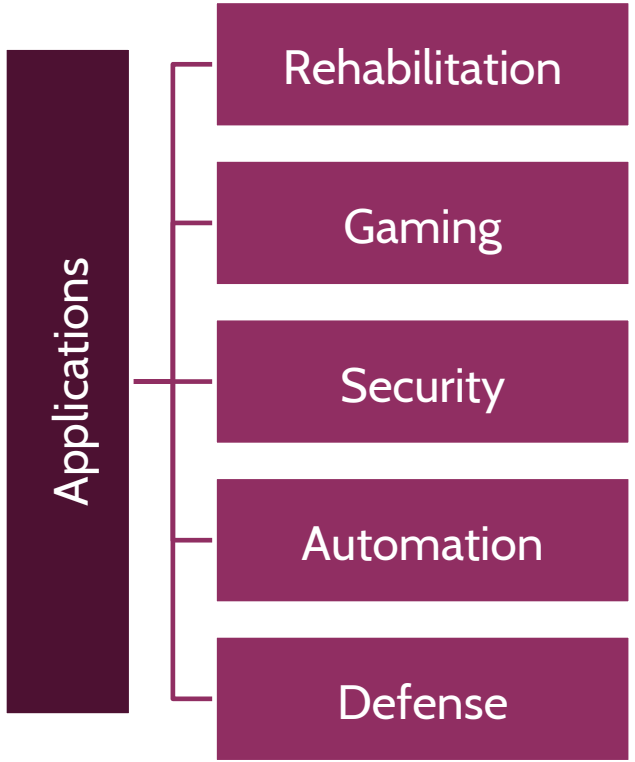
# SSVEP BASED BRAIN COMPUTER INTERFACE

NEUROCOM 2018 WORKSHOP, IISc
ANSHUL, MARI, SAURABH, SOUMYAJIT, VARSHA

# BRAIN COMPUTER INTERFACE

- Communication from brain to external devices.
- Challenges:
  - Robust brain signals
  - Communication
  - Control



# MAIN COMPONENTS

| Brain Signals | Computer/ Mobile | External Device |
| --- | --- | --- |
| • Stimulus<br>• Acquisition Device | • Processing of input<br>• Command generation | • Medical<br>• Appliances<br>• Human |

