

# Estimation of Clinical Tremor using ST-AAE

Li Zhang\*, Vidya Koesmahargyo, and Isaac Galatzer-Levy\*\*  
AiCure, New York

\* currently at Covera Health

\*\* currently at Facebook

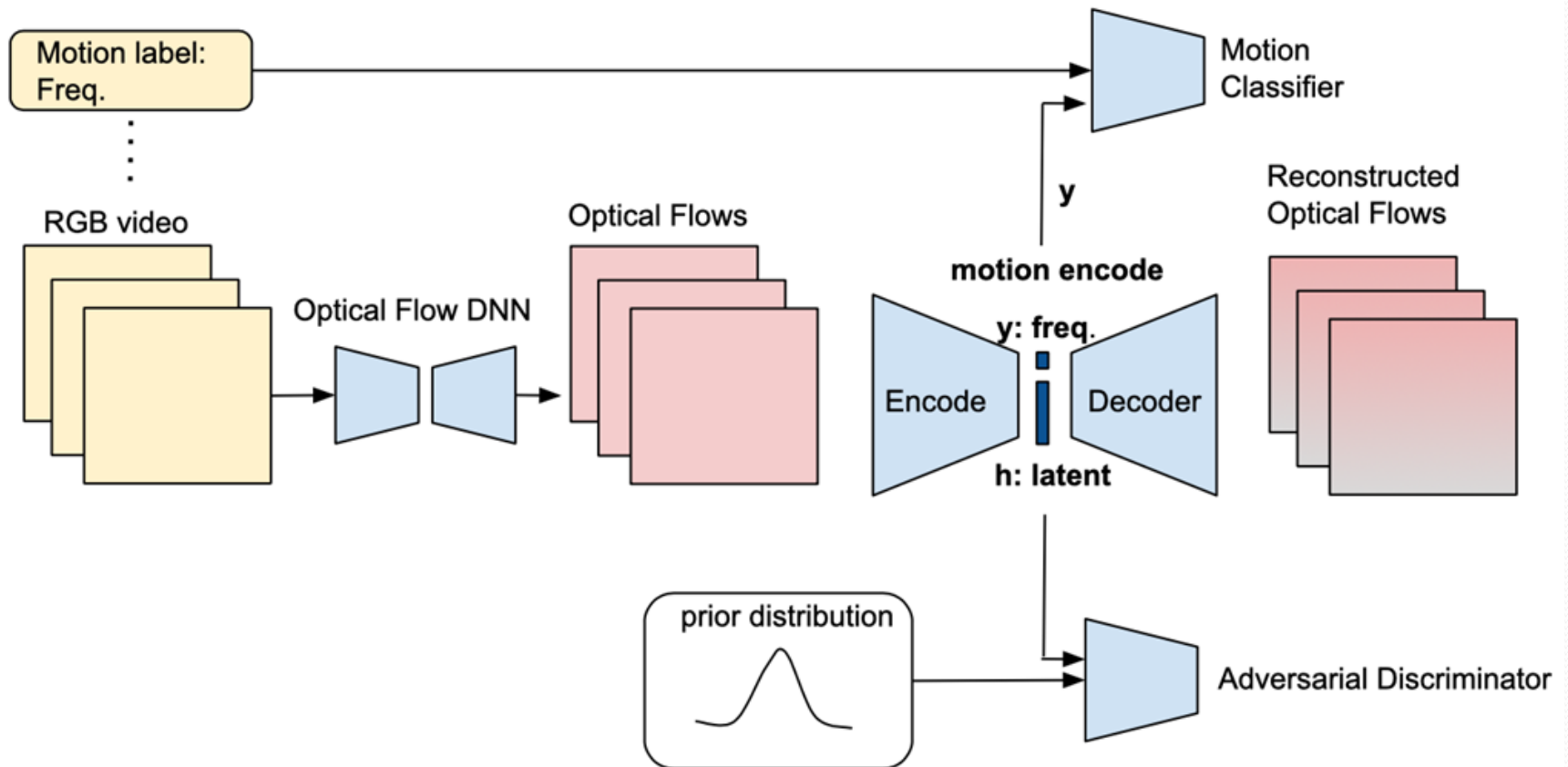
# Background

- Clinical Tremor
  - Rhythmic, involuntary oscillatory movement
  - Diagnostic feature of multiple central system disorders
    - Parkinson's disease
    - essential tremor,
    - medication side effect
- Monitor across diverse population with limited mobility
- Clear value in automated methods for remote assessments

