PEACH GRAND CHALLENGE

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A Grand Challenge for Presence
Presence 2007 Panel

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This paper provides a summary of the conclusions of the Peach Grand Challenge panel session that took place during Presence 2007 International Conference in Barcelona, Spain.

A Grand Challenge for Presence
Phase 1: Presence 2007 Panel

Summary by G. Ruffini, Starlab[1]

The nominal schedule for the Grand Challenge Panel session was:

00-15 min Intro/A Grand Challenge for Presence(G. Ruffini)
15-30 min Grand Challenges in HMI (M. Buss)
30-45 min Grand Challenges in HC (M. Slater and M. Sanchez)
45-60 min Grand Challenges in MC (P. Vershure)
60-90 min Discussion

In reality, the Panel was very interactive and lasted a bit over 2 hours.

1. Giulio Ruffini

Peach is a FET coordination action supporting the whole Presence community. An important goal is to come up with ideas for a science and technology research roadmap for the field.

The term Presence is used in different, but fully consistent, ways: 1) to describe a *qualia* (fundamental in nature but unassailable by science), 2) an observable phenomenon (observable correlates with the *qualia*, *if you respond as if it were real, then it is Presence*), 3) a research field focusing on explanation and prediction of the observable phenomena, and 4) a technological field targeting the development of technologies to control the phenomenon. *Presence* and *reality* are very close concepts.

Presence research is wide and deep interdisciplinary field, and the danger of focus dispersion is also great. It is important to focus on well-defined measurable phenomena. In this sense, the reference to *successful replacement* is particularly appropriate, when success is refers to to measurable aspects of the phenomenon.

The field is wide because collaborative work is needed in major areas: human cognition (how do

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we model self and reality, how do we interact with the environment and each other?), human-machine interaction (developing technologies for information exchange/interaction between humans and machines), and machine intelligence (how is the immersion environment controlled in terms of light, sound and semantics?).

One early but important conclusion reached within Peach is that there is a clear need for unification and focus of efforts. A challenging and visionary project centered on the main questions and goals of Presence Science and Technology can provide an efficient framework for focus and establish a consensus on the key questions and objectives to be addressed.

Despite the different views on the focus of the field, it appears to be easier to reach a consensus in terms of the fundamental goal of the field : to achieve successful replacement/interaction (i.e., the measurable correlate of the Presence *qualia*, being something, there) and open up a wide range of powerful applications: producing "real" experiences through sensorial replacement and interaction with "bits".

Such a visionary project could bring together several communities working today in the field, and should have a time scale of around 5 to 10 years, with, e.g., 3-year milestones, while opening up a large set of powerful applications.

There are some basic considerations in the definition of such a Grand Challenge. Such a project should be at the core objective of Presence: producing measurably "real" experiences through sensorial replacement or augmentation and interaction with "bits". It should also be ambitious, hard, medium to long term (~10 year horizon with 3 year milestones say). It should engage the needed communities (presumably in Human Cognition, Human-Machine Interaction) and Machine Cognition around a focal problem. Finally, such a project should lead to major advancement in Presence Theory, Experiment and Technology, and result in major positive social impact.

More specifically, the requirements could be as follows.

<u>Science requirements</u>

• Should lead to major advancement in the neurobiological foundations of Presence. What are the open questions in Presence Science today?

• Should deliver globally accepted standards for measurement and benchmarking of Presence

• Should provide clear guidelines for technology development

• Should have the potential to lead to a scientific paradigm shift for research in this area (we mean "paradigm" in the technical sense of Thomas Kuhn).

<u>Technology requirements</u>

• Should deliver unobtrusive Presence technologies for researchers everywhere

• Should deliver tangible technologies and applications for everyone

<u>Impact requirements</u>

• Should deliver at least one immediate powerful, important application (e.g., Global Warming mitigation by travel reduction).

