New Conceptual Investigation between Wireless Powered Devices and CMOS Neuron IC

A team of researchers and professors at the Inje University, South Korea and NITK surathkal, India startup Nano-vision neuron IC have developed a new conceptual investigation (application or prototype) at the interface of CMOS neuron IC and wireless power devices for retinal image acquisition in the first time that brings research a step closer to restoring the ability of neurons in the retina to respond to light. These researchers have developed interfacing prototype ICs for "Retinal Image Acquisition Using Wireless power transmission and CMOS neuron IC.

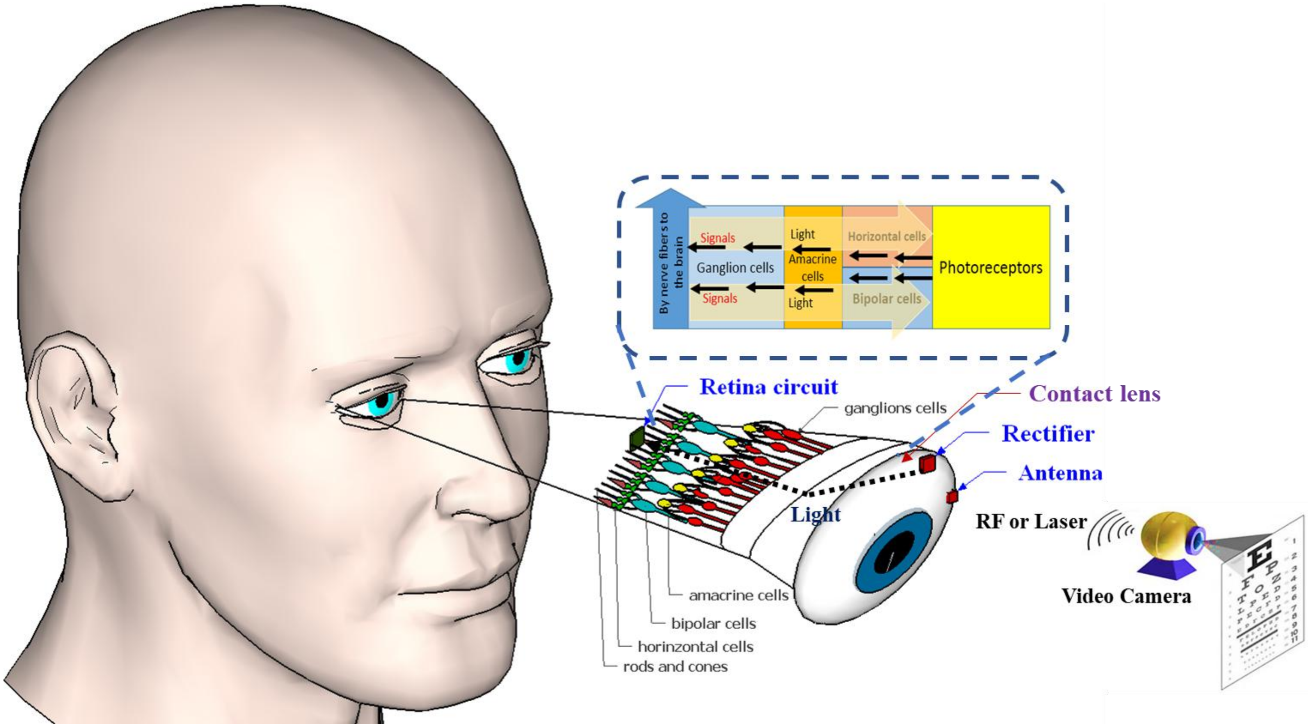
Inje University, South Korea and NITK Surathkal, India have implemented and completed this concept after working on this project for the last two years. This research work has been supported by the National Research Foundation of Korea.

The Department of Nanoscience and Engineering, Inje University South Korea and Department of Electronics and Communication Engineering and the National Institute of Technology Karnataka (NITK), Surathkal, India had signed a MoU agreement for academic and research exchange agreement on 15th March 2019.

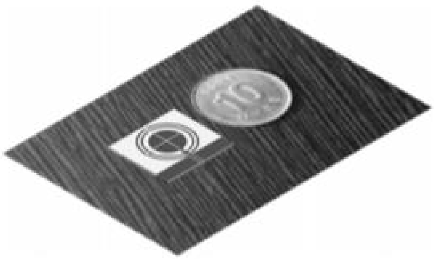
After the signing of MoU between the institutions, the **research group of Professor Hanjung Song at Inje University and the research group of Prof. Sandeep Kumar, ECE Dept. NITK Surathkal** have developed a new (application or prototype) for Retinal Image Acquisition using wirelessly powered devices and CMOS neuron IC. The research group has also published the first article titled on 'A Conceptual Investigation at the Interface between Wireless Power Devices and CMOS Neuron IC for Retinal Image Acquisition' in 'Applied Sciences Journal' MDPI on September 04, 2020.

