Superhuman Sports: Applying Human Augmentation to Physical Exercise

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Have you ever imagined flying through the sky like a bird, climbing walls like a spider, or playing fictional sports—such as Quidditch in the *Harry Potter* books? When we're young, we often role-play and pretend we have superpowers. Inspired by these experiences, we started working on what we refer to as *superhuman sports*, focusing on how we might make some of these powers a reality.

We want to create an application area to explore human augmentation and enhance human abilities in a playful way. The field of superhuman sports combines competition and physical elements from traditional sports with technology to overcome the somatic and spatial limitations of our human bodies. The field serves as a fascinating application area for human augmentation.

TOWARD SUPERHUMAN SPORTS

Science—in particular, information technology—is already an integral part of today's sports training and events. However, traditional sports emphasize the achievements of the individual. Sport federations and competitions struggle when it comes to knowing how to deal with the augmented human concept.

Consider, for example, Markus Rehm, an amputated long jumper with a prosthetic right leg. He uses a blade-type leg prosthesis when competing. In 2014, he qualified for the European Championships but wasn't allowed to compete,[1] because his prosthesis was viewed as a violation of the rules, even though it hasn't been proven that the prosthesis gives him a natural advantage; other athletes with similar prostheses didn't perform so well.[2] This illustrates the current direction and challenges of allowing augmented humans to participate in conventional sports.

In contrast, superhuman sports aim to create a field where people compete, overcoming technological—rather than solely human—limitations. The focus is on improving cognitive and physical functions of the human body, creating artificial senses and reflexes to participate in sports competitions. We want to create and explore new experiences with these novel senses and reflexes by augmenting old sports and designing new ones, enhancing sports training, and sharing the experiences with both local and remote audience members.

Superhuman sports exploit human augmentation, using technology to surpass the physical and cognitive restrictions of our bodies and enabling superhuman senses and abilities. The core concepts of superhuman sports include augmenting the body, playing field, training opportunities, and even spectators.

EXAMPLES AND EXPERIENCES

Superhuman sports researchers span a few different disciplines, but most are focused on the fields of augmented and virtual reality, wearable computing, and human-computer interaction. Here, we present some example technologies from these areas.

Body Augmentation

Augmenting the body is the most straightforward notion. The goal is to enhance a sports practitioner's inherent abilities using wearable technologies and implantables.

For example, Skeletonics lets the user climb into a completely mechanical exoskeleton so that he or she can enjoy a different body model and new perspective (see Figure 1a). Bubble Jumper (or Bubble Sumo) deploys a combination of skyrunner stilts and a bubble ball around the player's torso (see Figure 1b). The goal of the sport is to knock over the other player.

Field or Sport Augmentation

Augmenting the playing field aims to make the sports more interesting and enjoyable to play—for example, using projection technologies to indicate where a play ball might go or converting part of a sports field into a virtual ocean. A representative case that one of us (Inami) has worked on is AquaCave,

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(a) (b)

Figure 1. Examples of body augmentation: (a) Skeltonics (http://skeletonics.com) offers mechanical exoskeletons for entertainment, while (b) Bubble Jumper lets participants use stilts and a bubble ball to knock over the opponent.

(a) (b)

Figure 2. An example of a mixed reality sport: (a) Hado and (b) HadoKart, which moves the mixed reality sport into a motor kart scenario.

which enhances the swimming experience by surrounding the swimmer with rear-projection acrylic walls, providing an immersive stereoscopic projection environment.[3]

However, such augmentations can also lead to entirely new sports. One example is Hado (http://meleap.com), where players compete against each other using a head-mounted display for augmented reality and a gesture armband to detect muscle activity and arm movements (see Figure 2). Hado is already a commercial sport in Japan, marketed by Meleap Inc. These mixed-reality experiences serve as an inspiration to create new sports.

Another example that one of us (Inami) has worked on, involving more toward state-of-the-art research, is SpiderVision,[4] a wearable device that can extend the field of human vision. SpiderVision merges the view from front and back cameras on a VR headset to inform users about activities happening behind them (see Figure 3). Having 360-degree vision is a valuable skill for any complex team sport (from football to synchronized swimming), where formation and relative positioning of players to each other matters.

