**2. Literature Survey**

**[1]Patel, K., Bailenson, J.N., Hack-Jung, S., Diankov , R., & Bajcsy , R. (2006). The effects of fully immersive virtual reality on the learning of physical tasks. Proceedings of PRESENCE 2006: The 9th Annual International Workshop on Presence. August 24 – 26, Cleveland, Ohio, USA. Retrieved October 20, 2015.**

Fully immersive virtual settings are different from traditional virtual reality settings in that they are able to capture full body motion. This ability allows people to use their full range of physical motion to interact with other avatars, computer controlled agents, and objects in the virtual environment. As such, fully immersive virtual reality presents a novel mediated learning environment in which people can learn physical activities. Capturing human motion for virtual settings has traditionally been a modelbased approach where a few degrees (on the order of tens) of freedom are mapped to virtual model.

In contrast, we use an image-based solution that sacrifices visual fidelity for motion fidelity and increased degrees of freedom (on the order of hundreds). Due to the difficulties involved with building such an image-based immersive system, very little work has been done to assess the effectiveness of this form of mediated learning. In the current work, participants were taught several tai chi moves in either a 2D video system or a 3D immersive system equipped with features not possible to implement in traditional video systems. We demonstrated via blind coder ratings that people learned more in the immersive virtual reality system than in the 2D video system, and via self-report ratings the social presence was higher as well. We discuss these findings and the resulting implications for designing and testing fully immersive systems.

Some virtual systems have proven successful for learning , most VR systems lack the ability to capture the user’s full range of motion, limiting their ability to fully immerse the user in the virtual setting. In contrast, fully immersive virtual reality allows for full mobility by capturing human motion and reproducing the same motion in the virtual representation. Full immersion is crucial to any type of learning activity that involves any type of body coordination such as medical training for surgery, learning physical therapy exercises, recreational activities (e.g., martial arts, dance, yoga), and manual skills (e.g., repair, combat training).

Recent advances in computer graphics, computer vision, motion capture, and computer power have made it possible to build systems that allow us to assess the effectiveness of fully immersive virtual reality [4, 5].

Full immersion can be achieved though model-based techniques (e.g., capturing a few degrees of freedom and reproducing the captured human motion in a 3D avatar) or image-based techniques (e.g., creating a model of the human from large scale camera arrays and computer vision).

Image based methods provide higher degrees of freedom and more accurate representations of the individual at the expense of model quality. Since empirical data supports the notion that motion fidelity is more important and visual fidelity [6], we believe an imaged based methods are most promising for learning fully body motions. In the current study, we compare learning in an imagebased fully immersive VR to instructional videos, the current ubiquitous method of learning full body motion without human interaction. Video-based learning [7, 8] is a good example of mediated learning since it affords instruction ondemand. Videos have a particular advantage over books in that they allow the user to view live, fluid motion of an expert performing a motion. By aggregating the results from 63 separate papers, McNeal and Nelson [9] show that across many different contexts video is a more effective form of instruction than books.

Immersive virtual reality extends the affordances of video, allowing the user to enter the same world as the teacher. First, immersive settings allow users to see in full three dimensions, greatly increasing detail, presence (i.e., learners feel psychologically as if they are in the digital learning environment, as opposed to the physical space [10, 11]), and social presence (i.e., they feel as if the digital reconstruction of the instructor is a real person [12]). Second, as opposed to stationary video, immersive virtual settings allow users to control how they view the environment by allowing them to change aspects such as camera position and orientation. Third, video settings only allow users to watch the instructor; immersive virtual reality allows the user to interact with the instructor and the environment, as well as to perform novel functions such as sharing body space with the instructor. In the current work, we compare image-based immersive technology and the established video training tools in their effectiveness in teaching tai chi. We choose tai chi as the learning context because it involves complicated full-body motion and provides clear guidelines for correct performance, and previous work on model-based fully immersive virtual reality has utilized similar learning content

Changes in technology can be assessed to discover their effects on learning physical motion. As interactivity and realism of our environment increases, we hope to bridge the gap between learning from a virtual teacher, in a virtual environment, to learning from face-to-face interaction with a real teacher. In the current work, we have demonstrated persuasive evidence that immersive virtual reality provides better learning of physical movements than a twodimensional video. As technology, and our understanding of how to use that technology, improves we should see larger gains in learning from virtual reality.

**[2].Wijnand A. IJsselsteijn\* Yvonne A. W. de Kort Antal Haans Eindhoven University of Technology Department of Technology Management Human-Technology Interaction Group Presence, Vol. 15, No. 4, August 2006, 455-464 © 2006 by the Massachusetts Institute of TechnologyThe Rubber Hand Illusion in Reality, Virtual Reality, and Mixed Reality.**

This paper presents a ﬁrst study in which a recently reported intermodal perceptual illusion known as the rubber hand illusion is experimentally investigated under mediated conditions. When one’s own hand is placed out of view and a visible fake hand is repeatedly stroked and tapped in synchrony with the unseen hand, subjects report a strong sense in which the fake hand is experienced as part of their own body. In our experiment, we investigated this illusion under three conditions: (i) unmediated condition, replicating the original paradigm, (ii) virtual reality (VR) condition, where both the fake hand and its stimulation were projected on the table in front of the participant, and (iii) mixed reality (MR) condition, where the fake hand was projected, but its stimulation was unmediated. Dependent measures included self-report (open-ended and questionnaire-based) and drift, that is, the offset between the felt position of the hidden hand and its actual position. As expected, the unmediated condition produced the strongest illusion, as indicated both by selfreport and drift towards the rubber hand. The VR condition produced a more convincing subjective illusion than the MR condition, although no difference in drift was found between the mediated conditions. Results are discussed in terms of perceptual mechanisms underlying the rubber hand illusion, and the illusion’s relevance to understanding telepresence.

