Low-Cost Stereo Vision on Reconfigurable Hardware

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Objectives

Obtaining an accurate, three-dimensional model of unstructured outdoor environments has long been a challenge in field robotics. Here, we present a low-cost stereo vision implementation suitable for use in autonomous vehicle applications.

The final prototype of this low-cost stereo vision on reconfigurable hardware utilizes **low-cost automotive-grade CMOS cameras** and a **Xilinx Spartan-3 FPGA** to process **320x240 pixel images at greater than 150 frames per second**. Through a USB 2.0 interface, the prototype is more than capable of delivering real-time depth maps to a host computer for visualization.

Stereo Vision Algorithm

Comparisons Made Between Windows
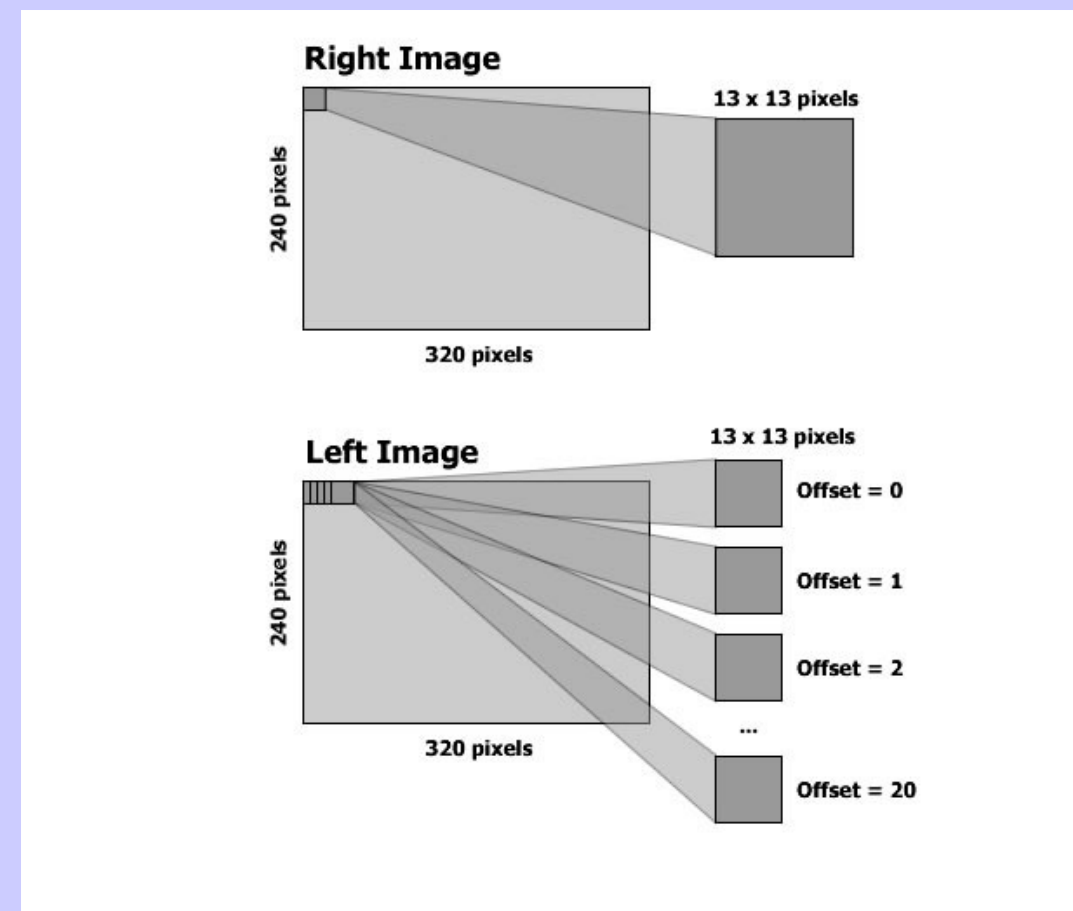
The Bit Strings Representing the Windows

