Project 77: mmWave HAR

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Human Activity Recognition

- Identification of human actions and behaviour
  - Camera Tracking
  - Motion Sensors
  - Fitbit / Fitness Watches
- Many Important Uses
  - High Risk Work Environments
  - Smart Home Control
  - Surveillance Systems
  - Medical & Lifestyle Care

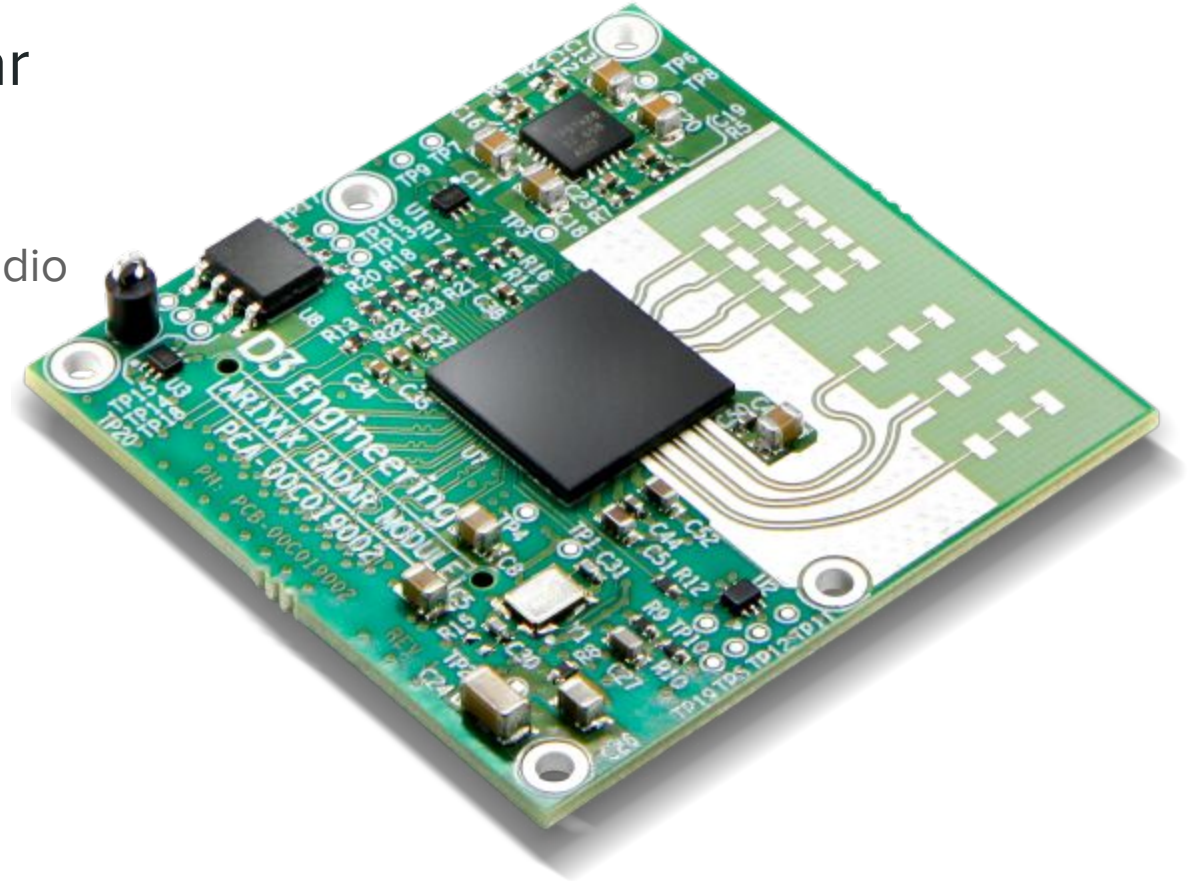
Current Approaches

- Optical Sensors
  - **Easy to process information**
  - **Cheap and versatile tech**
  - **Lighting Conditions**
  - **Environmental Interference**
  - **Privacy Concerns**

- CSI
  - **Readily Available Signal Technology**
  - **Can Utilize Existing Signals**
  - **Low Resolution Data**
  - **Signals Easily Disrupted**

Millimeter Wave Radar

- Non Optical Sensor
- Millimeter Wavelength Radio
- Utilizes Doppler Effect



Our Research

- benefits of Human Activity Recognition
- without the downsides of Optical Sensors

