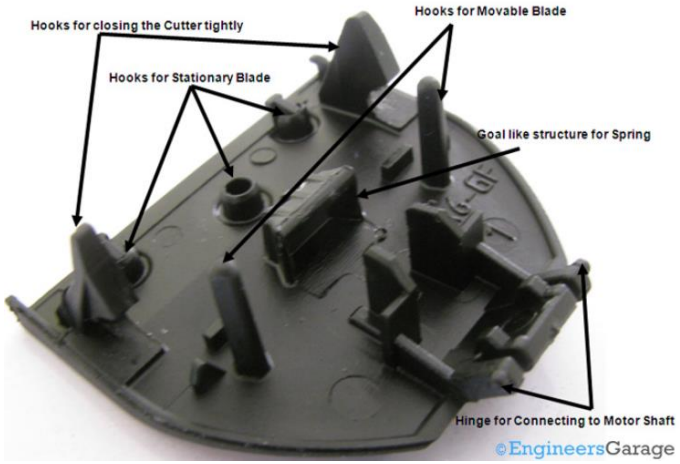
Basic working principle of a trimmer:

- A trimmer in general consists of the following parts as shown below

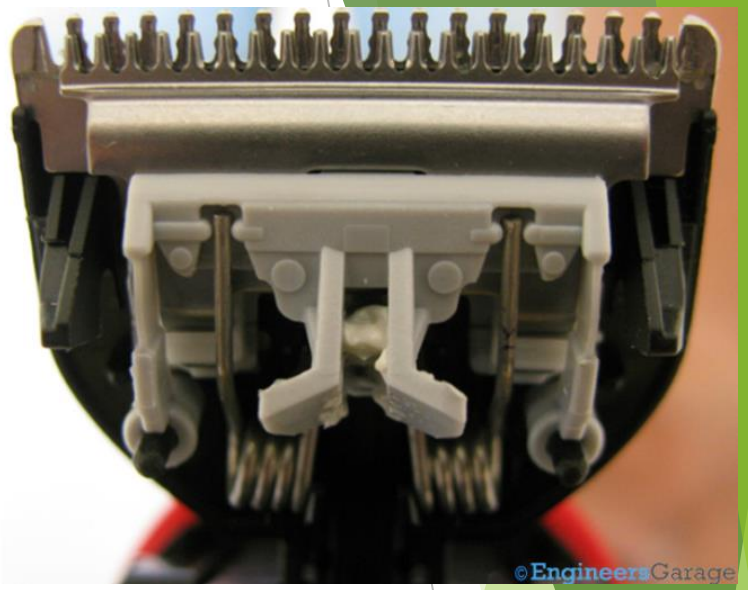


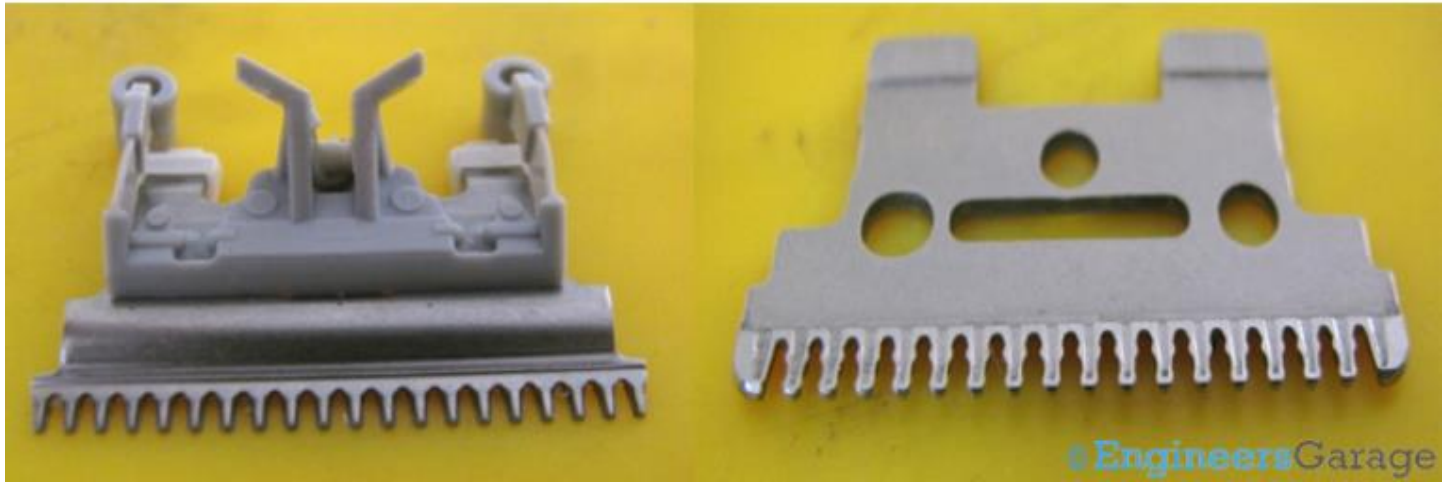

Area where Cam is Inserted
Cam of DC motor


DC
MOTOR



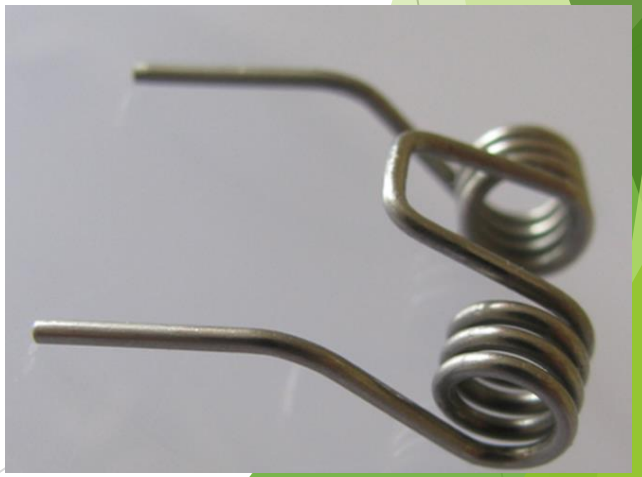
CAM

