Doctoral thesis/dissertation Digest Form

Title of Doctoral Thesis: Development of self-reset image sensor with high signal-to-noise ratio for in-vivo imaging
(生体イメージングに向けた高信号対雑音比を有する自己リセットイメージセンサの開発)

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Intrinsic signal imaging was chosen as an alternative method for brain imaging without relying on the additional step of genetic engineering. Brain activities are reflected through changes in signal intensity. However, those changes are very minor signal shifts. A device with a signal-to-noise ratio (SNR) of more than 60 dB is needed to observe these brain signals.

In this research, a CMOS image sensor with a self-reset function was used to realize an implantable imaging device for in-vivo imaging. This research proposed two methods to improve the device performance to gain an even higher effective SNR than the requirement. First, we introduced a modified photodiode structure to increase the photodiode capacity. The P-diff/N-well/P-sub was chosen as a photodiode because it has a higher full-well capacity compared to the N-well/P-sub at the same size. Another method is to enlarge the FWC by introducing a MOS capacitor at the photodetector node. We also used a new relay board with improved performance. Moreover, we developed image processing to reduce artifacts from the self-resetting system.

As a result, an image sensor with a self-resetting function and a signal-to-noise ratio (SNR) of more than 70 dB has been fabricated. By introducing the MOS capacitance into the pixel, a high FWC with improved linearity is realized. This tiny design is capable of implanting on the mouse head. Therefore, it will not hinder the mouse's natural behavior for study in the freely moving mouse in the future.