- Real-World Context
- Complex Activity Sequences

- Privacy concerns addressed
- Robust in varying conditions

Experimental Survey

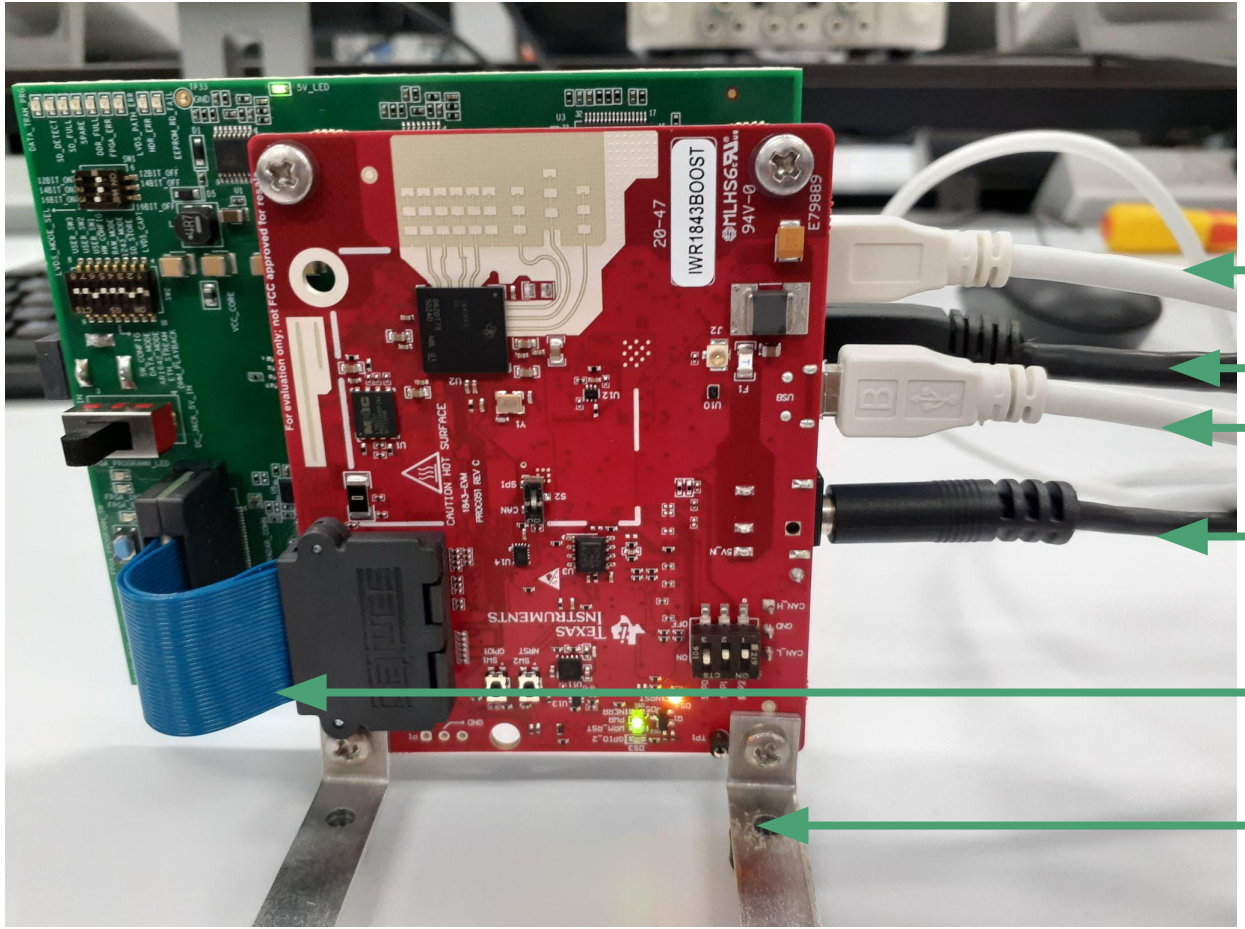
- Ethics Review

- Privacy Concerns
- Data Storage
- Participant Comfort

Radar Data Formats

- Point Cloud
- RDI
- RAI
- RDAT
- Combination

Radar Setup



DCA1000EVM USB

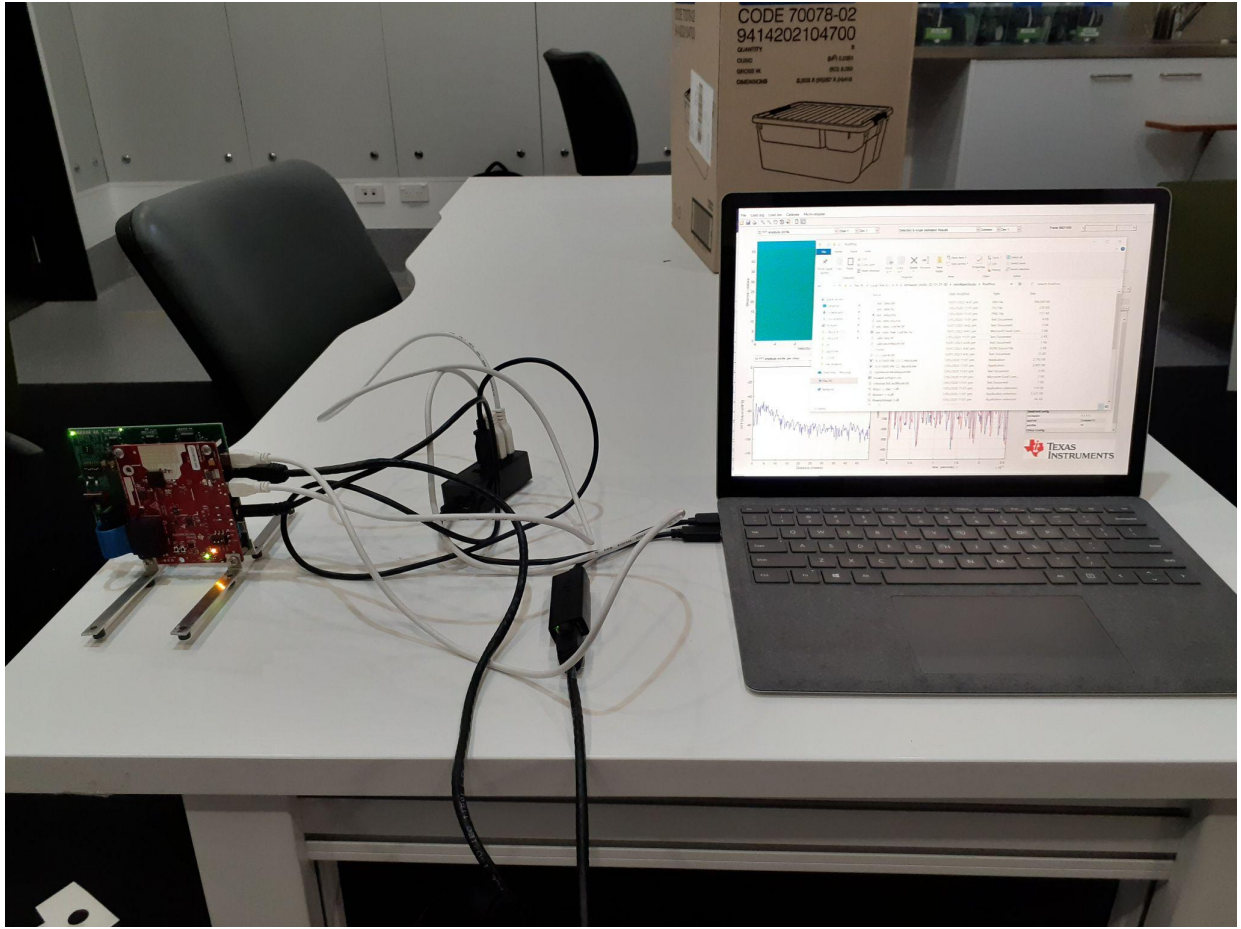
Ethernet Cable

BOOST USB

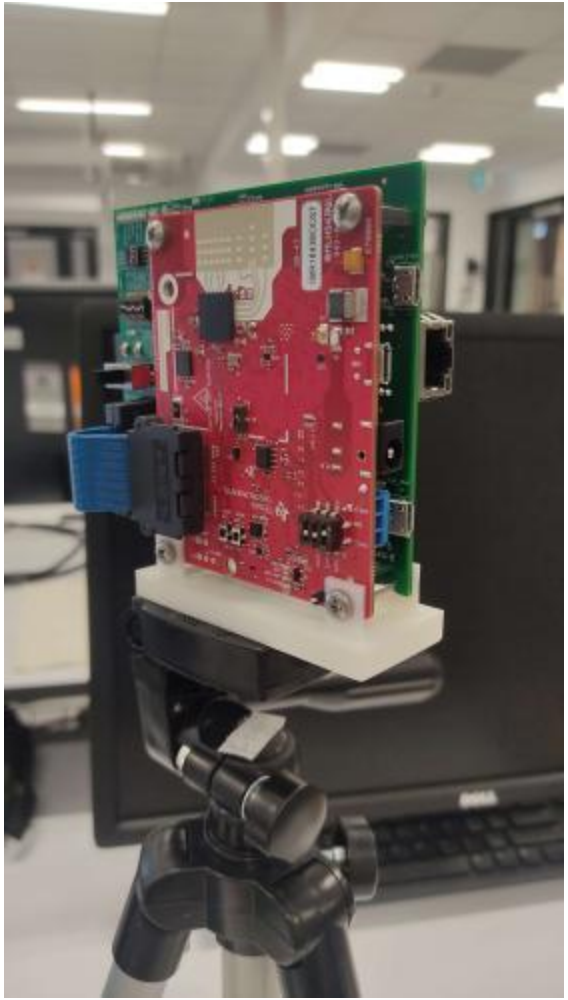
Power

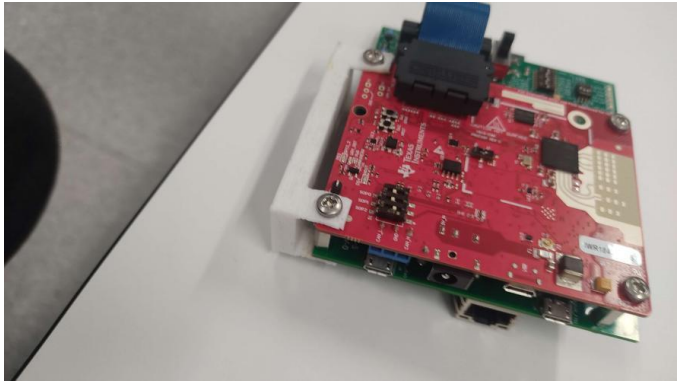
Samtec Ribbon Cable

Mounting Brackets

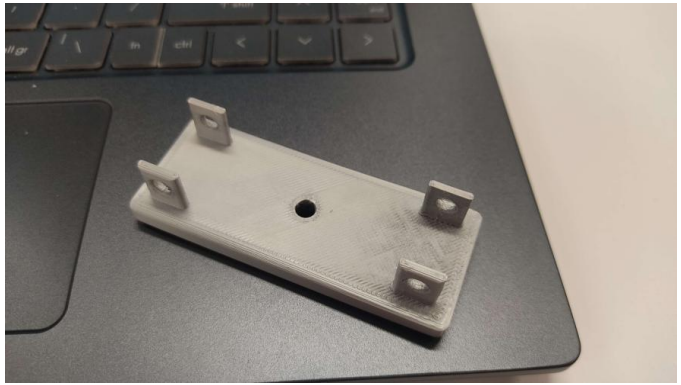


Radar
Setup Cont.