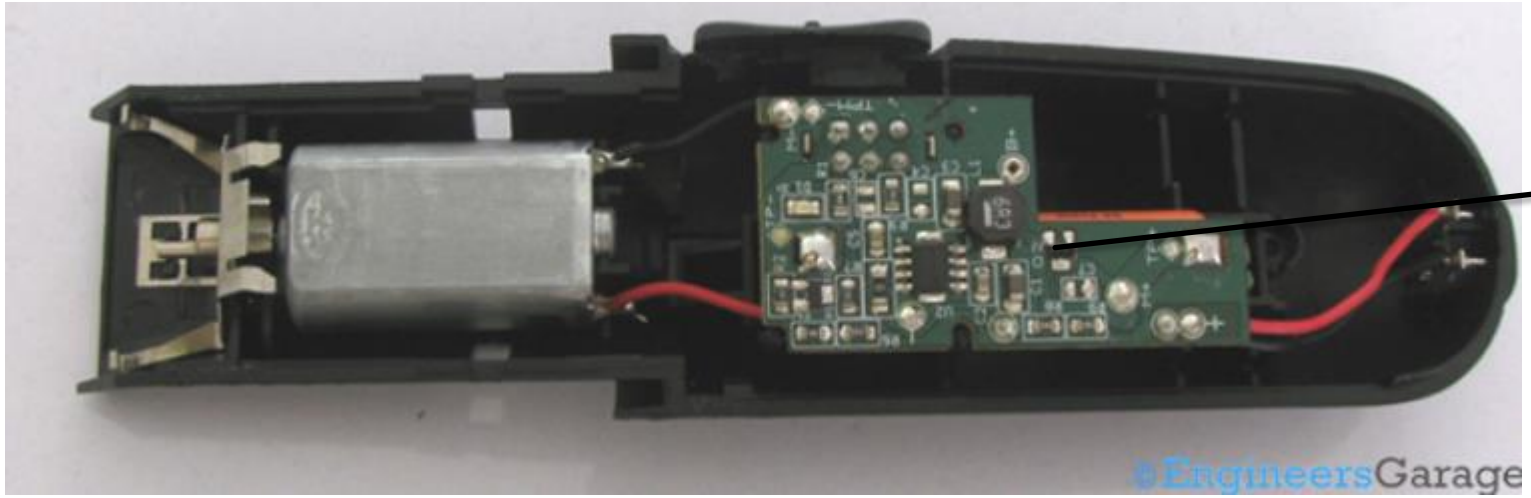




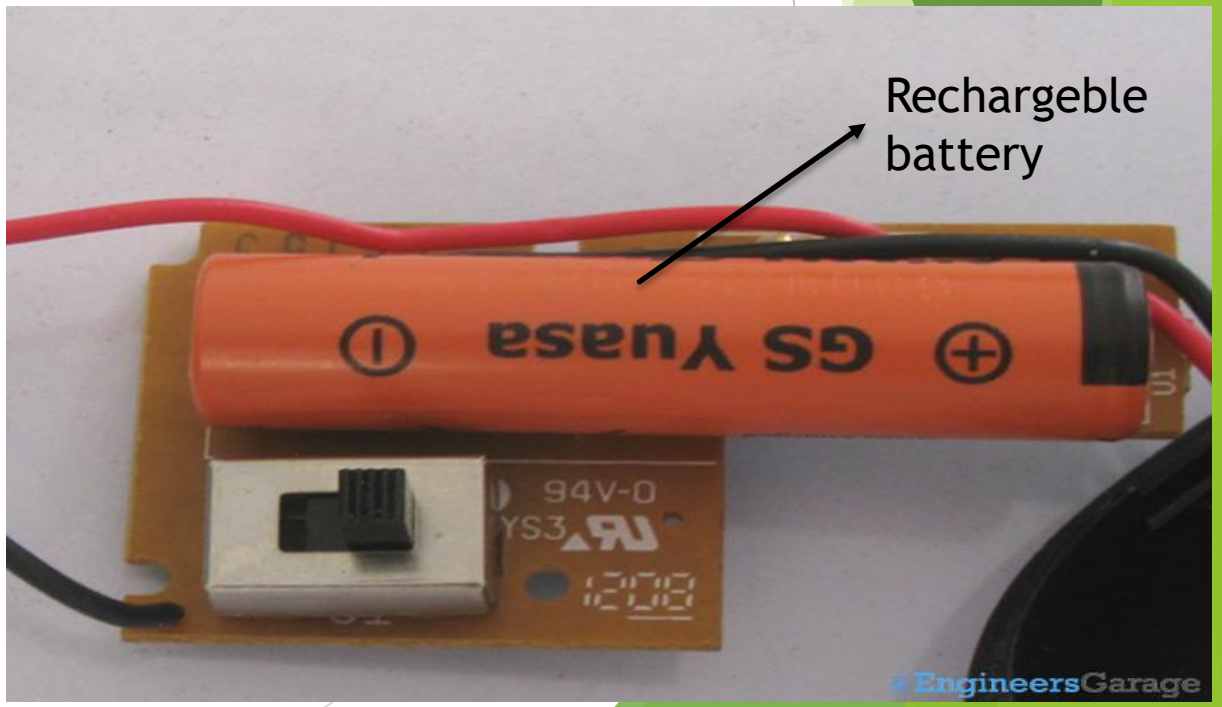
MOVABLE BLADE

FIXED BLADE

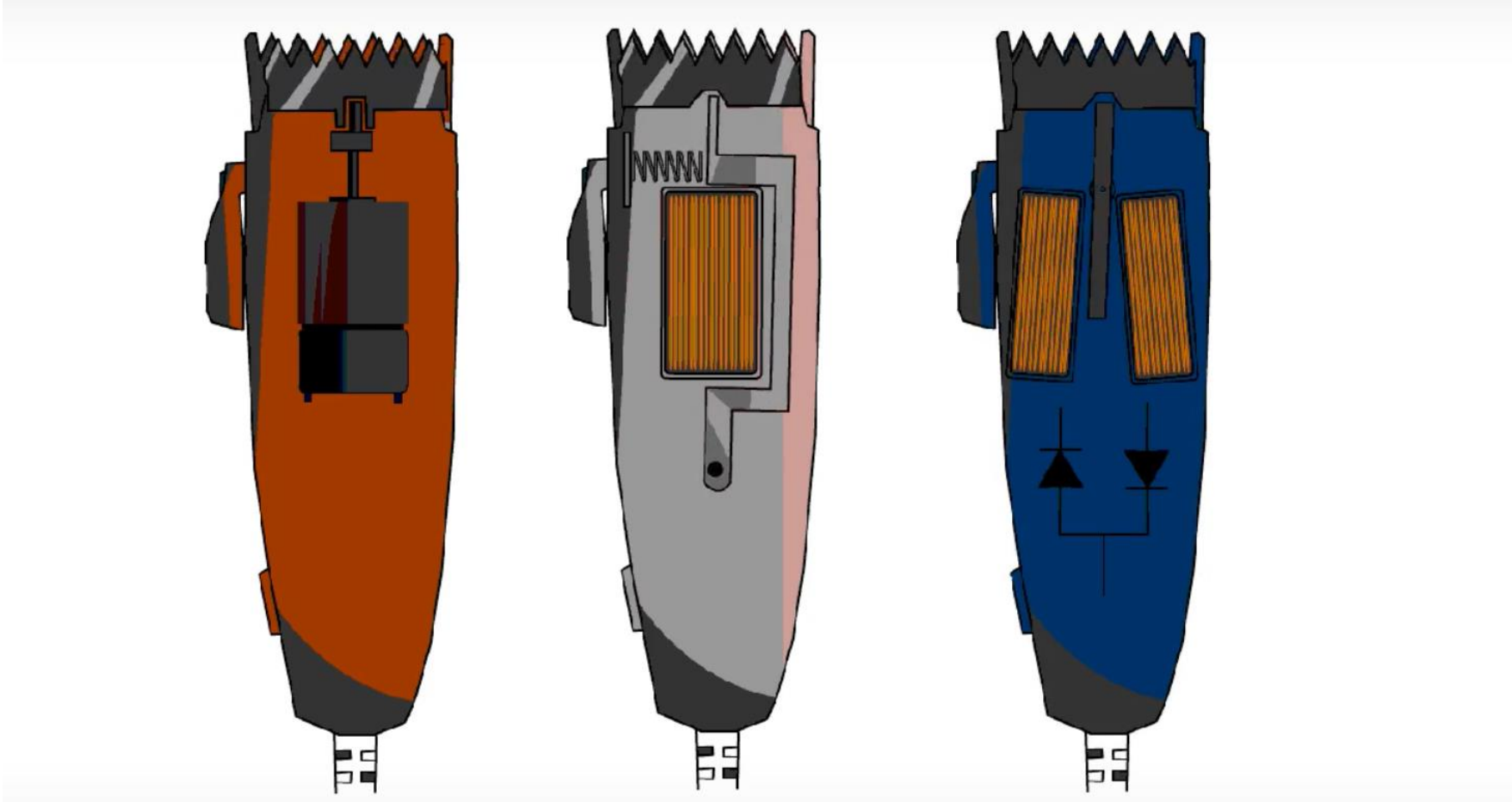


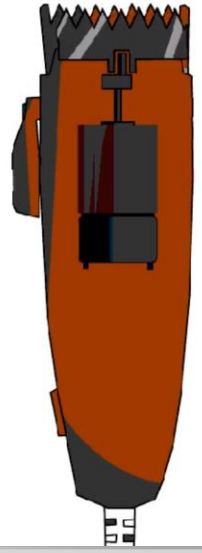


TRIMMER CIRCUITRY



Also there are different types of trimmers depeneding on how the blades in them are given oscialltory cutting motion.





