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

Miguel Xochicale
School of Engineering
University of Birmingham

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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 (Davids et al., 2003). This work is hypothesising that nonlinear analyses can be used to quantify subtle variations of facial expressions that can be related to different mental states (i.e. anxiety, disinterest, relief, etc) (Back and Jordan, 2014). This 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?, and

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

In order to give insights into the raised questions, this work is proposing the use of Recurrence Quantification Analysis (RQA) to quantify the complexity of facial expressions which is based on previous investigations of the author with nonlinear dynamics to quantify movement variability in human-humanoid interaction (Xochicale, 2018). RQA computes measurements based on the density of recurrence points of diagonal line structures in the Recurrence Plots. For which, RQA provide understanding of the dynamics of a system i.e. the determinism (predictability of a system) or Shannon entropy (complexity of a system) (Marwan et al., 2007). With that in mind, a pilot experiment is designed to show the complexity of facial expressions variability. In the experiment one participant (the author) were asked to perform three levels of variability of face expressions: (i) neutral variations, (ii) slow variations, and (iii) faster variations. Then, using time-series data of 67 face landmarks collected with OpenFace (Baltrusaitis et al., 2018), 3D plots of RQA Entr (Shannon entropy) were computed in order to quantify the complexity of face expressions and therefore relate 3D plots of RQA Entr to both (i) the subtle variations of facial expressions and (ii) the state of mind of a person. Additionally, this work will present potential applications in the context of human-humanoid interaction for automatic quantification of face expressions that can be related to person's state of mind.

References

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