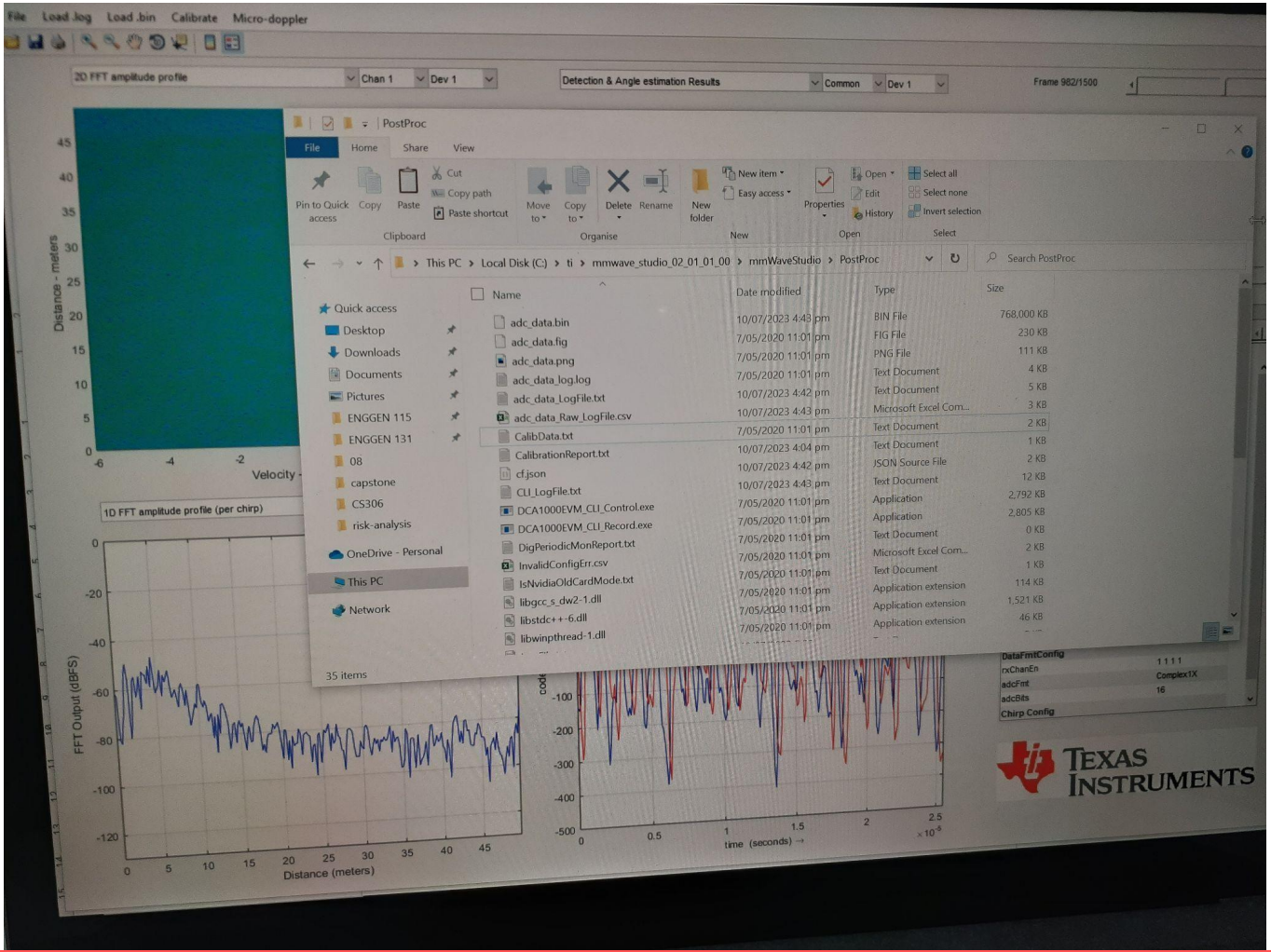




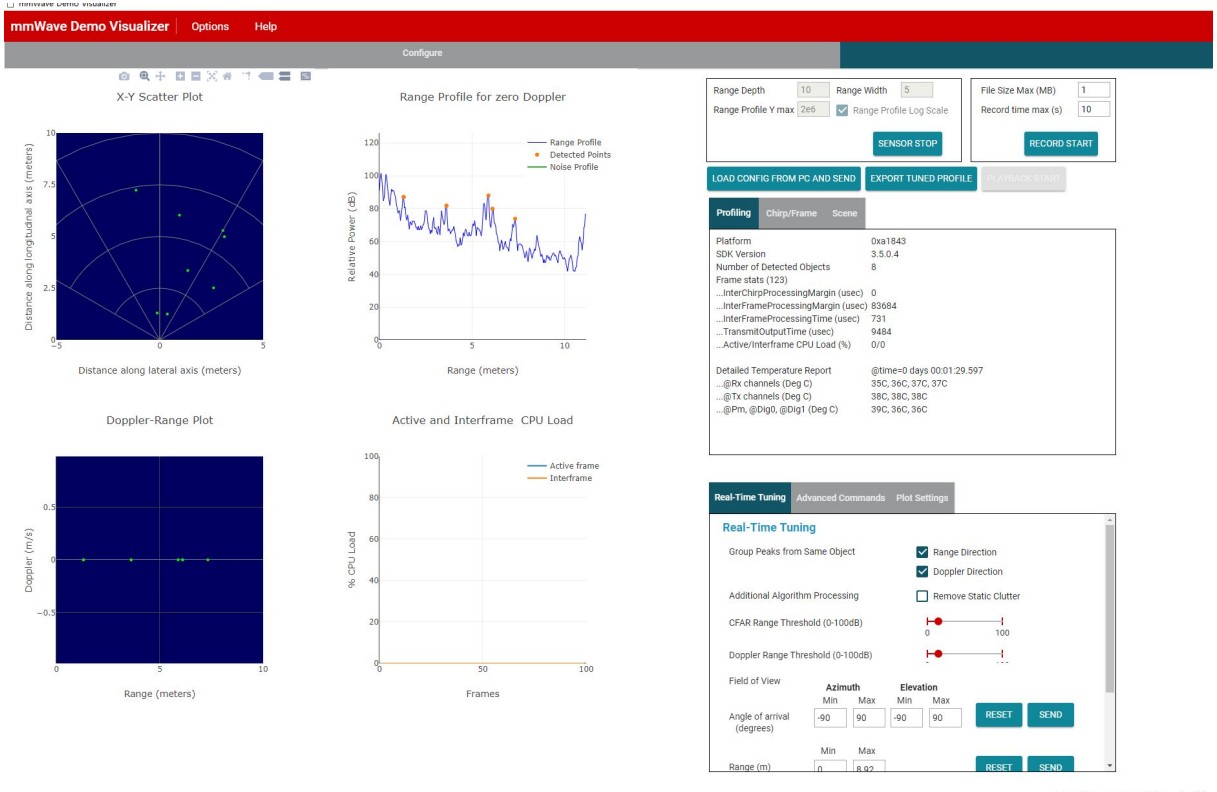
Radar
Setup Cont.



