An Epi-Retinal Visual Prosthesis Implementation

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Abstract—
Retinitis pigmentosa and age-related macular degeneration leads to blindness through progressive loss of retinal photoreceptors. This paper describes an epi-retina visual prosthesis intended to provide electrical stimulation of the remaining, post-degenerative retina in order to recover some useful vision. The system includes extraoccular image acquisition and processing, a telemetry link based on inductive coupling, and an implantable neuro-stimulator for retina stimulation.

Keywords— **Retina, visual prosthesis, retina prosthesis, ganglion cell, image processing, inductive link, stimulator**

I. Introduction

It has been shown that surface electrical stimulation of RP and AMD degenerate retina in blind humans can elicit visual sensations which may prove compatible with mobility [1]. It is also observed that in such photoreceptor degenerative diseases that neurons of higher order retinal layers can remain intact in large numbers [2]. It is proposed that the defective photoreceptors can be bypassed and that remaining retina can be stimulated electrically to produce image perception.

II. Methods and Discussion

A system view of the prosthesis is shown below in figure 1. The eye is a hostile environment for implanted electronics. The longevity of the prosthesis in vivo can be extended by moving all components unrelated to retinal stimulation outside of the eye, as implied in the figure. The coupled coils in the figure represent the boundary between intraoccular and extraoccular portions of the prosthesis.

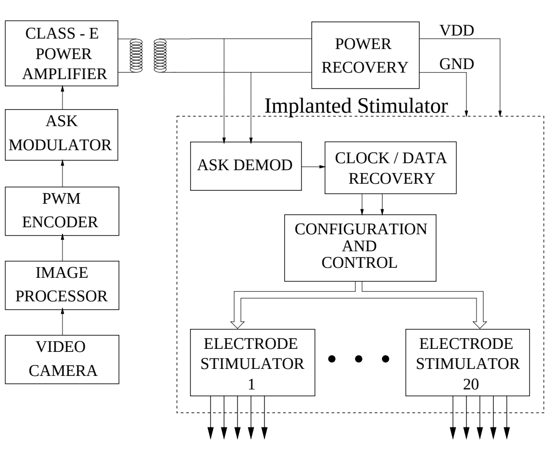

Fig. 1. System-level block diagram of the prosthesis (taken from [3]), copyright IEEE, ISSCC, Feb. 1999

An external CMOS minicamera provides video input to image processing hardware. The host processor is an FPGA/EPLD that can be in-system programmed with image processing algorithms which run in hardware directly, as opposed to software running on an embedded microcontroller. This will allow complex imaging operations to be executed concurrently. This board, shown in figure 2 below, can be worn in a shirt pocket or on a belt.

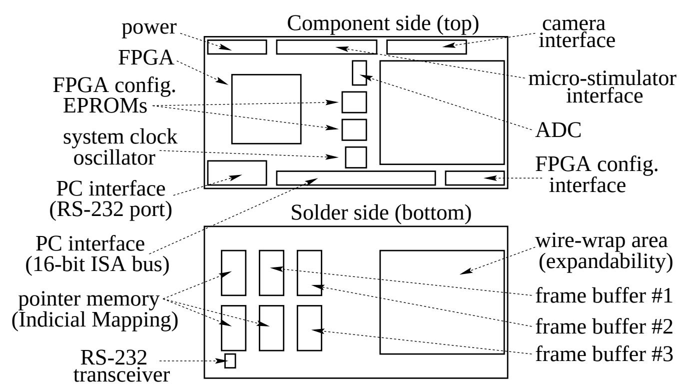

Fig. 2. Image processing hardware

Wires penetrating the sclera could dislodge the implant, or be infectious or irritating. Therefore, a link is designed to power the implant and communicate data to it wirelessly. This link is based on an extra-occular coil and intra-occular coil which couple together as shown in figure 1.

The stimulator is a CMOS-IC receiving its power and data from an AM carrier on the co-implanted secondary coil [3]. A DLL-based power and data recovery sub-circuit extracts serial-digital chip-configuration and image-data from the coil carrier. Image data is a stream of 4-bit pixels routed to 100 stimulus-waveform synthesis circuits which produce biphasic current pulses. The amplitude of the two phases is specified by the image data. The 100 stimulus currents of the stimulator provide a 10x10 image on the retina.

References

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