In summary, we are asking the Panel:

I. What are the fundamental questions in Presence Science today?

II. What are the fundamental issues in Presence Technology (engineering) today?

III. How can we focus the community to work on this through a (technological and/or scientific) Grand Challenge with impact?

We will post a summary in http://peachbit.org and present conclusions to the Commission for the human-computer confluence work program 2009-2010; ingest and highlight the conclusions in the Peach Presence Roadmap v2 (May). We will open a discussion forum in http://peachbit.org until Nov 30th for the community to post their ideas of a Grand Challenge S&T project. The best idea will be selected by the Peach team. The winner will get an iPod touch. The two runner-ups will get iPod Shuffles.

2. Martin Buss

Martin started explaining that there are key areas for continued work today in <u>Human-Computer Interfaces</u> multi-modality, including graphics, gestures, speech, etc.), <u>VR</u> (multi-modality, ding 3D graphics, audiovisual immersion, VR presence), <u>Telepresence and Tele-operation</u> (i.e., Presence in real remote environments).

The field of <u>Haptic interfaces</u>, addressing the touch of virtual or real remote objects through technology with force feedback is still a growing area, and a very important in the near future. In 5-10 years haptics will become important economically as well.

In terms of system aspects, there is in particular an area which we refer to as <u>Joint Action</u> which is rather interesting and challenging. Consider for example cooperation with a robot, or tele-cooperation with a person. This requires understanding how to manage a feedback loop with two control agents. It is complex and relevant. Several version of this problem can be studied, including the mediated interaction of a person with an object (P2O), with another person (P2P), and with another person through and object (POP).

A brief overview of Immersence[2] followed. Haptics is the focus of this IP. Feedback is an important aspect for tele-operation, and much work remains to be done.

In both VR immersion and tele-operation we are missing today the cognitive aspects, in the sense of machine cognition. Learning and adaption technologies are missing and are needed in the field. We can think of a robot, for instance, as being fully autonomous or fully tele-operated (as a "remote control"), but these are extreme scenarios. There is a continuum in between these extremes in which the tele-operated robot is semi autonomous. As an example, there are systems that aid surgeons fulfill time intensive tasks (such as stitching a liver). These gray areas are a rich research opportunity.

Another interesting area of research is how to make people interact with robots longer. What is needed to make people find it interesting/ relevant/endurable to interact with robots for longer times (this can define a measure of success)?

A related point made was that non-verbal, emotional communication is underrepresented in Presence today, and it is really important. The research framework needed includes integration of nonverbal cues and communication, and there are important scientific and design issues, including psychologic al analysis and design, nonverbal cue recognitions, actuation/induction devices for non-verbal feedback modeling, etc.

In summary, more work is needed in the field of truly multi-modal interaction, in which the haptic modality is perhaps the least developed today. Work in nonverbal interaction is also needed, as is symbolic reasoning and in machine intelligence, learning/adaptation on all levels. Finally, both real and augmented environments are relevant to the field. Finally, Martin encouraged people to visit ROMAN 2008 (IEEE International Conference,s 1-3 August 2008).

3. Mel Slater

Mel started the discussion emphasizing that he believes the word Presence has been used for many different things ; he proposed the tem *PreTence* to be more specific about what he and his group and project (PRESENCCIA[3]) is working on.

He gave the following definition for *PreTence*: realistic activity and response within a simulated simulation (substitution). Here response refers to measurable quantities, and can include brain activity, physiological response, behavior (unconscious, overt), feelings and emotions, thoughts,

cognitive processes, in essence, *responding as it was real*.

As a Grand Challenge addressing a real problem today (travel and Global Warming) he proposed to create a fully immersive system for meetings between people who are physically remote, yet feeling as they were together for real; this is a big technological problem which, if solved, will have a huge impact. The representation, to feel real, would have to be high quality, unencumbered, easy to set up and certainly multi-modal. New scientific aspects include to establish a better understanding of the roles of subtle clues, such as odors, eye gaze, skin tones, ..hormones.