11111 11001 11001 01100 10000
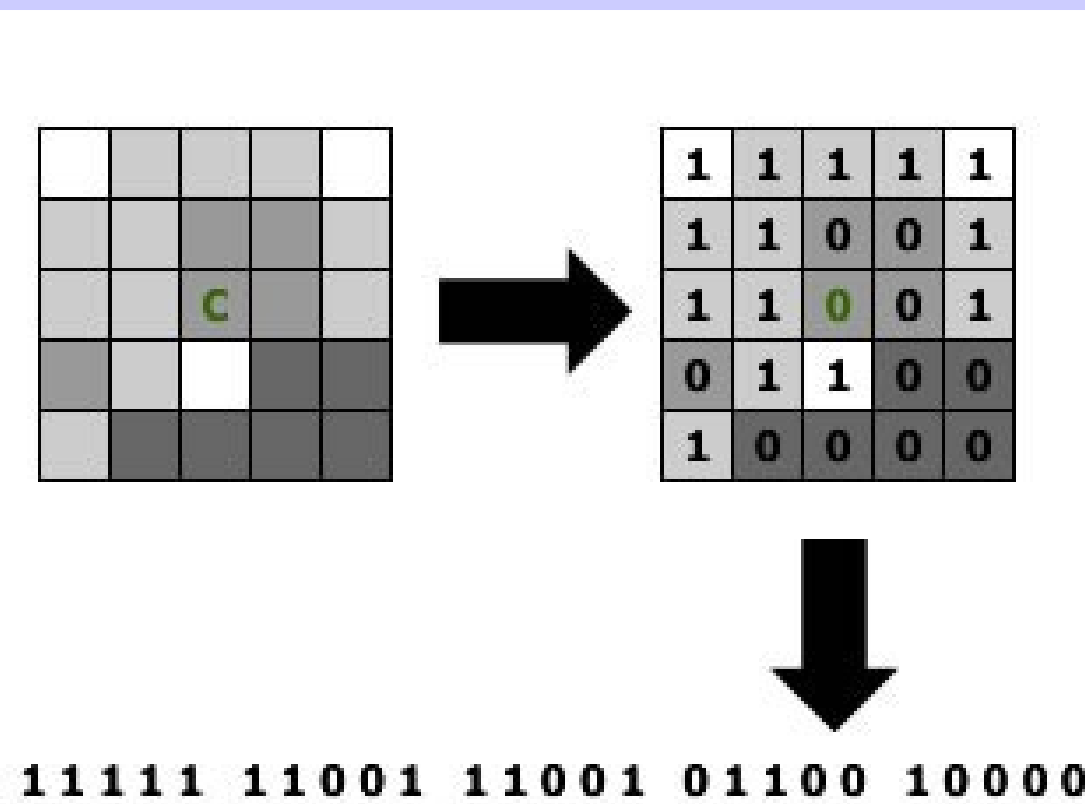