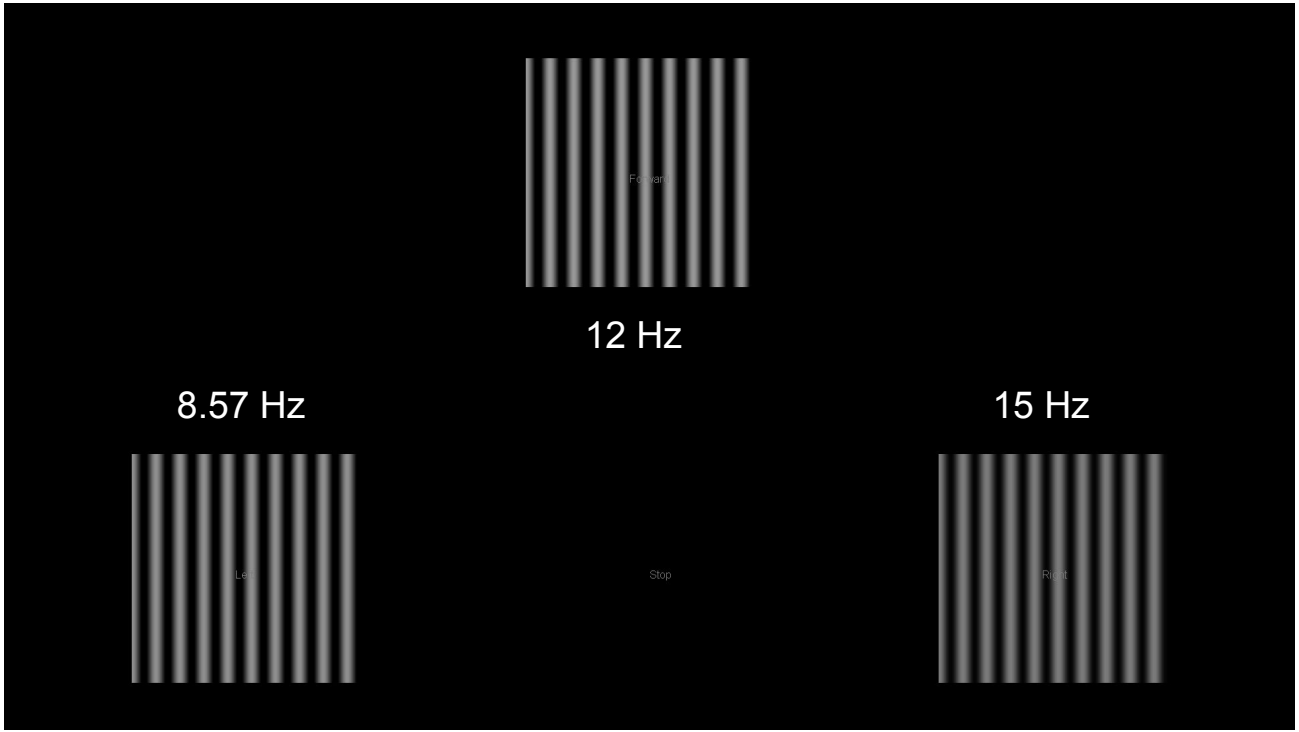
# SSVEP BASED BCI

**SSVEP (Steady State Visually Evoked Potential)** - Electrical response of brain to flickering visual stimulus.

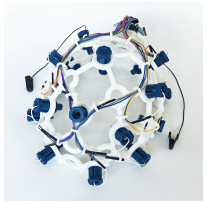
**Principle** -

- SSVEP signal has high powers at stimulation frequency.
- SSVEP based BCI detect the frequency of the signal and generate command signal assigned to that frequency.

