

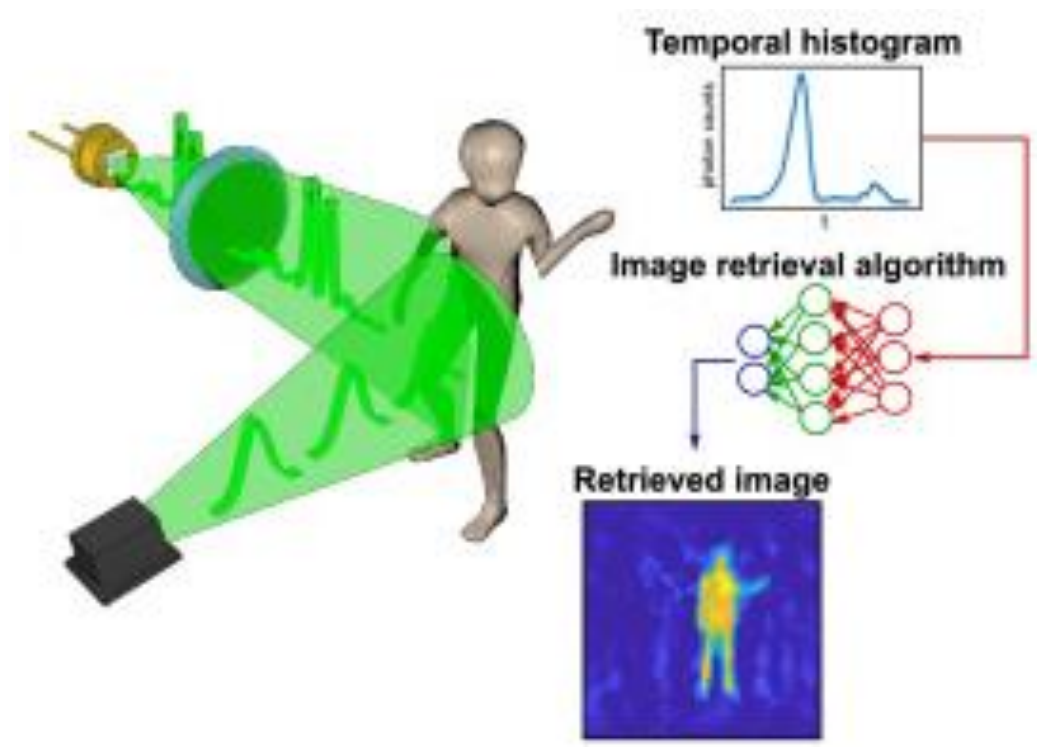
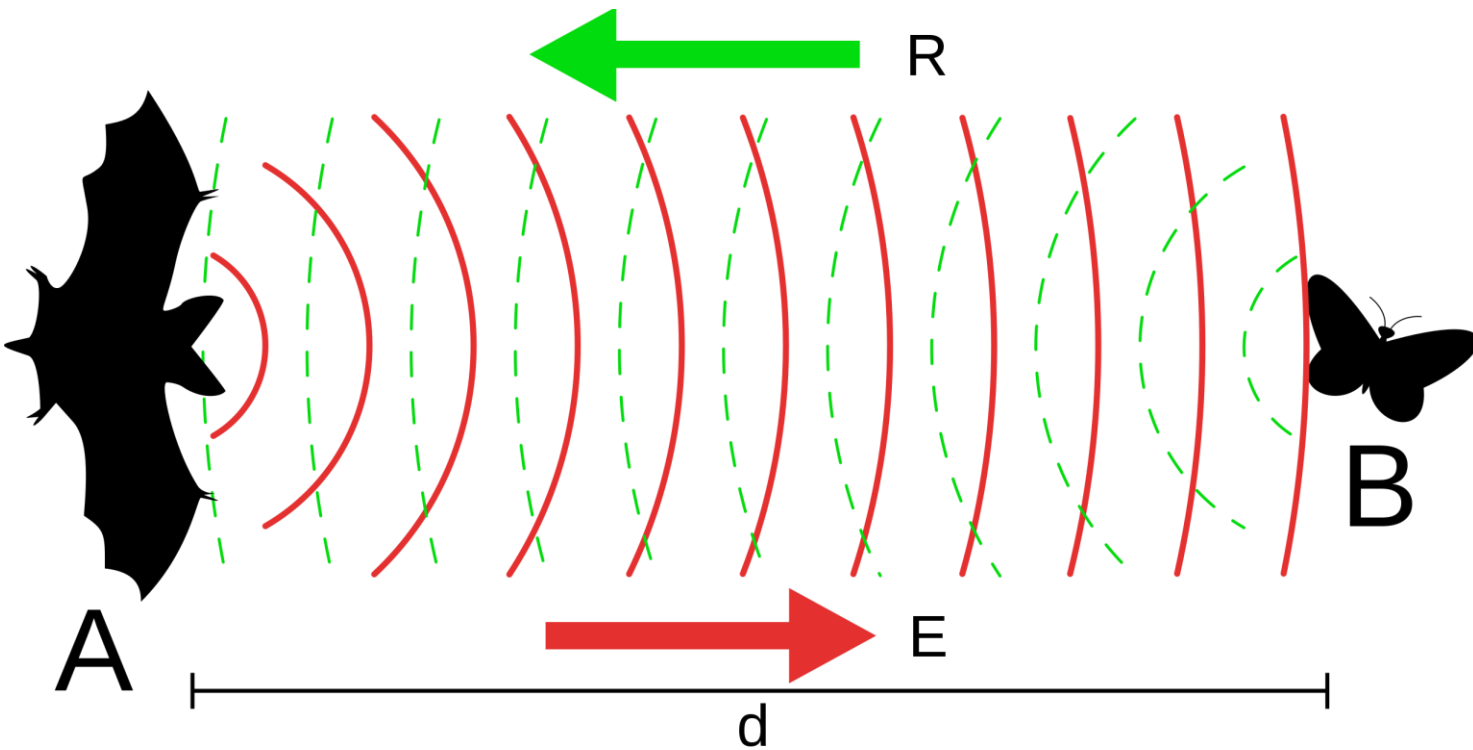
Can the **Depth Map** computation  
potential of **Stereo Images** be  
**transferred to Mono Acoustic**  
**Recordings?**

**- Mapping Space with Time -**

**Xabier Oianguren Asua**

Computer Vision – *Computational Mathematics*  
*Universitat Autònoma de Barcelona 24/05/2022*

# Inspiration



A. Turpin et al., ***"Spatial images from temporal data,"*** Optica 7, 900-905 (2020)

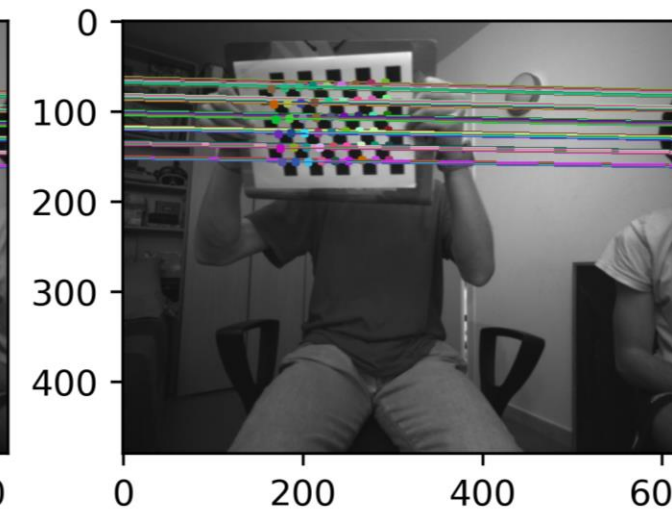
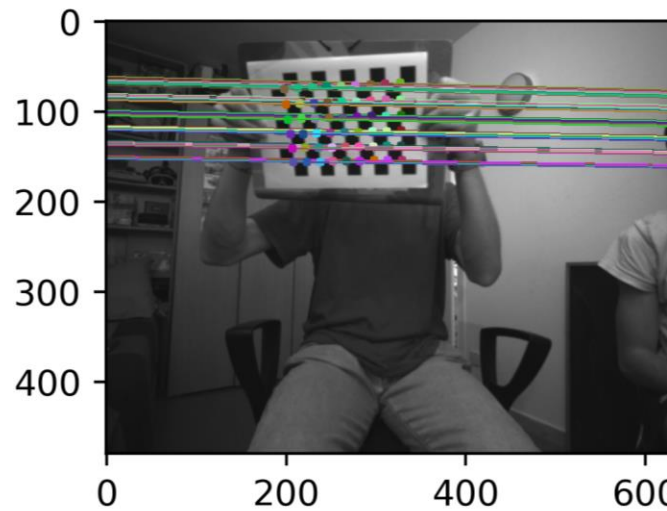
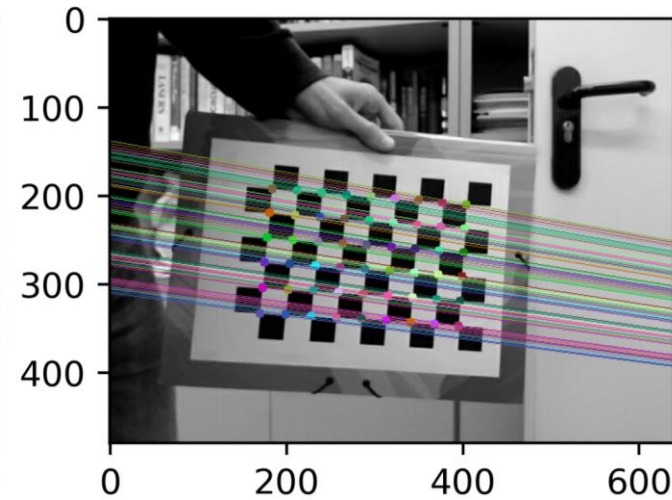
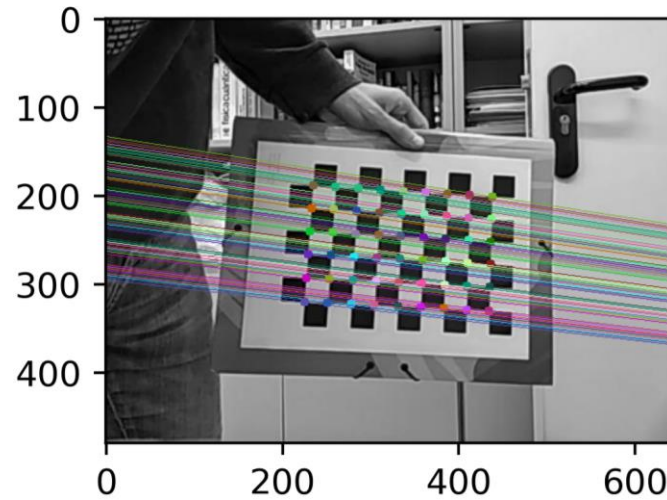
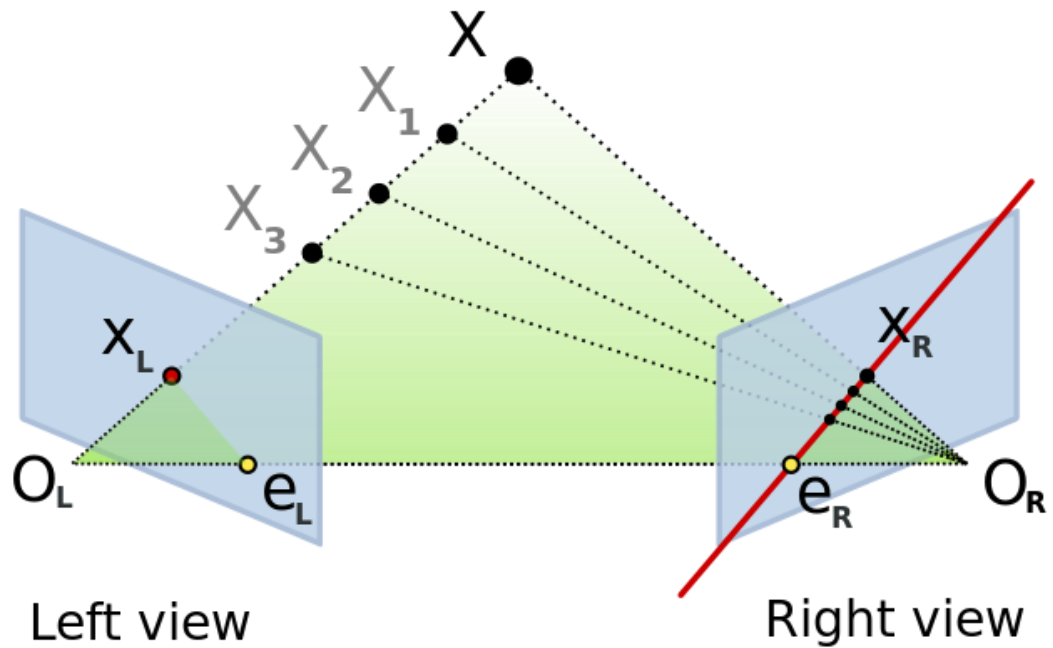
A. Turpin et al., ***"3D imaging from multipath temporal echoes,"*** Phys. Rev. Lett. 126, 174301 (2021)

