

Robophthalmotrope

Proposing a Biologically Inspired, Mechatronic Platform to Study Sensorimotor Control

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ABSTRACT

To further investigate theoretical concepts associated with sensorimotor control and brain-machine integration, the design and development of a robotic ophthalmotrope for the purpose of producing controlled, multidimensional eye and head movements is proposed.

Central to this research is the implementation of a biomimetic, time-optimal, control strategy used to precisely orient two CCD cameras, each having three rotational degrees of freedom within a moving reference frame of the head, to rapidly acquire a target of interest and pursue its trajectory in real time.

Unlike any of its predecessors, Robophthalmotrope will be the first intelligent mechatronic design to produce finely graded 3-D ocular rotations with the agonist and antagonist control actuation separately maintained. Moreover, it will be shown that the incorporation of a linear muscle model for biomimetic force generation is ideal for robotic applications.

This work relies heavily on a unified framework for integrating a multitude of engineering disciplines in conjunction with anatomical and physiological evidence to achieve a common thread of concurrent, mixed-system design.

The multidisciplinary nature of this project benefits a number of important research areas. First, insight pertaining to 3-D oculomotor control and the diagnosis of pathological disorders such as strabismus can be further investigated. Second, it provides a guideline on how linearized, physiological models can serve as a basis for controlled actuation in robotic applications. Third, human-like motor movements have important implications in the field of service and sociable robotics. Finally, through the development of Robophthalmotrope's biomimetic neuromuscular control strategy, a new generation of brain-machine interface technology could be developed for the prospect of novel prosthetic device design.

SCOPE

The scope of the project can be broken up into two core foundations. The biomedical foundation includes the most relevant research in the fields of ophthalmology, physiological modeling and neurophysiology. Biomimetics, biomechanics and robotics comprise the second framework for the mechatronic foundation. Analogous relationships exist between these two frameworks and it is the goal of this work to exploit them.

The interconnection between the two foundations is illustrated in Fig. 1 and specifies the methods that will be required to design build and test Robophthalmotrope.

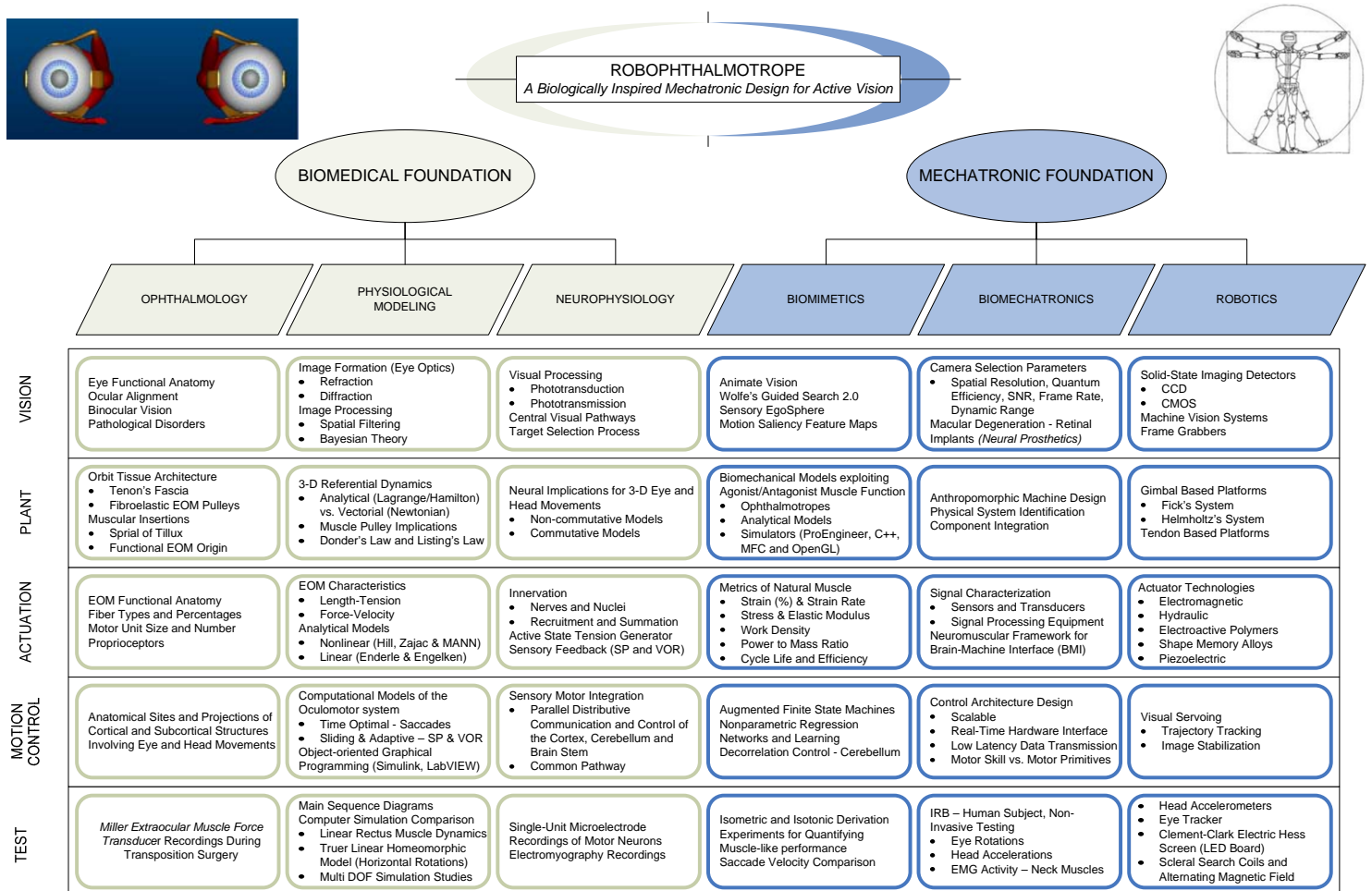


Fig. 1. The proposed research centers on the oculomotor system and its application to the field of robotics to study sensorimotor control with the foresight of developing novel brain-machine interface technologies. The common theme of this work is concurrent, mixed system design and heavily relies on a unified framework for integrating a multitude of engineering principles in conjunction with anatomical and physiological evidence.

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Presenting Author's Brief Biography:

G. Alexander Korentis is co-owner and engineering manager of QCI Engineering in Seekonk Massachusetts which provides design and manufacturing services for a wide variety of industries. He received his B.S. in Mechanical Engineering from the University of Massachusetts, Amherst, and a M.S. in Biomedical Engineering from the University of Connecticut, Storrs where he is currently a Ph.D. candidate. Alex recently completed advanced coursework in mechatronics and robotics at the Massachusetts Institute of Technology and is interested in the deployment of embedded control technology for the medical device industry. He is a member of the IEEE EMBS and RAS.