Cerebellar Neurocontroller Project, for Aerospace Applications, in a Civilian Neurocomputing Initiative in the "Decade of the Brain"

Andras J. Pellionisz
Charles C. Jörgensen
NASA Ames Research Center, Rm 261-3*, Moffett Field, CA 94035

and

Paul J. Werbos
National Science Foundation, Rm 1151*, Washington, D.C. 20550

ABSTRACT

Neurocomputing has entered a critical period in its development as a field. The driver is that mathematical brain theory emerging from Computational Neuroscience needs to be incorporated with algorithm development and implementation characteristic of neuroengineering. A key question involves how to utilize civilian government agencies along with an industrial consortium so as to successfully complement the so far primarily defense-oriented neural network research. Civilian Artificial Neural System projects, such as Artificial (Vestibulo)-Cerebellar Neurocontroller's, aimed at duplicating Nature's existing neural network solutions for adaptive sensorimotor coordination, are proposed for such a synthesis. The cerebellum provides an intelligent interface between higher possibly symbolic levels of human intelligence and repetitious demands of real world control problems, where complexity, nonlinearity and noise are far beyond the capacity of conventional controllers. The generation of such intelligent interfaces could be crucial to the economic feasibility of the human settlement of space [1], which will require new control technologies in transportation [28] and an improvement in telerobotics techniques so as to permit the cost-effective exploitation of nonterrestrial materials and planetary exploration and monitoring. We propose a scientific framework within which such interagency activities could effectively cooperate.

A PERSPECTIVE ON NEUROCOMPUTER INDUSTRY: MUST SCIENCE PRECEDE TECHNOLOGY?

Half a century ago, the Nuclear Industry was founded on a scientific useful fact that nuclear energy is released during fission or fusion. A sequence of developmental steps led to this result. First, basic research (Nuclear Physics) was required; to understand mathematical principles underlying the new phenomena (quantum mechanics). Second, technology development was needed, such that well-understood phenomena could be controlled and exploited. Existing research efforts in neurocomputing attempt to take a similar path. First, they support basic research to develop theories of the brain, in order to scientifically understand the underlying mathematical principles. Then they try to generate application efforts to translate these principles directly into artificial neural networks. In practice, this approach has not been the most fruitful way to develop the necessary mathematics. In reaction some engineers have gone to an extreme of developing ANNs without any biological inspiration. However, real brains demonstrate capabilities far beyond what conventional controllers have yet been able to capture. Nonetheless even early attempts to imitate biological principles have led to remarkable success in applications, c.f. [28]

It is evident in retrospect that even nuclear technology could not have been developed by physicists without first establishing a scientific foundation i.e. nuclear physics. With brain-

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