DIGITAL FLAGSHIP THINK PIECE

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VIRTUAL REALITY REDEFINES KNOWLEDGE AND COMPUTATION

Computers are not only symbol processors, they are reality generators. Until recently, computers have generated only one dimensional symbolic strings. Text and numbers. Text is a code which, when read, generates images of reality in our minds. During the 80s, we enhanced the expressability of computation by adding space and time dimensions to the realities being generated. Two dimensional windows, 2D animation, solid modeling, simulation. Now, in the 1990s, computer systems can generate virtual environments, entire multisensory worlds which include us as interactive participants. Digital information can seem as-if-real, changing our notions of computation, symbolism, meaning, metaphysics, self, and culture.

The potential for VR to contribute to societal infrastructures such as manufacturing, marketing, telecommunications, science, entertainment, art, education, medicine, and media, suggests an economic impact that rivals the Gross National Product. We live in two superimposed worlds, the one of mass and the one of information. The huge accumulation of difficult to access words on paper indicates that the world of mass is not particularly well-suited for dealing with information. As our culture matures into an information society, we are now discovering the virtual world, an ideal place for interacting with information.

DIVERSITY OF RESEARCH

The VR research suite consists of three components: behavior transducers, inclusive computation, and intentional psychology.

Behavior transducers map natural behavior onto digital streams. Natural behavior is what two year olds do: point, grab, issue single word commands, look around, toddle around. Behavior transducing interface devices include body trackers, voice recognizers, spatial sensors, kinesthetic feedback devices, and subjective audio and video displays. Transducers work in both directions, physical behavior to digital information (the virtual body) and virtual display to subjective experience (the physiological model).

Inclusive software provides tools for construction of, management of, and interaction with digital environments which surround a participant/user. The central design issue for VR is getting behavior transducers and virtual environments to feel good to a participant. The intentional psychology of VR will require a deep knowledge of how we work, our physiology, our sensations, our cognition. We must refocus the effort of interface from the needs of symbol processors to the needs of people.

VR unifies a diversity of current computer research topics, providing a uniform metaphor and an integrating agenda. VR includes multisensory presentation, 3D audio, tactile feedback, voice recognition, real-time graphics, and kinesthetic interaction. The physical interface devices of VR are identical to those of the teleoperation and telepresence community. VR requires image integration and HDTV display technologies. It provides a context both for interactive, dramatic scripting and for military simulation. VR entities incorporate artificial intelligence, expert systems, pattern recognition, and reactive planning. The entirely new interface techniques and software methodologies cross all disciplines, creating totally new alignments between knowledge and activity.

VR requires innovative mathematical approaches, including physiological modeling, structure mapping, deduction in the presence of contradiction, imaginary algebraic logics, visual programming languages, void-based axiomatics, spatial representations of mathematical abstractions, and experiential computation.

Currently, symbolic logic is split in half, between syntax (representation) and semantics (meaning). Syntax is strictly formal, it has no basis in experience. Semantics attempts to connect syntactic symbols to the reality of the world by mapping representation onto meaning. The problem is that it does so without regard to context external to the formal symbols. Since environments necessarily introduce external unknowns, standard semantics is just too literal. VR, in comparison, is totally situated. By defining natural behavior as the rules of interaction, by displaying recognizable spatial structures as output, by providing context in toto, and by including the participant, VR redefines the relation between syntax and semantics. Semantics, what we consider to be anchored to reality, is displayed directly as (virtual) reality. Syntax, the symbols that guide computational activity, is hidden in the background, out of sight.

INTERACTION AND COLLABORATION

VR requires a new conceptualization of human interaction with symbol generators. Interface is physiology, interaction is natural behavior. We no longer need to filter computation through a haze of symbols. Natural semantics means that what you experience is how you interface. VR is more general than physical reality, providing a context that is both less constraining and easier to configure. VR can be intimately customized, providing personal realities that are responsive to personal choice.

One advantage of customized environments is that we can be explicit about what is shared. VR suggests an approach to cooperative work in a computational environment: rather than assume communality and specify differences, assume complete difference and specify what is common. VR addresses the current known difficulties in cooperative software environments: difficulty of use is reduced by non-symbolic interaction in as-if-real space, limited functionality is reduced by multisensory information spaces, and inflexibility is reduced by dynamic modeling.

VR provides an empirical context for exploration of theories of cooperation between human groups and software configurations. Coordination between participants depends upon mutually consistent models of shared environments. Virtual worlds coordination theory extends broadcast and message-passing models by including map-based cooperative models which permit complete communication with environmental entities while maintaining individual perspectives. Unlike objective reality, virtual spaces accommodate multiple concurrent realities, each associated with a different participant or perspective. We can each dwell in entirely different virtual environments, establishing communality only for those aspects of the environment we explicitly wish to share.

We are applying contradiction maintenance techniques to a broader project called televirtuality. The idea is to transmit virtual worlds over fiber optic telecommunications networks, to replace telephone and television with shared virtual realities. The conventional objective model calls for coordination of a single virtual space across multiple concurrent participants. Contradiction maintenance reduces the transmission bandwidth and synchronization bottlenecks of objective approaches. The shift in perspective is analogous to moving from a knowledge database relying on accumulation of inferential assertions to a constraint database permitting any satisficing world configuration.

PHILOSOPHY

The Copernican revolution introduced a physics that differed fundamentally from appearance. VR introduces a metaphysics that differs fundamentally from the material. At the foundation of Objectivism is an attempt to be realistic about the material world. VR calls for immaterial realism, for being realistic about information. The currency of VR is organization, not possession, not accumulation, not territory. All laws are transmutable, we can satisfy fantasy rather than fact. It is science itself that is redefined. In VR, we can choose to be reductionalist, but at the bottom of it all, there is not Mass or Nature, there is the Void. VR is representational, but not a priori rational, empirical, or verifiable. VR is illogical positivism: if you can specify it, it is meaningful. All empirical hypotheses are true.

VR promises to challenge every aspect of the computer industry. Rather than viewing external monitors, we will be writing digital images directly onto our retinas. Rather than wiggling our fingers to generate character streams, we will be waving our arms to generate visual models. Rather than memorizing arcane invocations, we will be acting naturally.

Information space is real. It is the place our minds go to when we have a telephone conversation. It is the cultural substrate of books and video. It is where our money lives. Until now, we have not been explicitly aware of this space which transcends discipline and geography. VR research is a direct attempt to make explicit the rules and conventions of the space of information.

The tremendous interest in VR across our nation and within our media is apparent. The idea of using technology to construct enjoyable and functional worlds, entire environments, has captured the minds of a wide range of top quality researchers. The experience of VR is known to capture the heart of whomever participates. It is both empowering and exhilarating, both freeing and pregnant with potential. Yet this interest is pale compared to the waves of excitement sweeping both Europe and Japan. The European intellectual community is enamored by the deep philosophical and cultural implications of readily accessible alternative realities. The Japanese community is enraptured with the potential of infinite space, the application of high technology to exploration of information.

It is already clear that VR will be the high impact computer technology of the 1990s. It is the sine qua non of all forward looking programs.