Training Augmentation

Augmented training deploys information technology to improve training and enhance the inherent capabilities of professional and amateur sports practitioners—for example, using electric muscle stimulation to build up specific muscle regions or transcranial direct current stimulation to improve hand-eye coordination or other motor tasks.

Another project one of us (Kunze) is exploring aims to alter the clues in our

HUMAN AUGMENTATION

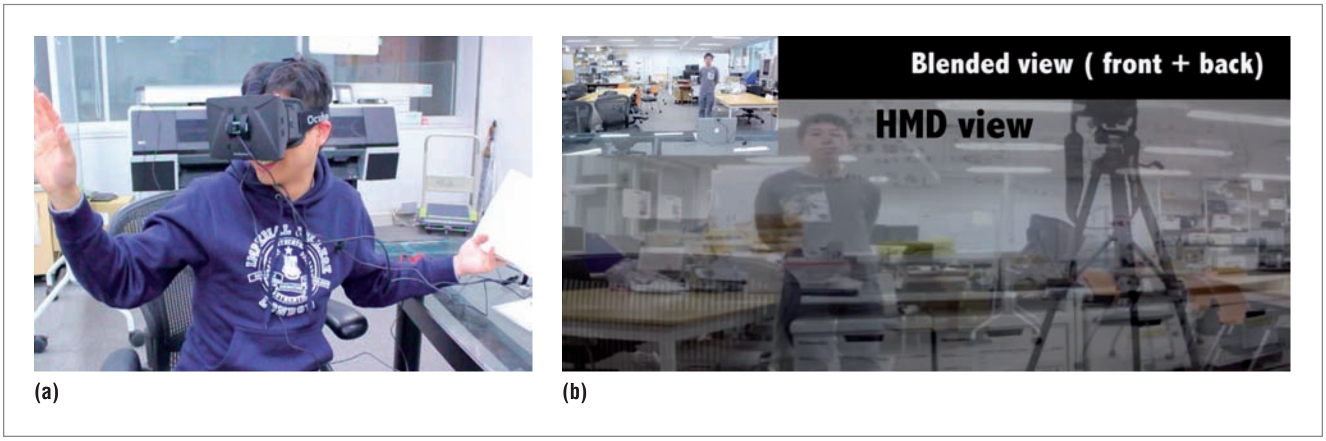


Figure 3. SpiderVision: (a) the VR headset with rear and front cameras can (b) blend the view of both for the user.

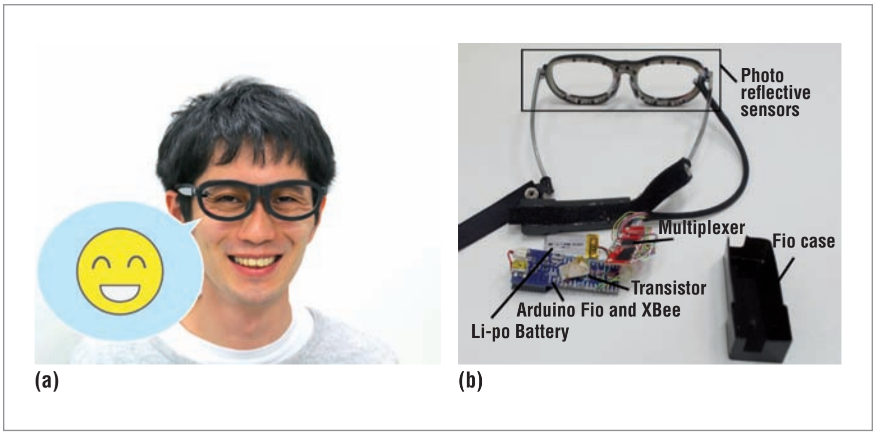


Figure 4. AffectiveWear: tracking facial expression of sport spectators using smart glasses.[8]

perception using smart glasses that influence our motions using projections in our peripheral vision.[5] So far, the smart glasses apply the principle of a "vection field" to alter the speed of a person walking. Future prototypes might also encourage slight changes in direction. To give a couple of examples, the technology could be used during running competitions to regulate and find the optimal pace of an athlete. In training situations, we could teach athletes to perform movements (such as changes in direction) with precise timing.