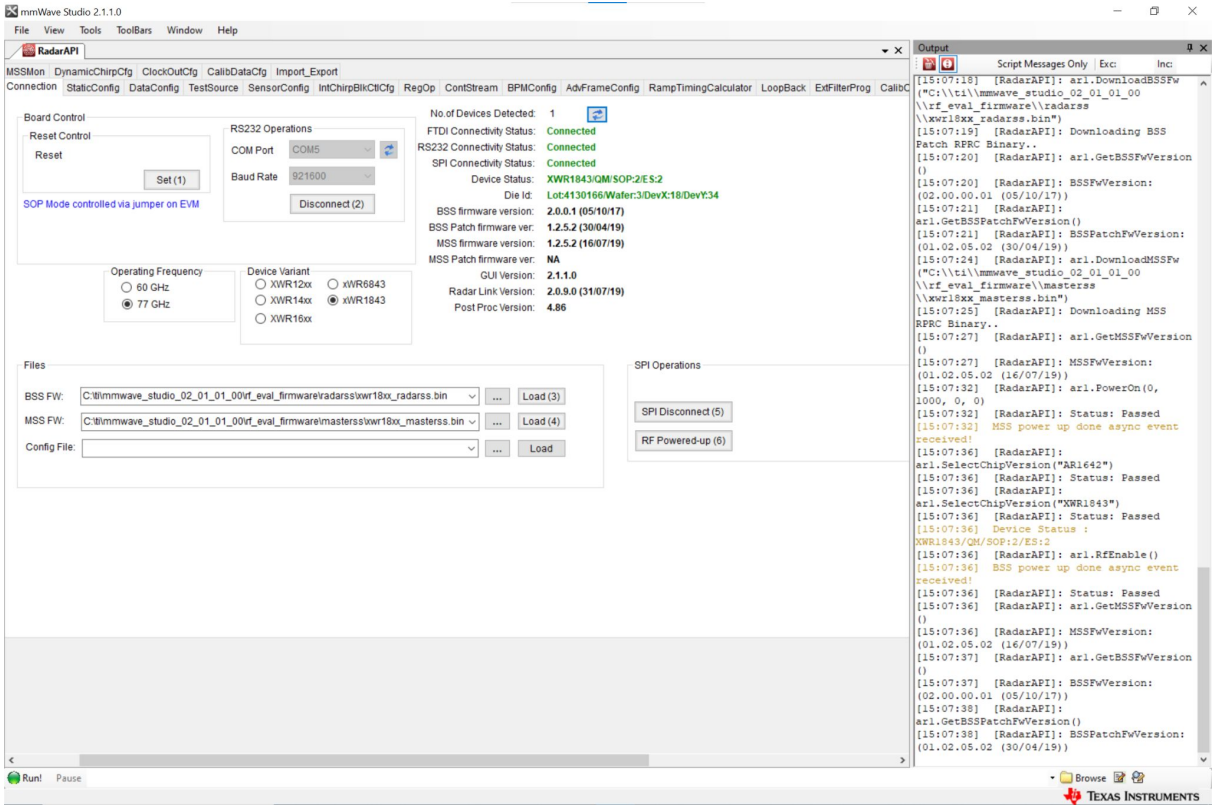
Radar
Save Data



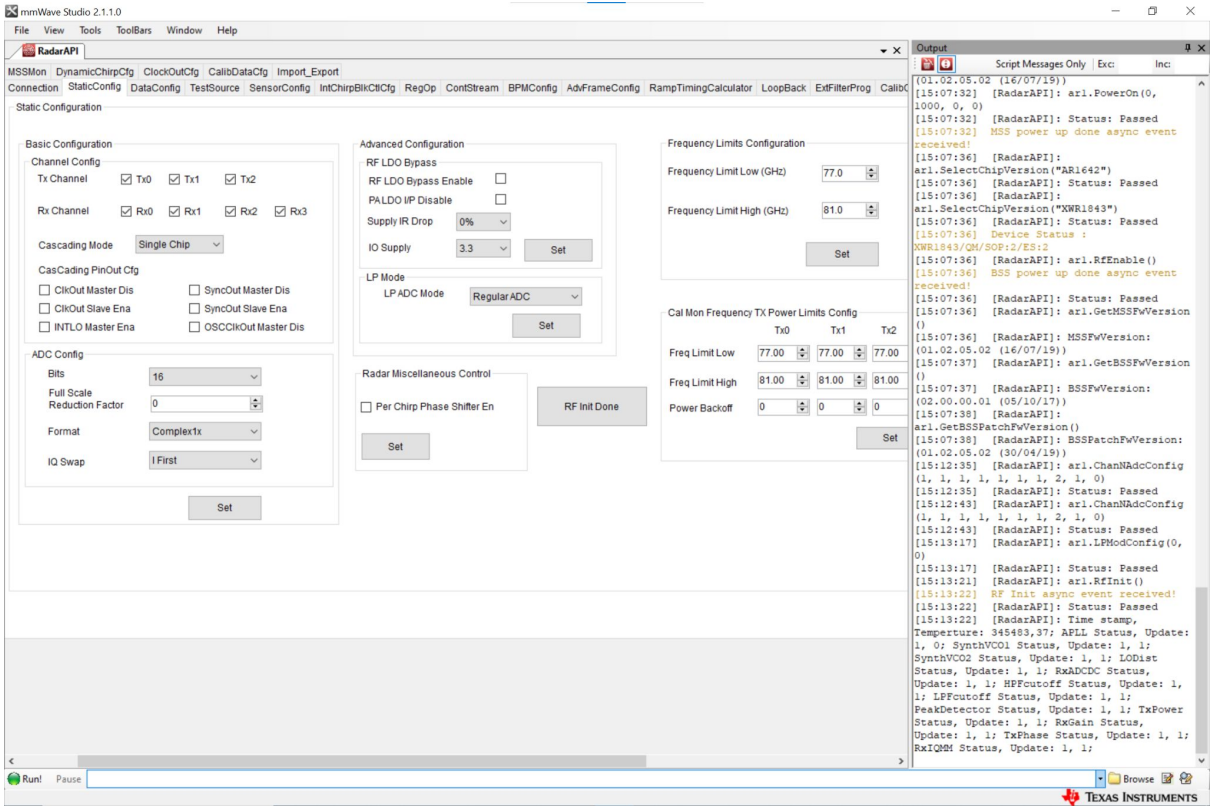
mmWave Demo Visualiser



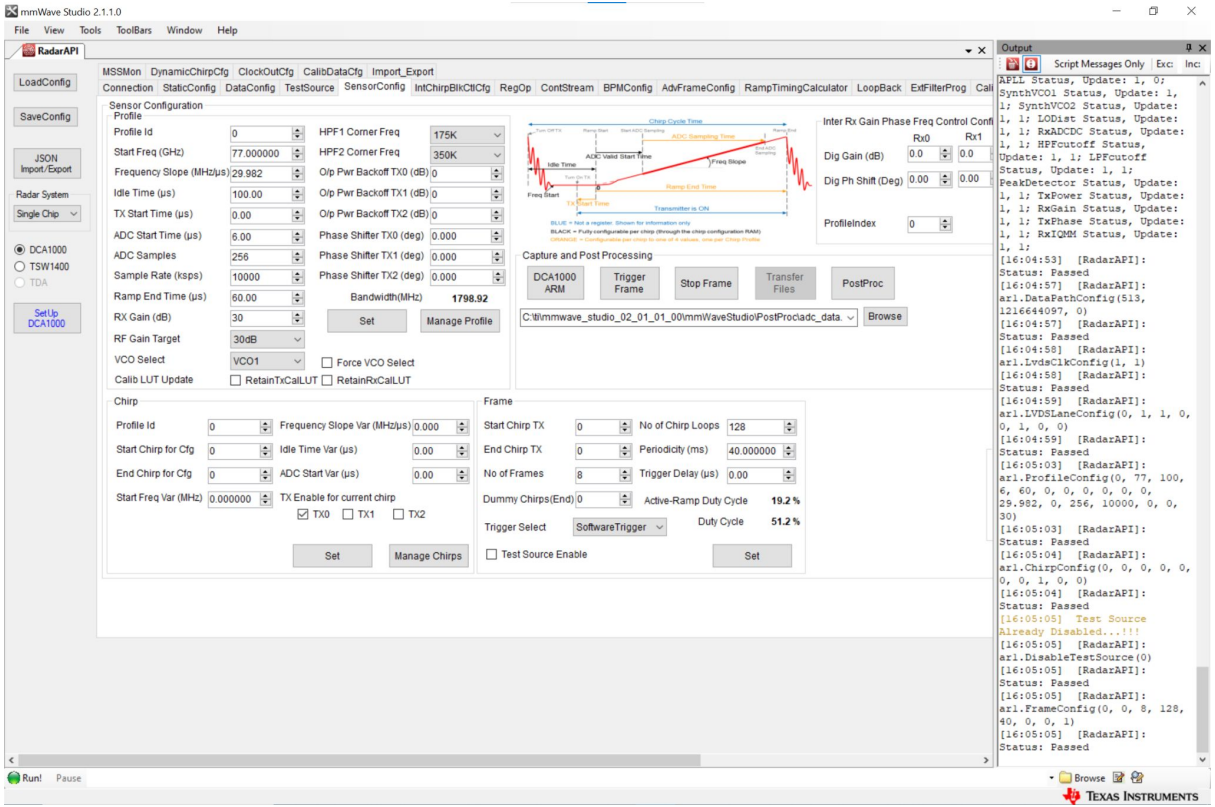
mmWave Studio



mmWave Studio Cont.



mmWave Studio Cont.