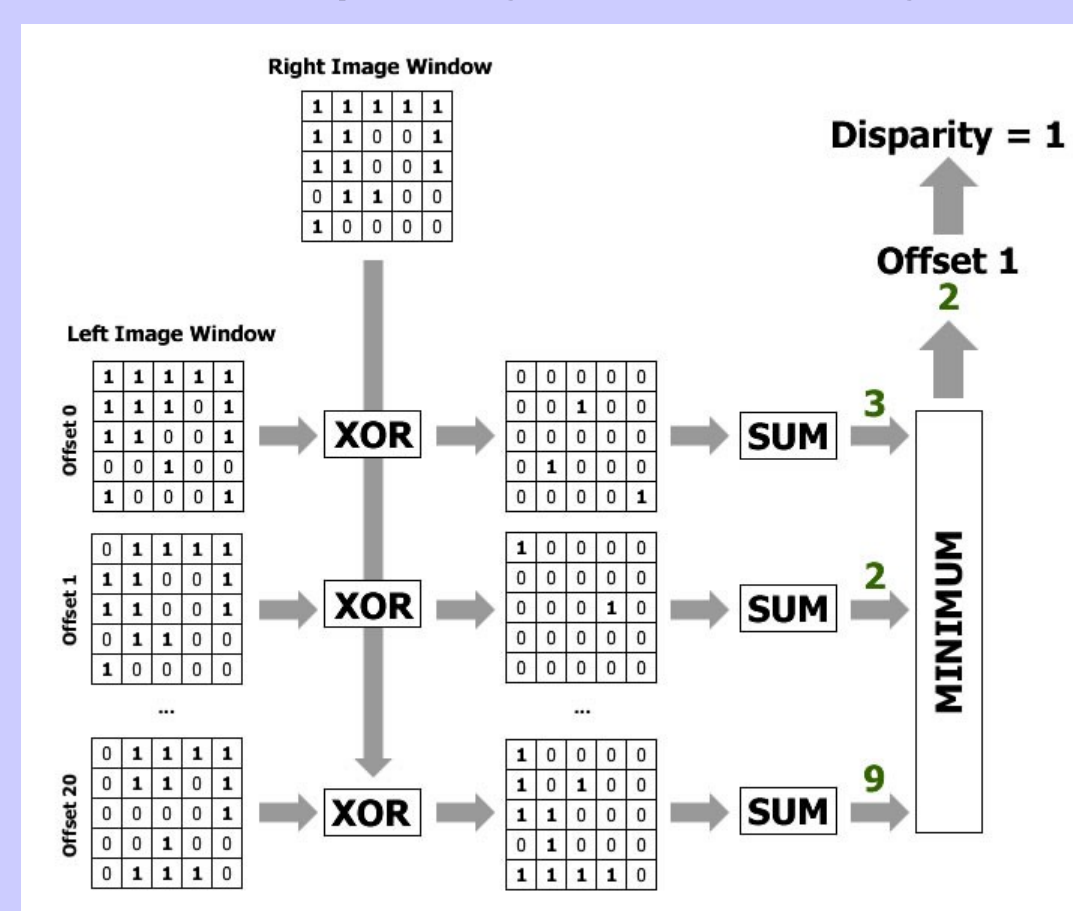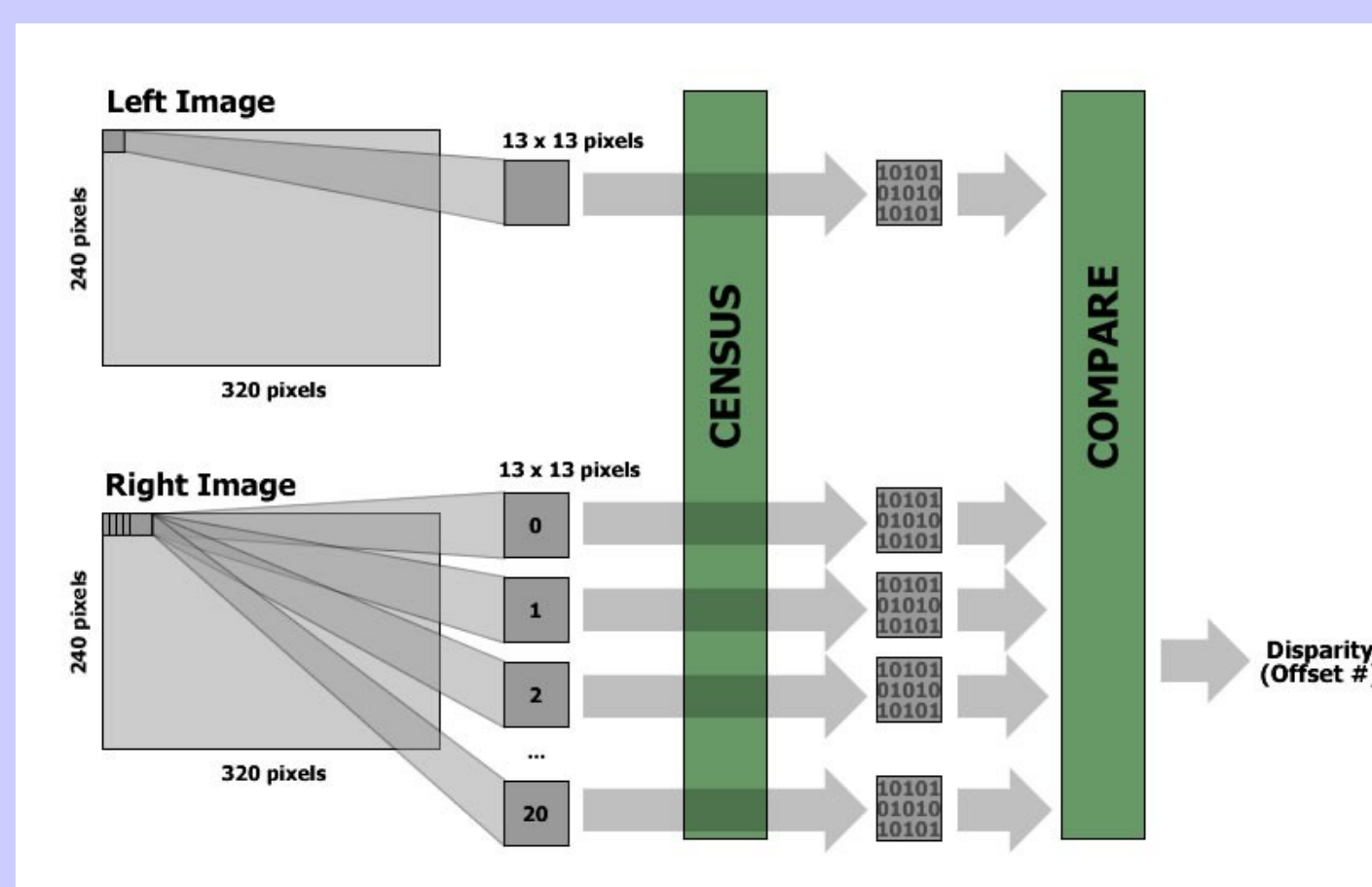
Comparing the Bit Strings