More invasive and futuristic is the use of galvanic vestibular stimulation (GVS) to alter a practitioner's movements. GVS stimulates the vestibular system using a weak current behind the user's ear. This influences the sense of equilibrium so the user feels like falling toward the anode. GVS can be used to "steer" people and influence the user's perception of speed.[6] This technology can augment any sport relying on a sense of balance or velocity. Take skiing as an example—applying GVS in a training situation could better stabilize the athletes and help them determine the best body posture relative to the ski slope.

Spectator Augmentation

Augmenting "cheering" focuses on new experiences for those watching a sporting event. For example, those in the crowd might feel the adrenaline rush of an athlete before scoring an important point, or they might experience the exhaustion of a marathon runner just before he or she crosses the finish line.

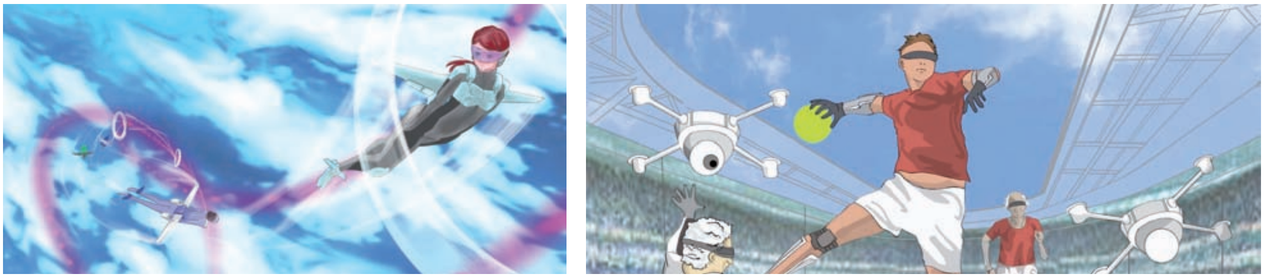
JackIn Head is a new device that one of us (Rekimoto) is working on that has given users an immersive 360-degree camera view from the sport practitioner's perspective, with minimal setup.[7]

Moving away from sharing basic vision and sound, new technologies can help share the "affect" of the sport. For example, two of us (Kunze and Inami) are working on AffectiveWear smart glasses, which can detect the user's facial expressions by monitoring the distance between glasses frame and face using photo-reflective sensors (see Figure 4).[8] AffectiveWear can aggregate the facial expressions of spectators to help organizers evaluate a sporting event and to offer a more crowd-like experience for home viewers with virtual cheers.

On another level, haptic feedback can provide more immersion while watching sports competitions. For instance, the Synesthesia Suit (a project Minamizawa is researching) gives an immersive embodied VR experience with 24 vibro-tactile actuators distributed over the entire body.[9]

LOOKING TOWARD THE 2020 OLYMPICS

To promote the concept of superhuman sports, we founded the Superhuman Sports Society in Japan in 2015. The early activities included ideation workshops with designers, art schools, and the general public working on concepts for novel sports (see Figure 5). In the next stage, we're holding workshops and hackathons to test technologies and create experiences. We already successfully held a Superhuman Sports Expo and several Superhuman Sports Games events, where the broader public tried



(a) (b)

Figure 5. Working on concepts for novel sports—two pieces from ideation workshops: (a) fusing the human dream of flying with a competitive superhuman sport and (b) augmented sports involving all people disregarding age, physical ability, and cognitive skills overcoming our bodies' limitations.

out the novel sport designs, including Bubble Jumper and Hado.

For Tokyo 2020, we're creating a superhuman sports culture. Through these efforts, we're not only creating new sports and augmenting players, fields, training opportunities, and spectators; we're also educating creators of future superhuman sports.

The next steps include preparing for the first superhuman sports tournament this year and moving slowly from amateur to professional players. For 2018, a superhuman sports competition is scheduled to be included in the National Sports Festival in Fukui, and we're in preparations to host a Superhuman Design Competition at TU Delft at the end of 2019 (contact us at s.g.lukosch@tudelft.nl if you're interested in participating). Finally, in 2020, we plan to hold a National Superhuman Sports Championship, and we eventually hope to make such events international.

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