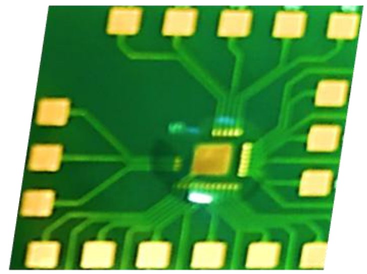
Proof-of-concept

Nowadays a retinal prosthesis has shown a great interest towards the usage of wireless power devices, such as RF antenna and RF harvester IC to restore the image vision for blind people. However, once these wireless power devices are placed on transparent contact lens, they can be designed to enable the implanted neuron ICs through wireless approach without the need for any external power source or battery. The image vision depends upon interior functions of the retina, which responds to light from photoreceptors to the ganglion cells. There are several retina diseases, such as retinal degenerative (RD) disease, retinitis pigmentosa (RP), and age-related macular degeneration (AMD), which are leading causes of blindness, affecting millions of people worldwide. In order to guard clear vision of blind people, recent technologies have required the integration of biological sensors and telemetry. Moreover, an active lens could be used to provide a new tool/method for research studies without the need for lab chemistry or needles. In the figure, we have shown the proposed schematic which illustrates the layout of wireless interfacing between RF power devices and CMOS neuron IC. The fact is that a contact lens placed exterior to eye could capture image information from the RF wireless video camera, which can pass through the antenna and the RF power harvester IC. The harvested power penetrates into contact lens in the form of light, which passes through photoreceptors to the ganglion cells inside the human eye where retina neuron IC provides appropriate magnitude of read-out spikes for biological image acquisition. The dashed marked figure shows signal flow process from photoreceptors to the brain.



A conceptual investigation at the interface between wireless power transfer and CMOS neuron IC for retinal image acquisition has been proposed for the first time. The proposed implementation includes a wireless antenna, RF power harvester, and retina neuron circuit. The on-wafer antenna and RF power harvester IC could be placed on contact lens, which delivers light energy to the photoreceptor placed in the retinal circuit. The transmission of power and data transfer between devices on contact lens and implant device inside eye is enabled by light, which carries a packet of information for image acquisition by retina. In order to maintain safety standards, RF telemetry has been employed on contact lens where antenna delivers the RF power to harvest circuit. The harvesting circuit provides DC power to custom micro-light-emitting diode (μ-LED). The μ-LED is mainly responsible for light production and transmission. Once light passes through ganglion, amacrine, bipolar, horizontal cells, and photoreceptors, it eventually stimulates the photoreceptors that convert it into electrical signals. These photoreceptors generate signals that are transmitted through an intermediate layer of neurons to the ganglion cells. Finally, they would propagate the information to the optic nerve and then to the brain in form of action potentials. These action potentials in form of output spikes are generated by neuron retina circuit





< Prototype packaged ICs have developed from Joint research program>

It is important to note that the area of slotted antenna and RF power harvester IC are obtained according to general dimensions of contact lens. Generally, the area of standard contact lens is about $1\mathrm{cm}^2$ with total thickness of about 200 µm. The calculated area of small electrical antenna is 4 mm with thickness of 0.12 mm while the area of power harvester IC is 1.2 mm^2. This research was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science, and Technology (NRF-2019R1F1A1056937).

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Article

A Conceptual Investigation at the Interface between Wireless Power Devices and CMOS Neuron IC for Retinal Image Acquisition

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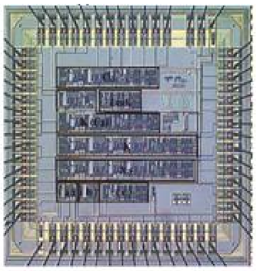

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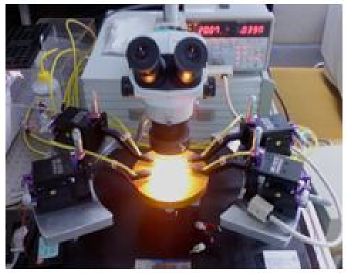

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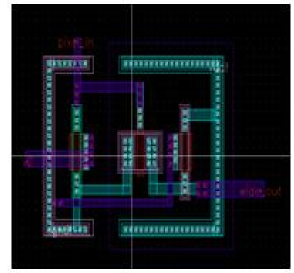

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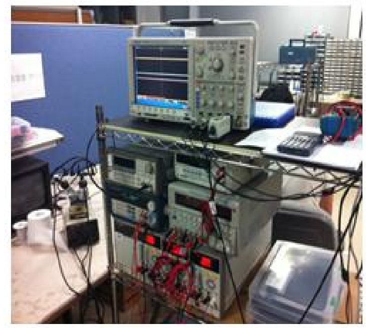

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<Professor Hanjung song research lab photos>

Fabrication and Measurement Labs

<Professor Hanjung song Lab: fabrication and measurement facilities>

- **Dr. Sandeep Kumar received a visiting researcher from NCDL lab, Inje University, Korea for 6 months during summer 2019. We worked on chaos modulation and antenna for E-healthcare application. And we successfully fabricated chip on neuromorphic application using India-Korea collaboration.**

<Measurement of IC in communication lab, Dept. of ECE, NITK Surathkal>

<Research Group of Prof. Hanjung song organized international symposium 2019>