4. Maria Victoria (Mavi) Sanchez-Vives

Mavi emphasized first the need to provide a unified and limited definition of the field and its goals, and in particular proposed to focus on virtual reality scenarios. She posed the problem of finding the neural signature for Presence and to find improved neural correlates of Presence. From her point of view, an important scientific challenge is to find measurable brain activity that correlates with Presence. She suggested to look for frequency features, synchronies, correlations of activity in different areas. Breaks in Presence could provide an interesting experimental scenario. If found, such features could in fact become the experimental hallmark of Presence, and could be tested in a variety of scenarios. This is a clear research line to pursue in fundamental neuroscience of Presence. One problem today is the low resolution of imaging systems today, either in space (EEG) or time (e.g., fMRI).

She then posed the direct interfacing with brains as the Grand Challenge (as in the movie Matrix). That is, to create the technological means and science to allow for direct interfacing to the CNS to machines. Implant technology needs to advance, and will deliver very important benefits along the way (e.g., to tetraplegics). Open questions are how to access the inputs and outputs of the brain. She also mentioned that Presence technologies for rehabilitation would be a very relevant application to focus on.

5. Paul Vershure

Paul provided a set of ideas with more focus on Machine Intelligence in Presence. He started by explaining that exposing our work to other people is a healthy practice, and that Art is a good medium to see if we can be effective in our tech-

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niques. He stated that the "zeroth" challenge is to to forget about the definition of Presence. It is commonly understood today that the brain is a modeling tool in constant work to analyze sensorial stimulation, and that if we can alter the models in the right way through substitution/alteration of the the inputs we will achieve Presence. This is simply what we are trying to achieve, despite the ongoing discussions and ramifications of the concept of Presence. Presence can also be looked at from the point of view of substitution: replacing the brain by electronic systems (machine intelligence), the person by an avatar, the world by virtual reality. A fundamental aspect in presence is maintaining the coherence between brain models and sensorial stimulation.

He presented a vision of Presence in terms of a brain interacting with a body interacting with the environment and others.
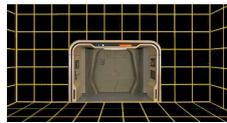
 As a first Grand Challenge he described a Teleportation Gateway scenario. A room in which you enter and go into another world (as in the [Holodeck in Star Trek[4]].

He also explained that we need a scientific paradigm for Presence, and that we need not repeat the history of Psychology. Some of the related work in Presence today is parallel to what happened in psychology before we realized that we need a scientific basis squarely based on physiology and cognitive neuroscience.

A way to improve the approach is to focus on what we can make (Giambatista Vico[5]). *The act of understanding is in the constructions*.

Work is needed in the development of an integrated technology to deliver Presence. There are really lots and lots of work to do there. Other areas for challenging work include narrative, interactive storytelling in VR. The Virtual human project in physiology and the biological sciences can be replicated in Presence with the goal of creating virtual humans, copies of people in VR, including all aspects: physical, sound, gestures, knowledge...

With regards to applications with impact, which is a crucial aspect, a clear line to focus is on rehabilitation. Using VR with Presence for rehabilitation can provide extremely relevant tools for the field, and this was also posed as a Grand Challenge.

6. Panel discussion

Ralph Schroeder asked whether the Grand Challenge of virtual meetings is needed, given the fact that there are today very sophisticated video-conferencing systems. Perhaps more practical aspects should be addressed (e.g., improve sound). Mel Slater replied that today's video-conferencing systems are still very far from providing the same experience as real meetings, and that in his opinion this will only be achieved through full immersion.

Cheryl Bracken posed the question of how to find or use neural signatures of Presence as a benchmark when they should be present always (people are always experiencing Presence, after all). Paul Vershure replied that an approach is to try to identify certain patterns associated to the "where" or "how" of Presence (e.g., emotions of fear near a fire).