# STIMULUS DESIGN



# WIRELESS EEG ACQUISITION AND DATA STREAMING



OpenBCI headset

Bluetooth

COM port over USB

Acquisition Server

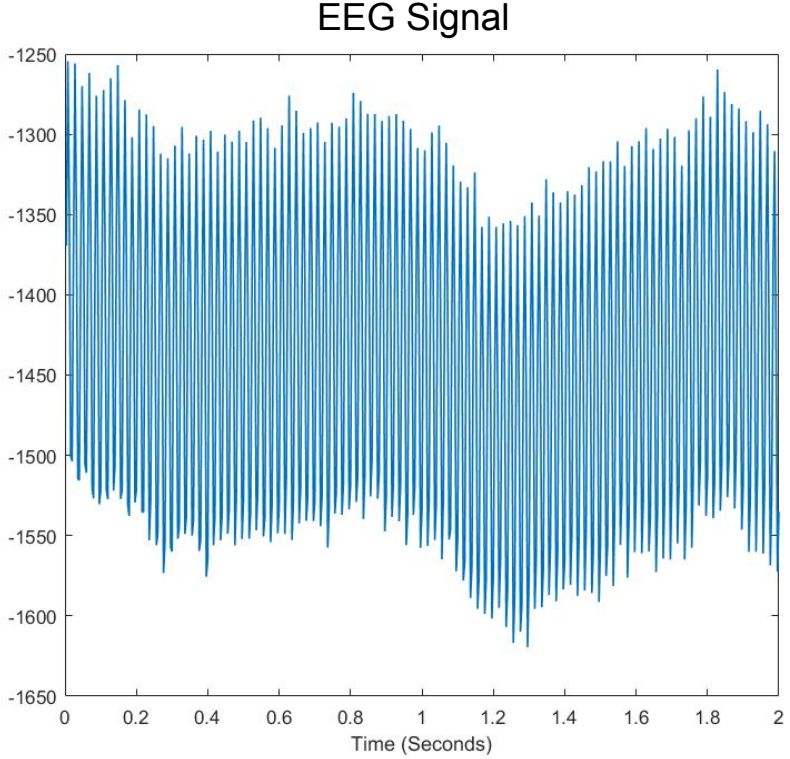
