The Omnitek warp processor is a highly optimised FPGA solution for creating arbitrary image warps on a real time video stream of up to 4096 x 2160 x 60Hz. Maximum image quality is achieved via per pixel filtering and bi-cubic interpolation on 4:4:4 video data at up to 12 bits per colour plane. Alternatively a single warp processor can process multiple HD video images and stitch the resulting videos together for applications such as creating a surround view from multiple cameras or projecting a large image from multiple projectors. The IP core fits into a single mid-range FPGA with a single DDR3 SDRAM interface, providing a highly cost effective solution.

Key Features

Video Input Formats

- 10-bit 4:4:4 processing
- 8, 10 and 12-bit, 4:2:0, 4:2:2 and 4:4:4 processing when used in conjunction with Omnitek Scalable Video Processor (OSVP)
- Up to 600MHz pixel rate
  - Provides support for up to 3840*2160 resolution at 60Hz or 2712*1528 at 120Hz
  - Support for 90° rotation of 2160*3840 input to 3840*2160 output

FPGA optimised design

- BiCubic filter optimised for embedded DSP blocks.
  - Options for nearest neighbour, bilinear to reduce resource usage
- Integration with Vivado IPI design environment.
- AXI4 memory and control interfaces suitable for Xilinx MIG.
- Compact design fits in a mid range Kintex 7 160T for full 4K60 4:4:4 high quality warp processing or multiple HD video processing paths with video I/O
- Reduced resource count for simple transforms e.g. 90° rotation

Transforms

- Fisheye, Keystone, Rotation, Perspective mapping
- Arbitrary Warps within a 0.5x to 2x scaling limit

Features

- Low latency (1 frame down to 1/6th of a frame depending on transform)
- Efficient external memory interface
  - 3840x2160p60 UHDTV requires a single 64bit interface to DDR3 SDRAM
- Option to support multiple lower resolution inputs or single UHDTV input in same core
- Asynchronous Warp Engine
  - Will run at best achievable speed for targeted FPGA fabric
  - Can add multiple cores in parallel to improve system performance
- Low Pass Filter coefficient sets available for highest filter quality
- Per-pixel low pass filtering
- Control software for OSD wireframe and mesh calculation
Fixed warp transforms
The Omnitek Warp Processor provides support for common transforms: pre and post barrel/pin cushion correction and arbitrary perspective correction. These transforms can be easily configured and graphically previewed.

Arbitrary warp transforms
The Omnitek Warp Processor also offers support for both the complete mapping of input pixels to output pixels (‘Forward Grid Transformation’) and/or the mapping of output pixels to input pixels (‘Inverse Grid Transformation’).

Picture Shape Controls
The Warp Processor determines the transformation that is needed in terms of pixel positions in the input and output. The user, however, will be able to specify the transformation that is needed in terms associated with the type of transformation that needs to be applied.

3D Re-Ordering
Thanks to the integrated frame sync, stereo 3D video can be delivered either as separate Left and Right image streams in a dual pipe arrangement or as a ‘Frame Sequential’ stream of Left and Right images.

Frame Sequential HDMI 1 or HDMI 2
1080p @ 120Hz/100Hz/96Hz

Dual Pipe HDMI 1 or HDMI 2
1080p @ 60Hz/50Hz/48Hz

GPU Overlay
In order to achieve a speedy response, the selected transformation is applied first to a wire frame overlay (the transformation of which is almost instantaneous), then to the image.
**Edge Blending**

To allow multiple projectors to be used to give a combined view (e.g., a panoramic view), edge regions are defined over which the image in each projector is reduced in intensity down to black using a gamma function so that the resulting intensity in the overlap regions is not excessively bright as the result of being sourced from two projectors.

**Reference Platform**

Omnitek OZ745 reference platform with Xilinx Zynq-7045 All Programmable SoC.

**Typical resource use**

<table>
<thead>
<tr>
<th>Module</th>
<th>LUTs</th>
<th>Registers</th>
<th>Memory Blocks</th>
<th>RAMB36</th>
<th>DSPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raster to Block</td>
<td>300</td>
<td>500</td>
<td>60</td>
<td>0</td>
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<tr>
<td>Block to Raster</td>
<td>400</td>
<td>800</td>
<td>20</td>
<td>0</td>
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<tr>
<td>Memory Interface</td>
<td>2,100</td>
<td>3,700</td>
<td>40</td>
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<tr>
<td>Warp Engine (2 required for UHDTV)</td>
<td>2,200</td>
<td>3,000</td>
<td>44</td>
<td>64</td>
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<tr>
<td>Total Warp Processor for 4K60</td>
<td>7,200</td>
<td>11,000</td>
<td>208</td>
<td>128</td>
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<tr>
<td>Other IP:</td>
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<tr>
<td>MIG</td>
<td>13,000</td>
<td>9,300</td>
<td>2</td>
<td>0</td>
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<tr>
<td>Typical Target Devices:</td>
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<td></td>
</tr>
<tr>
<td>Kintex7 325</td>
<td>203,800</td>
<td>407,600</td>
<td>445</td>
<td>840</td>
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<tr>
<td>Zynq 7045</td>
<td>218,600</td>
<td>437,200</td>
<td>545</td>
<td>900</td>
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</tbody>
</table>
Applications

- Projector correction
  - Vertical & horizontal
  - Keystone
  - Lens correction
  - Arbitrary warp on to curved surfaces
- Arbitrary angle rotation for digital signage
- Fisheye lens correction
- Creation of single surround view from multiple cameras

Licensing Options

- Evaluation licence
- Encrypted Source licence - NRE
  - Allows IP to be compiled into designs.
- Full Source Code licence
  - Allows customisation of IP.

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