Experiment Methodology

- Participant prepares in front of radar
- Given start command as recording begins
- Recording file is processed by mmWave Studio PostProc
- Processed file is moved to external drive and renamed
- Participant given next activity

File Naming Scheme

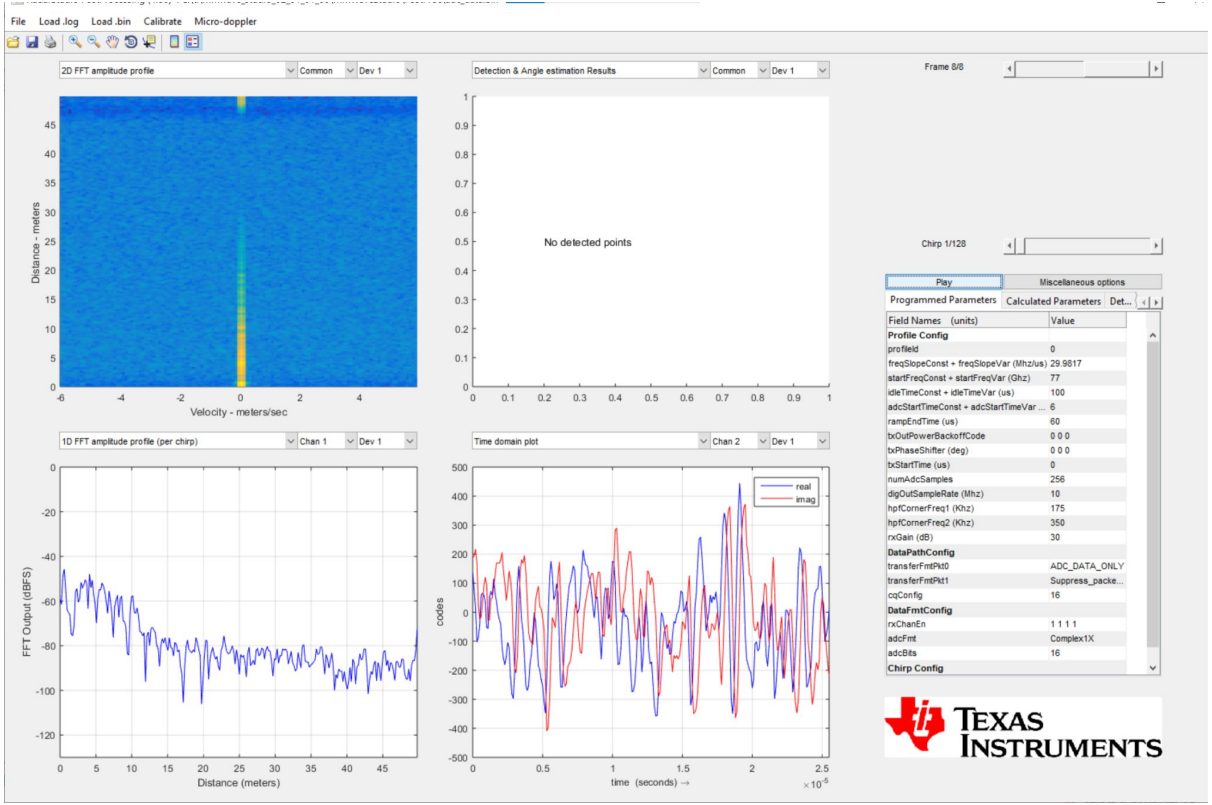
Files should be named according to:

- The activity being performed
- The participant number
- The activity duration
- The activity number according to the activity only (starts at 1)
- The starting timestamp (unix)

Some example file names could look like this:

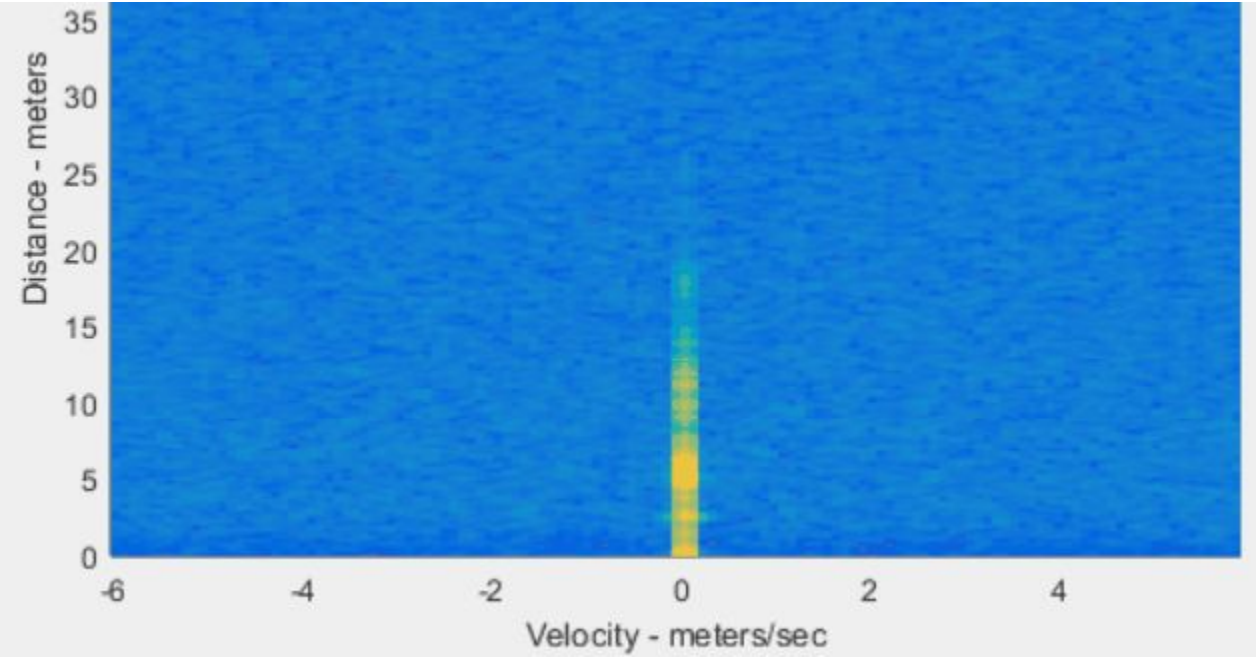
- boxing_01_6s_1_1689832549
- jumping_01_1m4s_3_1689839667
- sitting_standing_walking_03_15s_2_1689833322
- throwing_catching_11_6s_1_1689832676