Psych ToolBox on Matlab

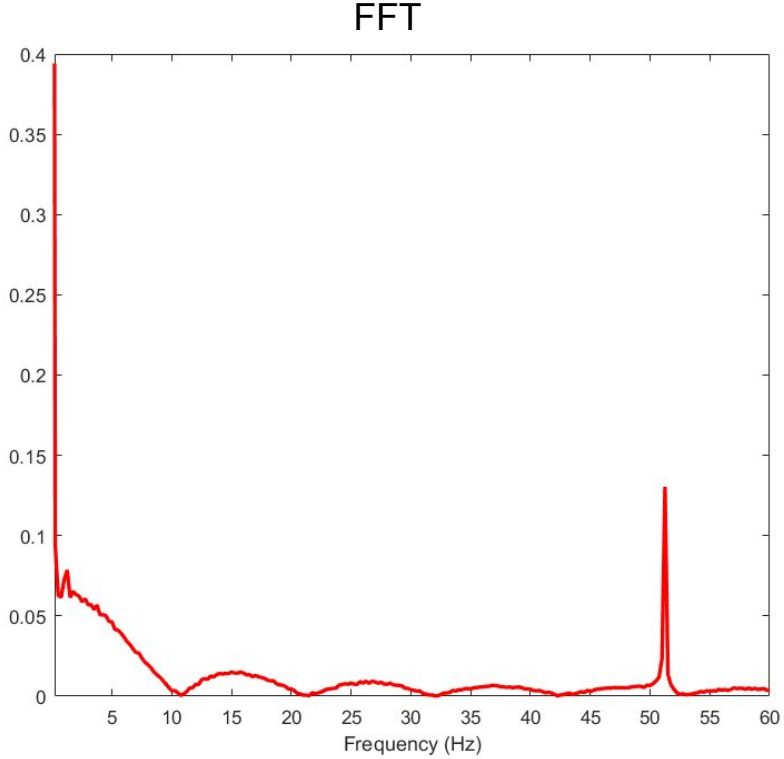
Lab Streaming Layer

Control signals

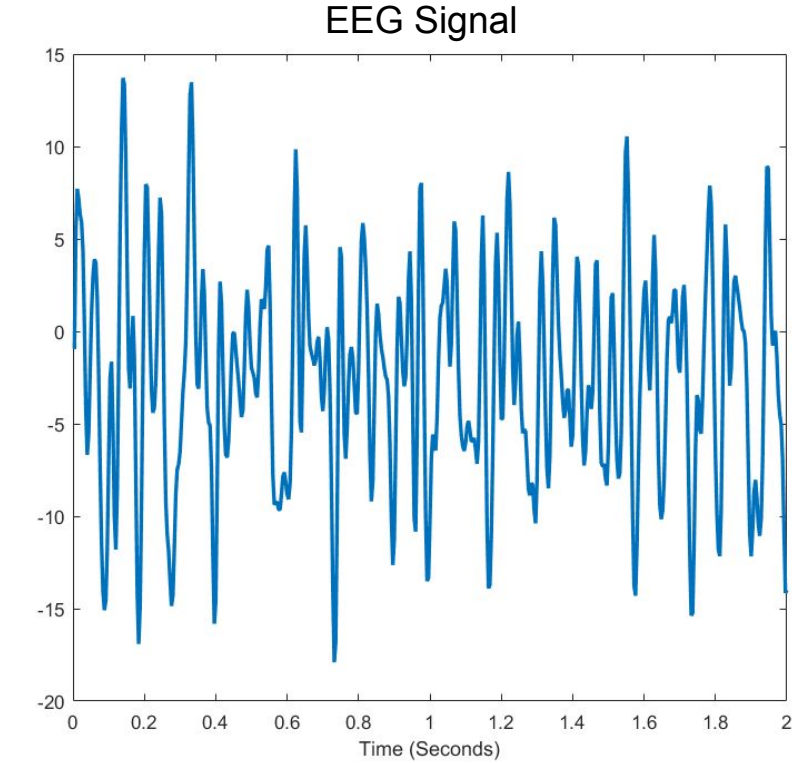
Computer

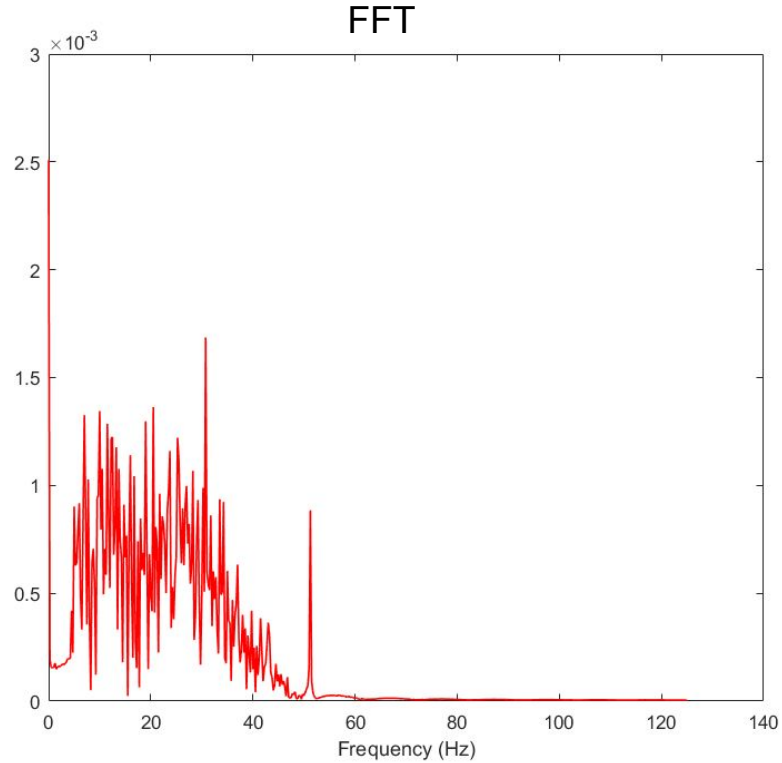