# Depth Maps using Stereo Imaging

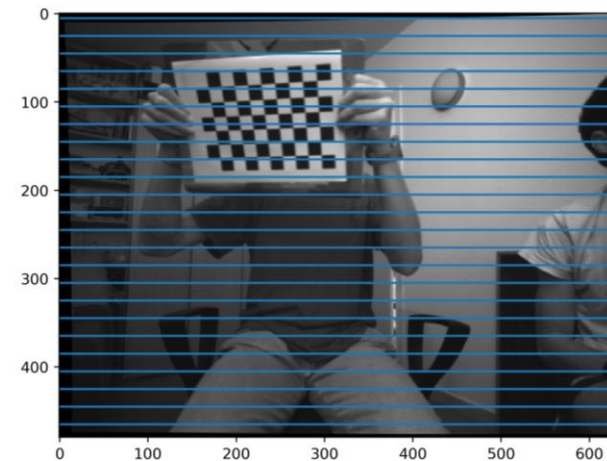
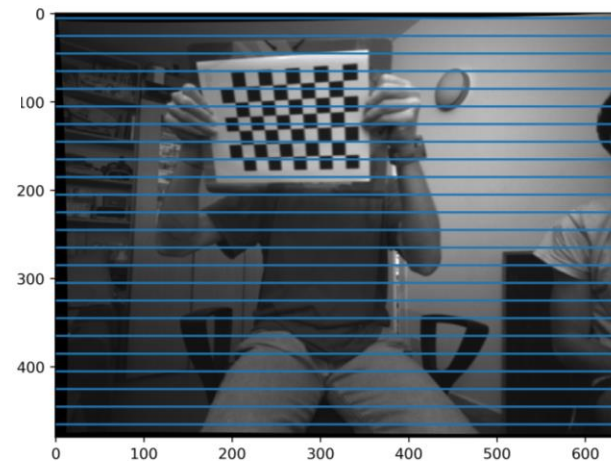
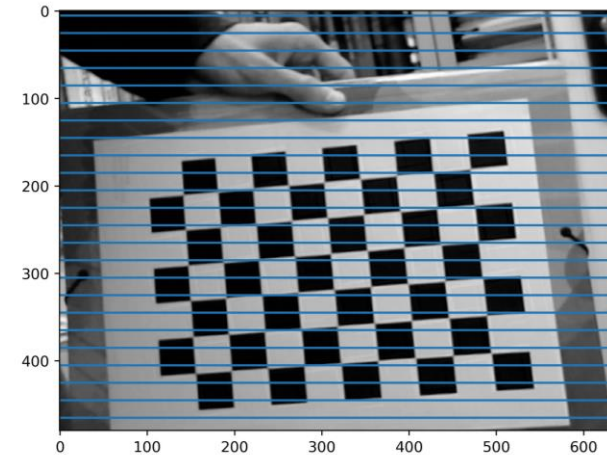
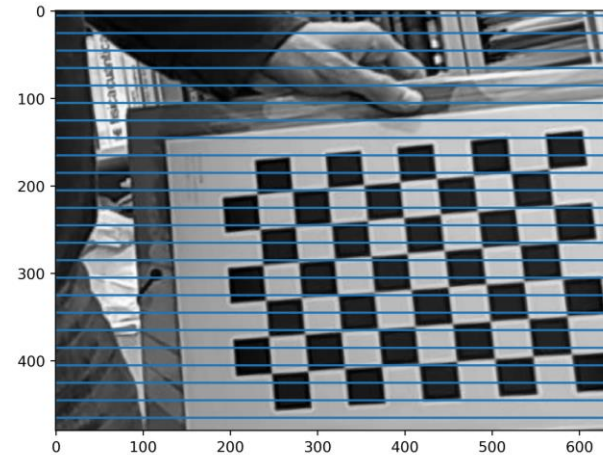
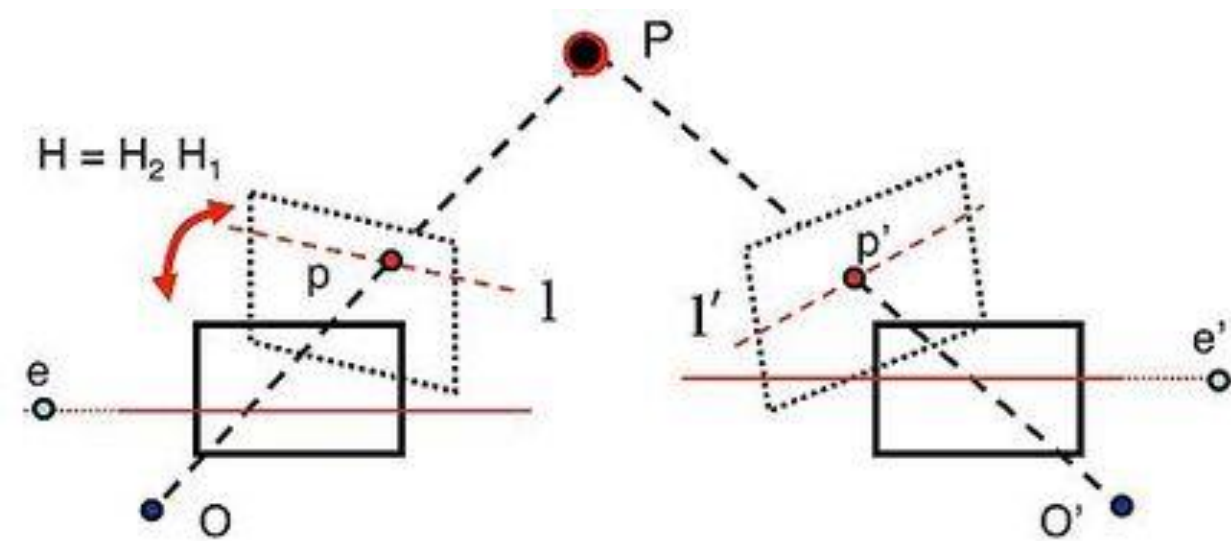
# Camera Calibration (Intrinsics)



