Objective quantification of tic expression in Tourette syndrome patients

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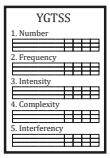
Tourette syndrome (TS)

- A childhood-onset disorder characterized by the presence of involuntary, repetitive stereotyped movements or vocalizations termed tics.
- Tics typically follow a waxing and waning pattern of severity, intensity and frequency.
- Tic expression is modulated by behavioral states and environmental factors.
- Quantifying tic expression can provide insights to the modulation factors influencing tic expression, supply clinicians with a powerful tool for patient follow-up and assist in evaluating the efficacy of current therapeutic options.

Current methods for measuring tics



Yale Global Tic Severity Scale
- Clinician report
- Taken periodically
- Subjective

Video recordings
- Labor intensive
- Observer's perception
- Limited duration

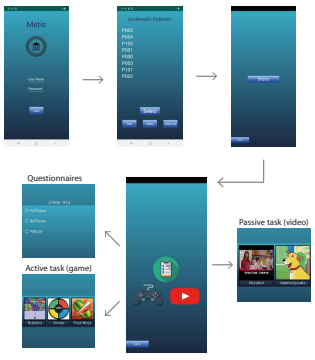
Research goal

To create an automatic objective measure for quantifying tic expression.
This goal is part of a larger project: quantifying behavioral state modulation of tic expression in Tourette syndrome patients.

Experimental setup

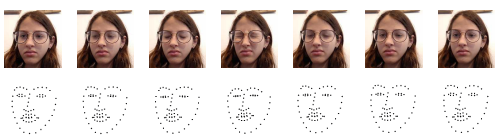
Participants
- 13 patients
- Males and females (≥ 6 years old)
- Chronic motor/vocal tic disorders (TS or other chronic tic disorders)

Sessions
- 42 sessions
- Patient's home
- 1-4 sessions per patient
- 30-60 min per session
- Metis app



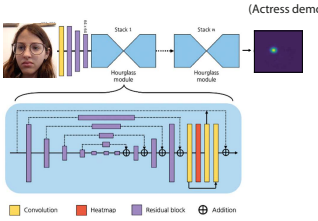
Landmark detection

Neural network for detecting and tracking keypoints on faces to reduce the dimensionality of video data.



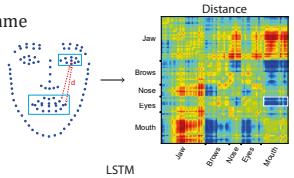
(Actress demonstrating an eye-blink tic)

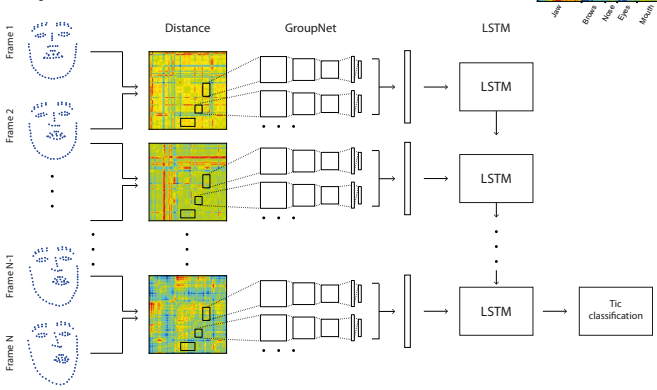
Stacked hourglass network:



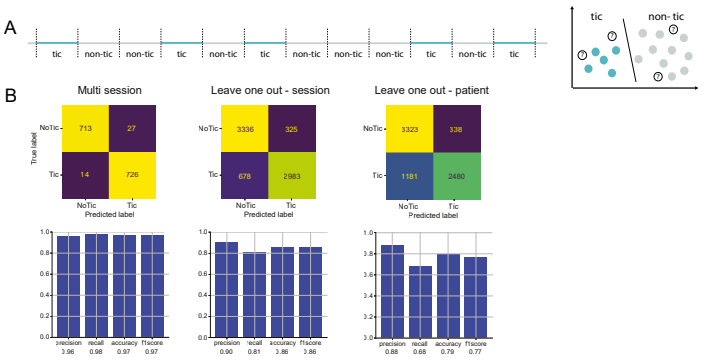
Tic identification using landmark feature maps

- 98-point facial landmarks extracted from each frame
- Two dimentional landmark feature maps
- GroupNet - facial areas related to tics
- Model consists of two stages:
  - Spatial network - GroupNet (multiple CNNs)
  - Temporal network - LSTM

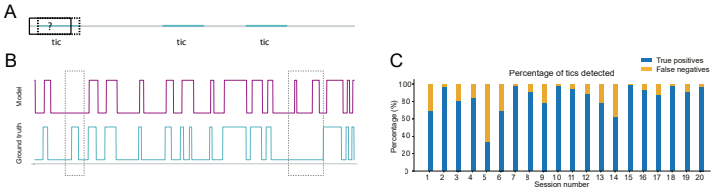




Binary classification



Detection validation over entire video



Summary

- Smartphones provide useful tools for collecting clinical data from natural environments.
- Our current algorithm can detect over 90% of tics from videos.
- Further analysis will include classifying different types of tics, testing the model on new sessions and patients that it has not been trained on, and comparing to other algorithms.
- Contributions of this study will include examining the efficacy of therapeutic options.

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