# Raw EEG Signal - example



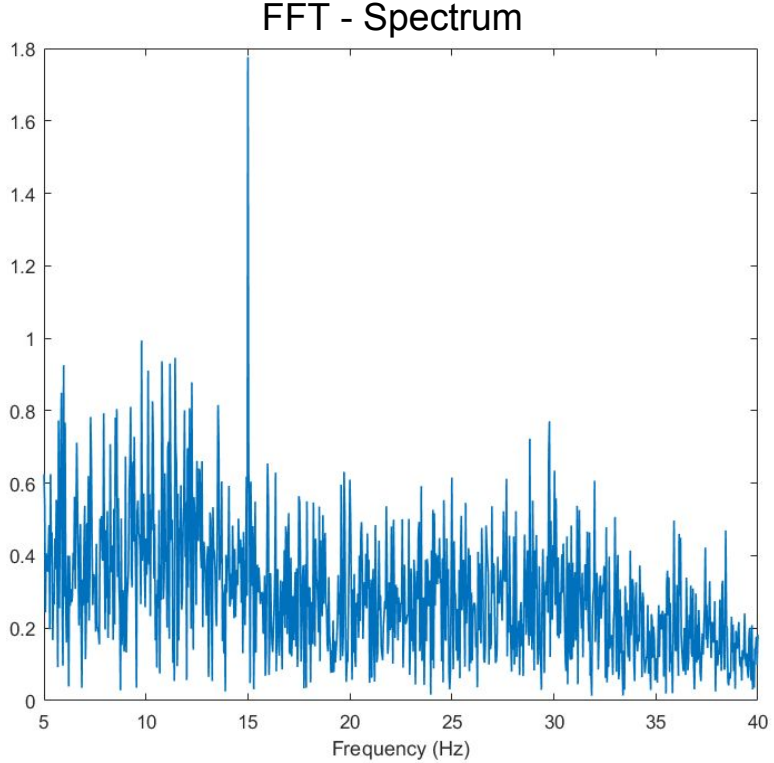



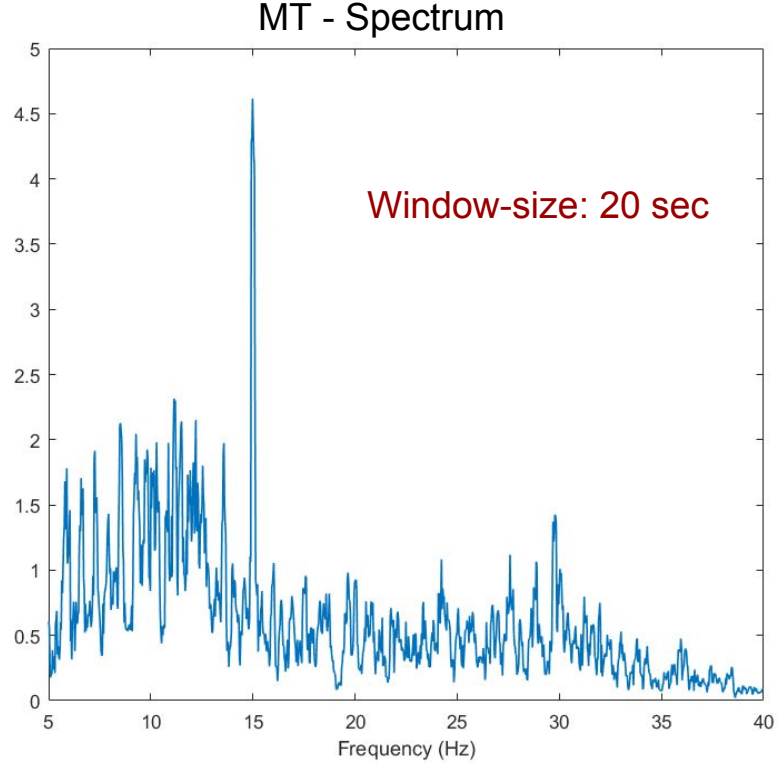
# Filtered EEG Signal - example



