



### Accelerate your vision applications!

Performance, accuracy and energy efficiency are critical parameters for Machine Vision solutions at the edge. Edge computing solutions facilitate data processing near the source of data generation and serve as a decentralized extension of the cloud or data center networks. Field Programmable Gate Arrays (FPGAs) provide a powerful number crunching platform, high energy efficiency and enable compact solutions due to their integrated memory blocks and network interfaces.

#### Applications for optical flow

The Optical Flow algorithm is used in many Machine Vision applications, for example:

- motion detection
- process automation
- vision guided robotics

It is often combined with other functions such as edge or corner detection and its results can be used for example in object tracking or accurate movement measurements.

Our demonstrator combines the Lucas-Kanade algorithm for dense optical flow estimation with Harris corner detection.

#### Optical flow demonstrator

AimValley's demonstrator enables comparison between implementations running in software on a CPU, and off-loaded processing on a GPU card or an FPGA accelerator card. The design reads from a video file or live images from a webcam and writes outputs directly to a display or to a file.

The optical flow algorithm is computationally intensive and implementation on an FPGA is challenging from both a design and a performance perspective.

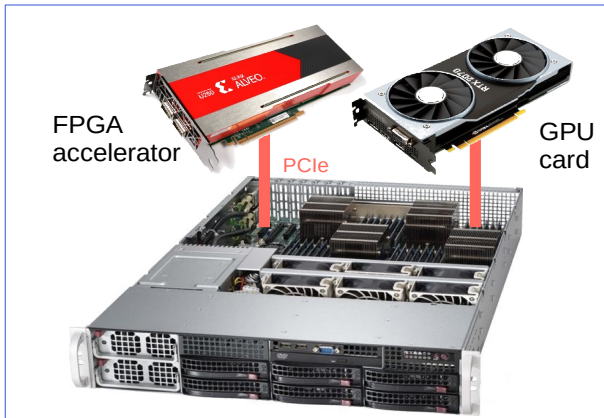
The design uses OpenCV, OpenCL, C/C++ and HLS that are optimized and integrated by AimValley's experienced Accelerated Edge Computing team in less than 6 weeks.

#### System configuration

In our demonstrator a standard x86 server is equipped with an FPGA card and a GPU card. The configuration with a server provides ease of use of GUI software on the server.

Three designs were created, to enable comparison of the FPGA with GPU and pure CPU software based implementations. This allows us to determine the throughput, power efficiency and other parameters.

Traditionally the challenge has been the difficult programming model for FPGAs; but that is solved by AimValley's Accelerated Edge Computing team and tools. Using high-level languages such as C/C++, OpenCL and HLS and modern design compilers the implementation is translated into FPGA programmable logic. For the CPU and GPU, off-the-shelf libraries based on OpenCV were used.

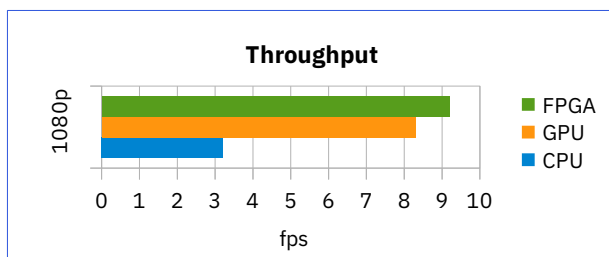


## What is Optical Flow?

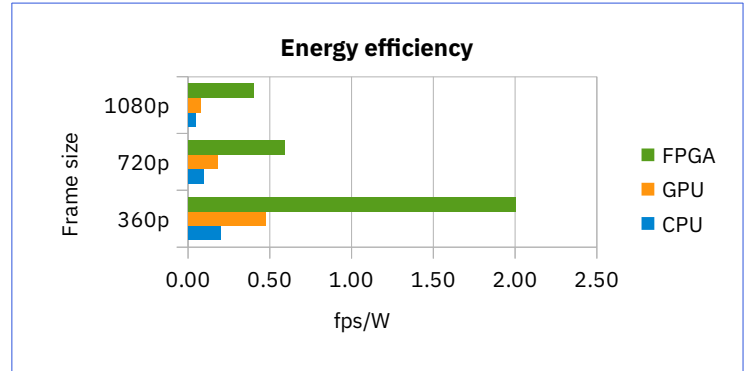
Optical flow is a technique to estimate the apparent motion of image objects caused by their movements in a video sequence. The demonstrator uses the Lucas-Kanade implementation with a configurable amount of pyramidal levels, to improve the tracking of large movements in the video sequence. The algorithm's output is a vector field where each point's vector indicates the displacement between points due to their movement from a first image to the next image.

## Measurement results

Several parameters were measured on the CPU, GPU and FPGA implementations. The demonstrator is currently optimized for 1080p frame size, and the FPGA provides high throughput on this resolution.



When comparing power efficiency, the FPGA shows 4x better performance than the CPU and GPU implementations.



## Why AimValley?

AimValley is a reliable provider of Edge technology since 2003, delivering solutions for:

- High speed data processing applications
- Complex FPGA-based accelerated systems
- High speed, low power hardware equipment
- Robust Embedded software
- Early adopter of Acceleration Technology

AimValley understands the full complexities as well as the subtle nuances of designing great edge solutions. We excel in building complex systems that are part of your product in the fields of Factory 4.0, Big Data, Healthcare and Transportation markets. Our combined skills represent all the important aspects required for the development of end-to-end systems.

Our customers enjoy the benefits of working with a strong team with more than 2 000 years engineering experience. AimValley is a trusted partner of Tier 1 customers in Telecom and Industrial markets and has shipped more than 100 000 products.

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