Alcon’s existing Ngenuity system seeks to capture stereo images from an ophthalmic surgical microscope, process the two images on a host computer, and provide a high-definition 3D image that can be displayed on a supporting display. This provides the surgeon with both a higher resolution as well as an ergonomic working environment. The use of a separate computer and a USB communication protocol, however, has introduced significant delays and image quality issues into the system, which Alcon seeks to correct.

**Overview**

To reduce latency, we attempt to remove the need for intensive graphics processing on the host computer by utilizing a FPGA. The two image inputs will be processed into a display form suitable for a 3D monitor. The user will have to choose between visual formats, including side-by-side, top-bottom, and traditional intersampled mosaic. The input type will also support both HDMI and DisplayPort. All processing will happen on the camera itself, without requiring an external computer.

**Block Diagram**

### Hardware

#### PolarFire Video Kit
- 64 bit RISC-V CPU
- Compatible with MIPI CSI-2, DSI, and CS
- HDMI 2.0 and HDMI 1.4

#### Dual Camera Sensor Board
- Allows for use of 4K HDMI port
- Resolves compatibility issues

#### Alcon Camera Lens
- Connected to 4K sensor board
- Allows for better focus and production of final 3D image

**3D Modes**

- Top/bottom
- Row-interleave

**Software Flow**

- External button triggers a GPIO interrupt
- CPU writes to 3D mode select register
- Changes method for how data is read and selected
- Camera data is packed and written into memory
- Camera data is selectively read from memory and unpacked
- Data for both cameras is simultaneously processed one pixel at a time in a video pipeline module
- Module decides which camera’s data will be forwarded to the output image for a given pixel position
- Processed camera data is sent to an HDMI output port

**Final Product**

In the final enclosure, camera sensors are aligned according to an adapter that is specific to the microscope. Stereo lens feeds are visualized in 3D via HDMI, and can be polarized by specialized monitors. The user can switch between display modes and camera order.

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