Designing bodily materialistic representation for effective communication within virtual reality multimedia

Jude Afana

Mixed Reality Lab, Computer Science, University of Nottingham, jude.afana@nottingham.ac.uk

Joseph Marshall

Mixed Reality Lab, Computer Science, University of Nottingham, joe.marshall@nottingham.ac.uk

Paul Tennent

Mixed Reality Lab, Computer Science, University of Nottingham, paul.tennent@nottingham.ac.uk

Physical communication and interaction is a major and essential part of our daily life, it can take many shapes, such as handshakes, hugs, gestures, body language, physical movements classes and much more. This went missing with the outbreak of COVID-19 as people had to socially distance and started working and living online instead. Different online communication software was available, but this lacked physicality. This research aims to explore the possibility and effectiveness of using virtual reality to visualize, support and enhance remote bodily communication. In particular we are interested in whether VR can help us to remotely communicate bodily movements for training of physical skills such as martial arts. We describe here our interviews with expert physical activity trainers, and our planned future work exploring whether adding haptics that represent touch sensations on the body can enrich the remote training experience and make it more engaging and useful for participants.

CCS CONCEPTS • Human-centered computing • Interaction design • Interaction design process and methods

Keywords: Physical, remote, communication, haptics, virtual, reality

1 INTRODUCTION

Virtual reality (VR) has been used as a training method for physical tasks in a range of different fields due to its ‘immersive’ qualities and its ability to simulate different environments - This sense of ‘presence’ has potential to change how people learn new skills [3]. Virtual reality technology has demonstrated a capability to provide engaging ways of learning and simulating real life experiences [7]; it is used as a training method for students and professionals in many fields including kinesiology, military and firefighting [3, 5, 8].

Whilst VR allows users to feel transported from one world to another, its use for communication between multiple people at the same time is bounded by the fact that people have a reduced sense of the bodily configuration and physical actions of the other person. Research has demonstrated the importance of the physical aspects of communication such as eye contact [2], body posture [4] etc. which are poorly supported by current VR communication methods.

Physical touch has always been an important way in which we discover and connect with the world around us. Different textures, materials, temperatures, collisions with other objects and people each have different meanings. Touch is essential in daily life, but when we use computers to connect with each other and the world, we lose that sense of physical touch with others. When it comes to physical training such as martial arts this removes a key source of skill learning. So how can we translate touch without people being physically present around us?

Physical training is not served well by the traditional ‘out-of-body experience’ [6] of VR. Instead, in our work we aim to combine VR presence with a sense of physical embodiment - not just of ourselves, but of others in the space-provided by use of haptic materials. With this work we aim to enable people to feel more engaged and immersed together, and be able to teach and learn physical skills even when they are physically miles away.

2 RESEARCH INTERVIEWS

Our first phase of research was to recruit eight professional instructors from diverse fields of physical training and different cultures but with relevant experiences in terms of being affected by COVID restrictions. They were of the following fields: Kickboxing, Oriental Dance, CrossFit, Drawing, Jujitsu, Rugby, Choreography and MMA.

Interviews were conducted to help us understand how training sessions usually take place, highlight the issues faced when teachers were unable to continue face to face sessions due to the pandemic and how they tried to mitigate these issues. We then discussed what would be required to present a remote training session that serves the main needs, elements and purposes of their teaching practice. Interviews were semi-structured with participants asked about what they do in a session, requirements of their training, how they interact with tutees etc.. We then discussed changes that occurred upon the start of COVID and how it affected their training sessions and their tutees commitment and development.

Afterwards, we transcribed the interviews and conducted inductive Thematic Analysis on the transcribed data. The main themes that emerged from the qualitative analysis conducted are as follows:

1. A detailed walkthrough of the real sessions.
2. The importance of physical presence and how they interact in face-to-face sessions.
3. Online sessions differences: How bodily interaction is reflected in online sessions.
4. How assessment can be done online for physical moves.
5. Suggested solutions that could make it work online.

One key factor in relation to physical touch, our trainers reported that in person they typically provide verbal feedback as a start, but they prefer to use the sense of touch to correct or assess their trainee's movement since it is more direct and has more effective results. They do it either by touching their own bodies to show the trainees where to focus their movements or tapping/moving the trainees' bodies to correct them if the former did not work. For these instructors, lack of ability to physically touch participants was highly detrimental to their work when forced to teach remotely.

3 CONCEPTUAL DESIGNS FOR REMOTE HAPTIC TRAINING

Given our interview finding that physical touch is a key feedback mechanism, our current future work involves the use of a haptic feedback suit to provide sensations of physical touch. We use a Teslasuit (https://teslasuit.io), a full body electro- muscular stimulation (EMS) suit, which allows haptic sensations to be delivered over the torso, arms and legs of a user. Our theory is that we can provide a better teaching and learning experience using the digital sense of touch, for example, you can touch somebody's arm for assessment, or move the elbow to a higher angle, we also think providing different touches in terms of intensity and frequency can mean different results, just as touching is different to moving.

In the case of our focus on martial arts, which is, by itself, an activity can involve pain, our designs consider multiple ways to use haptics to support the learning process; making use of the full stimulation ability of the Teslasuit, ranging from gentle touch sensations to deliberate moving of muscles, all the way up to extreme sensations such as knocking people down or causing pain. With this work we aim to explore how each type of stimulation has the potential to aid people in learning the complex sensory-motor skills involved in martial arts.

In the following sections we describe four types of physical sensations that we will explore with the Teslasuit, and the potential learning opportunities we envisage from each.

