Multi-Scale Entropy Analysis of Dominance in Social Creative Activities

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ADRESSING THE CHALLENGE

We address the Radvision Challenge 2010 to propose a new metric of the meeting experience. This metric results from our research on the modeling of non-verbal social and creative interactions in small groups. Specifically, our system aims at measuring in real-time the establishment of dominance/leadership within a group, starting from the analysis of behavioral data (e.g., head movement). The coordination of individuals and the work-group effectiveness that may describe central aspects of the meeting experience, are said to be fostered when the roles are clearly distributed within a group (leader/followers) (Turner et al. 2005). The real-time analysis of dominance can thus help evaluating the quality of the meeting experience in this respect.

THE MULTI-SCALE ENTROPY METHOD

Our system followed the approach by Costa et al. (2005), termed multi-scale entropy method (MSE), to define a complexity measurement that focuses on quantifying the information expressed by the body movement dynamics over multiple time scales. At each level of resolution, the multi-scale entropy algorithm yields a value that reflects the non-linear mean rate of creation of information. Preliminary results presented in our paper at the conference show that the emergence of dominance can be retrieved by analyzing the relative complex dynamics of participants' head movements in a social and creative activity such as music. Specifically, the leader appears as the one displaying the less complex behavior in the group and the one which is also the most correlated with the other group members. The leader reveals itself as the one able to "integrate" the others' activity and to decrease the whole entropy of the group. Subjective evaluation of dominance were assessed on Likert Scale in questionnaires submitted to the participants and confirmed our results.

REAL-TIME IMPLEMENTATION

Our system is implemented in the open software platform Eyesweb (Camurri et al, 2005), (www.eyesweb.org, see figure 1) . Standard video tracking techniques are employed to extract the heads center of gravity (COG) in both anteriorposterior (AP) and mediolateral (ML) directions. The MSE algorithm itself comprises two distinct processes : (i) a coarse-graining procedure to represent the system's dynamics at different time scales, and (ii) the quantification of the degree of irregularity of each coarse-grained time series through the application of Sample Entropy (SampEn). Sample Entropy computes the negative average natural logarithm of the conditional probability that subsequences similar for *m* points in the time series remain similar (as defined by Eq. 1) when one more point (*m*+1) is added to those sequences. Small values of SampEn indicate regularity. Similar subsequences (or *template vectors*) of length *m* within the times series are estimated by the correlation sum n_i^m (see Eq (1)):

$$n_i^m = \frac{1}{N-m-1}\sum_{j=1,j\neq i}^{N-m}\Theta\left(r - \left\|u_i(m) - u_j(m)\right\|_\infty\right) \text{ (Eq. 1)}$$

where $u_i(m)$ and $u_j(m)$ are the template vectors of length *m* formed from the standardized original times series, at time *i* and *j* respectively, *N* is the number of samples in the time-series, *r* is the tolerance (or *radius*), Θ is the Heaviside function, and $\|\|_\infty$ is the maximum norm.

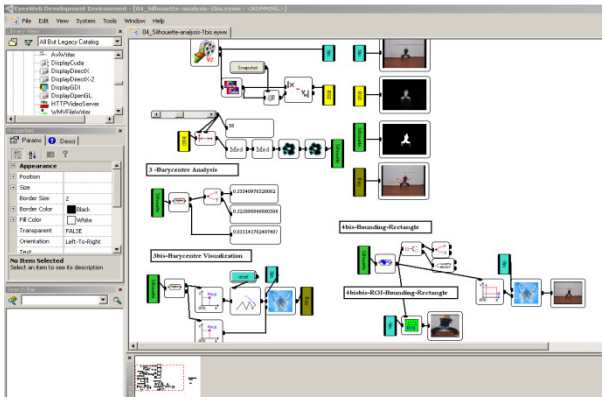

Fig. 1. An EyesWeb application for body movement analysis

INNOVATION

Our system may help the designer and the developer of video-conference applications to have a better understanding of social dynamics at work in a meeting. In particular, the real-time multi-scale entropy algorithm identify when the dominance is exerted within the group. Evaluating the absence of a clear leadership and the resulting impossibility for the participants to find their bearings' may deeply affect the meeting experience. Dominance as a *social* metric may contribute to achieve a fine-grain analysis of networked media applications. It may also support the development of automatic models for regulating creative joint activities and supporting the work out of a successful meeting. Future extension of our system includes the integration of multimodal data (audio-video) in the analysis.