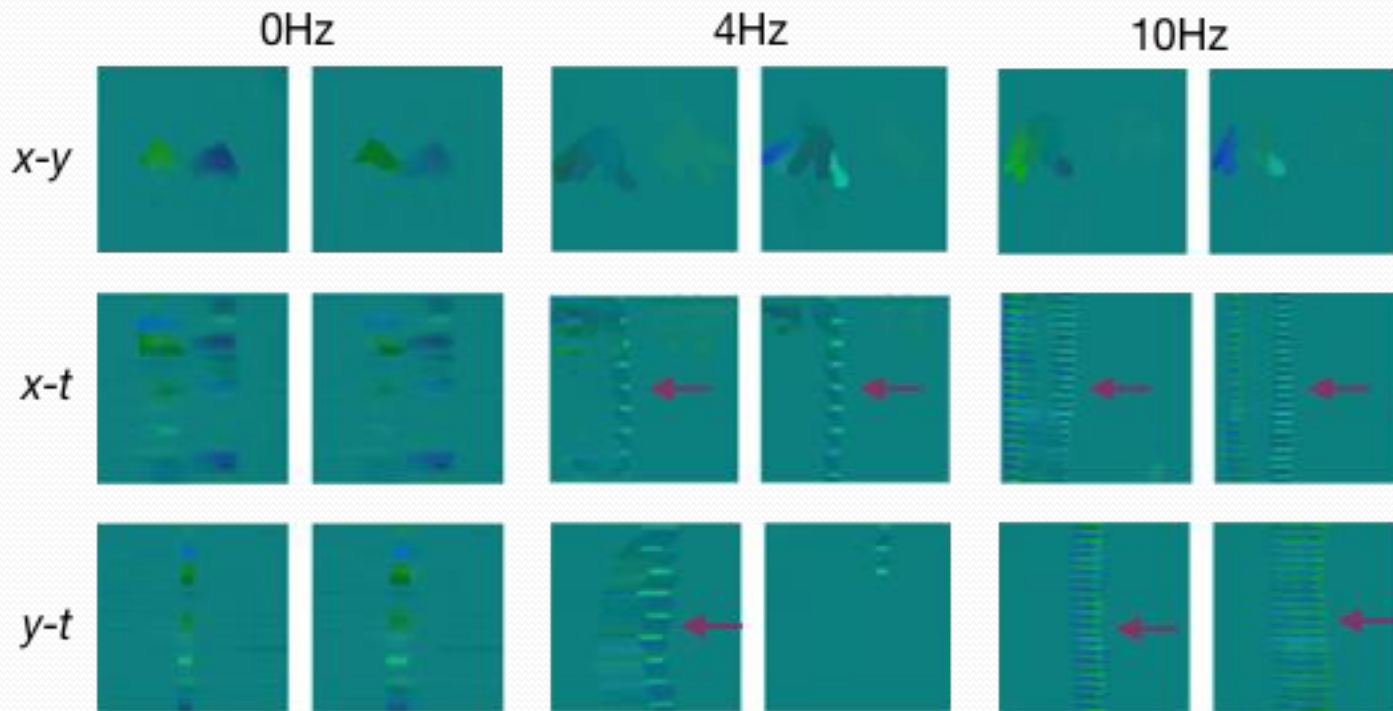
# Why Spatio-Temporal Adversarial AutoEncoder?