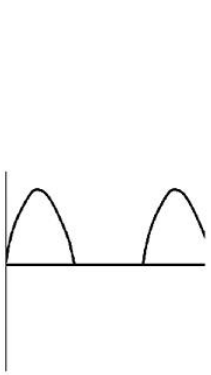
ROTARY MOTOR

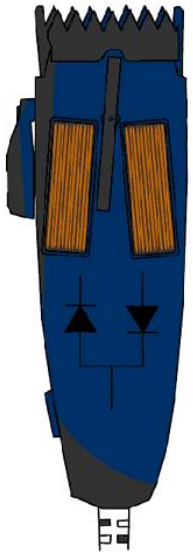
CIRCULAR MOTION TO LINEAR

RECHARGEABLE BATTERY

VERY SIMPLE AND CHEAP

VARIABLE SPEED

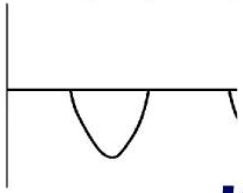




PIVOT MOTOR

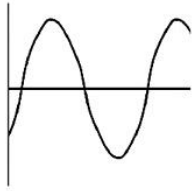
MAGNETIC PULL ACTION

60HZ X 60S = 3600RPM

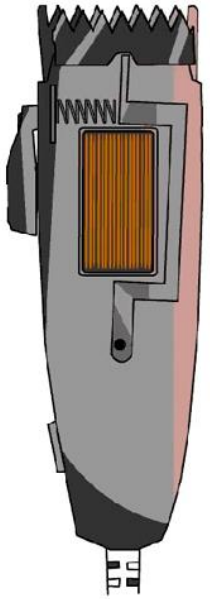


HIGH TORQUE

LOW FRICTION HEAT



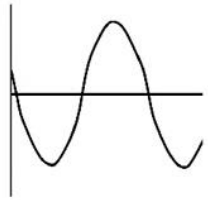
LOW BLADE SPEED



MAGNET MOTOR

FASTEST CLIPPER IN THE MARKET

BARBER WORKHORSE



60HZ AC POWER

SPRING-PUSH ACTION

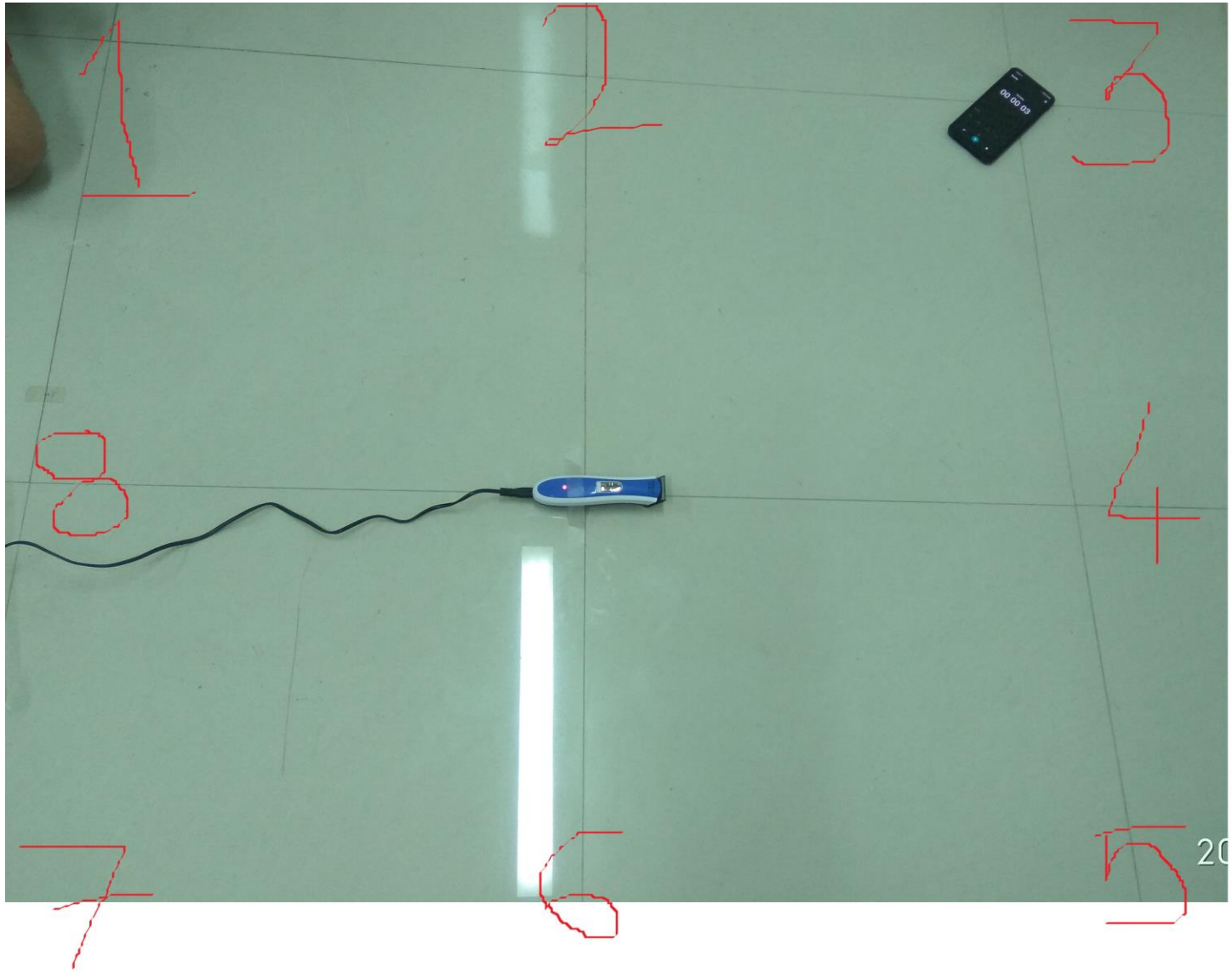
SPRING-PUSH RESULTS IN LOW TORQUE

HIGH SPEED RESULTS IN HIGH HEAT

Possible Noise Sources

1) DC Motor
2) Trimmer Body
3) Friction between fixed and movable blades
4) Joint between Cam Shaft and Blades
5) Connecting link between trimmer body and blades
6) Hair length adjusting attachment