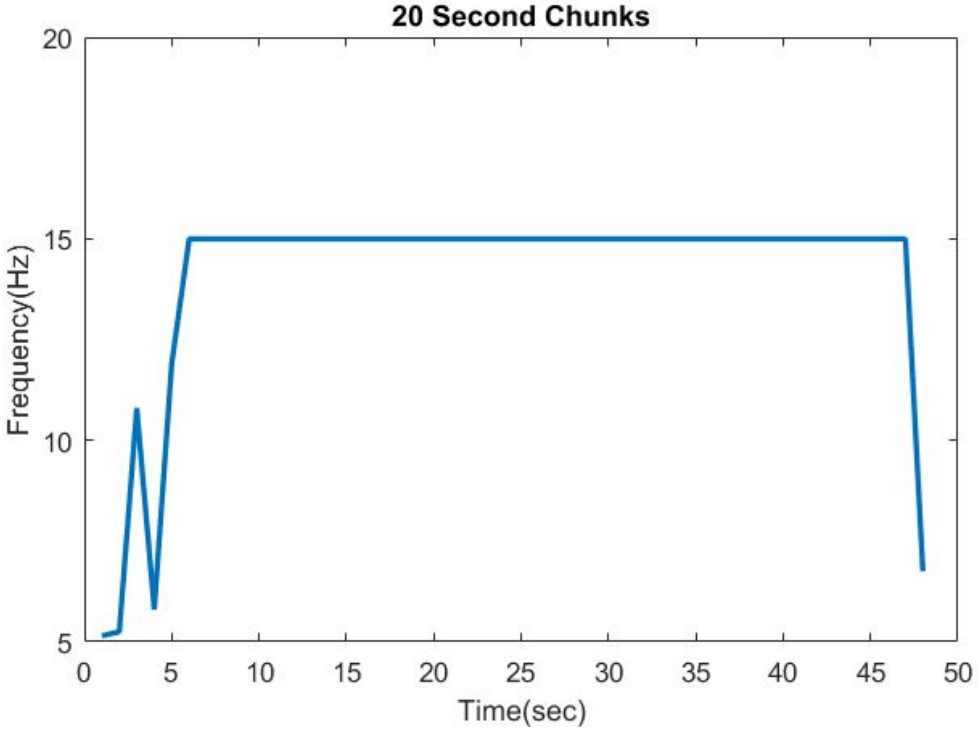



# SSVEP seen in FFT

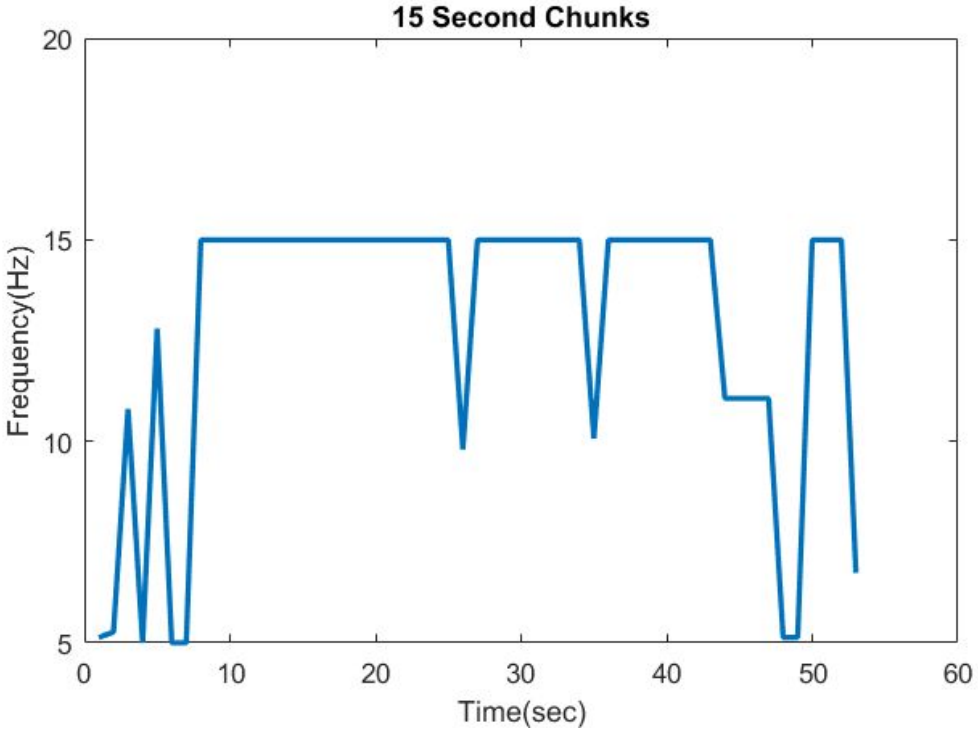


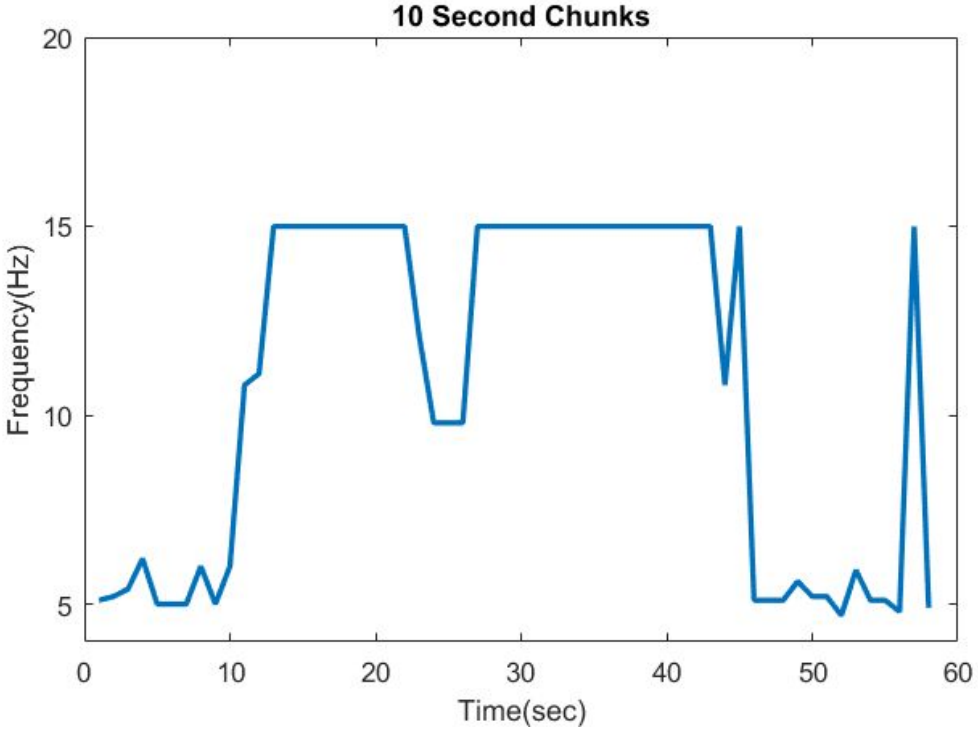
# SSVEP seen in FFT (Why it is difficult)



