Xilinx-based Virtual Reality

One Billion Operations Per Second!

What do virtual reality, your kid's most recent PC game, and professional flight simulators have in common? The answer is real time 3D-graphics acceleration, a function provided by specialized circuits called rasterizers.

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There are several specialized rasterizing ASICs in the market. Custom made circuits like these however, have an important limitation: you must use them "as is," making them unsuitable for certain low- to mid-volume applications.

We wanted to develop a high-performance, state of the art rasterizer which could also be easily (and cost-effectively) adapted to different application scenarios. The requirement for adaptability lead us to FPGA technology, but the big question was: could an FPGA deliver the required performance? The answer, as it turned out, was that Xilinx FPGAs can.

The architecture of the Xilinx FPGAs is particularly well adapted to 3D graphics applications, because of three main reasons:

- The distributed memory concept, which allows you to overcome the most common bottlenecks in 3-D graphics systems. You can tightly couple the processing and storing elements, instead of having the data passing through a common bus.
- 3D-graphics algorithms can be decomposed into a complex sequence of linear operations, which can be easily implemented using the Xilinx carry chains.
- The large number of available logic cells and routing resources allows you to use pipelining and parallelization techniques to increase the speed of the resulting algorithm.

Our Derissa D66 is a 3D-graphics rasterizer using an XC4085XL device. It provides Gouraud shading and perspective-correct texture mapping functionality, 66 MPixel/sec maximum speed, 16-bit z-buffer, and double frame buffering. Applications include VR systems, arcade games, LBE systems, and high-end simulators.

Derissa D66 provides a single chip solution including a PCI-compatible host interface, four built-in memory controllers, eight interpolation units, and four perspective correction modules. The design was realized using the Foundation 1.4 tools. In order to achieve the performance goals, LogiBLOX and Coregen modules were extensively used in the design, as well as custom made RPMs for the critical sections of the circuit. The result is a device capable of performing one billion operations/sec, with 600 MBytes/sec data transfer rate to/from the supporting memories.

An incremental design approach was selected in which each module was simulated, added to the design, and software tested, before adding a new module. To facilitate this approach, the architecture of the rasterizer has been optimized both for the underlying FPGA structure and for the characteristics of the implementation tools. As a result, compile time is less than three hours in a Pentium 300, allowing us to avoid using guided design, and making it possible to change the design in record time.

Conclusion

Xilinx FPGAs deliver the performance required by real time 3D graphics applications, while preserving the flexibility of a programmable device. You don't have to adapt your 3D-graphics needs to a custom circuit — using the Xilinx-based Derissa rasterizer; you can adapt the circuit to your custom needs instead.

For more information, contact Memondo Graphics S.L. (www.memondo.es) Σ

Buh-Buh-Buh-Billion!