Directivity Measurement



Trimmer with Blade

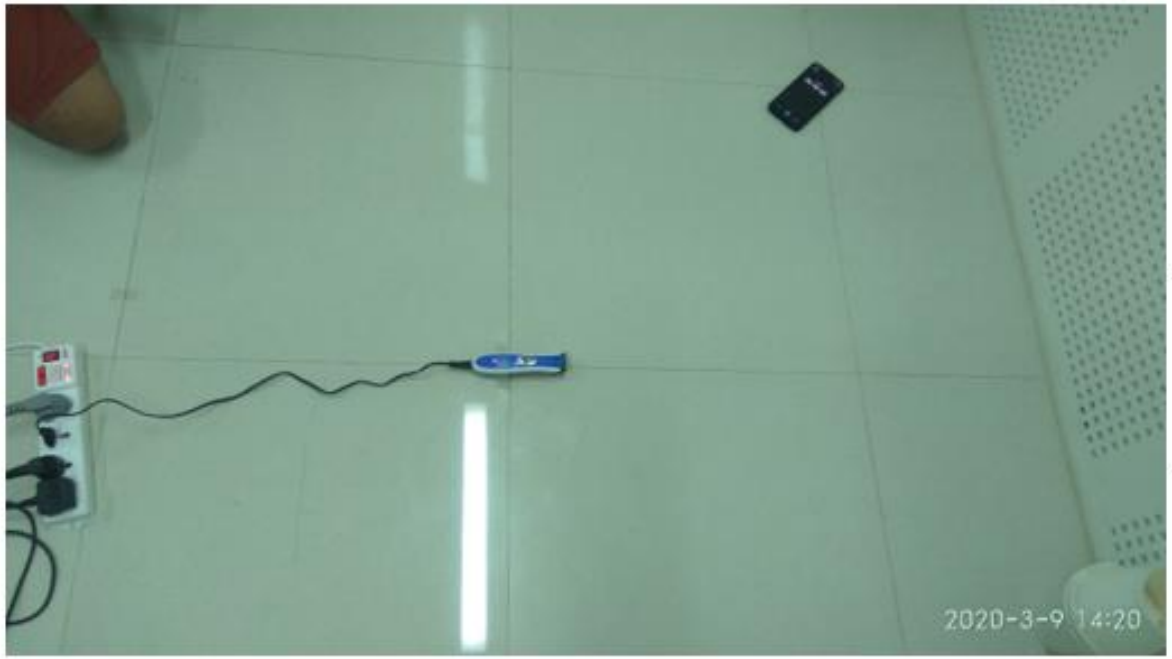
SPL_avg=64.08 dB
DI= SPL_(R)-SPL_avg

SPL: 63.14
DI: -0.94

SPL: 66.40
DI: 2.31

SPL: 63.72
DI: -0.36

SPL: 63.27
DI: -0.80



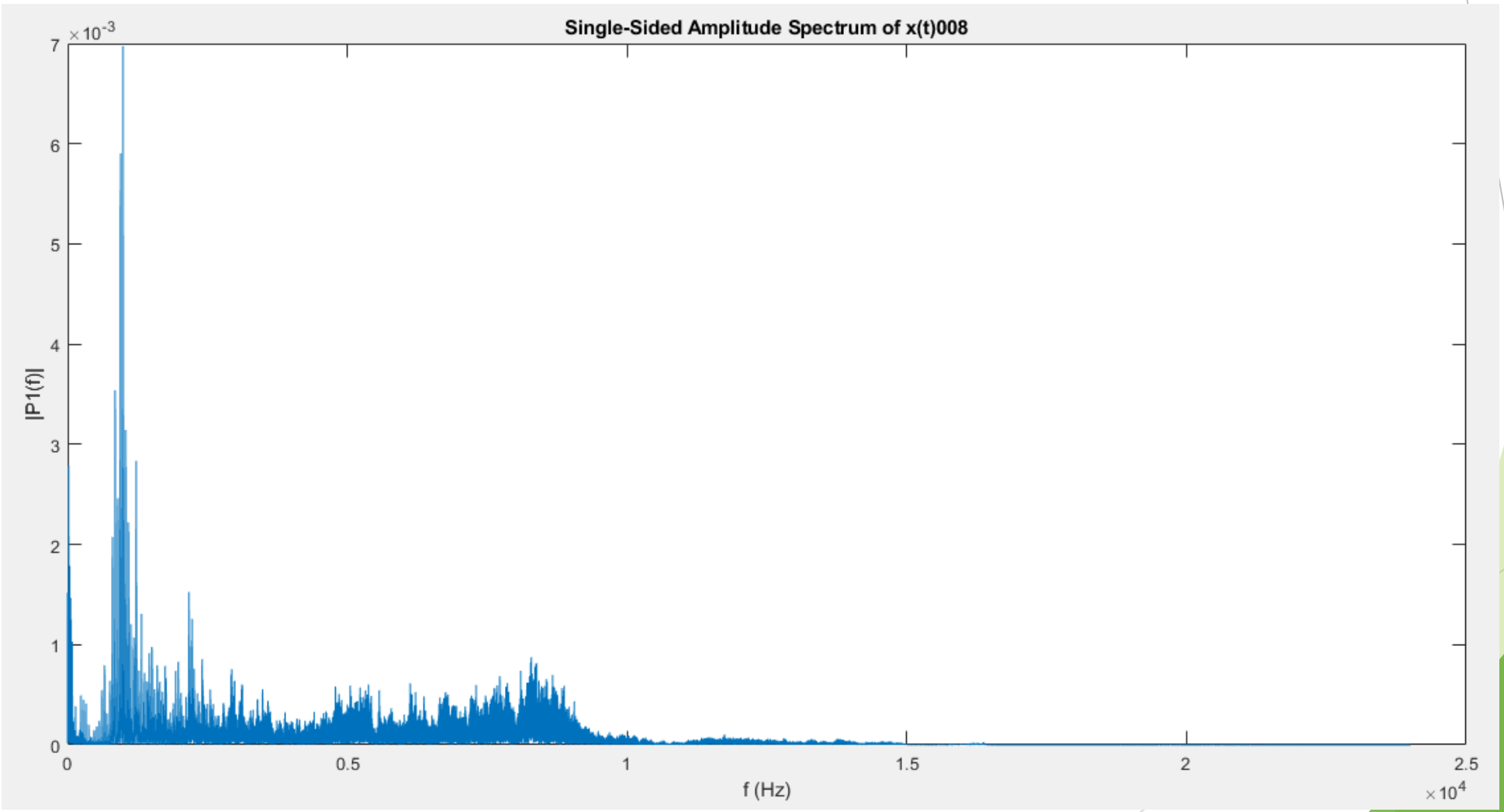
SPL: 65.95
DI: 1.86

SPL: 60.97
DI: -3.11

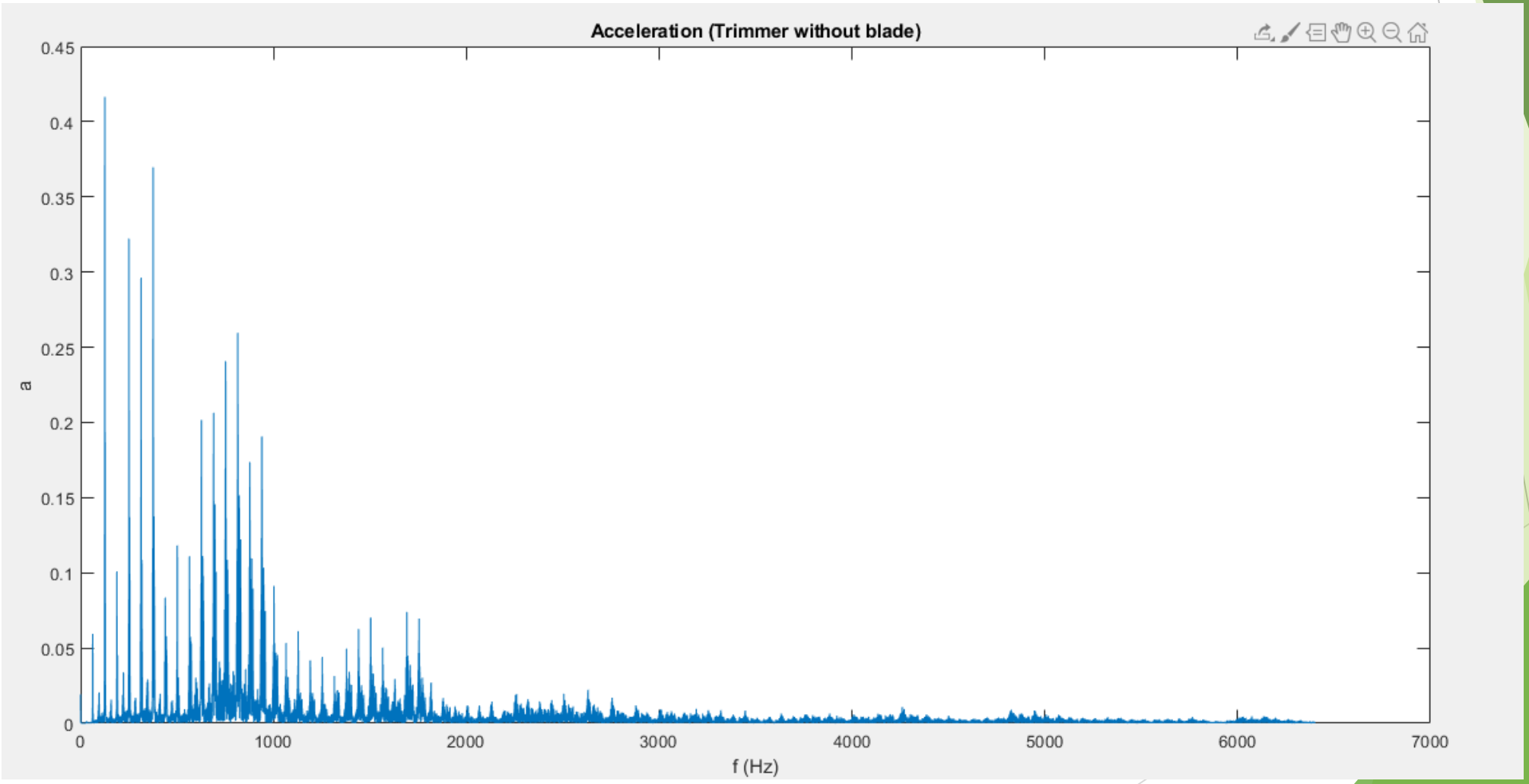
Trimmer without Extension
SPL: 63.77
DI: -0.31