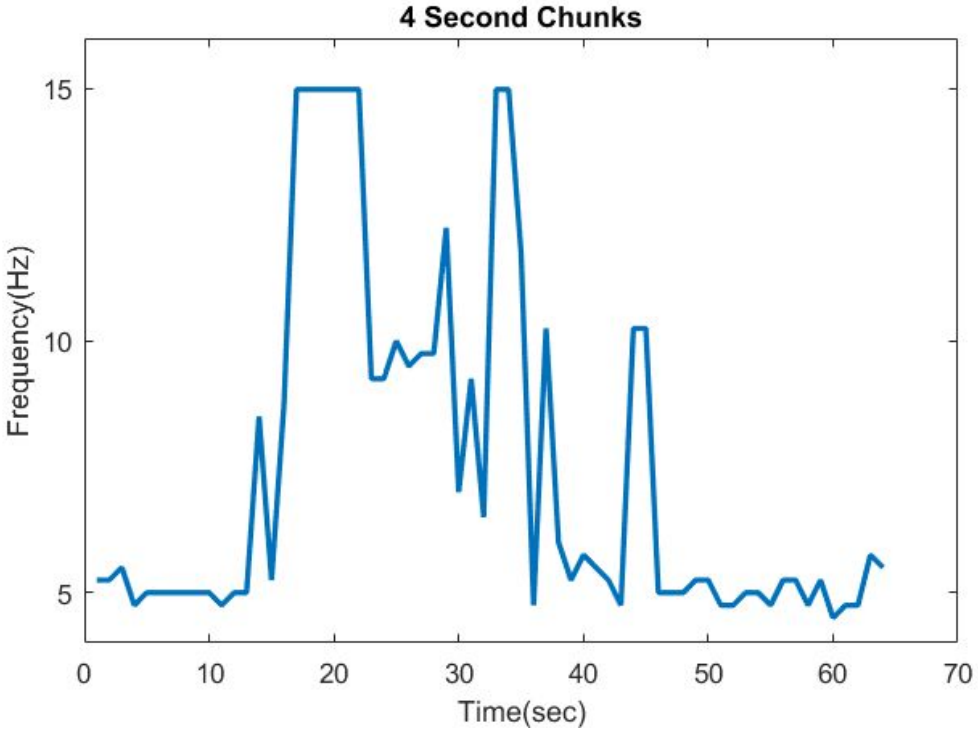
# SSVEP seen in FFT (Why it is difficult)



# SSVEP seen in FFT (Why it is difficult)



# SSVEP seen in FFT (Why it is difficult)



# Canonical Correlation Analysis

- A way of inferring information from cross-covariance matrices
- X: Time Domain signal
- Y: Flicker Sinusoid and its harmonics

# Setup

- Three frequencies displayed on monitor: 8.57Hz, 12 Hz and 15 Hz sampled at 250 Hz
- 30s Data filtered between 8Hz and 30Hz
- Sliding window of 4s and a shift of 0.5s for calculation

# Offline, Single Target Multiple Flickers - FFT vs CCA

| Target Frequency | FFT | CCA |
|---|---|---|
| 15 Hz | 0.434 | 0.434 |
| 8.57 Hz | 0.037 | 0.679 |
| 12 Hz | 0.773 | 0.81 |

# Future Work

- New accuracy measure during period of overlap between two target signals
- Improve the reliability of classical techniques (CCA, FFT threshold based classification)
- Machine learning (SVM,  MLP, CNN etc.) with larger dataset
- Augment control commands from EEG with environmental cues obtained using a camera + ML algorithms

# THANK YOU