

REAL TIME IMAGE PROCESSING ALGORITHMS FOR A HIGH-RESOLUTION RETINAL PROSTHESIS

Abstract

The thesis describes the development and implementation of image-processing and tracking algorithms for a high-resolution retinal prosthesis, designed for blind patients suffering from macular degeneration and retinitis pigmentosa. A retinal prosthesis chip is implanted in the retina and stimulates directly the inner retina with signals acquired by a video camera. Image processing between the camera and the implant is required to reproduce the lost processing of bypassed degenerated neural circuitry in the retina. For this task, developed and implemented are:

- A tracking algorithm that determines the position of the retinal implant at each instant of eye movements.
- Image cropping in accordance with the tracked retinal implant coordinates.
- Geometrical transformation for matching images to the stimulated cells coordinate system.
- Image filtering in the spatial-space variant and time domains to compensate for the loss of spatiotemporal filtering normally performed in the retina.

Methods are suggested and implemented to speed up processing by employing, for real time operation, data redundancy in time domain and by computing using lookup tables generated at a pre-processing stage. The lookup tables allow flexible control of the stimulation parameters and are adjustable to the retinal architecture. This computationally efficient algorithm that use data redundancy resembles, in some aspects, biological strategies of efficient coding in the retina.

Publications

1. Alon Asher, William A. Segal, Stephen A. Baccus, Leonid P. Yaroslavsky, and Daniel Palanker, Image-processing software for a high-resolution optoelectronic retinal prosthesis, submitted to IEEE Transactions on Biomedical Engineering (July 2006)
2. Daniel Palanker, Philip Huie, Alexander Vankov, Alon Asher, Steven Baccus, Towards High-Resolution Optoelectronic Retinal Prosthesis, SPIE Proceedings BIOS 2005, Ophthalmic Technologies XV, v. 5688, paper 37