SPL: 63.03
DI: -1.05

Fast Fourier Transform (FFT) of SPL data



Fast Fourier Transform (FFT) of Acceleration data



Measurements

	SPL data		Accelaration data	
Sr no.	Amplitude	Frequency (Hz)	Amplitude	Frequency (Hz)
1	0.0069	989	0.416	125
2	0.005	947	0.369	376
3	0.0035	850	0.322	250
4	0.0031	1038	0.296	313
5	0.0028	1225	0.259	814.5
6	0.0027	17.76	0.241	750
7	0.0024	896.7	0.206	690
8	0.0022	1085	0.202	626.8
9	0.002	802	0.191	940
10	0.0017	37	0.174	877

Interpretation

- The Noise is predominant at Position 2 i.e. $90°$ to the blades of the trimmer followed by position 4 i.e.$0°$ to the trimmer
- The Major Noise levels correspond to frequency of 1000 Hz (standard reference frequency)
- The Major amplitude peaks occur nearby 1000 Hz (trimmer design condition) for easy detection of the trimmer sound
- The Acceleration peaks are the harmonics of 125 Hz frequency

Trimmer without Blade attachment

SPL_avg=53.93 dB

DI= SPL_(R)-SPL_avg

SPL: 52.83

DI: -1.09

SPL: 53.75

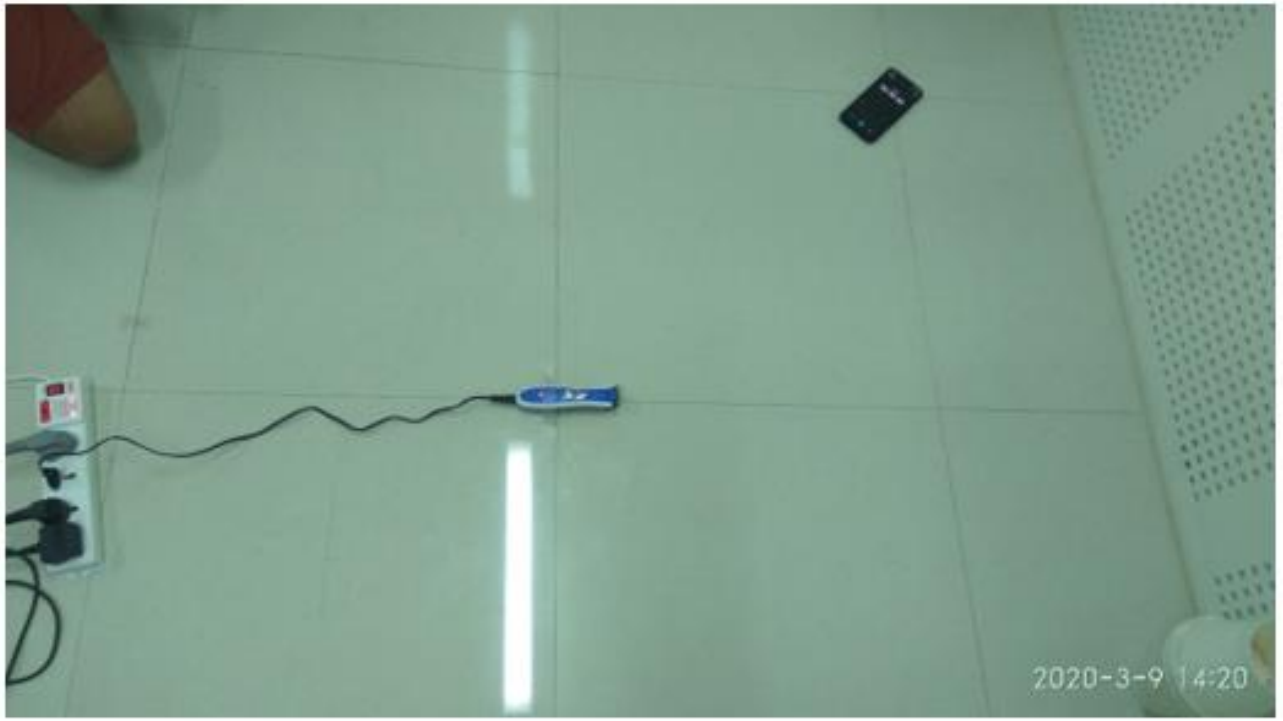
DI: -0.17

SPL: 52.75

DI: -1.17

SPL: 54.64

DI: 0.70



SPL: 56.09

DI: 2.16

Trimmer without Blade

SPL: 52.49

DI: -1.43

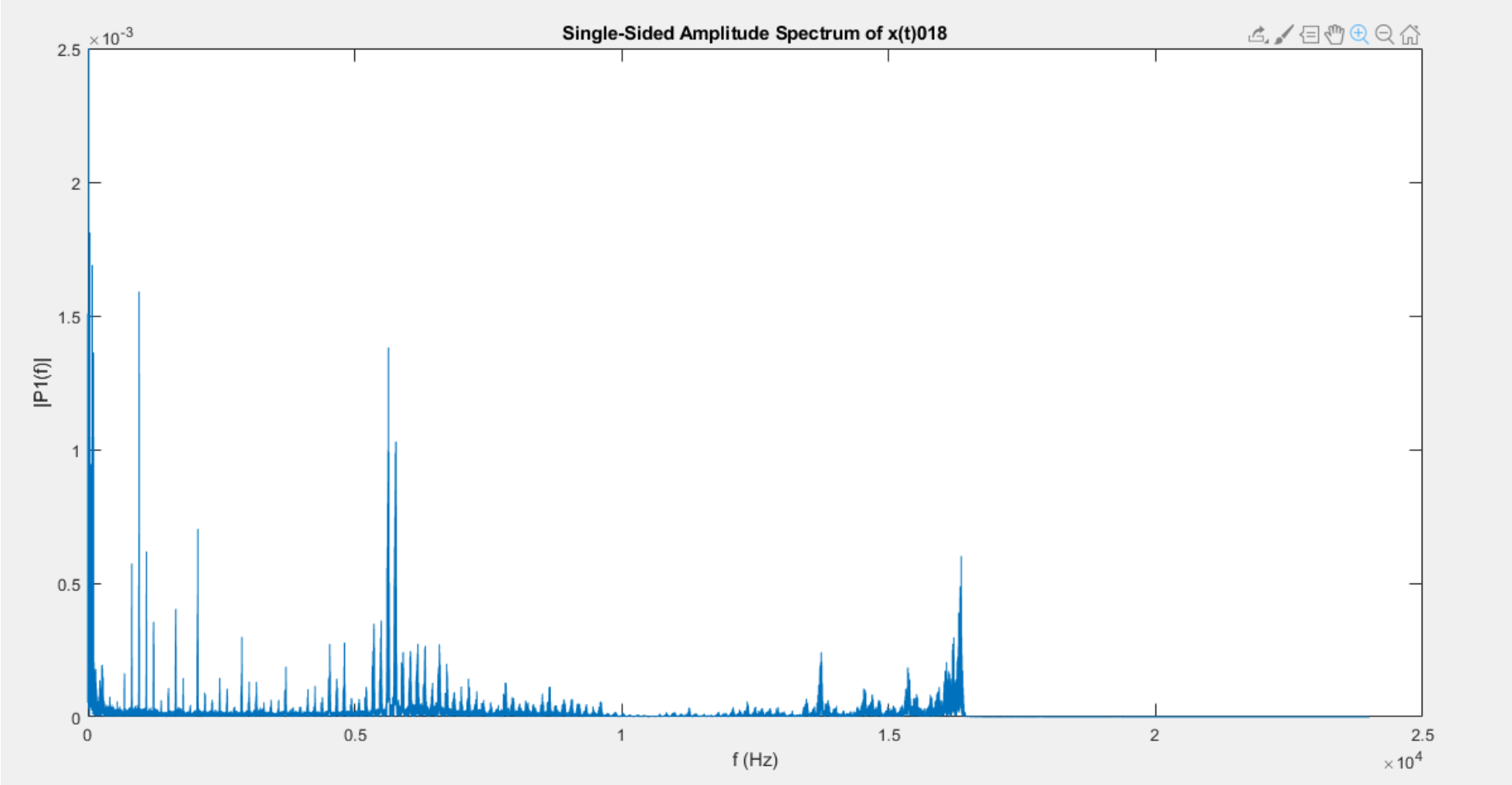
SPL: 53.88

DI: -0.05

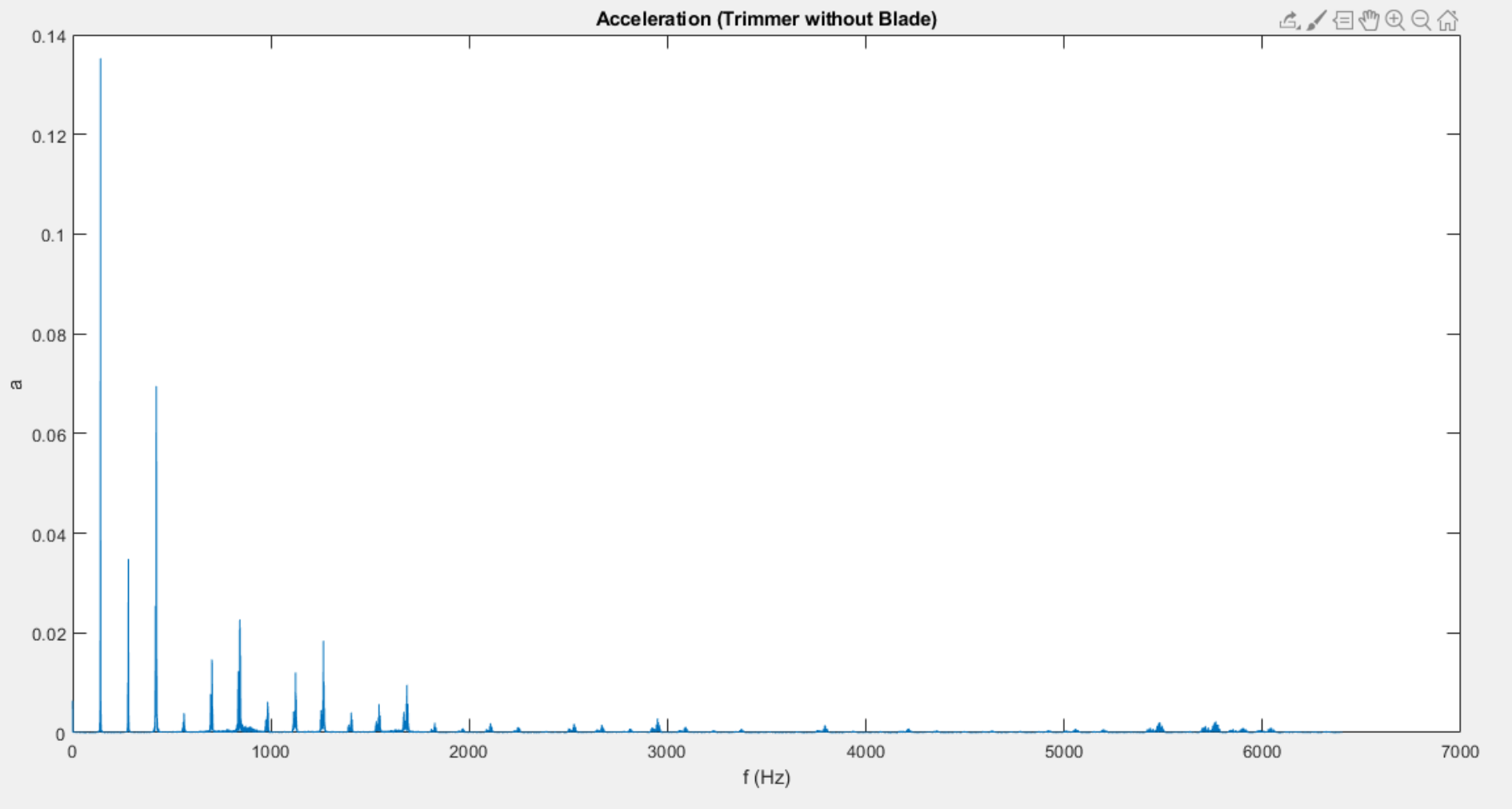
SPL: 53.79

DI: -0.13

Fast Fourier Transform (FFT) of SPL data



