VisualApplets® is a graphic-oriented tool, which dramatically simplifies the programming of image processing on FPGA hardware. VisualApplets® is a high-level programming tool for image processing tasks on FPGAs. The self-explanatory graphical user interface is easy to use, fast to learn and inspierable for new solutions. Programs run on FPGA hardware in real-time. Image processing designs are arranged by the combination of operator modules, filter modules and transport links. The provided libraries include more than 200 hardware based operators for Machine Vision applications which cover standard as well as advanced image processing functions. The complete set of functions is implemented as hardware operators and guarantees an image processing in real-time. The complexity of the image processing designs is mainly limited by the available resources of the FPGA hardware.

Benefits using VisualApplets®

- Reduced time-to-market; development times are drastically reduced
- Economy of time and saving of development resources
- Know-how protection; development is done in-house
- Expert knowledge in FPGA programming is needless
- Protection of investment; re-use of applications and parts of applications
- Easy switching to different target architectures
- Automatic documentation on different levels
- Short education time of new employees

VisualApplets® was awarded in 2006 with the international VISION Award, a prize for outstanding solutions and contributions regarding applied machine vision.

VisualApplets® Workflow

- Initial Steps
  - Analyzing the algorithm and mapping on VisualApplets® resources
  - Selection of the target hardware
  - Generation of requirements document
  - Design Implementation
  - Selection and structuring the operators
  - Parameterization of the operators and the data-flow, considering the entire application setup
- Verification at Software Level
  - High-Level simulation based on real image data
  - Calculation of Bandwidth and performance
  - Estimation of consumption of FPGA resources
- microDisplay
  - The software tool microDisplay allows immediately a testing and adjusting of the settings of your generated Hardware Applet

Any information without obligation. Technical specifications and scope of delivery are liability-free and valid until revocation. Mistakes are excepted.
Software Development Kit (SDK)
- The automatically generated SDK example code can directly be executed and integrated in a certain software framework

Currently there are 14 libraries with more than 200 operators available (selection):

- Operators for Pixel Manipulation
- Operators for Color Processing
- Operators for Memory Management
- Operators for Color Processing
- Operators for Pixel Manipulation
- Image Filter Operators
- Operators for Arithmetic Processing
- Logic Operators
- Operators for Synchronization
- Operators for Signal Control
- Operators for Statistical Processing
- Operators for Compression (Extended VisualApplets® library)
- Operators for Blob Analysis (Extended VisualApplets® library)
- Miscellaneous Operators

Hardware Dependent Operators
- Camera interfaces: BASE, MEDIUM, FULL and FULL 10-tap in combination with
- Acquisition modules: Area and Line scan operator, Grayscale, RGB and Bayer color modes
- Digital interfaces: DiGiOPort module
- Trigger interfaces: AreaPort, LinePort modules, native trigger modes
- Transfer interfaces: DMA read and DMA write model

Operators for Memory Management
- Image memory interfaces: Image buffer, image FIFO, sequence buffers, dynamic and multiple ROI control, image buffers with internal spatial correction or tap sorting
- Frame and line memory
- Lookup tables and coefficient buffers

Operators for Color Processing
- Bayer color reconstruction modules
- Color space modules: RGB2YUV, RGB2HSI, HS2RGB, L*a*b, GRAY2RGB and GRAY2HSI
- Channel extraction operators: HSI channel splitting, RGB channel splitting
- White balancing RGB and Bayer

Operators for Pixel Manipulation
- Processing modules: Increase and decrease of parallelity
- Extraction modules: Parallely, components, pixel field, bitfield, images
- Module relations: Merge, split and branch
- Resolution: Down- and up-sampling
- Definition operator: Constant value, boxes
- Type conversion operator: Type cast, bit cast, change of pixel format
- Value conversion operator: Bitrange

Image Filter Operators
- Filter matrix operators: 1- and 2-dimensional convolution and FIR filters
- Morphological operators: Erode and Dilate
- Statistical information: Determination of Minimum, Maximum and Median
- Comparison: Hit and miss, numbers of hits, sort

Operators for Arithmetic Processing
- Mathematical operators 1: Addition, subtraction, multiplication, division, scaling, shifting, randomising, absolute value, sum
- Mathematical operators 2: sine, cosine, tangent, cotangent, arcs functions, square roots

Logic Operators
- Causal operators: IF, CASE, logic NOT, logic AND and logic OR
- Boolean operators: comparison between two numbers or between number and constant
- Binary operators: Threshold

Operators for Statistical Processing
- Statistical operators: Median, Minimum, Maximum, column, row and frame based
- Counter and memory models
- Register and histograms

Operators for Synchronization
- Image operator: Remove and insert pixels, lines or frames

Operators for Signal Control
- Status information and control of delays, synchronization and events, signal waveform, polarity and format
- Shaft encoder
- Signal scaling and generating

Operators for Compression (Extended VisualApplets® library)
- JPEG image buffer and encoder

Operators for Blob Analysis (Extended VisualApplets® library)
- Operators for 1D and 2D Blob analysis with object segmentation and classification

Miscellaneous Operators
- Look-up table modules: Standard and knee look-up table for image enhancement
- Memory operator: Storing of coefficients
- Counter operators: Column counter, row counter

Blob Analysis - Detection and Feature Extraction of Objects in Binary Images
- the segmentation and mapping of neighbored foreground pixels to objects
- object description by geometrical and statistical shape parameters such as “area”, “bounding box”, “centre of gravity”, and others
- used for classification

Advantages on using Blob Analysis
- Blob Analysis is the best established standard method for segmentation of objects
- Very robust method to describe objects
- applied in numerous machine vision applications
- used for detection, counting and sizing of objects such as in surface inspection, position detection and compensation.

Blob Analysis in VisualApplets®
- detects connected objects in binary images
- objects of any shape are detected
- supports 10-taps Full Configuration CameraLink interface (850MByte/s)
- combinable with existing VisualApplets® pre-processing operators such as morphological filters and adaptive thresholds
- objects are determined in a single pass which reduces the latency to a minimum
- multiple object properties are determined such as area, bounding box, contour length, centre of gravity, circularity
- arbitrary number of concurrent objects may exist in the image
- processes images of any size
- highly efficient resource optimization by selection and parameterization of features
- included error handling system

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