Multi-Camera Synchronisation for the NanEye CMOS Image Sensor

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ABSTRACT:

The smallest sensor available in the market for medical applications is a CMOS sensor designed by Awaiba. This sensor, commonly used for endoscopy and 3D medical imaging, has huge potential to improve the visualization of elements inside the human body. However, when used to construct 3D images, synchronizing multiple sensors is problematic. This work uses Awaiba’s NanEye CMOS image sensor family and a FPGA platform with USB3 interface and synchronizes up to 8 individual self timed cameras.

Minimal form factor (smaller than 1 mm2) self-timed camera modules do not generally allow for external synchronization. The Awaiba sensor has a 4-wire interface and no-external sync signals. However, stereovision or 3D reconstruction or applications with pulsed illumination requires multiple cameras, and thus sensor synchronization. We solve this problem by adaptively regulating the power supply for each of the cameras to synchronize frame rate and frame phase.

To that effect, a control core was created to constantly monitor the operating frequency of each camera by measuring the line period in each frame based on a well-defined sampling signal. The frequency is adjusted by varying the voltage level applied to the sensor based on the error between the measured line period and the desired line period. To ensure phase synchronization between frames of multiple cameras, a Master-Slave interface was implemented. A single camera is defined as the Master entity, with its operating frequency being controlled directly through a PC based interface. The remaining cameras are setup in Slave mode and interfaced directly with the Master camera control module. This enables the remaining cameras to monitor its line and frame period and adjust their own to achieve phase and frequency synchronization. The result of this work will allow the implementation of a 3mm diameter 3D stereovision equipment in medical endoscopic context, such as endoscopic surgical robotic or micro-invasive surgery.

BIO:

Morgado Dias is currently an Assistant Professor at the University of Madeira where he teaches several courses in Digital Systems and Electronics to Computer Engineering and Electronics Students. He is also a researcher at the Madeira Interactive Technologies Institute (M-ITI) Associated Laboratory in Portugal. He is the author of several book chapters, journal papers and conferences. He also published a book in Portuguese for Digital Systems.

Morgado Dias received his 5 years Engineering Diploma from the University of Aveiro, Portugal, in 1994, his Diplôme D’Études Approfondies in Microelectronics from the University Joseph Fourier in Grenoble, France in 1995 and his PhD from the University of Aveiro, in 2005.

His research interests include Artificial Neural Networks and their applications, especially regarding their hardware implementations and he participated in several research and development projects. Currently he is involved in SmanSolar, to monitor Photovoltaic energy production and detect faults and Vision3D, to produce 3D images for medical purposes endoscopy.

Morgado Dias is also a member of the Portuguese Engineering Organization, IEEE and he is the former president of the Portuguese Association of Automatic Control.