Data Visualisation

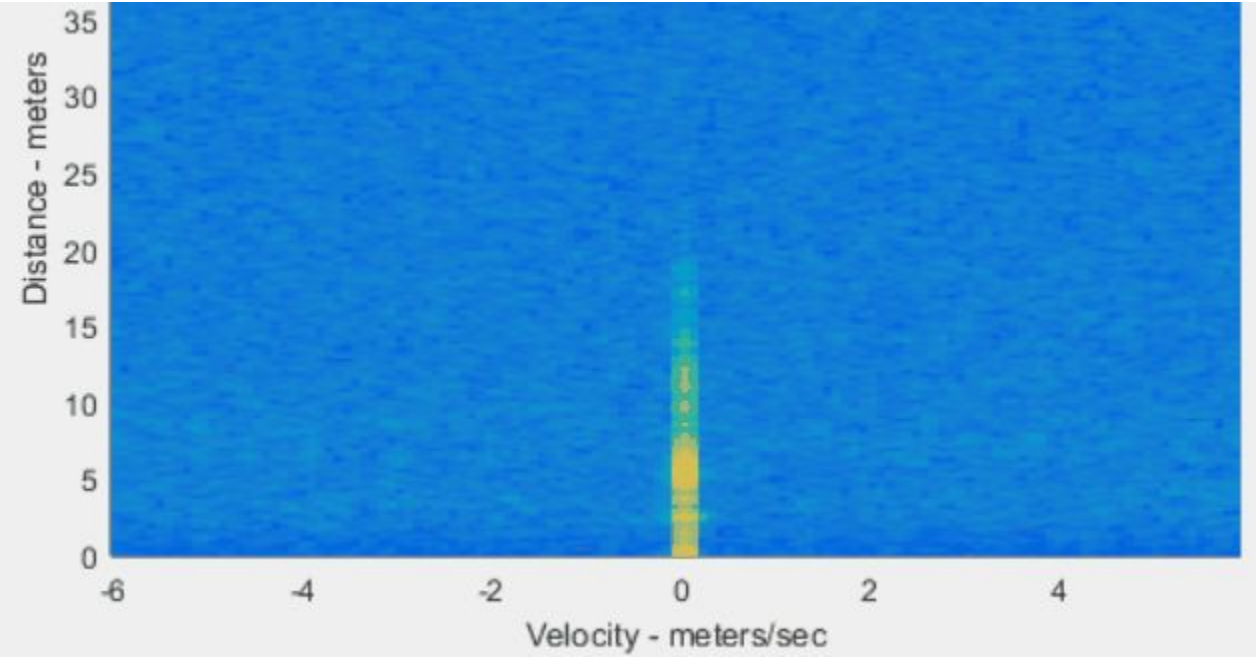


- 2D FFT amplitude profile
- Range-Angle plot (per Frame)
- Detection & Angle estimation Results
- Chirp Config Picture
- 1D FFT amplitude profile (per chirp)
- Time domain plot
- and more...

