Zero Mean Lag Communication Over Networks: A Route to Co-Presence?

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Introduction

Communication may be thought of as the exchange of coded information, in which case the distinctness of the parties (sender, recipient) is emphasised, and it seems inevitable that we understand there to be a lag between sending, and receiving, a message. This is well known as the conduit metaphor of communication (Reddy, 1979). This metaphor has proved enormously fecund in the development of technologies, from writing to the present day, and it is the informing principle of all speech and language technologies. However in many situations of close encounter, such as dancing a tango, chanting in unison, or cooperating in a handshake, the real-time reciprocal interchanges between parties is continuous, and the roles of sender and receiver collapse onto one another (Cummins, 2014). Real-time reciprocal exchange seems to be a better description of face-to-face interpersonal communication in which engaged parties work cooperatively to establish common ground, and to co-create meaning (De Jaegher and Di Paolo, 2007).

It is easy to demonstrate that current speech and language technologies do not support this type of co-presence. If the reader were to try to recite a common text (prayer, poem, etc) with another over a mobile phone or VoIP link, it will rapidly become clear that the inevitable small transmission delays preclude the reciprocal cybernetic error correction required to stay in synchrony with one another. In our experience, chanting together is barely possible over a conventional phone line with very small transmission delays, and is absolutely impossible over a VoIP link. It might reasonably be argued that there is little need to chant over the phone, as we employ this technology for transmitting novel messages, not to perform shared routines, but this objection simply reinforces the point that communications technologies have been developed with a conduit, rather than a coordinative, metaphor in mind.

We raise here the possibility that there is a veneer of "liveness" missing from interpersonal exchanges mediated by communications technologies informed by the conduit metaphor. We believe that the seemingly inevitable transmission lags drive a wedge between communicating parties such that the strong sense of co-presence, and the construction of an intersubjective common ground, are currently absent. We further suggest that it might be possible to work towards means for generating a strong sense of co-presence in such exchanges. Our hypothesis is that this reciprocity requires the development of zero mean lag communication protocols, and we hope to illustrate how this apparently impossible engineering goal can be met with relatively simple assumptions.

The Mirror Game

In order to work towards an alternative to the conduit metaphor, it is necessary to get away from thinking of joint action as being structured by turns or leader-follower roles. There is some helpful prior art here. Taking inspiration from improvisatory practices in the world of theatre, Noy et al (2011) allowed to participants working in pairs to each manipulate a slider on a short rail with the instruction to imitate each other, generating interesting and improvised synchronised movement. Movement was examined in two conditions.

In leader-follower mode, one player was designated as the leader, and hence was the agentive source of the patterns. In the joint-improvisation condition players interacted with no designated leader. There were two important findings. Firstly, movement patterns generated in the two conditions were of comparable complexity. Secondly, performance was better (i.e. less asynchrony and a wider range of velocities) in the joint-improvisation condition. The authors introduced a reactive-predictive control model in which each participant used a simple model to predict future trajectories of the other.

Co-Presence

We are developing an architecture provisionally called *"Co-Presence"* in which interacting parties jointly execute improvised manual movements that are registered by a Leap Motion controller (Weichert et al., 2013). Our goal is to illustrate the fundamental distinction between lagged communication and zero mean lag communication, in the expectation that only the latter will generate a strong sense of co-presence among participants. Each participant will see a marker on screen corresponding to their own hand position in the vertically oriented X-Y plane, along with another marker corresponding to a *prediction* of the position of the other person's hand, based on the last second or so of motion. Because biological motion is highly constrained (continuity, inertia), short term prediction of the position of the partner's hand based on a short time window of prior observations is eminently possible. Participants will be encouraged to execute joint, synchronised, movements, without differentiation of leader/follower roles. By switching between display modes that do or do not incorporate prediction, it will be possible to determine whether the secret sauce of intersubjective co-presence is noticeable in the joint creation of synchronised movement.

The Co-Presence application is intended to demonstrate proof-of-concept for zero mean lag transmission over networks, by leveraging local prediction within a restricted domain. Future work will seek to extend the domain of joint activity to include speech, thereby facilitating live collective vocalisation in both prayer and protest (and perhaps to cheer on teams). Short-term prediction in the speech domain is a well explored issue, and texts that are chanted do not pose the problem of unexpected lexical content. Later developments may seek to include whole body movement, allowing "live" dancing of shared repertoires over networks.

References

Cummins, F. (2014). Voice, (inter-) subjectivity, and real time recurrent interaction. *Frontiers in Psychology*, 5.

De Jaegher, H. and Di Paolo, E. (2007). Participatory sense-making. *Phenomenology and the Cognitive Sciences*, 6(4):485–507.

Noy, L., Dekel, E., and Alon, U. (2011). The mirror game as a paradigm for studying the dynamics of two people improvising motion together. *Proceedings of the National Academy of Sciences*, 108(52):20947–20952.

Reddy, M. J. (1979). The conduit metaphor: A case of frame conflict in our language about language. *Metaphor and Thought*, 2:164–201.

Weichert, F., Bachmann, D., Rudak, B., and Fisseler, D. (2013). Analysis of the accuracy and robustness of the leap motion controller. *Sensors*, 13(5):6380–6393.