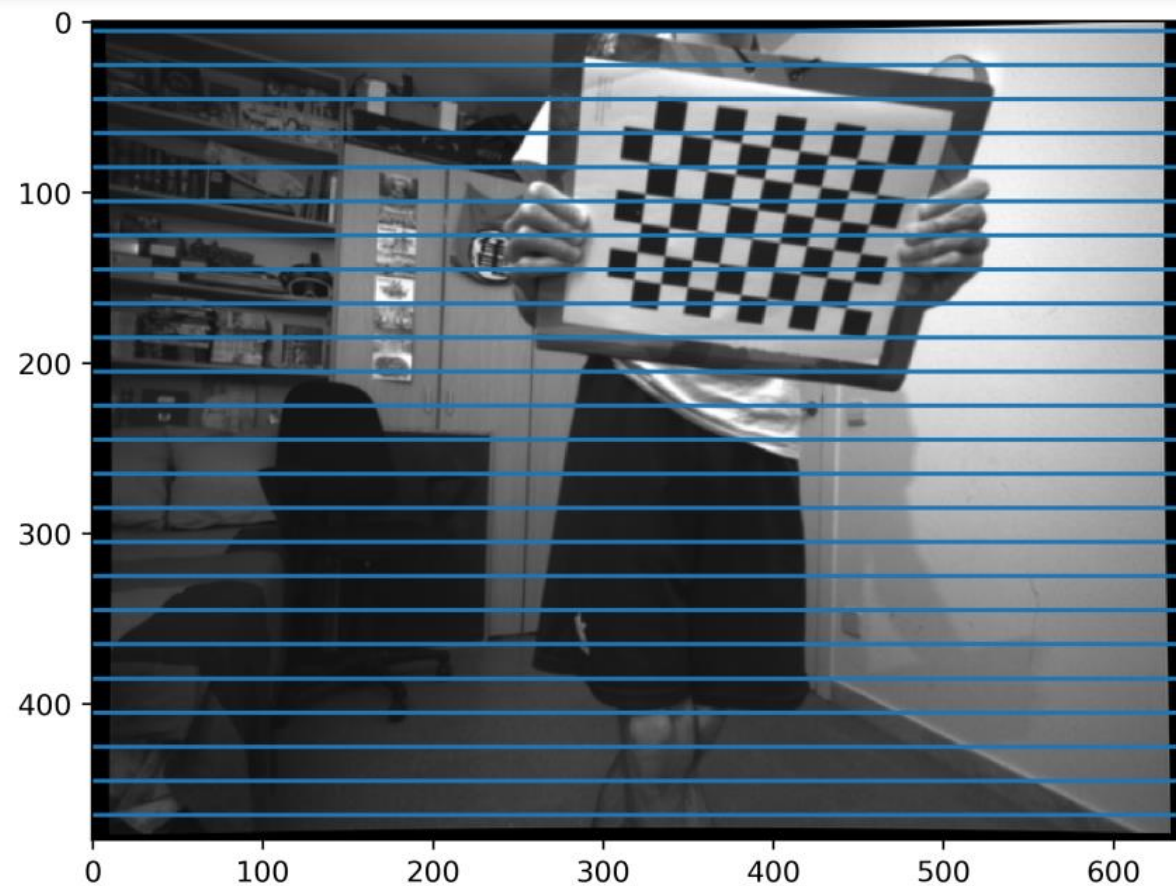
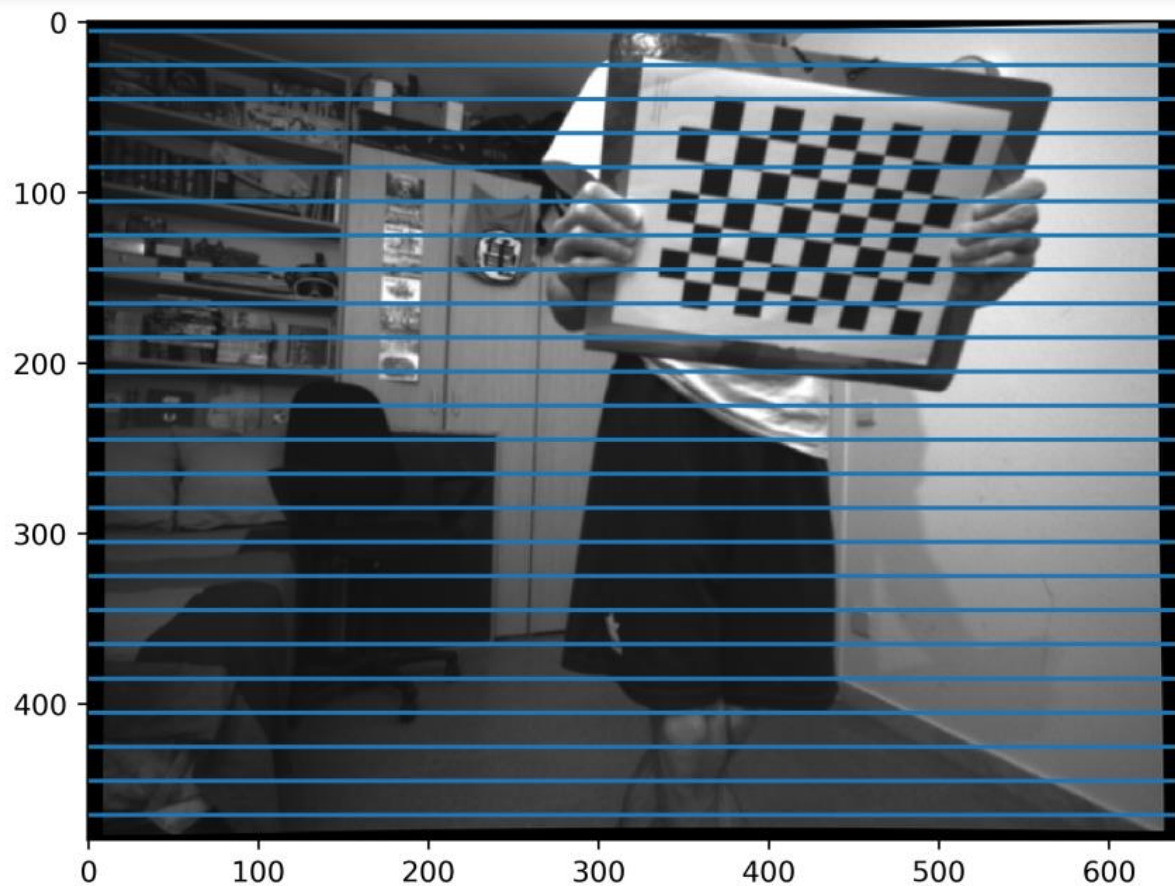
# On Epipolar Lines...



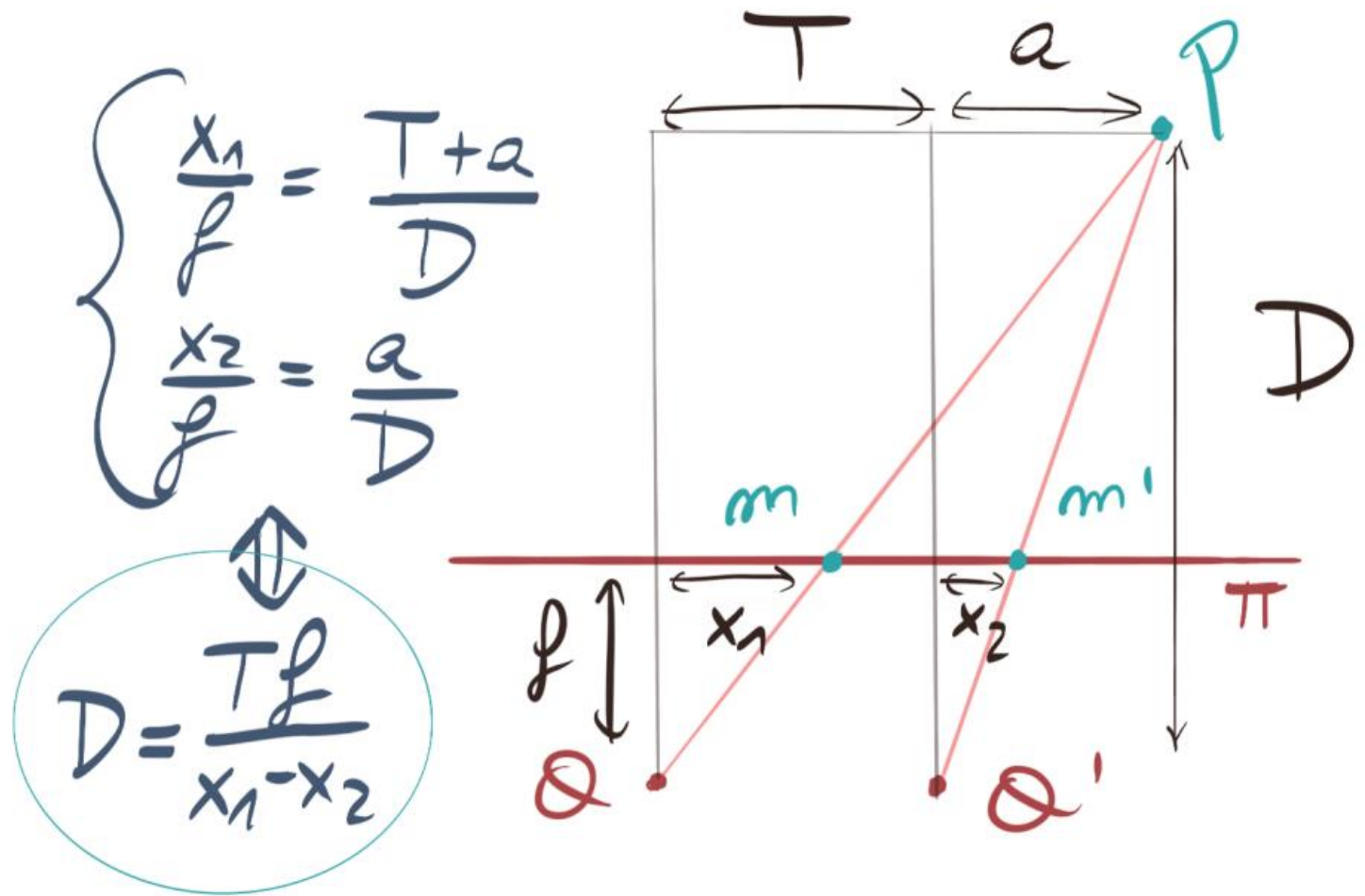
# On Image Rectification...