- Limitation of hand detection and tracking
  - Bounded by accuracy and robustness of underlying detection
  - Motion blurring, occlusions, and/or complex hand poses
  - End-to-end training frameworks should be more suitable
- Challenge of data collection
  - Very large amount data requires major effort, or not possible
  - Intra- or inter- observer variability
- Spatio-temporal adversarial autoencoder (ST-AAE)
  - Integrates spatial and temporal information
  - Adversarial generative model boosts learning
  - 3D Optical extracts only motion

# Spatio-Temporal AAE for Tremor

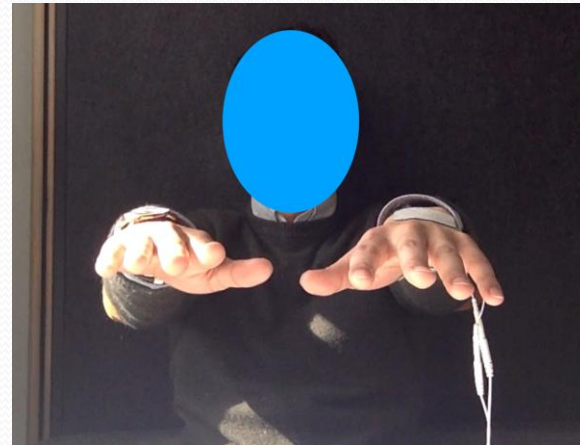


# Optical Flows at Different Frequencies



# Volunteer Data Collection

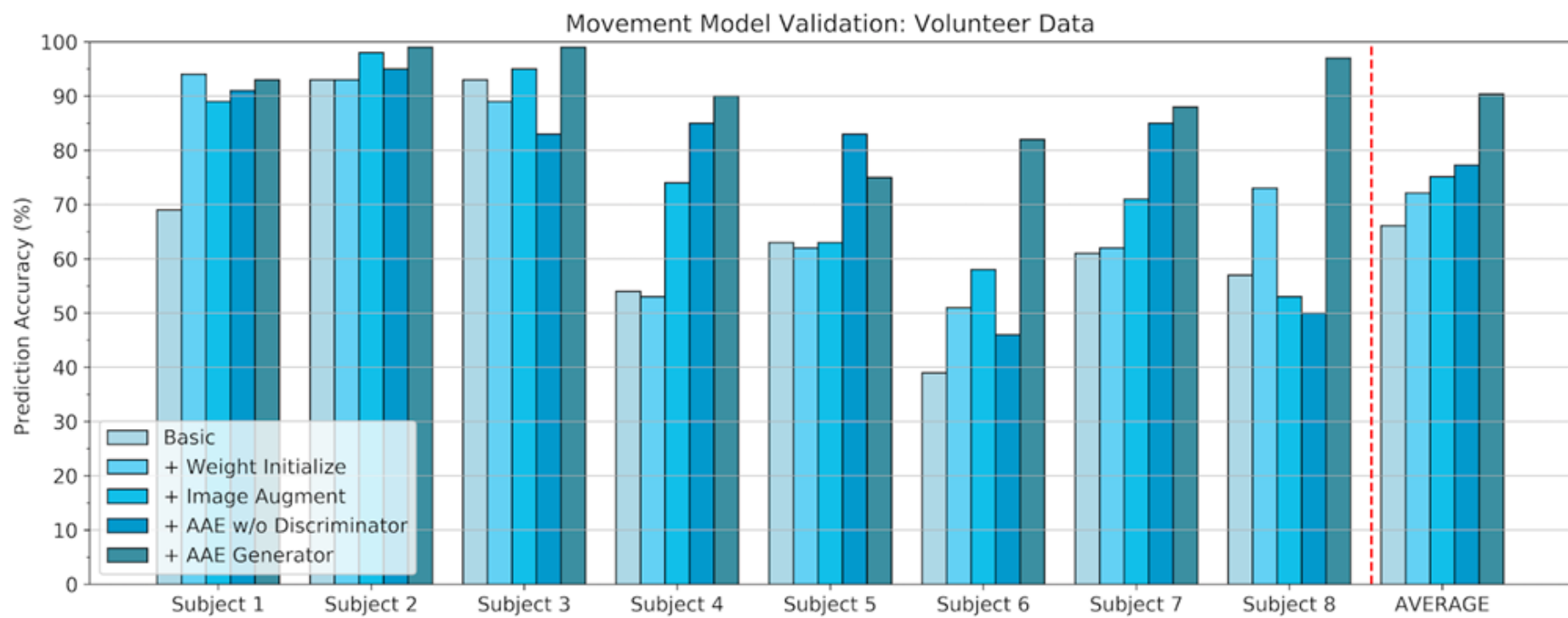
- Simulate tremor using an electronic pulse massager
  - Deliver electrical stimulus to hand via two 2x2 electrodes
- 3 frequencies
  - 0 Hz (no stimulus), 4 Hz, and 10 Hz
- 3068 video segments of 53 videos from 28 subjects
  - each segment of 2 seconds