Fast Fourier Transform (FFT) of Acceleration data



Measurements

	SPL data		Accelaration data	
Sr no.	**Amplitude**	**Frequency (Hz)**	**Amplitude**	**Frequency (Hz)**
1	0.002	17.7	0.135	140
2	0.0018	37	0.069	420
3	0.0016	83.3	0.034	280
4	0.0015	960.8	0.022	840
5	0.0013	106.8	0.018	1260
6	0.0013	5630	0.014	700
7	0.0007	2061	0.012	1120
8	0.0006	1100	0.009	1680
9	0.0005	823.4	0.006	980
10	0.0004	1650	0.005	1545

Interpretation

- Main Noise Source is the DC motor after removal of the blade attachment
- The Max SPL and Directivity is normal to the Source (Motor)
- Considerable (>10 dB) SPL reduction occurs after removal of the blade attachment
- The frequency 140 Hz corresponds to the RPM of the DC motor 8400 rpm and the other peaks are harmonics of this frequency

Source Ranking

1. Connecting link between trimmer body and blades
2. DC Motor

Inferences

1) The Major Noise source in hair trimmer is the connecting link between the blades and the body of the hair trimmer
2) Noise due to vibrations of the trimmer body is the dominant noise source (Structure based Noise)
3) Low frequency Noise is generated by the DC Motor whereas trimmer with blade attachment generates High frequency noise
4) The acceleration-based noise shifts to higher frequencies on adding the blade attachment