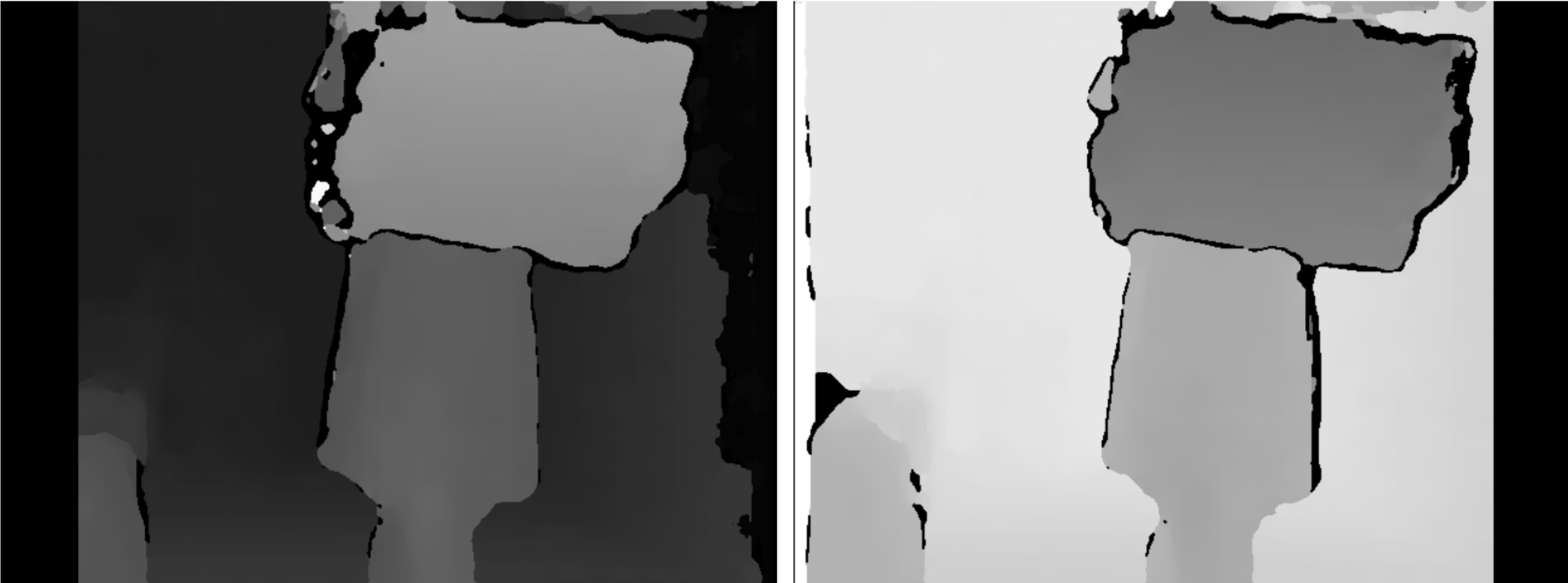
# Image Rectification



# On Disparity to Depth...



# Compute Disparity Maps

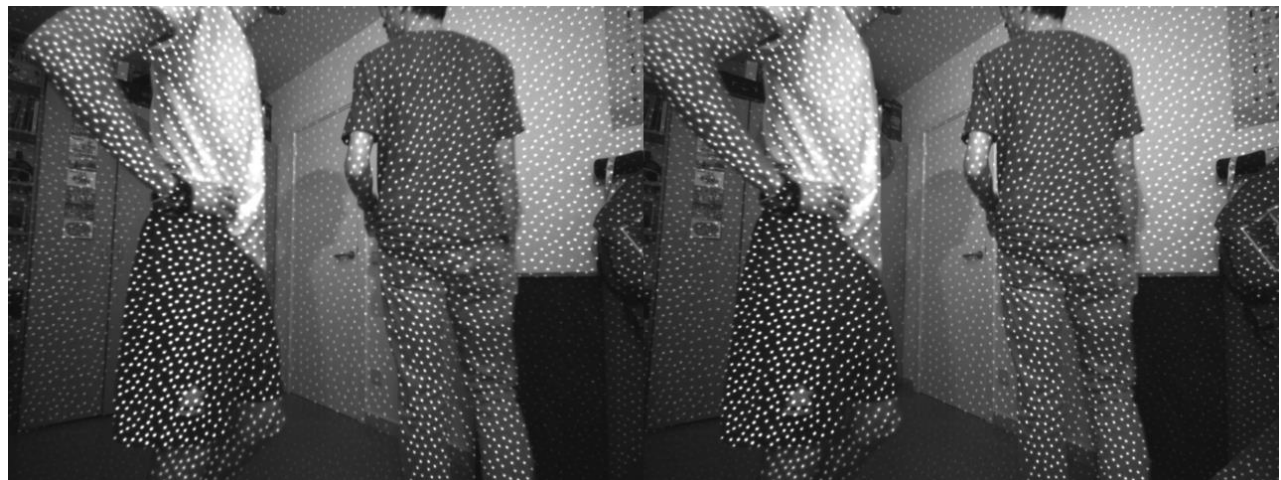
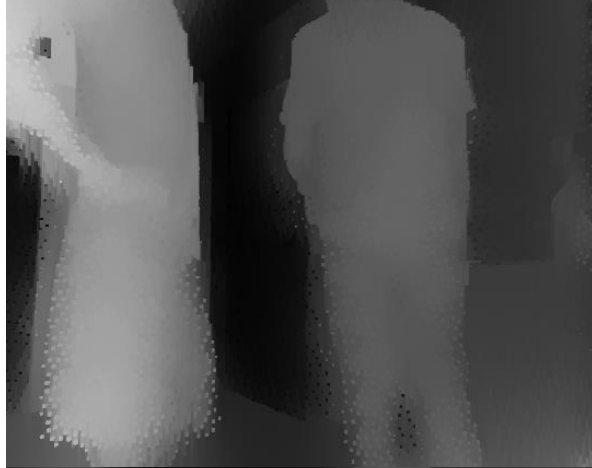


# Post-processing WLS Filter



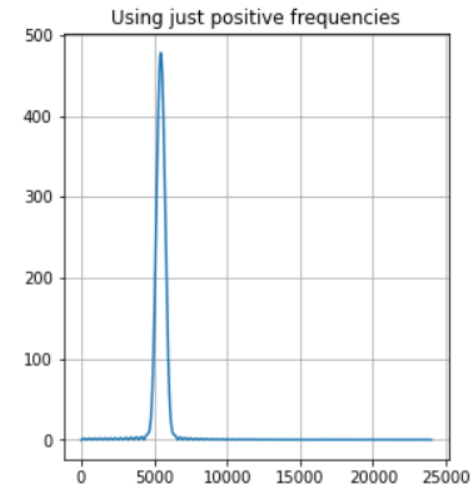
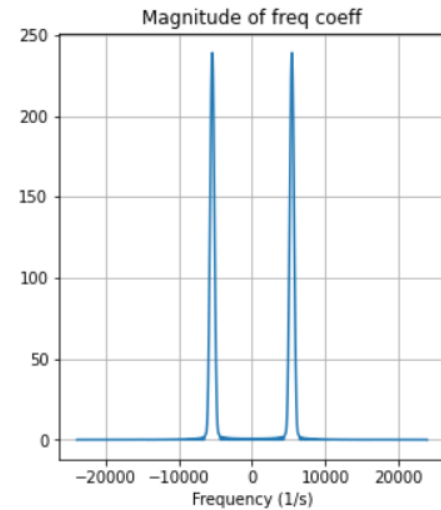
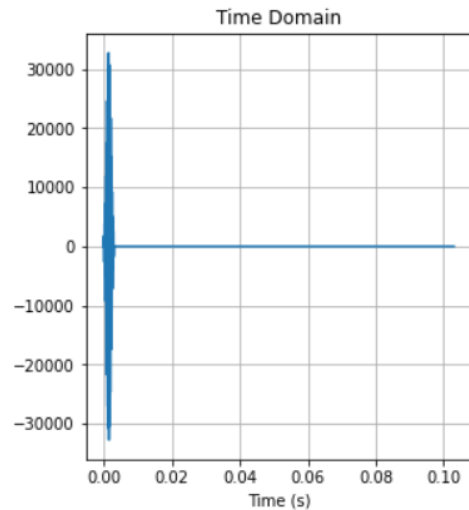
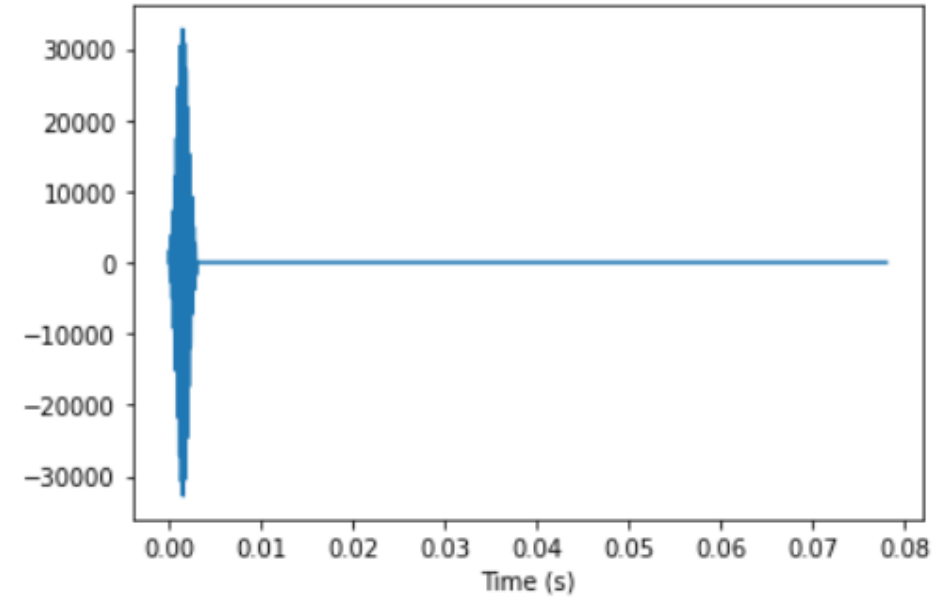
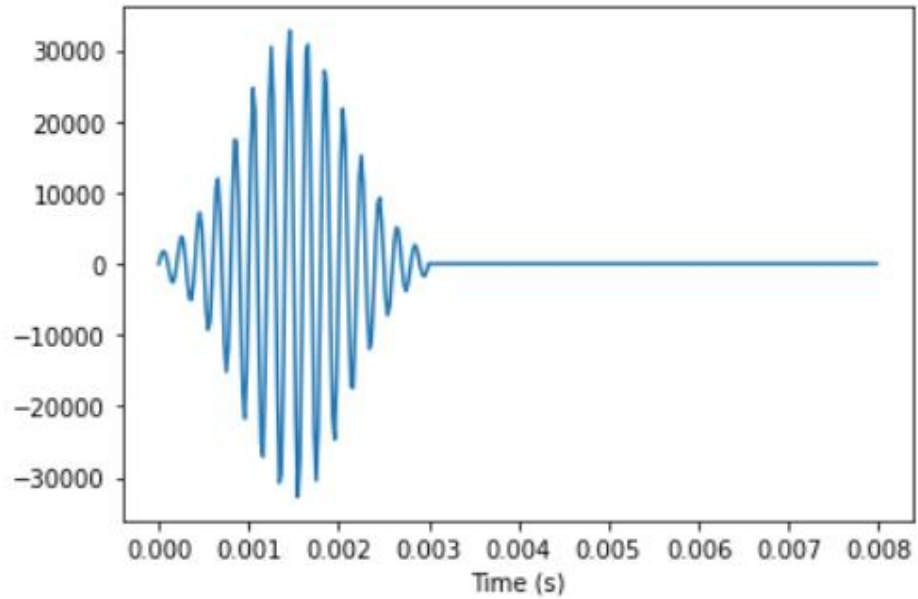
# Generate Depth Maps!



