Acceleration of Blob Detection within Images in Hardware

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Outline

• Implementation and evaluation of image processing algorithms on FPGA architecture

• Parallelization of image processing algorithms

• Experimental implementation of blob detection methods for evaluation purposes

• Computation of blob center point by bounding box and center of mass

• Comparison of performance and precision with similar solutions on General Purpose Processor architectures

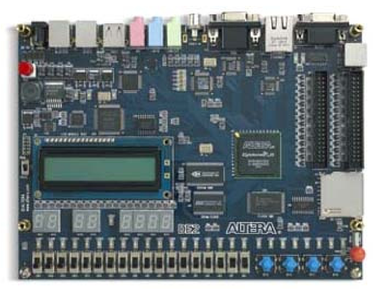
Motivation

Invention of a passive tracking system for estimation of position and orientation of the user in virtual environments

Representation of the user by laser emitting device, projecting a unique pattern to allow 6 degrees of freedom

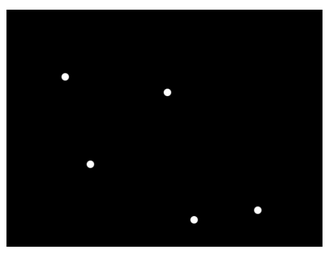
Material

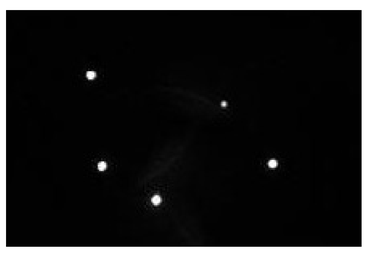
Altera DE2 board with Cyclone II



Quartus II Web Edition (ver. 9.0)
- Implementation in SystemVerilog
- Simulation with Waveform files
- Compilation and programming

Analog video input source providing simplified image material





Problem

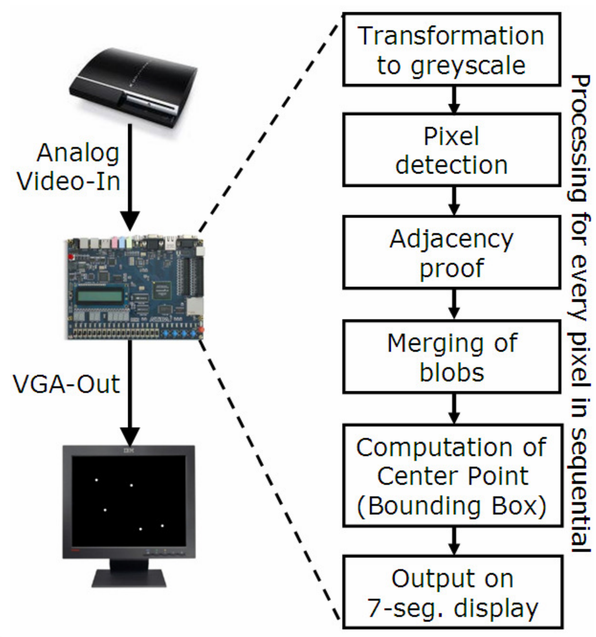
Computer Vision tasks are required in many applications. We need to find a balance between high image resolution and fast processing speed. Most of the time either one of those needs to be shortened to fulfill the desired criteria.

The problem addressed in this project is the detection of binary large objects (blobs) in a continuous video stream and compute their center point. It is related to a project at the Bonn-Rhein-Sieg University of Applied Sciences in Germany where the invention of a multi user interaction device for 3D projection environments is ongoing.

By employing standard image processing algorithms on FPGA architectures we are working to achieve a performance gain for real-time interaction.

Solution

The system performs a transformation from color to greyscale.
All pixels are processed sequentially and tracked as part of a blob if their brightness is above a defined thres-hold value.
Selected pixels are checked for adjacency to already detected blob pixels in the current frame.
Adjacent blobs are merged and their center point is computed by the bounding box method which is displayed on the seven-segment-display of the DE2 board.



Results

For evaluating the performance the very same blob detection method has been implemented on a GPP architecture. It scanned the frame pixels sequentially and computed the blobs center points by bounding box measurement.

It could be shown that the FPGA approach can perform with at least 20 frames per second faster than the very same program logic on a GPP architecture. This also includes the additional video processing on the FPGA system to convert from analog to digital before performing the blob detection while the GPP system could directly grab whole frames from the digital video file.

The extension of the system by a center of mass based computation of the center point is going to be one of the next steps in the future.

The design of the immersion square requires the computation of three video streams in parallel, since all three sides of the cube need to be tracked. This and the parallelization aspect of the FPGA architecture for the processing of the single image frames have not been taken into account until now.