**[3].** **Kurzweil, R. (2003, February 16). Human Body Version 2.0. Retrieved October 03, 2015.**

“Experience beamers” will beam their entire flow of sensory experiences as well as the neurological correlates of their emotional reactions out on the Web just as people today beam their bedroom images from their web cams. A popular pastime will be to plug in to someone else’s sensory-emotional beam and experience what it’s like to be someone else, à la the plot concept of the movie “Being John Malkovich.” There will also be a vast selection of archived experiences to choose from. The design of virtual environments and the creation of archived full-immersion experiences will become new art forms.

The most important application of circa-2030 nanobots will be to literally expand our minds. We’re limited today to a mere hundred trillion interneuronal connections; we will be able to augment these by adding virtual connections via nanobot communication. This will provide us with the opportunity to vastly expand our pattern recognition abilities, memories, and overall thinking capacity as well as directly interface with powerful forms of nonbiological intelligence.

It’s important to note that once nonbiological intelligence gets a foothold in our brains (a threshold we’ve already passed), it will grow exponentially, as is the accelerating nature of information-based technologies. A one-inch cube of nanotube circuitry (which is already working at smaller scales in laboratories) will be at least a million times more powerful than the human brain. By 2040, the nonbiological portion of our intelligence will be far more powerful than the biological portion. It will, however, still be part of the human-machine civilization, having been derived from human intelligence, i.e., created by humans (or machines created by humans) and based at least in part on the reverse-engineering of the human nervous system.

Stephen Hawking recently commented in the German magazine *Focus* that computer intelligence will surpass that of humans within a few decades. He advocated that we “develop as quickly as possible technologies that make possible a direct connection between brain and computer, so that artificial brains contribute to human intelligence rather than opposing it.” Hawking can take comfort that the development program he is recommending is well under way.

**[4].** **Rizzolatti, G. & Sinigaglia, L., & Gallese, V. (2006). Mirrors in the Mind. Scientific American. 54-61. Serino, S., Pedroli, Keizer, A., Triberti, S., Dakanalis, A., Pallavicini, F.Riva, G. (2015). Virtual Reality Body Swapping: A Tool for Modifying the Allocentric Memory of the Body. Cyberpsychology, Behavior, and Social Networking.**

An increasing amount of evidence has shown that embodiment of a virtual body via visuo-tactile stimulation can lead to an altered perception of body and object size. The current study aimed to investigate whether virtual reality (VR) body swapping can be an effective tool for modifying the enduring memory of the body. The experimental sample included 21 female participants who were asked to estimate the width and circumference of different body parts before any kind of stimulation and after two types of body swapping illusions ("synchronous visuo-tactile stimulation" and "asynchronous visuo-tactile stimulation"). Findings revealed that after participants embodied a virtual body with a skinny belly (independently of the type of visuo-tactile stimulation), there was an update of the stored representation of the body: participants reported a decrease in the ratio between estimated and actual body measures for most of the body parts considered. Based on the Allocentric Lock Theory, these findings provide first evidence that VR body swapping is able to induce a change in the memory of the body. This knowledge may be potentially useful for patients suffering from eating and weight disorders

**[5].** **Lanier, J. (2006). Homuncular flexibility. Retrieved November 6, 2016 from Edge Foundation, Inc., 2006.**

The homunculus is an approximate mapping of the human body in the cortex. It is often visualized as a distorted human body stretched along the top of the human brain. The tongue, thumbs, and other body parts with extra-rich brain connections are enlarged in the homunculus, giving it a vaguely obscene, impish character.

Long ago, in the 1980s, my colleagues and I at VPL Research built virtual worlds in which more than one person at a time could be present. People in a shared virtual world must be able to see each other, as well as use their bodies together, as when two people lift a large virtual object or ride a tandem virtual bicycle. None of this would be possible without virtual bodies.

It was a self-evident and inviting challenge to attempt to create the most accurate possible bodies, given the crude state of the technology at the time. To do this, we developed full body suits covered in sensors. A measurement made on the body of someone wearing one of these suits, such as an aspect of the flex of a wrist, would be applied to control a corresponding change in a virtual body. Before long, people were dancing and otherwise goofing around in virtual reality.

Why is homuncular flexibility a dangerous idea? Because the more flexible the human brain turns out to be when it comes to adapting to weirdness, the weirder a ride it will be able to keep up with as technology changes in the coming decades and centuries.

Will kids in the future grow up with the experience of living in four spatial dimensions as well as three? That would be a world with a fun elementary school math curriculum! If you're most interested in raw accumulation of technological power, then you might be not find this so interesting, but if you think in terms of how human experience can change, then this is the most fascinating stuff there is.

Homuncular flexibility isn't the only source of hints about how weird human experience might get in the future. There also questions related to language, memory, and other aspects of cognition, as well as hypothetical prospects for engineering changes in the brain. But in this one area, there's an indication of high weirdness to come, and I find that prospect dangerous, but in a beautiful and seductive way. "Thrilling" might be a better word.