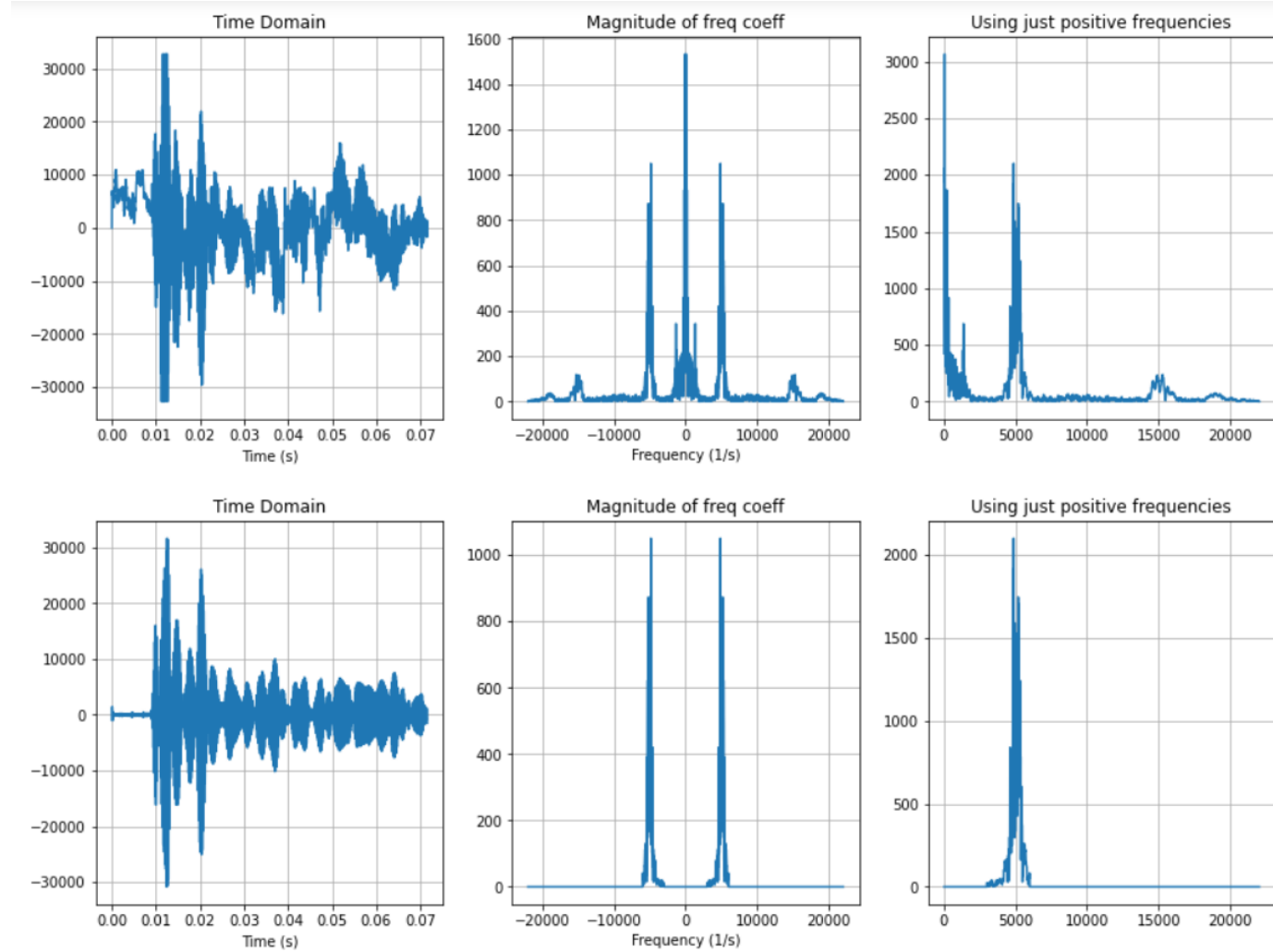
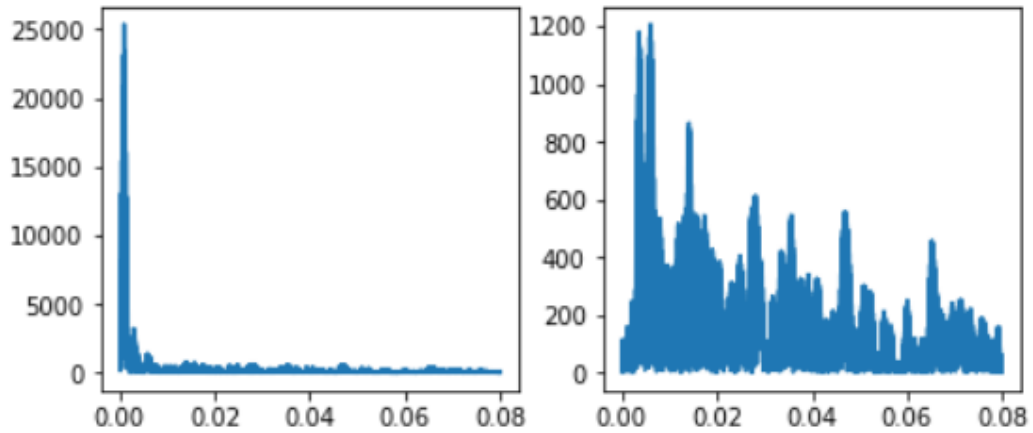


# Sound Pulse Engineering

# Emitted Pulse



# Recorded Sound



# GUI for the Pipeline

**Depth Map Generator using Stereo Imaging**

Calibrate System | Generate Depth Maps | Gather Sound Echo and Depth Maps

- Working Directory:

- Number of Photos to take in Calibration:

- Number of Photos to take for Test:

- Take all the correct images or allow choosing?  
 Allow Choosing  
 Take All

- If All Taken, timing (ms) of previsualization:

- Chess size:  x

- Chess square side (you will fix the units):

Use RealSense IR Cameras  
 Left cam idx:   
 Right cam idx:

Use Standard Cameras

Width (640, 1280):  Height (480, 720):

Laser ON

Opt. Stop Crit. | StereoCalibrate | StereoRectify | Disparity SGBM

Block Size (3-11):  Speckle Range (1-2):

Min Disparity:  Disp12MaxDiff:

Num Disparities: (max-min should 5-15):

Uniqueness Ratio (5-15):  Lambda:

Speckle Window Size (50-200):  Sigma:

FILTER parameters:  
 Visual Multiplier:

Use already taken photos in the Working Directory  
 Use already taken photos for testing  
 Remove old Data

Click Start Calibration to begin calibration process, or Click GO to start generating depth maps...

**Depth Map Generator using Stereo Imaging**

Calibrate System | Generate Depth Maps | Gather Sound Echo and Depth Maps

Sound Pulse Broadcast

Frequency (Hz):   Simple Sinusoid  
 Gaussian Envelope

Pulse Duration (s):  Std to duration ratio:

Audio Sample Rate:

Sound Recording

Audio Sample Rate:  Erase 1 from:  to freq:

Echo Recording Duration (s):  Erase 2 from:  to freq:

Filter Freqs

General Settings

Output Directory:

Number of samples to take:

Time between shots (s):

Erase Old Data  Show taken frames live

Depth Map Recording

- Stereo Calibrate  
 Calibrated Parameters:    Use average image of each pulse

- Stereo Rectify  
 Calibrated Parameters:    Use image in the middle of each pulse

Remember to choose the Disparity SGBM parameters and cameras in the first Tab!

Click Start Calibration to begin calibration process, or Click GO to start generating depth maps...

# Generated Datasets

# 2 Set-ups, 3 Datasets

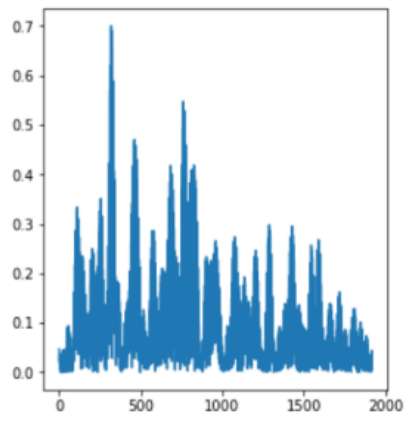
Setup A



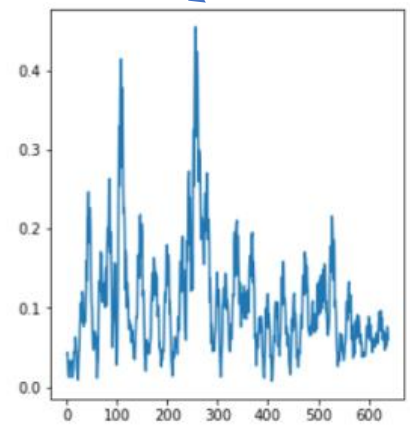
Setup B



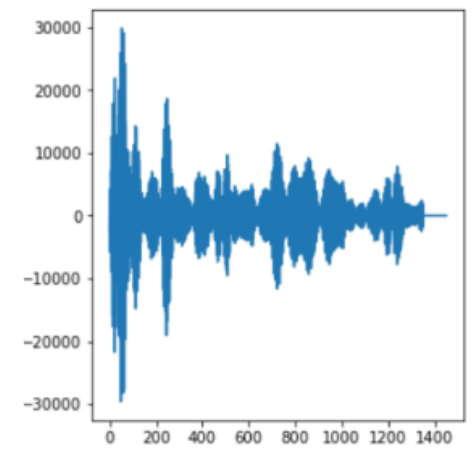
Dataset A



Dataset A'