# Validation on Volunteer Data

- Videos from selected 8 subjects were used to perform ablation study
  - Basic
  - Basic + Weight Initialization
  - Basic + Weight Initialization + Image Augment
  - Basic + Weight Initialization + Image Augment + AutoEncoder (w/o adversarial discriminator)
  - Basic + Weight Initialization + Image Augment + AAE Generator

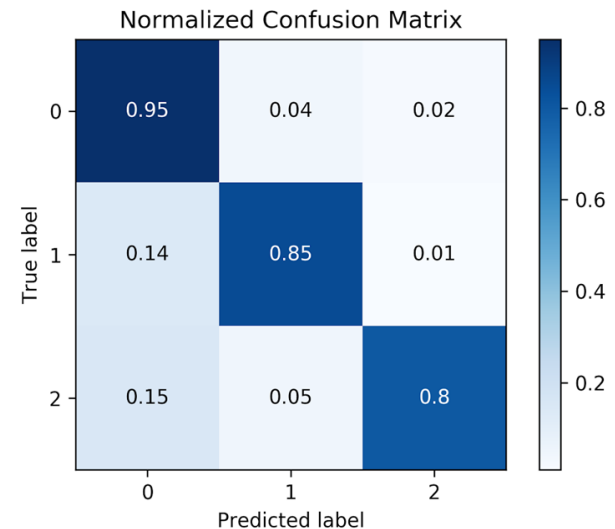
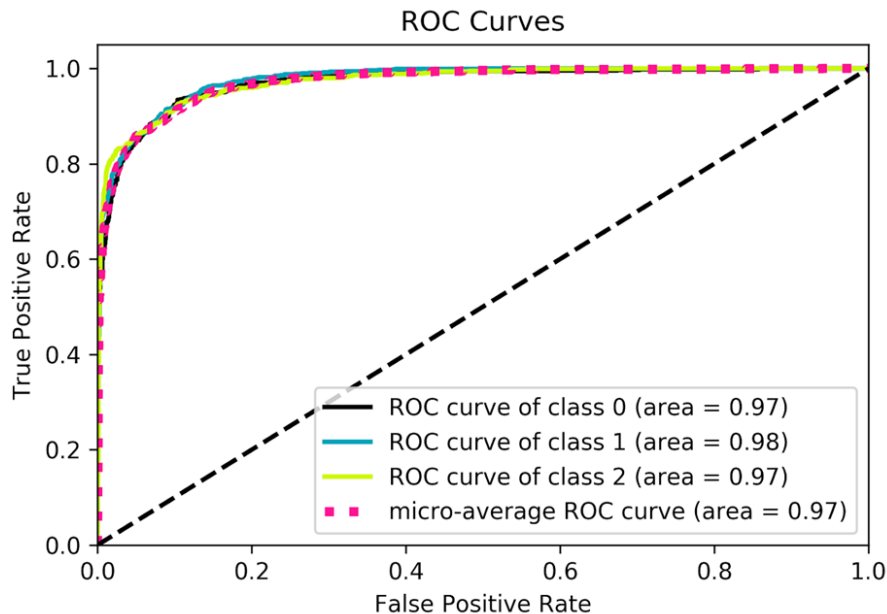
# Results





# Volunteer Data Results

- Leave-one-out cross validation:
  - Testing video segments from one subject
  - Videos from 3-4 subjects in the other subjects were selected as validation data
  - Videos from the remaining subjects were training data

