Quantification of Dynamic Facial Expressions with Shannon Entropy in Human-Humanoid Interaction

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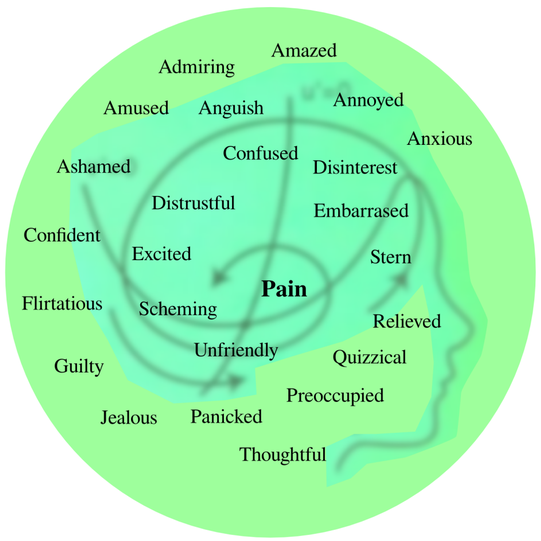
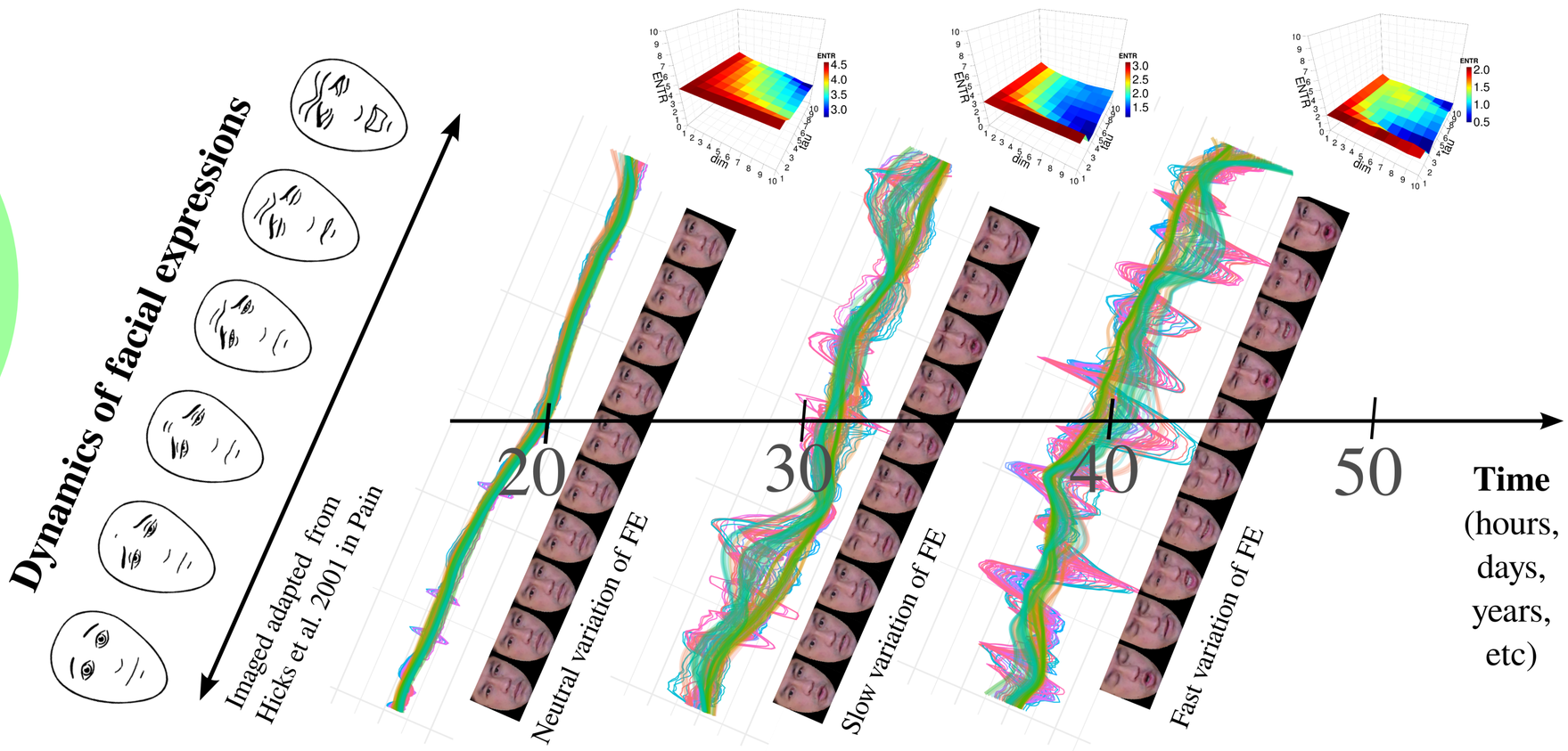
1. INTRODUCTION

Research on understanding and quantifying movement variability with nonlinear analyses has been well established in the last three decades in areas such as biomechanics, sport science, psychology, cognitive science, and neuroscience [1]. This work is hence hypothesising that nonlinear analyses can be used to quantify subtle variations of facial expressions that can be related to different mental states (i.e. pain, distrustful, relief, etc) of a person [2].