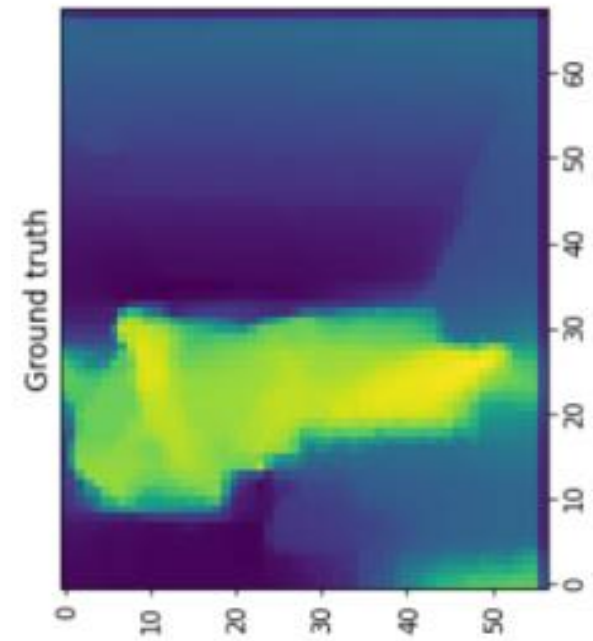
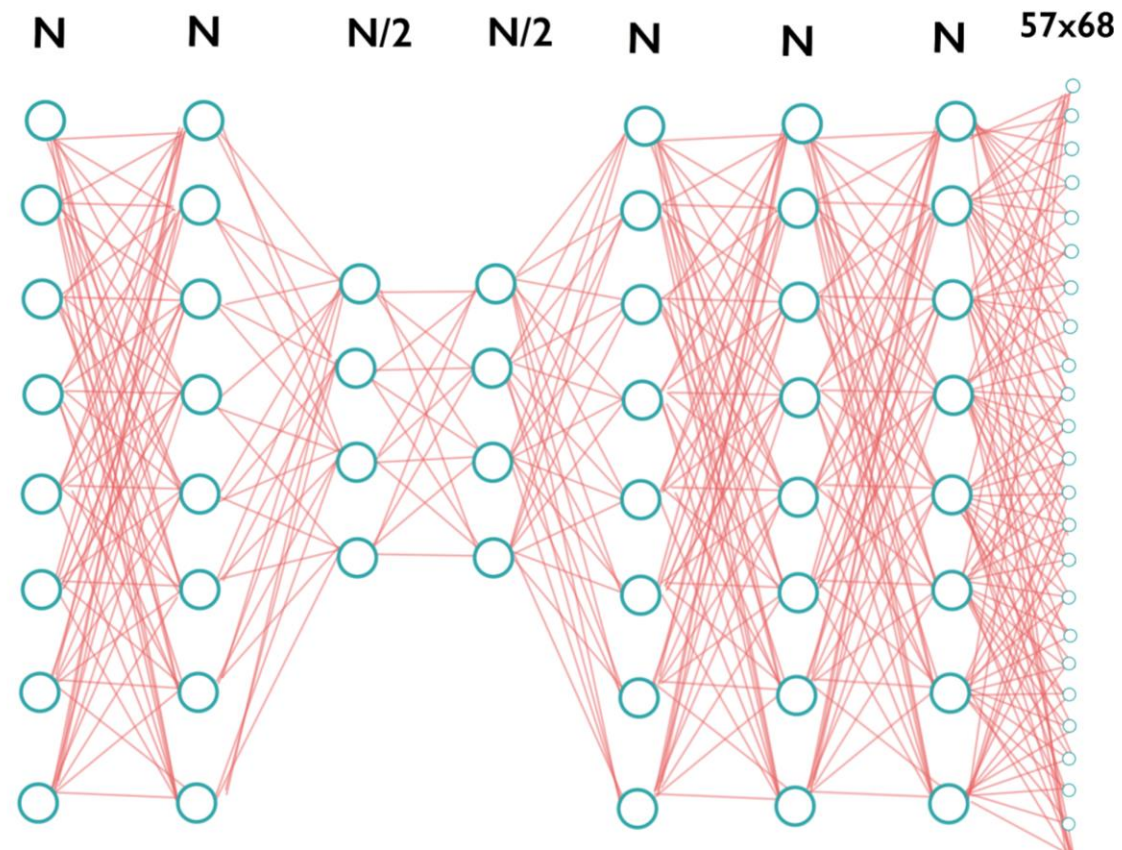
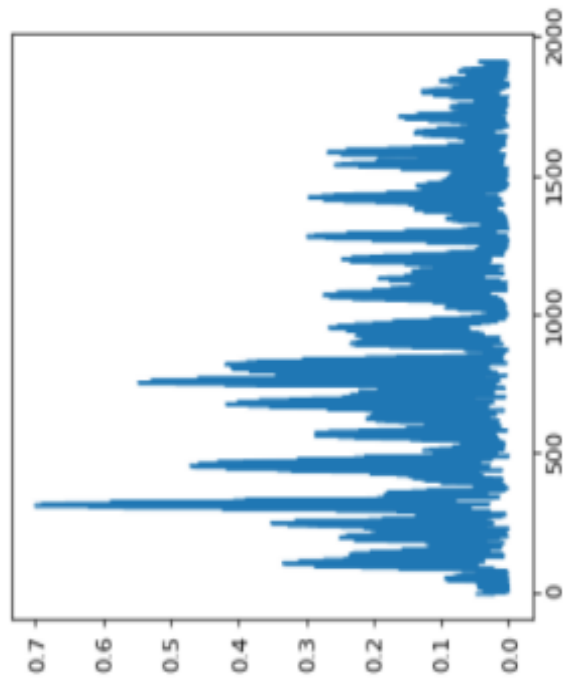


Dataset B

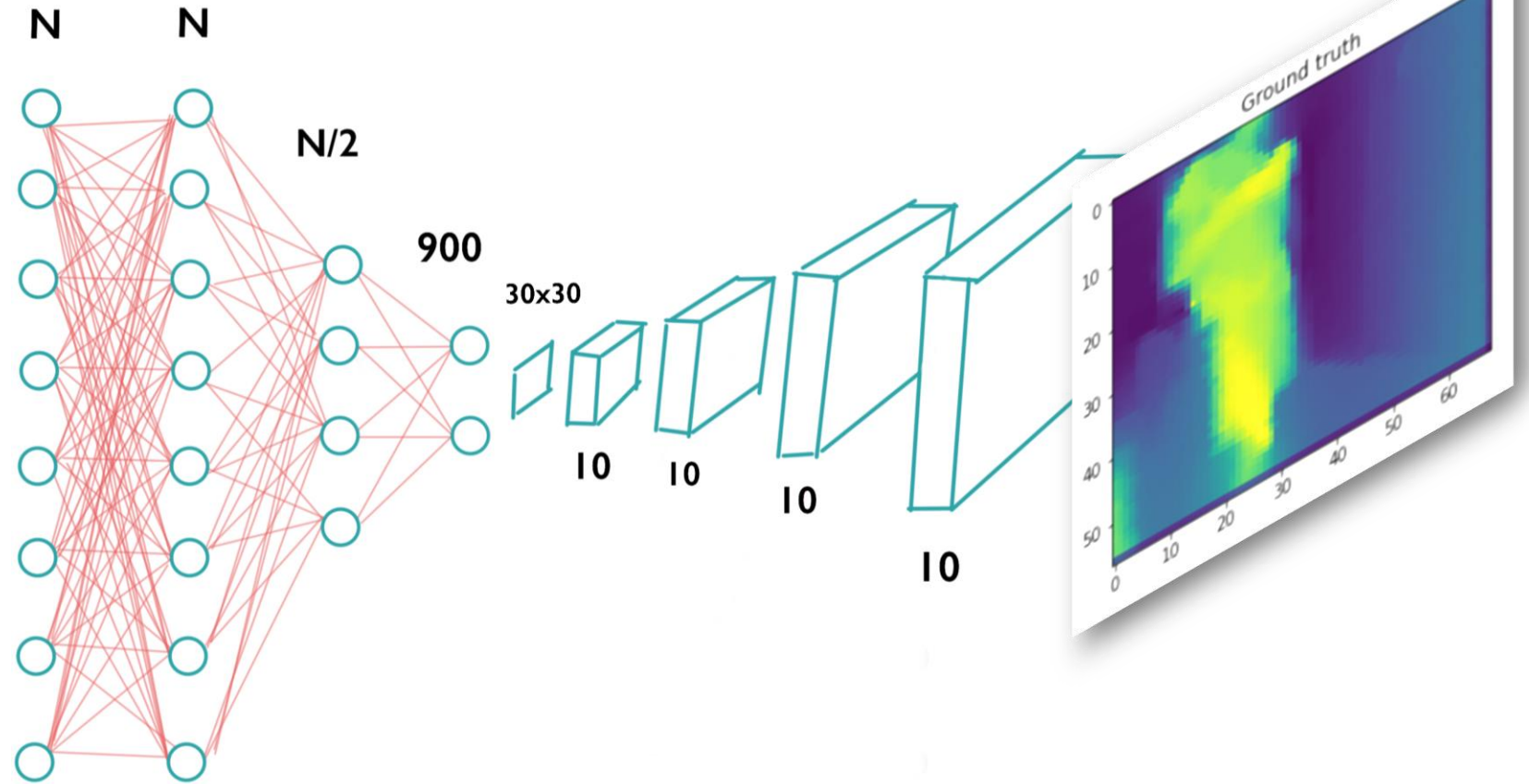
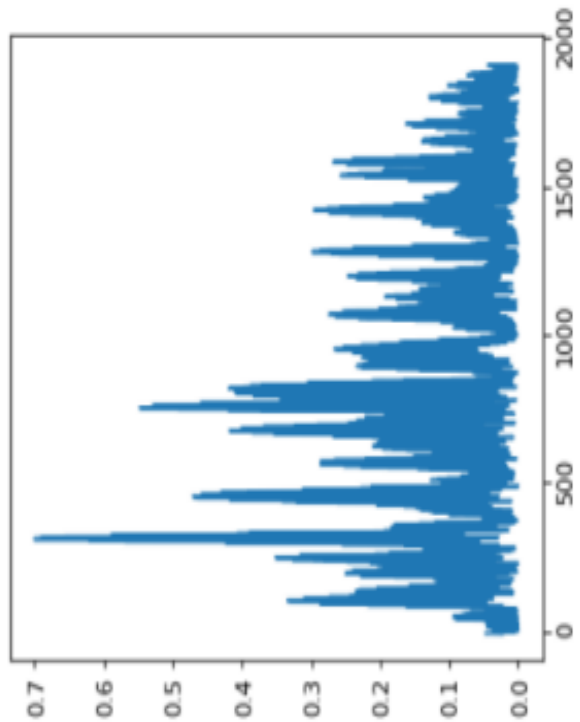


# Employed Neural Networks

# Fully<sup>2</sup> Connected

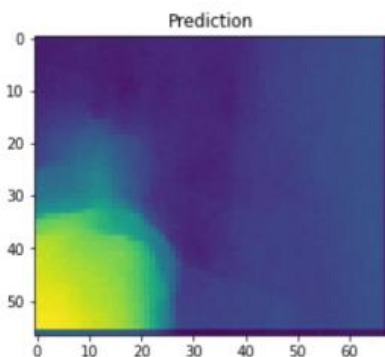
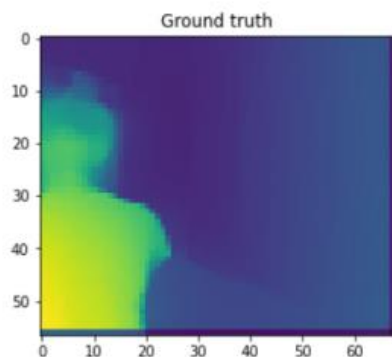
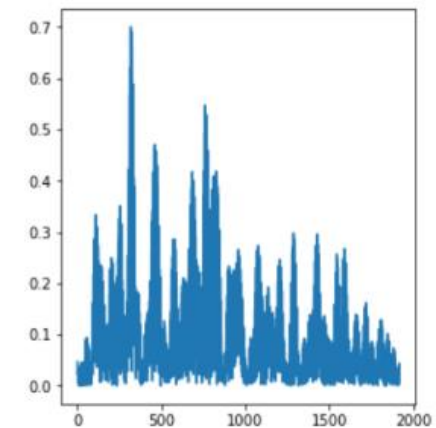


