A Novel Computer-Based Set-Up for the Analysis of Group Synchronisation

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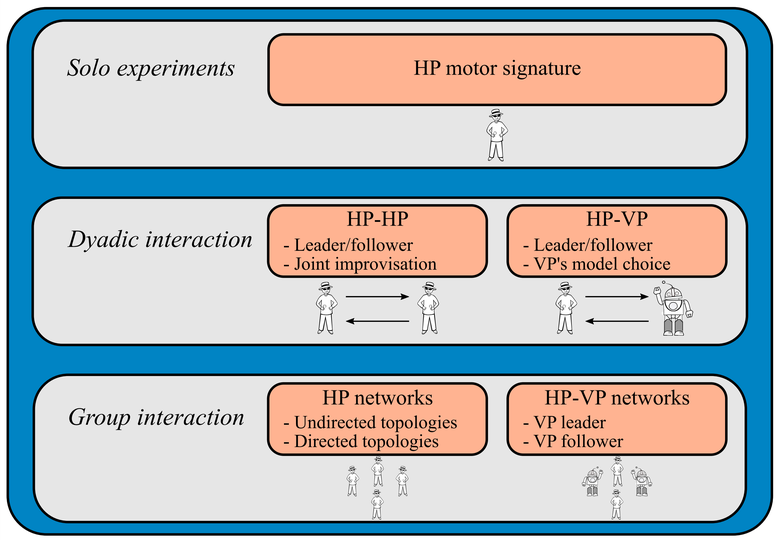
Introduction and Objective 1

- Multiplayer human coordination has been seldom studied in the current literature.
- Only all-to-all topologies, with participants sharing direct visual and auditory coupling, have been considered [1].

- Here, we present a novel computer-based set-up for the study of multi-agent human coordination where:
  - participants can be coupled over **different topologies** of interconnections;
  - **social interaction** is removed;
  - **virtual players** can be introduced [2].

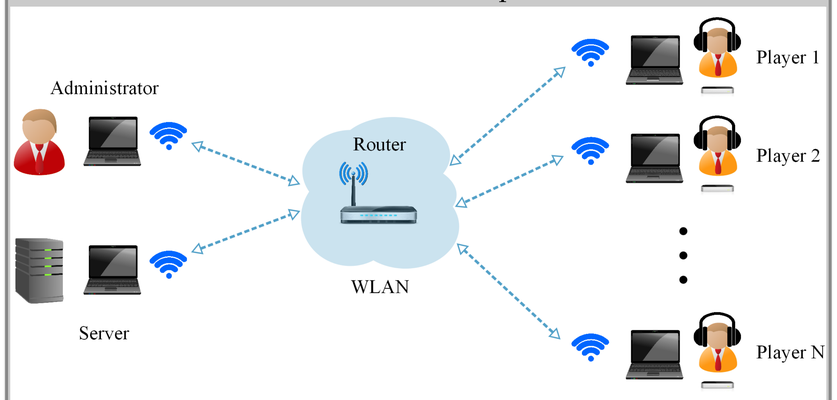
Types of experiments 2



- Human participants (HP) are asked to synchronise the motion of their hand with that of the others they are possibly coupled with.
- Their motor signature [3], recorded in *Solo experiments*, can be used to make virtual players (VP) exhibit human-like kinematic features when interacting.

Computer-based set-up 3

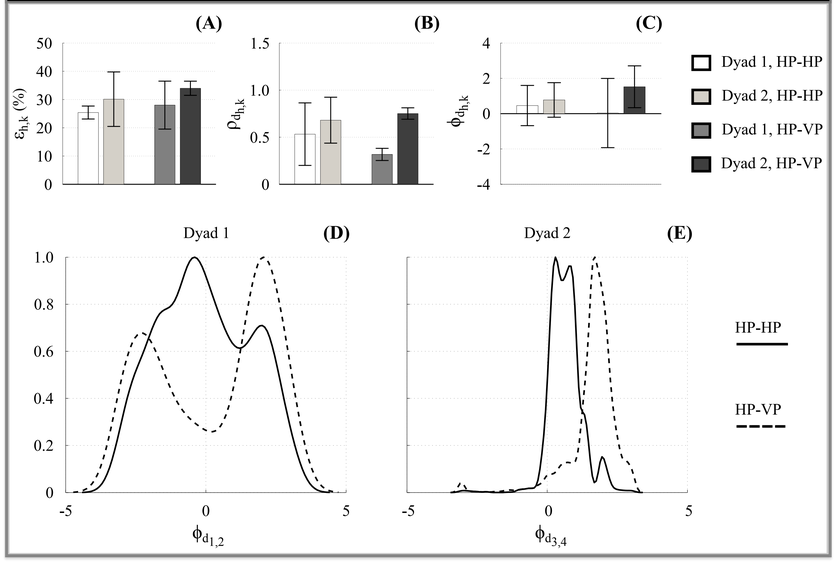
- A motion sensor is used to detect the position of each HP.