Noise Control Strategy

Source Solution

- Modify the connecting link between the blades and the body of the trimmer

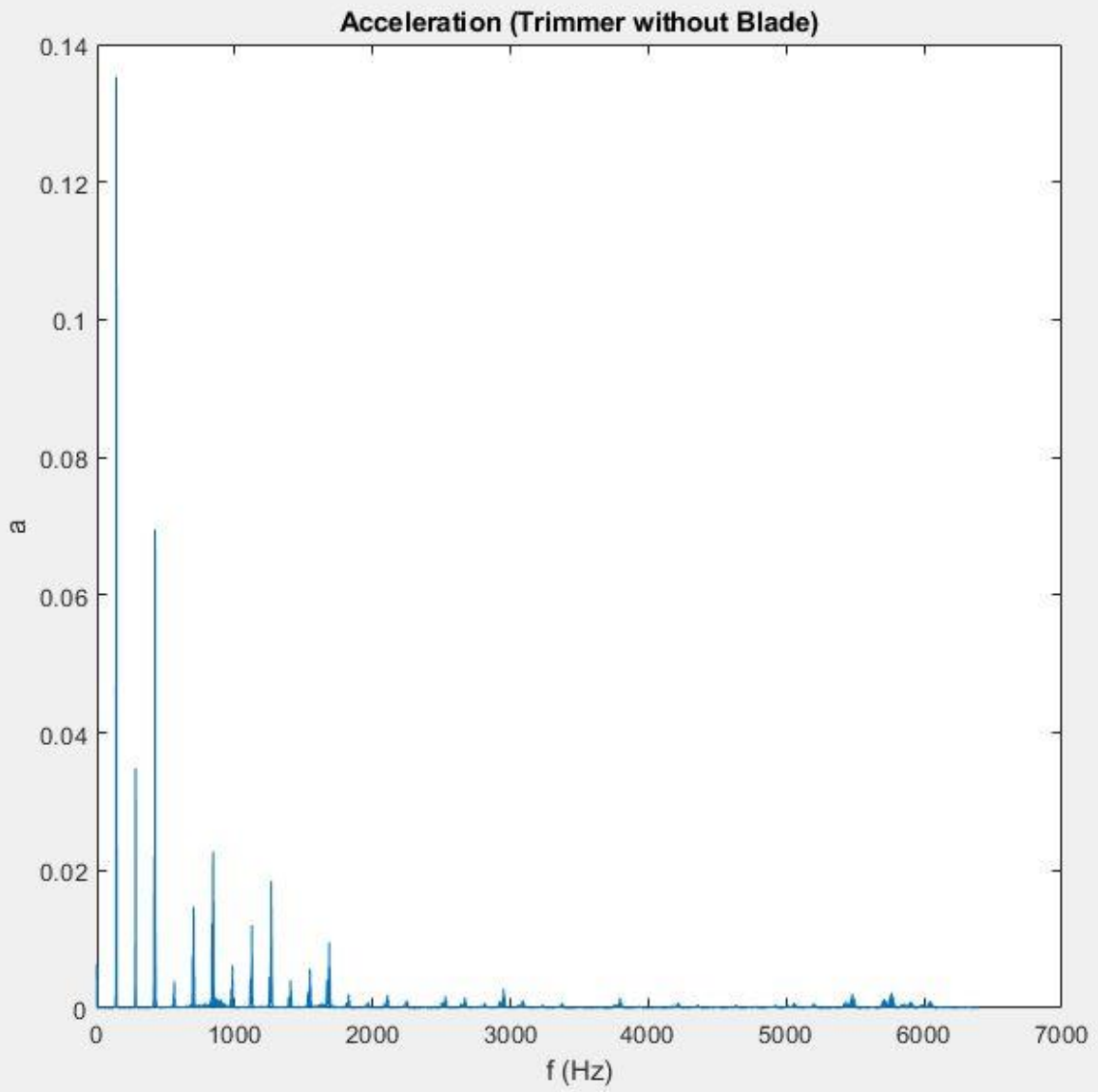
Path Solution

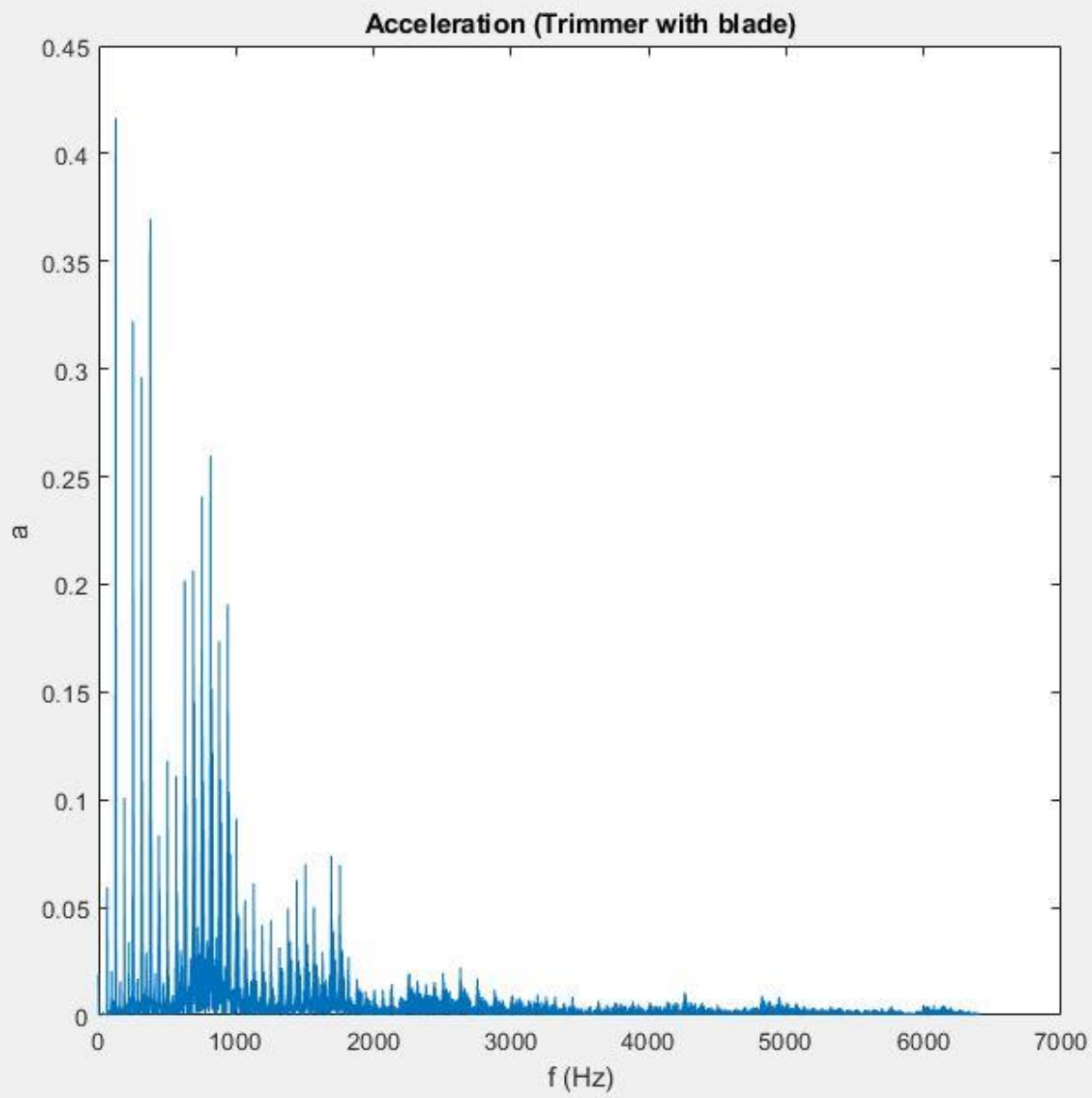
- Damp the Vibrations generated at the body of the trimmer