# Fully Connected + (De)convolutional Layers

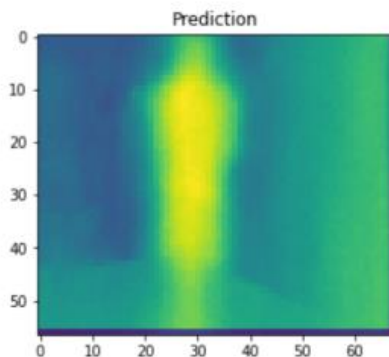
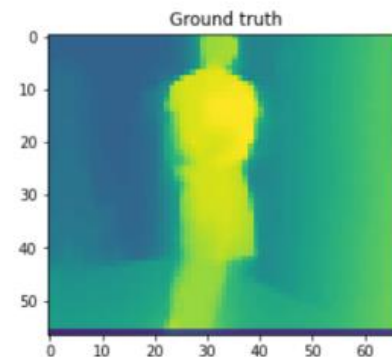
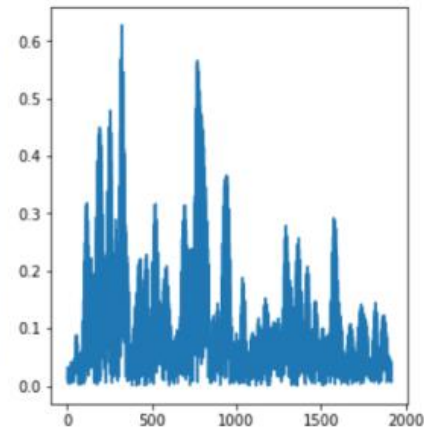


# Results

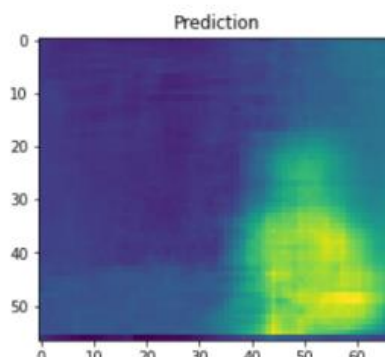
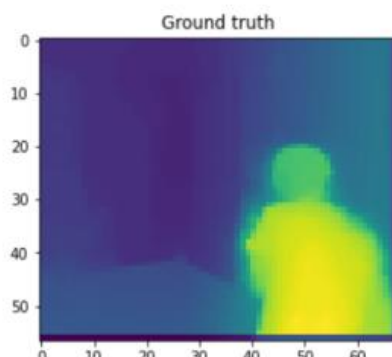
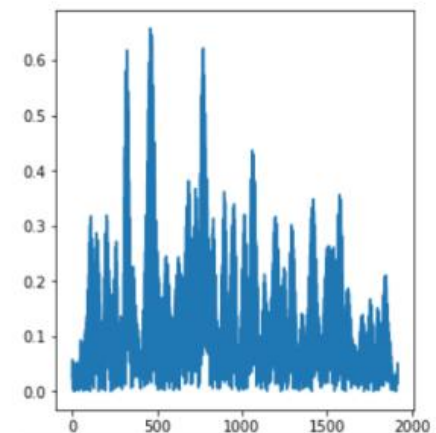
# Dataset A



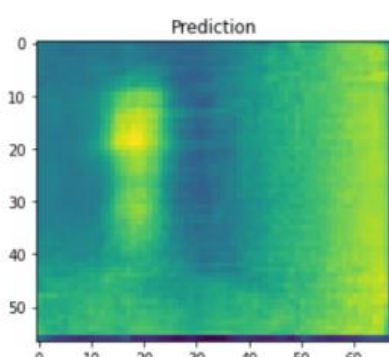
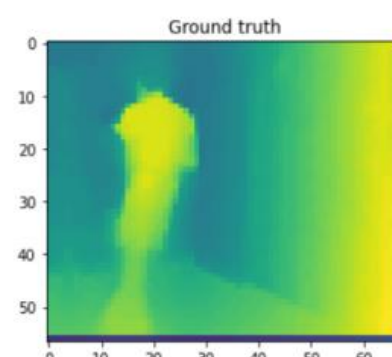
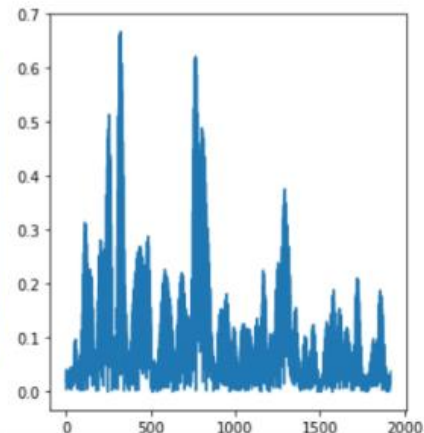
(a) Test set example 1, MLP



(b) Test set example 2, MLP

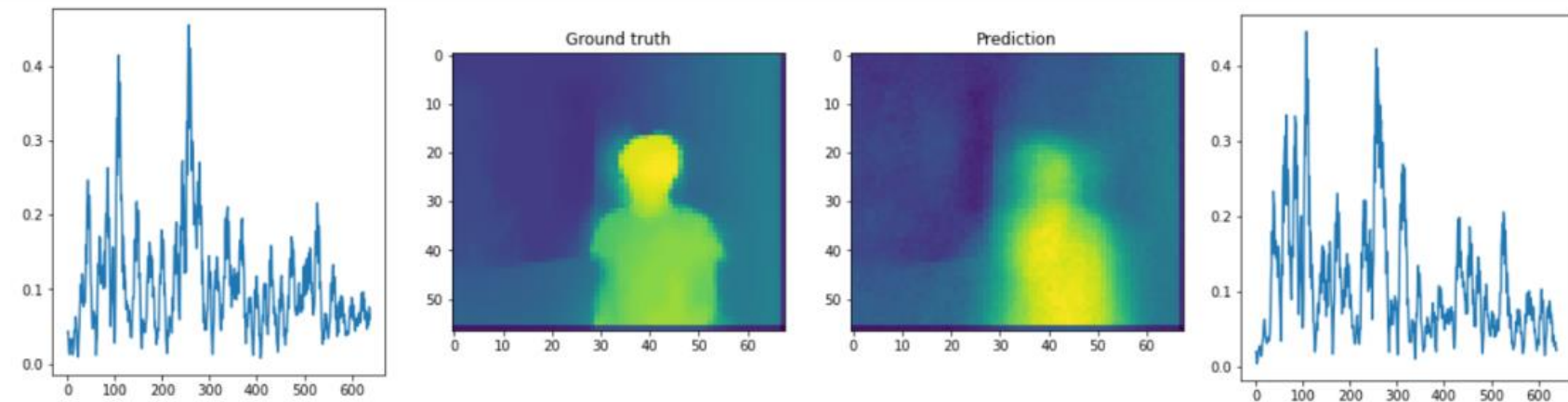


(c) Test set example 1, MLP+Deconv

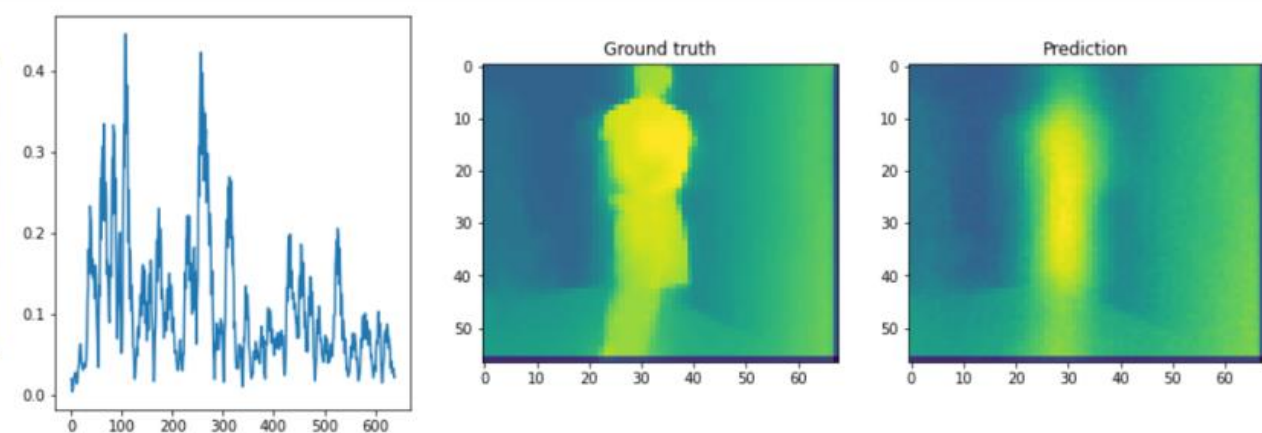


(d) Test set example 2, MLP+Deconv

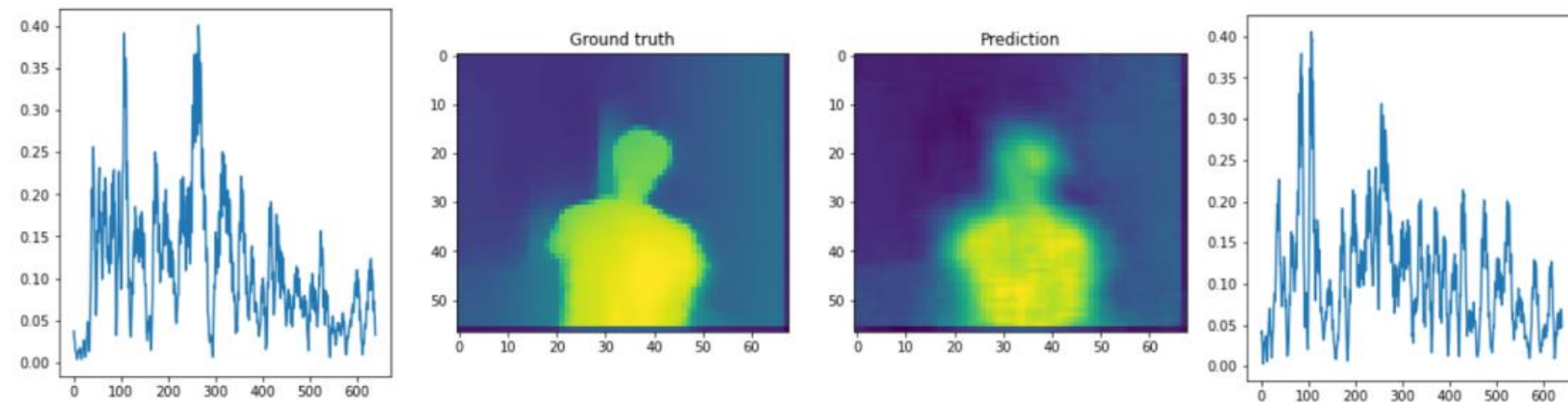
# Dataset A'



