Quantifying Complexity of Facial Expressions Variability with Nonlinear Dynamics

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Abstract

This proposal will investigate the use of a method from nonlinear dynamics (RQAEnt) to quantify the complexity of face expressions variability and its relationship with mental states (e.g. anxiety, disinterest, relief). The proposal contains two research questions, an introduction to RQAEnt, and a pilot experiment with preliminary results.

1 Introduction

Movement variability is an inherent feature within and between persons. Research on measurement and understanding of movement variability has been well established in the last three decades in areas such as biomechanics, sport science, psychology, cognitive science, neuroscience and recenlty in human-robot interaction [XB18a]. Hence, considering methodologies for movement variability to quantify complexity of facial expressions variablity with its preliminary experiments [XB18b], I am therefore interested in quantifying the complexity of facial expression that one person or multiple persons can present and in researching the subtle variations of facial expressions that can be related to different mental states (e.g. anxiety, disinterest, relief) [BJ14] both in the contex of human-robot interaction. Such interests have led me to ask two research questions for this proposal:

(i) does the quantification of the complexity of facial expressions variability can tell us something about the state of mind of a person?,

(ii) how the quantification of facial expressions can be related with the complexity of facial expressions?.

2 Methods

Considering the work of my Ph.D. thesis where I investigated nonlinear dynamics to quantify movement variability [Xoc18b], I am proposing to apply Recurrence Quantification Analysis (RQA) to provide some answers to the raised questions. RQA computes measurements based on the recurrence points density of diagonal or vertical line structures in Recurrence Plots [MRTK07]. Such measurements of dynamics can determine the dynamics of a system, i.e. the determinism (predictability) or Shannon entropy (complexity). Hence, the use Shannon Entropy with RQA (also known as RQAEntr) can be applied to quantify the complexity of face expressions variations.

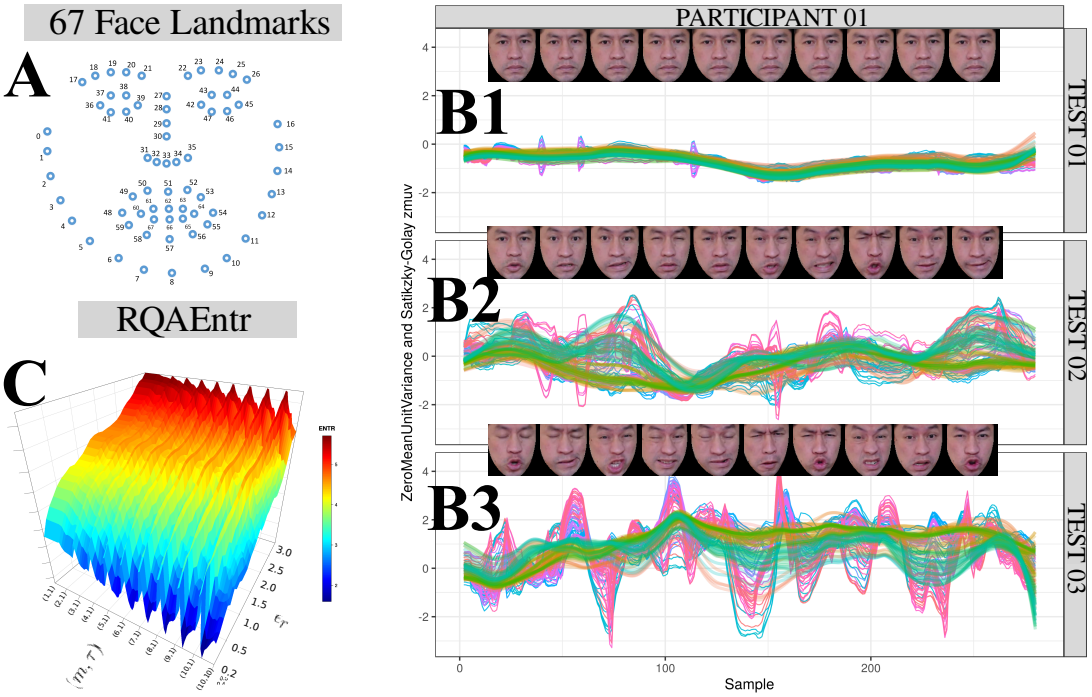

Figure 1: **Dynamics of face landmarks expressions variations. (A)** 67 2D face landmarks (FL) from OpenFace [BZLM18], time series and faces for **(B1)** neutral face expresions, **(B2)** slowly variation of face expresions, **(B3)** faster variation of face expresions, and **(C)** 3D surface of RQAEntr for x 2D landmark position over time. R code to reproduce the figure and the results is available from [Xoc18a].

3 Preliminary results

Fig 1 shows the proposed methodology where one participant (myself) were asked to perform three levels of variation of face expressions: (i) neutral, (ii) slow variation and (iii) faster variations. Figs 1(B) shows the time series from the x 2D landmarks for normalised and smoothed time series. Fig 1(C) shows a 3D surface of the RQAEnt for different embedding values and recurrence thereshodls (see [XB18a] for more about RQAEnt).

References

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