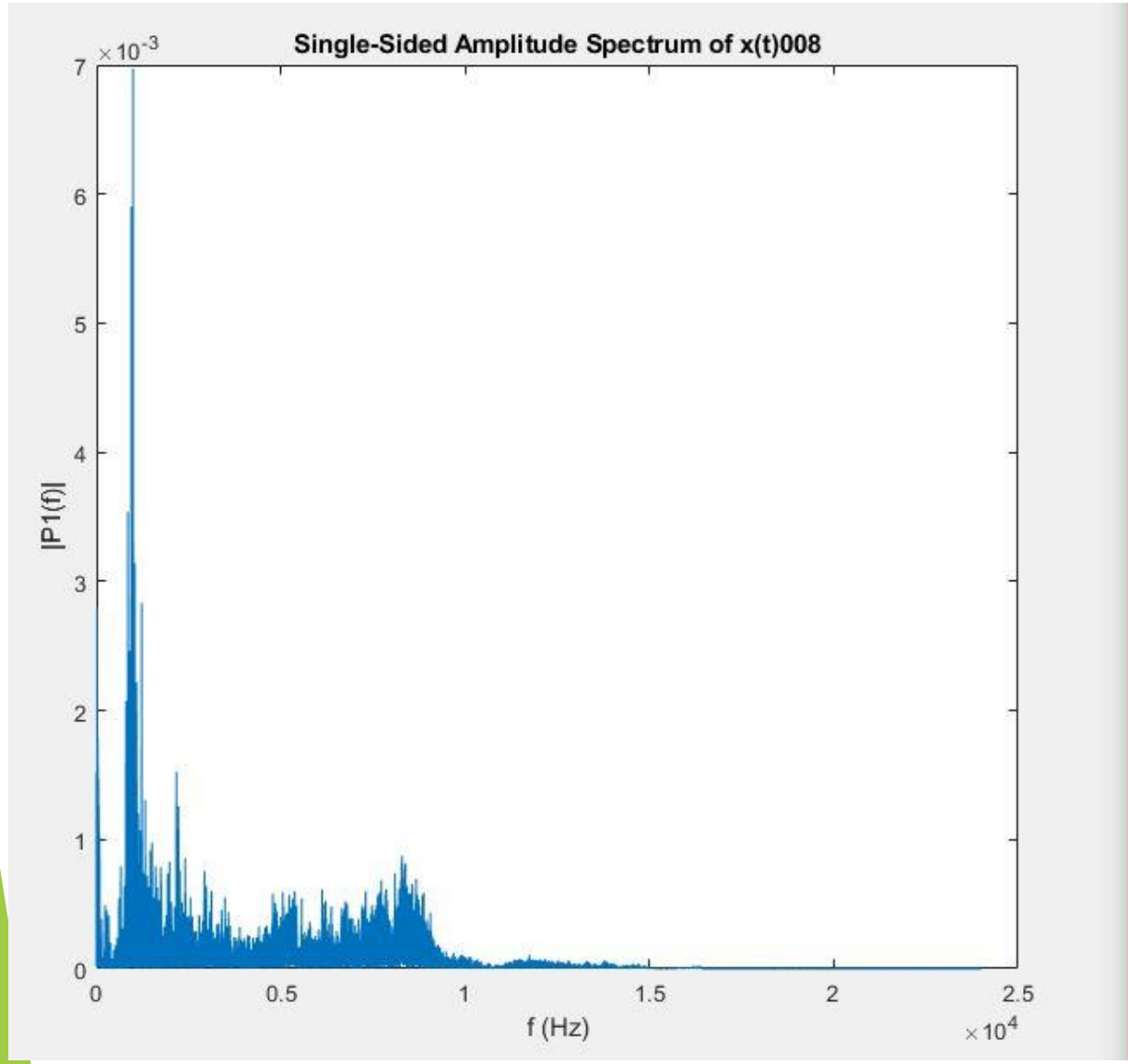
Future Work

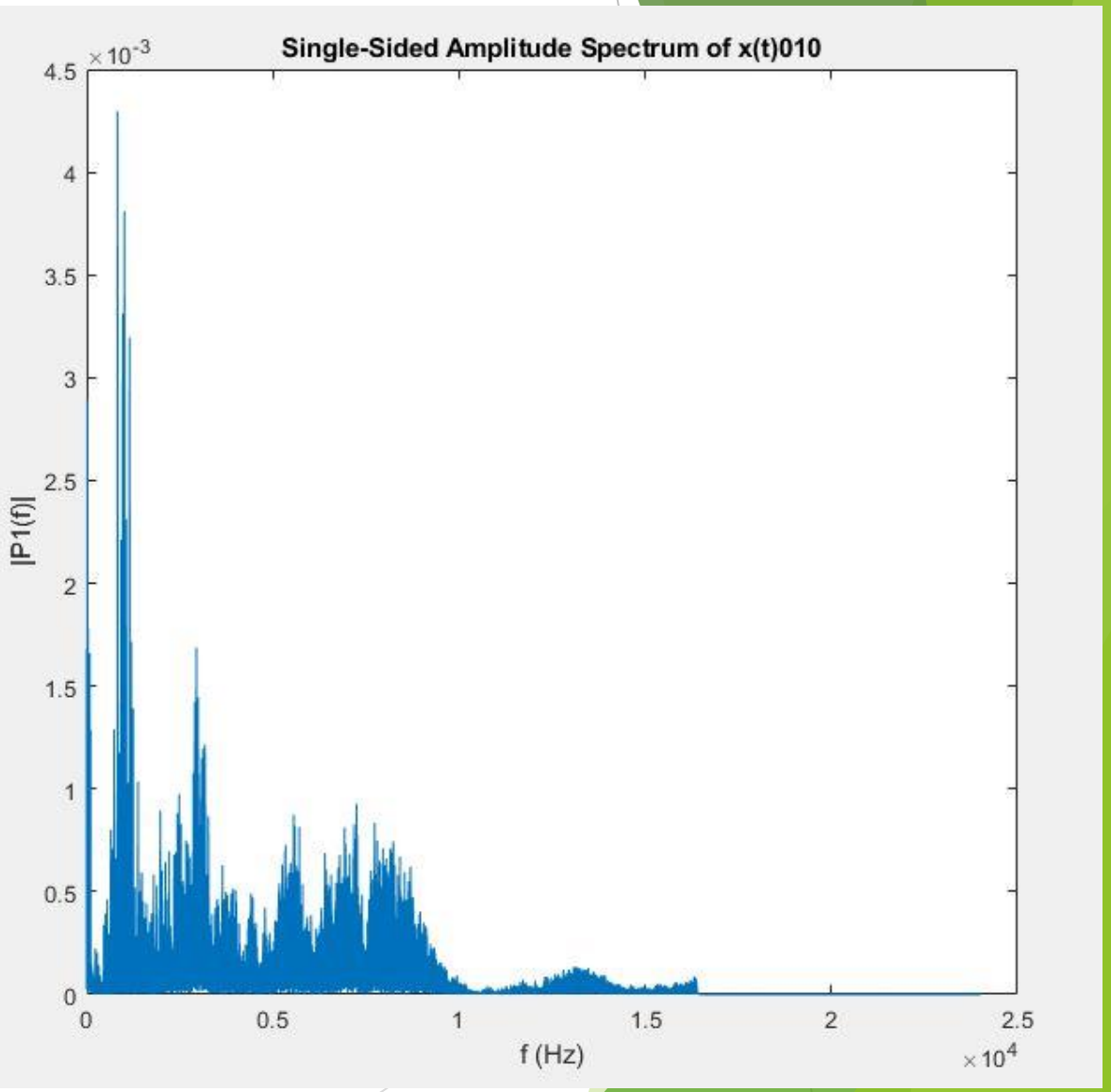
- Understand the Possibility of the DC motor as a Noise control option
- Understand the effect of Hair length adjustment on Noise level

THANK YOU !


Acceleration (Trimmer without Blade)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
a
0
1000
2000
3000
4000
5000
6000
7000
f (Hz)


Acceleration (Trimmer with blade)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
a
0
1000
2000
3000
4000
5000
6000
7000
f (Hz)


Single-Sided Amplitude Spectrum of x(t)008
×10^-3
7
6
5
4
3
2
1
0
|P1(f)|
0
0.5
1
1.5
2
2.5
f (Hz)
×10^4


Single-Sided Amplitude Spectrum of x(t)010
×10^-3
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
|P1(f)|
0
0.5
1
1.5
2
2.5
f (Hz)
×10^4