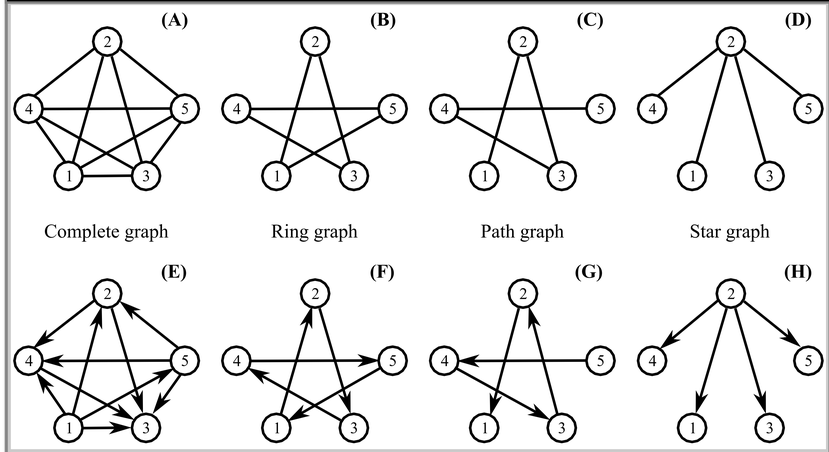
Metrics employed 4

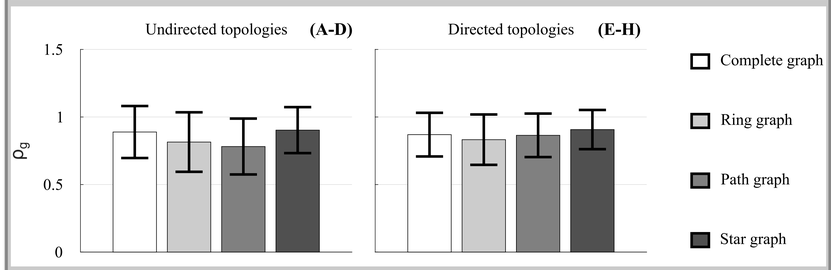
- Relative phase between 2 participants: $\phi_{d_{h,k}} \in [-\pi, +\pi]$
- Dyadic synchronisation between 2 participants: $\rho_{d_{h,k}} \in [0,1]$
- Position error Root-Mean-Square: $\varepsilon_{h,k} \in [0,100]\,(\%)$
- Group synchronisation: $\rho_g \in [0,1]$

Dyadic interaction - experiments 5



Group interaction - experiments 6





Applications 7

- Psychology: it is possible to investigate the effects of social interaction when people coordinate their motion.

- Movement Science: synchronisation tasks can be performed by athletes as training practice for team sports.

- Social Science: on-line gaming enhances social experience.

- Robotics: new artificial agents can be developed and enabled to merge and interact within a group of humans.

[1] Alderisio F., Bardy B. G., & di Bernardo, M. (2016). Entrainment and synchronization in networks of Rayleigh-van der Pol oscillators with diffusive and Haken-Kelso-bunz Couplings. *Biol. Cybern.* **110(2)**.
[2] Zhai C., Alderisio F., Slowinski P., Tsaneva-Atanasova K., & di Bernardo M. (2016). Design of a virtual player for joint improvisation with humans in the mirror game. *PLoS ONE* **11(4)**, e0154361.
[3] Slowinski P., et al. (2016). Dynamic similarity promotes interpersonal coordination in joint action. *J. Roy. Soc. Interface* **13(116)**, 20151093.