Industrial prototype for emerging TOF SPAD-based 3D imager

Subject: Embedded Systems
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External project partner: Fastree3D, Ecublens

3D cameras are much hyped, establishing new field of application. Although, for several applications improvement is needed. Fastree3D is a young company from Lausanne, developing a novel technology of 3D imaging sensors. A first setup with such a sensor was now built and assembled in this thesis. Also, the infrared illumination and the characterization of the device was made.

Situation

The technology is advancing rapidly and new possibilities are opened. Thanks to it, the first driverless cars already occupy the street, and fast and precise robotics are being developed – This progress needs a fast and save surveillance to prevent accidents.
3D cameras are a very good tool to observe moving systems in space. Different approaches for measuring 3D images are used, but each technology has its weakness. One of the biggest problems of usual systems is to calculate the 3D image.
A simple method to measure a 3D image is to detect the distance on different points and collect these points to one image. This ranging and distance measuring can be done with the Time-of-Flight (ToF) method, emitting an acoustic or optic pulse and measure the time the pulse needs to travel to the object and back, using reflection.
Fastree3D is a young company developing SPAD-based Sensors (Single Photon Avalanche Diode) for the ToF method and applications for this Sensor. The first sensor is already in development of use, providing a 1x256 Pixel image and using infrared pulses. Fastree3D built up a system to use the sensor as camera chip, providing measurement, calculation and software. The aim of the company is to develop a complete and compact camera.

Concept

The system built by Fastree3D is based on a Spartan-6 FPGA and a FX3 USB3 connection chip, providing measurement and communication for further development. One of the tasks in the ToF method is to give clear optical pulses, with a sufficient signal to noise ratio.
The volume of this thesis was to assemble a 3D camera on a line for short distances. Therefore, an illumination device needed to be built and characterized. The illumination needs synchronization with the FPGA to provide proper timing.

Adrian Maag

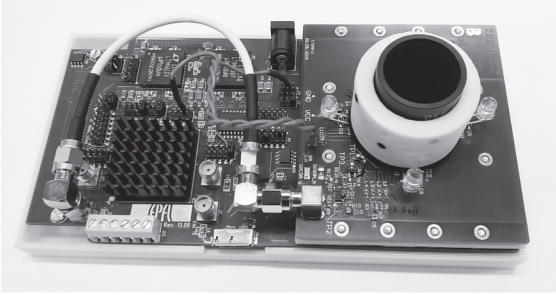
Realization

The illumination device was built with high speed electronic devices and optimized to emit a very short pulse of light (<5ns) with an adequate peak power.
This device was characterized in various versions.
For the synchronization the VHDL for the FPGA was adapted. To complete the assembly an optic was constructed. The final test showed a fully functioning 3D camera on a line for short distances!

Outlook

Next, a filtration can be programmed in the software part to determine the distance more precisely.
After a detailed testing phase the camera can be built up more compact and placed in a small housing.

Artwork of the imaginary 3D camera



Complete camera setup