Fusion

Full Body Surrogacy for Collaborative Communication

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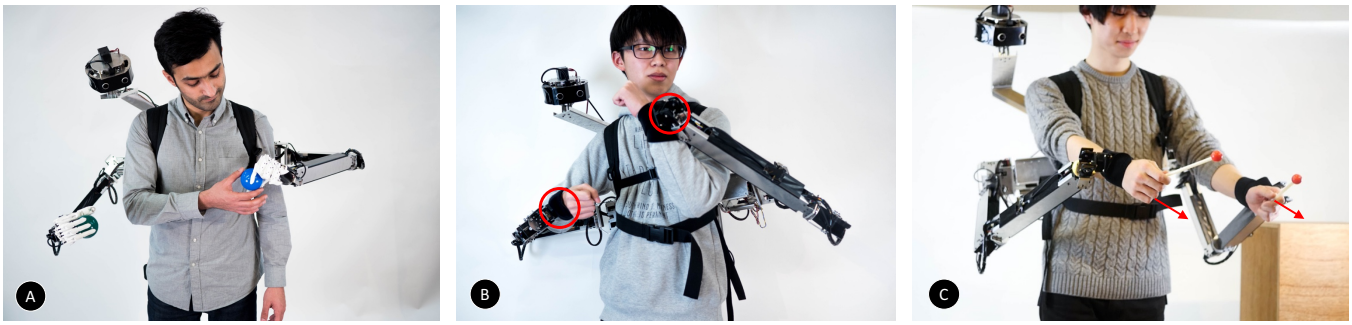

Figure 1: "Fusion" used as a bodily driven communication system of an operator and a surrogate. Three levels of communication are realized: (A) *Direct* actions using gestures and indications, (B) *Enforced* postures by forcing surrogate body to certain positions, and (C) *Induced* motions by altering the perception of body posture (red arrows represent the induced motion).

ABSTRACT

Effective communication is a key factor in social and professional contexts which involve sharing the skills and actions of more than one person. This research proposes a novel system to enable full body sharing over a remotely operated wearable system, allowing one person to dive into someone's else body. "Fusion" enables body surrogacy by sharing the same point of view of two-person: a surrogate and an operator, and it extends the limbs mobility and actions of the operator using two robotic arms mounted on the surrogate body. These arms can be used independently of the surrogate arms for collaborative scenarios or can be linked to surrogate's arms to be used in remote assisting and supporting scenarios. Using Fusion, we realize three levels of bodily driven communication: Direct, Enforced, and Induced. We demonstrate through this system the possibilities of truly embodying and transferring our body actions from one person to another, realizing true body communication.

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CCS CONCEPTS

• **Human-centered computing** → **Collaborative interaction**;
• **Applied computing** → *Telecommunications*;

KEYWORDS

Body Scheme Alternation, Collaborative Systems, Surrogacy

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1 INTRODUCTION

In collaborative and cooperative tasks, effective communication plays an important role in bridging the skills and knowledge between multiple people. A common say: "being in someone's shoes" reflects our need for empathy and understanding the context from someone else's point of view, resolving any ambiguities or challenges of communication.

During our daily communication with others, we rely on direct communications, such as verbal and body language, to express the internal thoughts and experiences. In scenarios which involve motor skills learning and body postural adjustment (e.g. dancing), a

trainer would adjust physical the postural of the trainee by enforcing his body to the correct posture. Also, the trainer might guide the body movement by inducing forces to direct the trainee to follow a certain route or sequence of actions. These three levels of communications: *Directed, Enforced and Induced* are bodily driven, which means they require the active involvement of body actions to communicate our intentions. In remote situations, such collaborative tasks become more challenging due to the lack of means to represent our body actions.

In this research, we present "Fusion", a novel wearable system that can be used to achieve full body surrogacy, producing effective body driven communications. Fusion enables two people to share the same point of view with the capacity to reproduce body motion of an operator into the surrogate, enabling the operator to effectively communicate and collaborate remotely. Figure 1 shows the three levels of communication achieved using Fusion.

2 RELATED WORK

A body of work has explored the use of shared the same point of view of other people for the purpose of remote collaboration. [Kasahara and Rekimoto 2015] realized the concept of Jacking In[1] into someone else's point of view using a mounted omnidirectional camera, allowing others to access one's visual feed and used verbal communication for collaboration. [Lee et al. 2017] uses a similar concept, but also adding the ability to share non-verbal cues in communication using Mixed Reality visual feedback. Such systems provide lightweight solutions for direct communication, however, they do not provide body driven actions towards the remote user. Body action synchronization and matching systems were also proposed to enable muscle control and mapping, such as [Nishida and Suzuki 2016]. Although Electro Muscle Stimulation (EMS) based solutions are promising for motor skills learning and control, however, they still lack the ability to produce continues motion trajectory. Also, such solutions are not suitable for long use due to the fatigue caused to the muscles.

In this work, Fusion, we addressed the previous limitations, while maintaining a high level of portability and accessibility of shared actions for remote collaboration and effective body communication.

3 FUSION OVERVIEW

Fusion, as shown in Figure 2, consists of an operator and a surrogate that are spatially separated. The operator uses off-the-shelf HMD (Oculus CV1) enabling him to access surrogate body. The surrogate mounts a backpack that consists of three axes robotic head with stereo vision and binaural audio, and two anthropomorphic robotic arms (Six Degrees of Freedom) with removable hands shown in Figure 3. The system is mobile, allowing the surrogate to freely move and walk while wearing the backpack, enabling outdoor applications. Fusion, as shown in Figure 1, enables three levels of communication: (A) Direct actions using humanoid hands, (B) Enforced postures by holding and moving surrogate hands, and (C) Induced motions by moving surrogate hands beyond the physical reach stimulating hand grasping effect.

Figure 2: *Fusion* system overview, an operator (left) can access a surrogate (right) to control and perceive feedback.

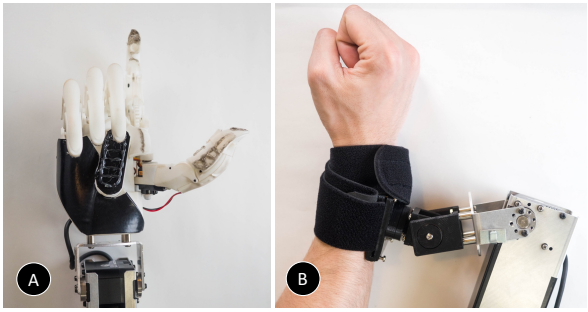

Figure 3: Two types of hands depending on the intended collaboration scenario: (A) humanoid hands for general and independent collaboration, and (B) mounted on surrogate wrists for assistive collaboration.

4 EXPERIENCE

At SIGGRAPH'18, attendees can experience *Fusion* as either of two roles (two attendees at a time): one surrogate, and other as an operator. The operator will be capable to access surrogate's field of view and uses robotic arms remotely as his own. The arms are operated as either collaborative mode (independent arms) or assistive mode (arm ends are linked to surrogate hands). The surrogate will mount Fusion as a backpack, and work with the operator at a different location on cooperative tasks or assistive tasks. A variety of tools will be provided to interact with. Also, auditing attendees can directly interact with the surrogate.

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[1]Referring to the term used by William Gibson's in "Neuromancer".