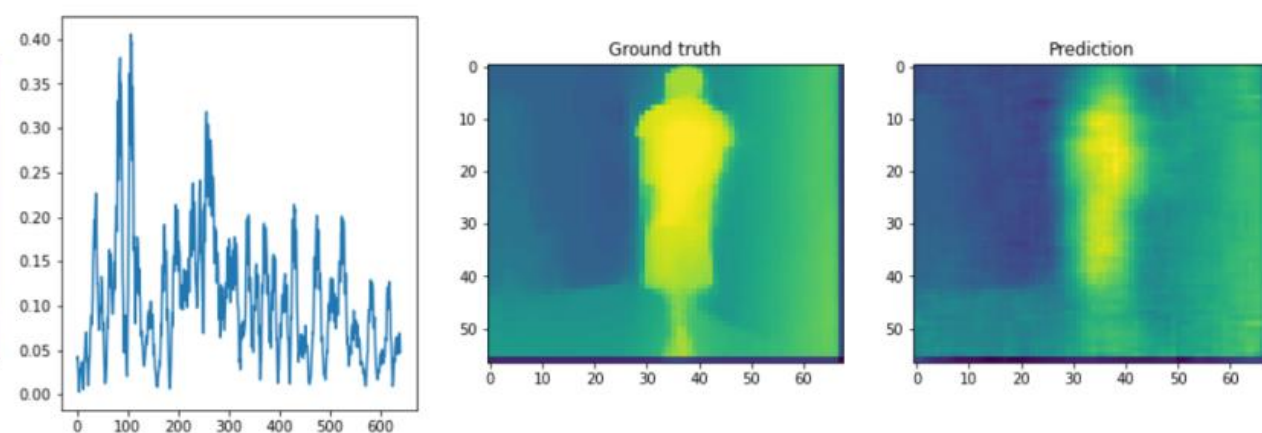
(a) Test set example 1, MLP



(b) Test set example 2, MLP

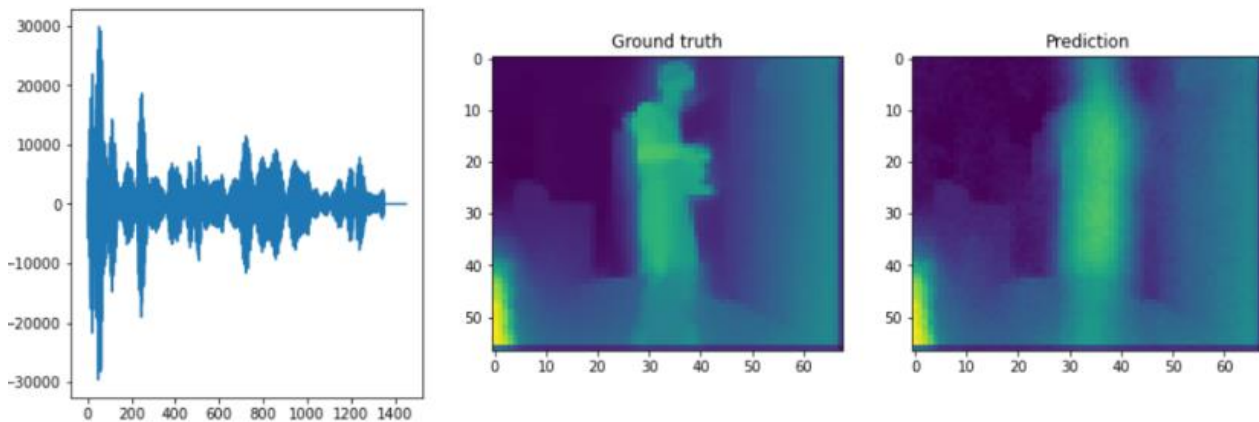


(c) Test set example 1, MLP+Deconv

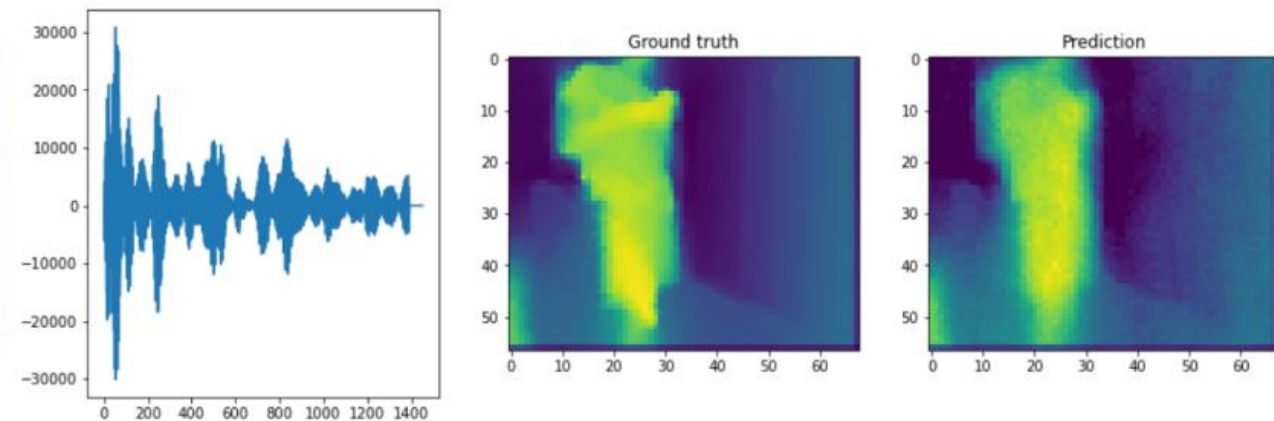


(d) Test set example 2, MLP+Deconv

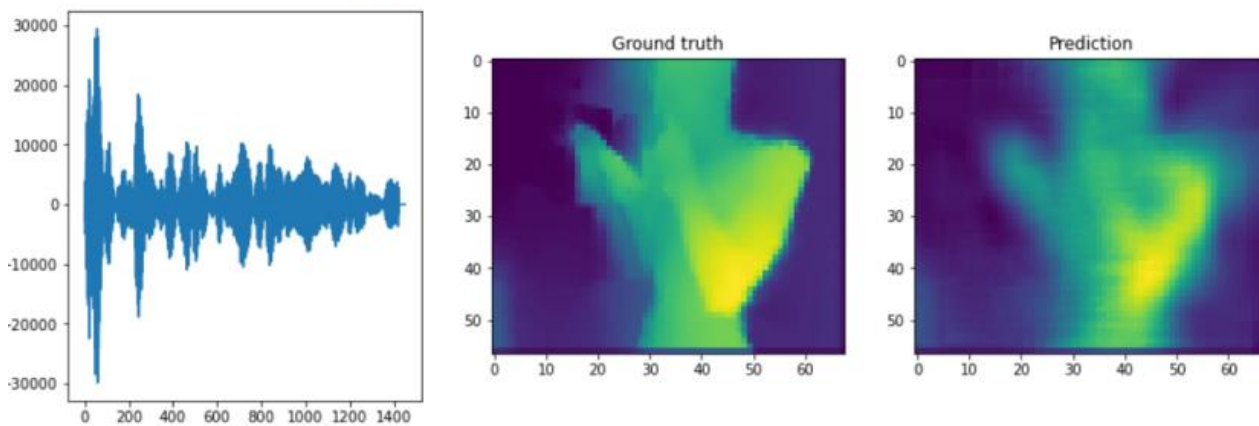
# Dataset B



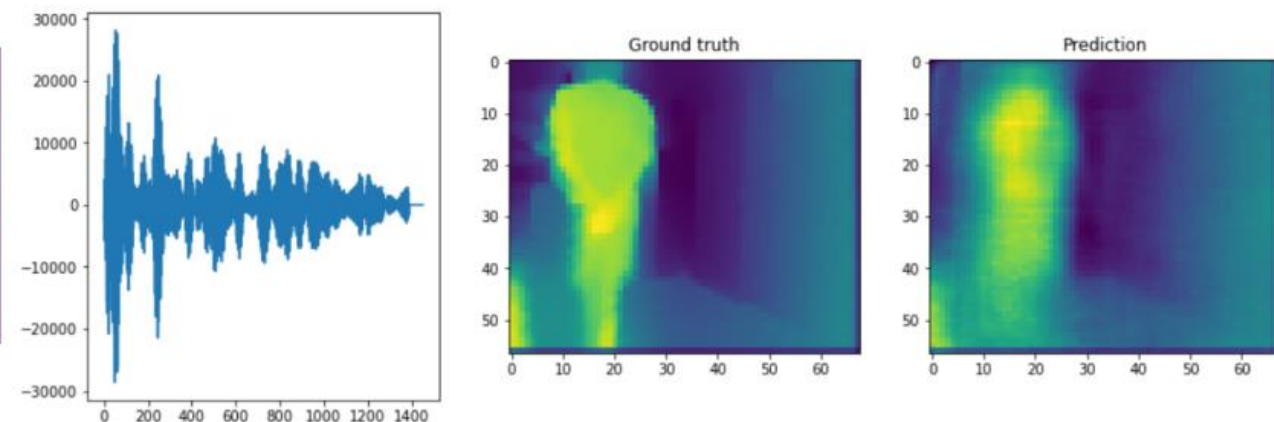
(a) Test set example 1, MLP



(b) Test set example 2, MLP



(c) Test set example 1, MLP+Deconv



(d) Test set example 2, MLP+Deconv

# Metrics on Test Sets

<b>Dataset</b>	<b>Network</b>	<b>Num. params.</b>	<b>MSE</b>	<b>SSIM</b>
A	MLP	23.12e6	0.00088	0.930
A	MLP+Deconv	7.3e6	0.0012	0.901
A'	MLP	4.2e6	0.00093	0.915
A'	MLP+Deconv	2.02e6	0.0011	0.906
B	MLP	14.6e6	0.019	0.720
B	MLP+Deconv	4.3e6	0.021	0.660

**Questions!**