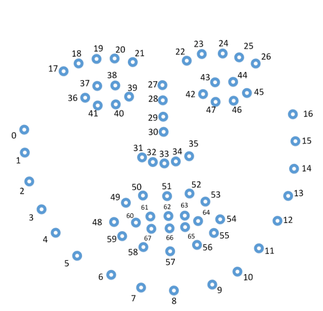


25 Mental States
Imaged adapted from
Izhikevich E. M 2007 and
Back et al. 2014

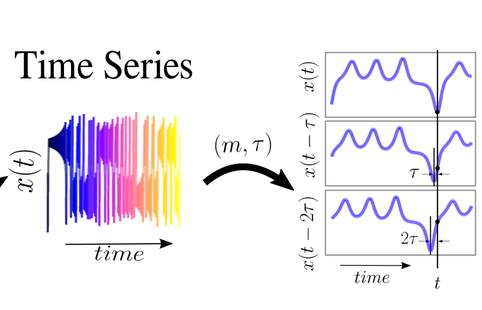


2. RQA ENTROPY

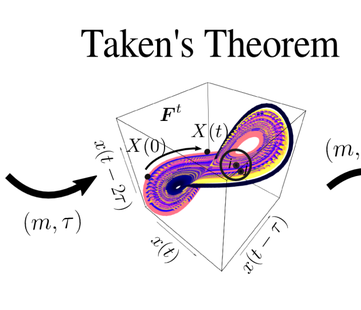
Considering that Recurrence Quantification Analysis (RQA) is a robust tool with real-world data time series (i.e. noisy, nonlinear and nonstatiounary) [3], this work is proposing the application of Shannon Entropy with RQA to quantify the complexity of face expressions landmarks from the openface framework [4].