Walter Van de Velde asked about the possibility of controlling subjective time experience and the possibility of creating virtual clones of oneself that may lead parallel lives. Paul Vershure replied that this is principle if we allow for hacking of not only inputs and outputs, but also of memory (RAM).

David Benyon posed as an additional challenge to enhance interaction in VR between two people to add the capability of exchanging real objects. Mel agreed this would be very useful.

Giulio Ruffini asked about the "hard limits" of Presence. For example, the speed of light is a hard limitation on interaction in tele-operation. Are there other hard limits we need to be aware of? It may be useful to understand what we can or cannot ultimately do. He also asked how far we are from actually moving beyond phenomenology in neuroscience (e.g., neural correlates of Presence) and into actually modeling how the brain works.

7. Conclusions

Once common vision in the panel is that the brain can be seen as a modeling tool and that Presence is the field addressing how to alter our reality models through sensory manipulation and interaction. *If it feels real, then it is Presence*. Or more precisely, *if your respond as if it were real, then it is Presence*. This is in fact a wide concept that en-globes in a natural way Virtual Reality (full immersion) and Mixed Reality Presence applications, as well as machine cognition aspects. In fact, the Turing test (*is agency perceived as real?*) could be seen as an

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[4] http://en.wikipedia.org/wiki/Holodeck

[5] The criterion and rule of the true is to have made it. Accordingly, our clear and distinct idea of the mind cannot be a criterion of the mind itself, still less of other truths. For while the mind perceives itself, it does not make itself." http://en.wikipedia.org/wiki/Giambattista_Vico

early precursor of modern Presence measurement ideas (agency as an illusion).

We may seek to alter the reality model of the <u>body</u>, the <u>environment</u>, or agency[6], time, etc. I would add the observation that in principle such brain models are actually physical - they reside in the physical brain, in brain connectivity, etc., - and are therefore in principle observable. Mixed reality was not addressed directly by all the participants but it was clear that it is a logical element of the same program

Martin Buss centered the discussion on interaction aspects, mainly technological ones relating to haptics, but he also made explicit mention of the machine intelligence aspects needed for interaction, autonomy and non-verbal interaction, for example. **Mel Slater** focused on giving a clear definition of Presence and, more practically, how to measure it, and in the realization of Presence in fully immersive environments.. He posed the practical and very relevant problem of reducing travel by providing the means for virtual but real-feeling meetings, and explained that a lot of science and technology is still needed to understand the communication channels humans use and how to implement them (including haptics, olfaction and perhaps even hormonal).

Maria Victoria Sanchez-Vives addressed the neurological basis of Presence, and discussed the vision of direct interfaces with the brain (as in the movie Matrix). This is a longer term program but in principle feasible. It is very important because it will provide the means to actually observe the implementation of brain models of reality in the physical brain. Finally, **Paul Vershure** discussed Machine intelligence aspects, the perceived (machine) intelligence side of Presence, as a crucial challenge, as well as the overall integration aspects of such complex systems. As a specific application, he referred to rehabilitation.

We may summarize the Grand Challenge scenarios presented in the Panel and also other presented during the rest of the conference:

- Making possible real-feeling meetings using full immersion

- Implementing haptic interaction with feedback in VR or in tele-operation for "Joint Action"

- Realizing the Matrix: creating technologies and the science for "jacking in"

- Creating a Teleportation Gateway (as in the Holodeck in Star Trek)

- Achieving Presence in other cultures and times: using VR to go and visit an experience them there

- Delivering interactive storytelling in virtual reality

- Creating better systems for rehabilitation using immersion

- Creating real feeling persons in virtual reality (virtual people)

- Living Parallel lives using virtual clones; altering the feeling of history through memory alteration

- Manipulation of subjective time in immersive environments

- Creating architecture through immersion

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[6] Agency as associated to the perceived existence of rational agents (see, e.g., AI, a modern approach, by Russel et al, 2003