3.1 Remote touch

One key way instructors physically interact with trainees is simply to tap body parts to emphasize what they are talking about, and to guide people to move their body in a particular way. The large number of stimulation channels on the

Teslasuit will enable us to allow instructors to physically touch the trainees via a virtual reality avatar. Whilst this could be done visually, our interviews with trainers suggest that the sensation of touch is vital in this kind of training, as it does not require people to look at the touched body part at the same time.

We believe that this kind of physical interaction has strong potential for guiding people's own reflection and practice, and that enabling them to focus on what is most important in a physical motion they are trying to do.

3.2 Body manipulation

If we stimulate specific muscle groups more strongly, it is possible to deliberately alter the position of a person's limbs. This further relates to a teaching style identified by instructors, of physically guiding participants through a motion; the ability of EMS to physically guide bodily motions has been demonstrated on a smaller scale with actions such as playing music [1] or head movements [9]; in this work we aim to enable instructors to guide participants remotely to enable them to understand motions which they cannot achieve with verbal and touch feedback alone.

3.3 Pain

Set to a higher level of stimulation, EMS can stimulate sensations of pain; we understand that military and gaming users of the Teslasuit are using this to simulate bullet impacts. In our work on VR training of martial arts, we would like to use this to enable a key element of feedback during martial arts activities, which is the physical manifestation of failure when you try to evade a hit. This has the potential to enable training of evasive moves and moves which involve moving your body to reduce the level of impact. We suspect there is a significant difference between the experience of evasion when there is a risk of pain as a result of failure and when there is not.

3.4 Falling and recoiling

At high power (approximately 50% of available suit power – we have yet to experiment with higher levels due to safety concerns), stimulation to the user's legs can lead to them falling, and arm or body stimulation can lead to strong recoils in those limbs. These will further extend the ability of the system to train users in martial arts, especially if we are able to direct these falls.

4 CHALLENGES OF REMOTE TOUCH DESIGN

We envisage three key challenges relating to the design and deployment of our planned remote touch designs.

4.1 Calibration and safety

The level of stimulation provided by EMS systems is highly variable due to differences in skin conductivity and muscle strength between users. As such, users must be calibrated to the suit before any experience can take place. This is done in a simple 5 minute calibration process, but does add time to any experience. Furthermore, we must consider the safety of participants; whilst EMS technology itself is relatively safe, it is important to consider carefully elements of the environment that people are in, particularly if we are causing pain or making people fall down. The fact that users will be wearing VR headsets may also cause safety concerns, as physical activities such as martial arts are not usually done with headsets on. We may need to consider safety equipment such as mats or safety clothing to be worn while experiencing the systems.

4.2 Teaching design

We see a range of possibilities for teaching using this kind of system – firstly, there is clearly a pure simulation approach – where we aim to enable teachers to touch learners in as natural a manner as possible; secondly, we have a pure 'stimulation' approach, where teachers have access to EMS tools which allow them to provide targeted feedback in a more instrumental manner. We believe that a range of approaches between these 'stimulation' and 'simulation' approaches may be possible also.

4.3 Automation for asynchronous learning

Participants reported that when they taught remotely during the pandemic, there were also scheduling issues which meant that some participants learnt primarily from pre-recorded video material. In order to support such learning, we think another key challenge is how one might automate such remote-touch feedback, and how instructors might be empowered to design such automated teaching material.

5 CONCLUSIONS - UNDERSTANDING REMOTE TOUCH DESIGN

To understand this work we are planning a series of studies comparing in-person, video, volumetric video and mocap based methods alongside our remote touch designs, to understand the advantages and disadvantages of this technology. We believe it has strong potential to engage participants in a way that may come close to the current gold standard of in-person tuition. Further to this, new modes of tuition which go beyond pure simulation of in-person touch may enable learners to have feedback on their actions which are not even possible in a traditional teaching environment.

REFERENCES

[1] Akifumi Takahashi, Jas Brooks, Hiroyuki Kajimoto, and Pedro Lopes. 2021. Demonstrating How to Increase the Dexterity of Electrical Muscle Stimulation using Back of the Hand Actuation. Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems, Association for Computing Machinery, 1–4.

[2] C. L. Kleinke. 1986. Gaze and eye contact: a research review. Psychological bulletin 100, 1: 78–100.

[3] Denis Pasco. 2013. The Potential of Using Virtual Reality Technology in Physical Activity Settings. Quest -Illinois- National Association for Physical Education in Higher Education- 65: 429–441.

[4] D.S. Sundaram and Cynthia Webster. 2000. The role of nonverbal communication in service encounters. Journal of Services Marketing 14, 5: 378–391.

[5] Emily Shaw, Tessa Roper, Tommy Nilsson, Glyn Lawson, Sue V.G. Cobb, and Daniel Miller. 2019. The Heat is On: Exploring User Behaviour in a Multisensory Virtual Environment for Fire Evacuation. Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, Association for Computing Machinery, 1–13.

[6] Howard Rheingold. 1991. Virtual reality. Simon & Schuster, Inc., USA.

[7] Laura Freina and Michela Ott. 2015. A Literature Review on Immersive Virtual Reality in Education: State Of The Art and Perspectives.

[8] Małgorzata Gawlik-Kobylińska, Paweł Maciejewski, Jacek Lebiedź, and Aneta Wysokińska-Senkus. 2020. Factors Affecting the Effectiveness of Military Training in Virtual Reality Environment. Proceedings of the 2020 9th International Conference on Educational and Information Technology, Association for Computing Machinery, 144–148.

[9] Yudai Tanaka, Jun Nishida, and Pedro Lopes. 2022. Electrical Head Actuation: Enabling Interactive Systems to Directly Manipulate Head Orientation. Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems, Association for Computing Machinery, 1–15.