Quantification of Complexity for Facial Expressions with Shannon Entropy

Miguel Xochicale
School of Engineering
University of Birmingham

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Research on measurement and understanding of movement variability with nonlinear analyses has been well established in the last three decades in areas of biomechanics, sport science, psychology, cognitive science, and neuroscience [DGAB03]. Considering nonlinear analyses to quantify complexity of facial expressions, this work is hypothesising that such approach can be used to measure subtle variations of facial expressions in order to quantify different mental states (i.e. anxiety, disinterest, relief, etc) [BJ14]. Such hypothesis has then led the author to ask two research questions:

(i) how the quantification of facial expressions can be related to the complexity of facial expressions?.

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

Hence, with the investigation of nonlinear dynamics to quantify movement variability in human-humanoid interaction [Xoc18], this work is proposing the use of Recurrence Quantification Analysis (RQA) to quantify the complexity of facial expressions to give insights into the raised questions. RQA computes measurements based on the density of recurrence points of diagonal or vertical line structures in Recurrence Plots to provide understanding of the dynamics of a system i.e. the determinism (predictability) or Shannon entropy (complexity) [MRTK07]. Hence, this work presents a pilot experiment of one participant (the author) who were asked to perform three levels of face expressions: (i) neutral variation, (ii) slow variation and (iii) faster variations to show the complexity of facial expressions variability. Then, using 67 face landmarks time-series data collected with OpenFace [BZLM18], this work shows 3D plots of RQA Entr (Shannon entropy) that can be used to quantify the complexity of face expressions and therefore relate such metric to both (i) subtle variations of facial expressions and (ii) the state of mind of a person. Additionally, this work presents applications of the proposed approach in the context of human-humanoid interaction.

References

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