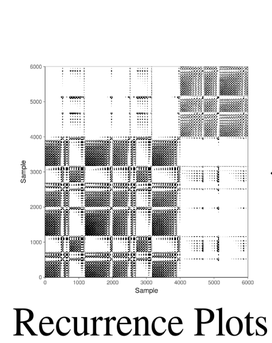


67 Face Landmarks

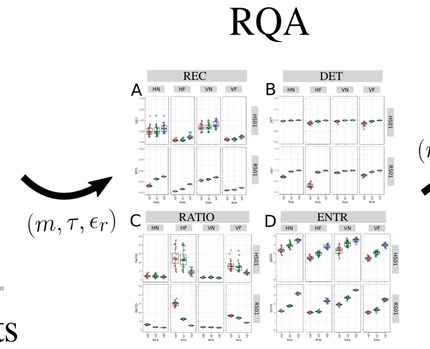


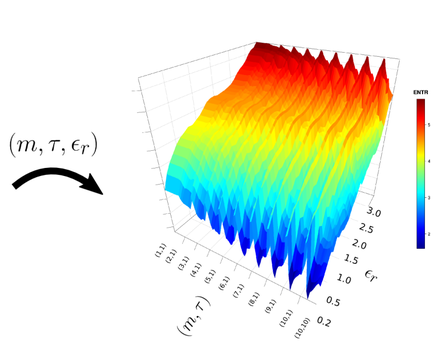
Uniform Time
Delay-Embedding





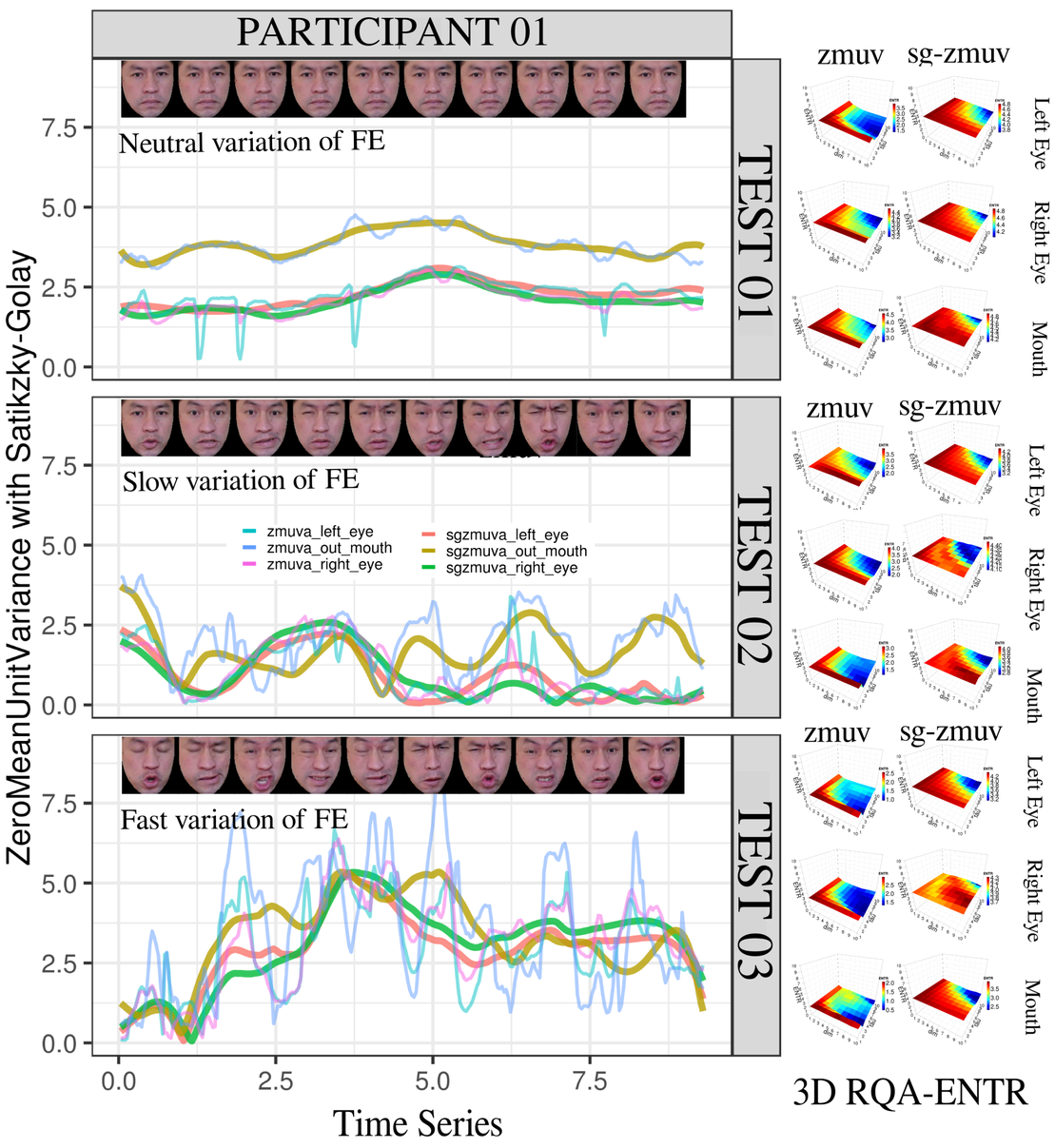
Recurrence Plots





3D RQA-ENTR

3. RESULTS



3D RQA-ENTR

4. APPLICATIONS

5. CONCLUSIONS AND FUTURE WORK

This work showed that Shannon Entropy from RQA can be use to quantify movement variability of face landmarks which can potentially be related to the persons' state of mind. The future work will test the robustness of RQA Entropy with different datasets of face expressions, also different classification techniques will be explored.

6. REFERENCES

[1] **Davids K., Glazier P., Araujo D. and Barlett R.** (2003). Movement systems as dynamical systems. *In Sport Medicine*, 33(4):245-260.
[2] **Back E. and Jordan, T. R.** (2014). Revealing variations in perception of mental states from dynamic facial expressions: A cautionary note. *In PLOS ONE*, 9(1):1-5.
[3] **Baltrusaitis T., Zedah A., Lim Y. and Morency L.** (2018). OpenFace 2.0: Facial behavior analysis toolkit. *In 2018 13th IEEE Conference on Automatic Face and Gesture Recognition*. volume 00, pages 59-66.
[4] **Marwan N., Romano M. C., Thiel M. and Kurths J.** (2007). Recurrence plots for the analysis of complex systems. *In Physics Reports*, 438 (5):237-329.
[5] **Xochicale M.** (2018). Quantification of dynamic facial expressions with Shannon entropy in human-humanoid interaction. In Symposium on Machine Learning and Dynamical Systems. **[https://github.com/mxochicale/mlds2019]**