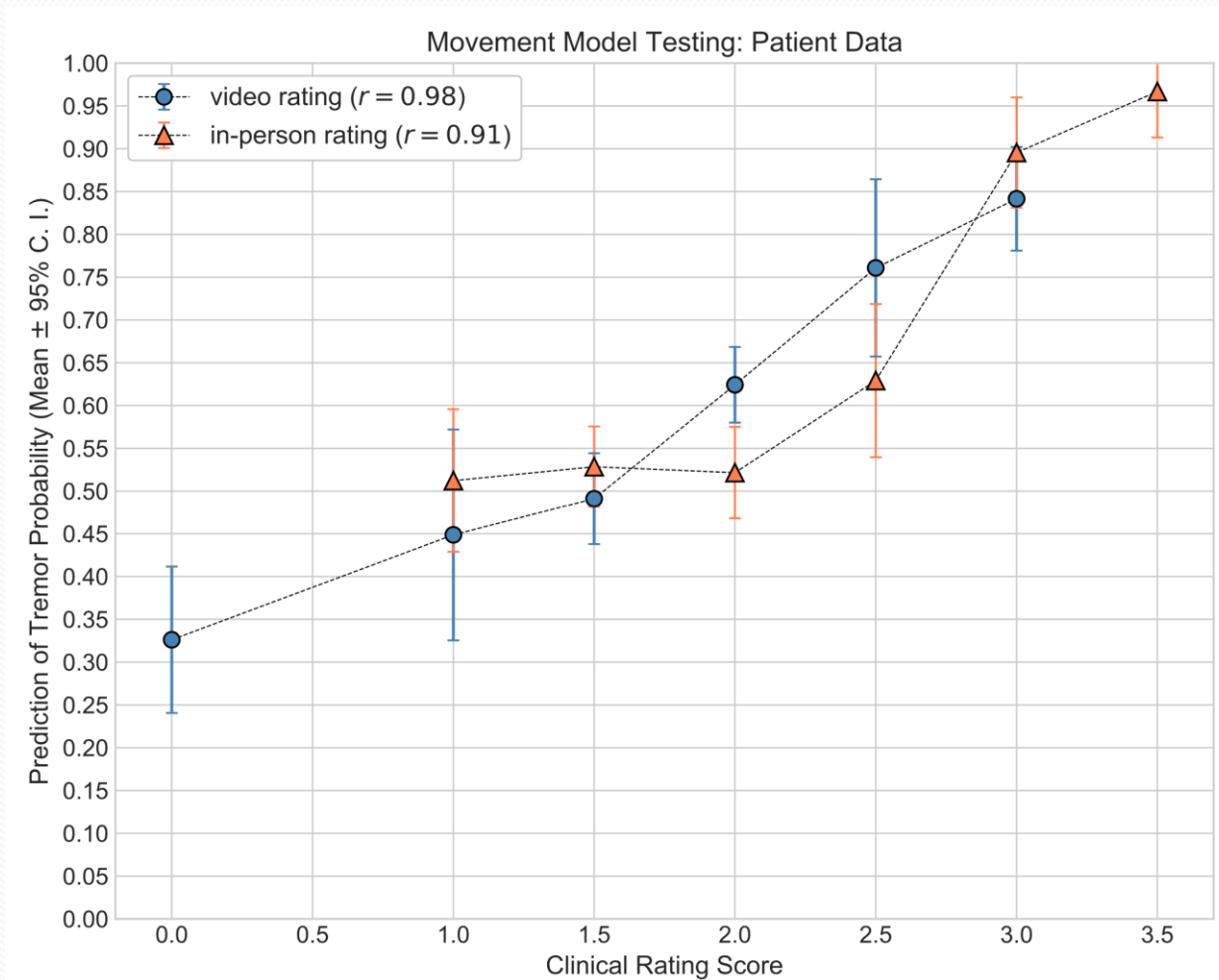


# Validation on Clinical Data

- 33 clinical videos from 9 essential tremor patients
  - Left / right hand
  - Hand forward position
- Clinical videos were coupled with clinical TETRAS scores

Hand	0	1	1.5	2	2.5	3	3.5	4
<b>R-forward</b>	none	barely visible	<1 cm	1- <3 cm	3- <5 cm	5- <10 cm	10-20 cm	>20 cm
<b>L-forward</b>	none	barely visible	<1 cm	1- <3 cm	3- <5 cm	5- <10 cm	10-20 cm	>20 cm

# Results of Clinical Validation



## Conclusion

- ST-AAE can be trained with limited data
- Can be used for a data-driven paradigm of healthcare applications, limiting the raters' impact on reliability and accuracy of assessment

Thank you!