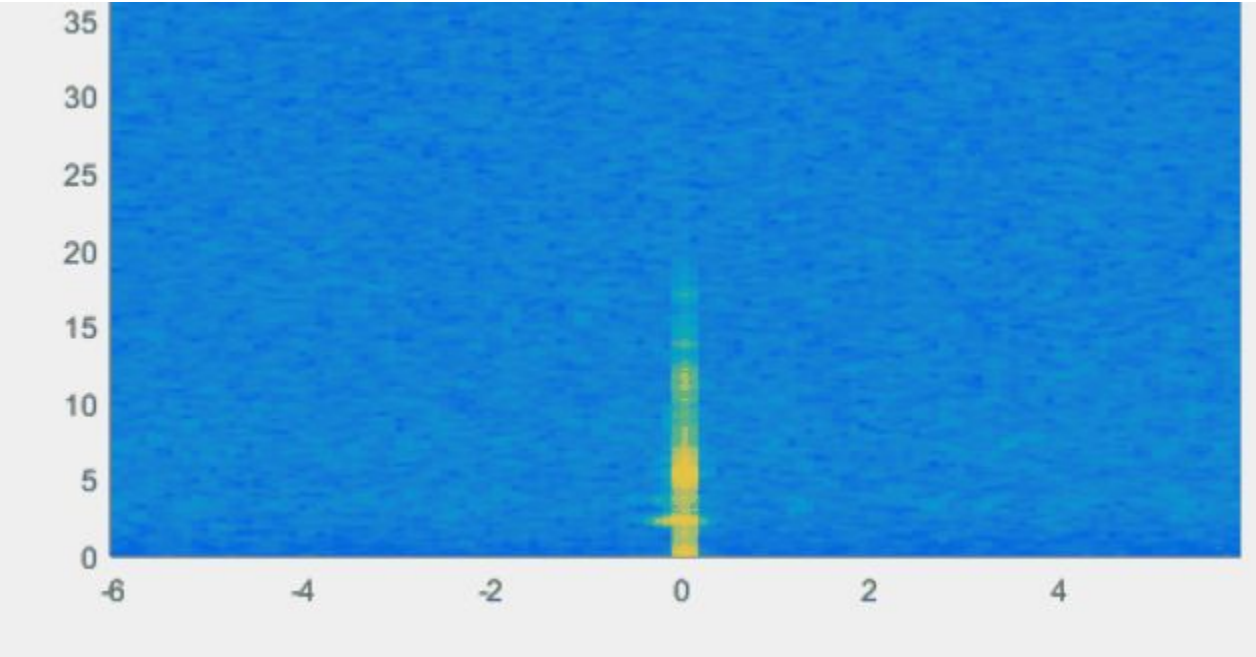
Sample Data Recordings - Walking



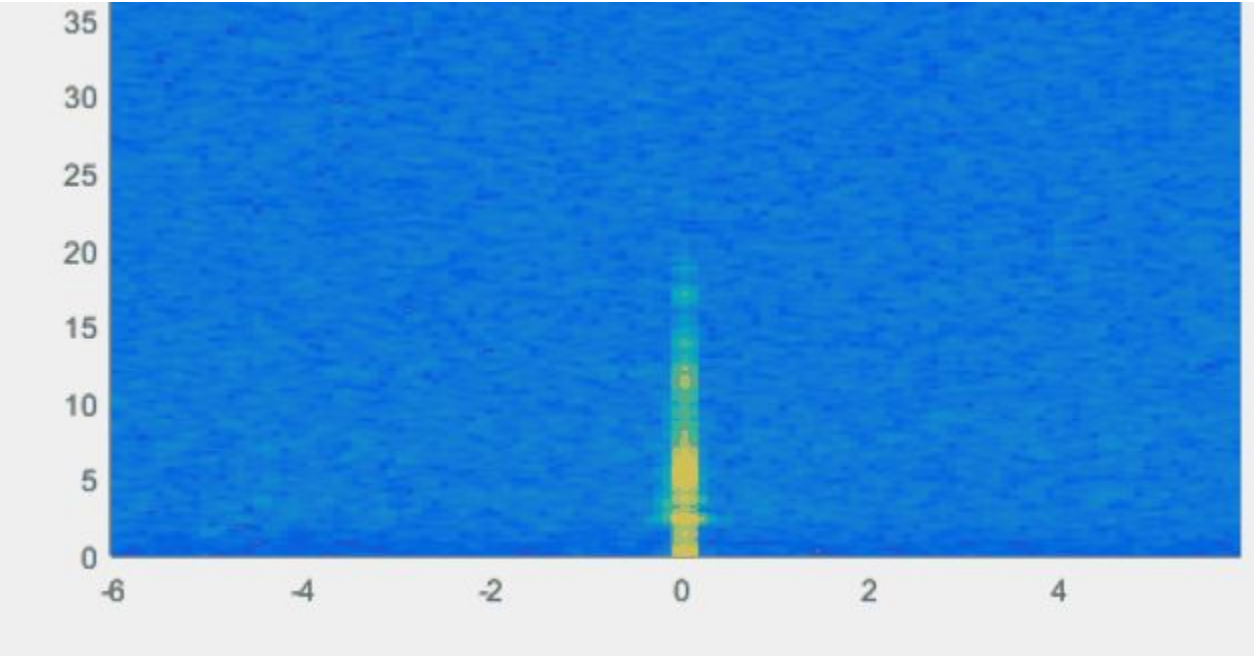
Sample Data Recordings - Reading



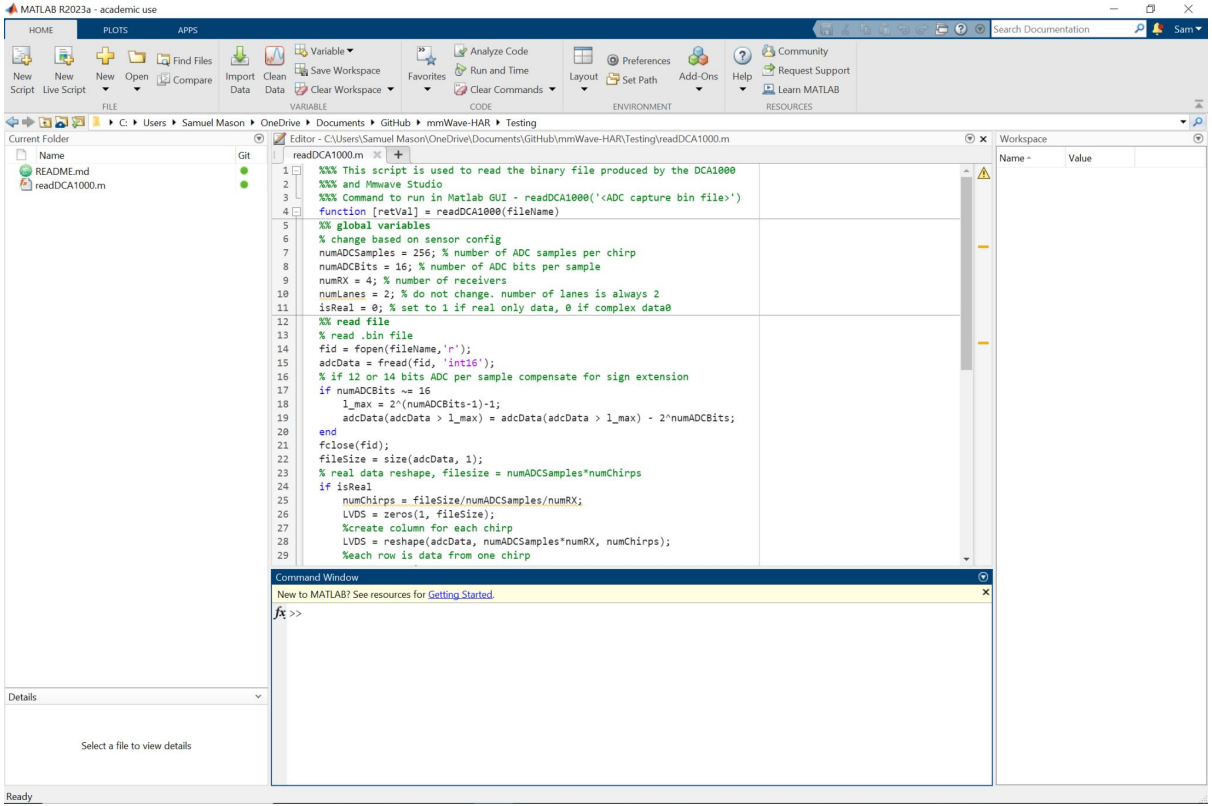
Sample Data Recordings - Jumping



Sample Data Recordings - Boxing



MATLAB Processing



Activity Classes (WIP)

Simple (12)
Sitting
Standing
Walking
Clapping (while standing)
Squatting down
Jumping
Throwing (L + R)
Catching
Reading
Writing
Snapping fingers (L + R)
Pointing (L + R)

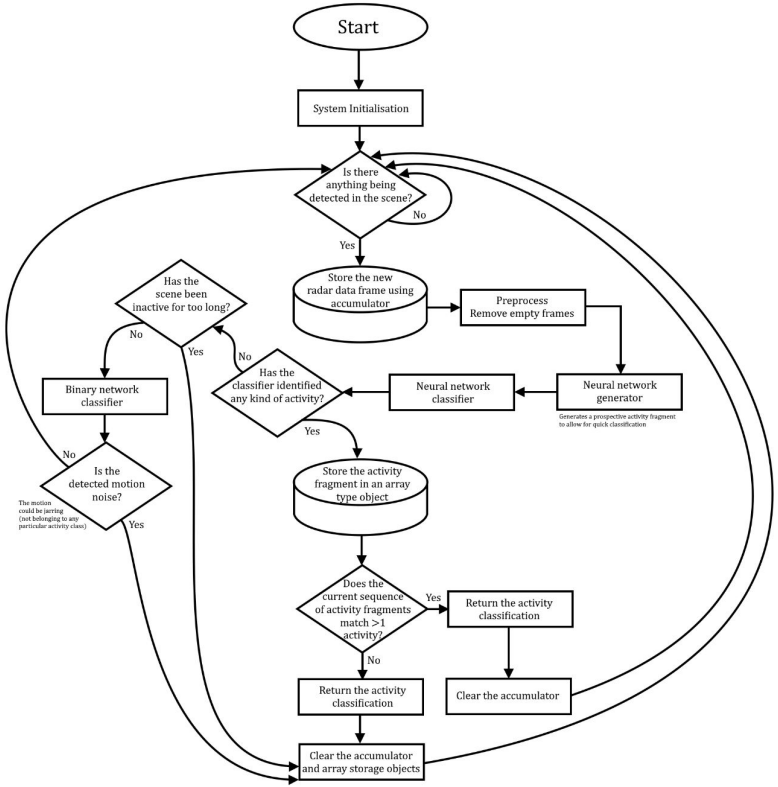
Complex (6)
Stand up then walk (3) [sitting -> standing -> walking]
Standing ovation (2) [sitting -> standing + clapping]
Squat jumps (2) [squatting down -> jumping]
Playing catch (2+) [throwing -> catching OR throwing -> standing -> catching -> standing]
Annotating (2) [reading -> writing OR writing -> reading]
Commanding attention (2) [snapping fingers -> pointing]

Aiming for activities:

- Office
- Living
- Exercise

Processing Flow (WIP)

The flowchart depicts a generative adversarial approach to allow for real-time predictive capabilities.



Machine Learning Model

- HMM
- CNN + LSTM
- TCN
- CGAN
- Other networks?

Real-Time Inferencing

- Explored in a limited capacity by existing literature
- Want to replace static/dynamic segmentation
- Generative capabilities needed?
- Yet to decide if we are to implement