Image Disparities
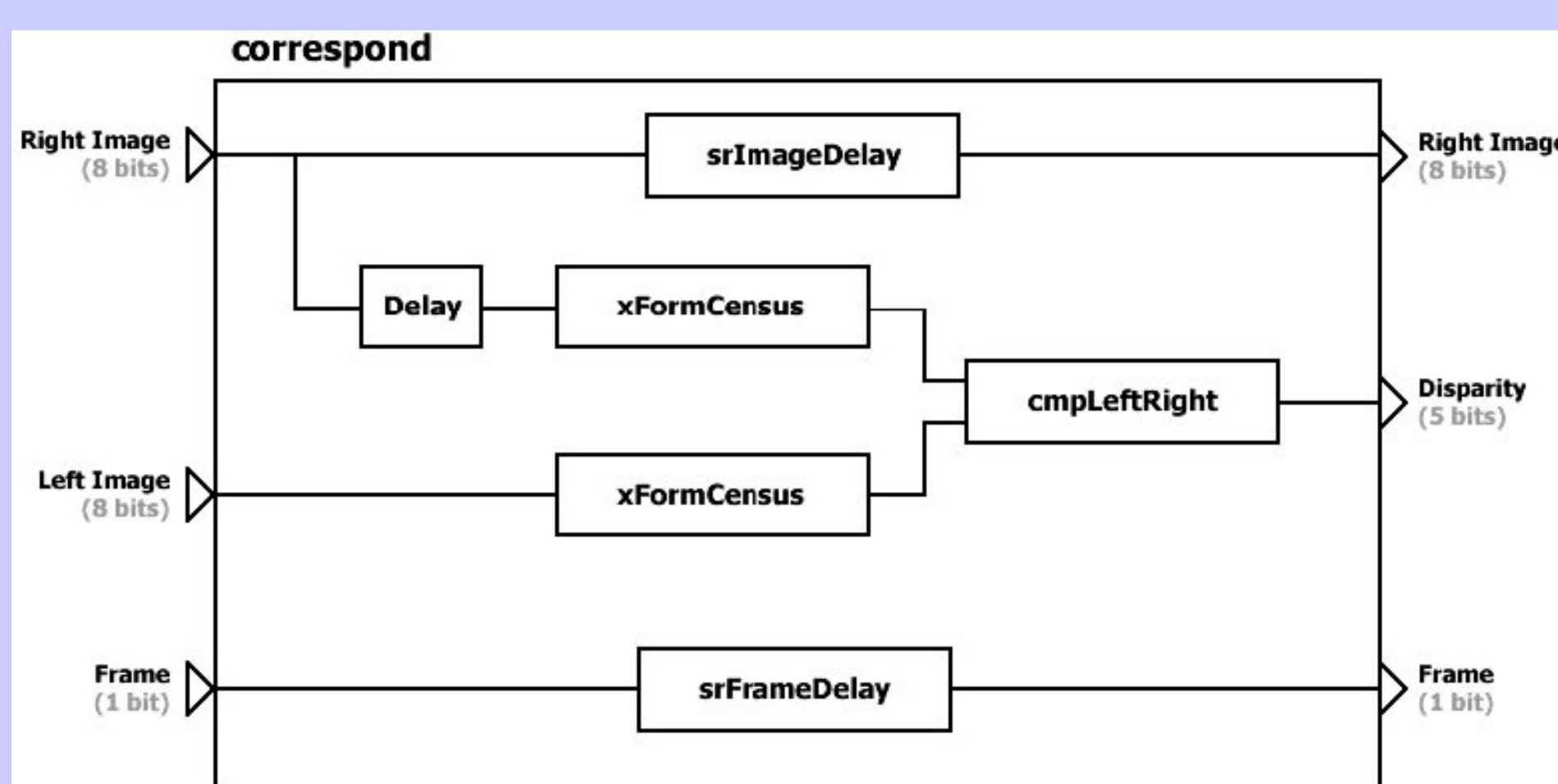

The Physical Prototype

The image pair is simultaneously acquired from two cameras. Correspondence calculations and disparity determinations take place on the FPGA. The results may be used to guide autonomous vehicles, and as shown above, may be viewed on a laptop.
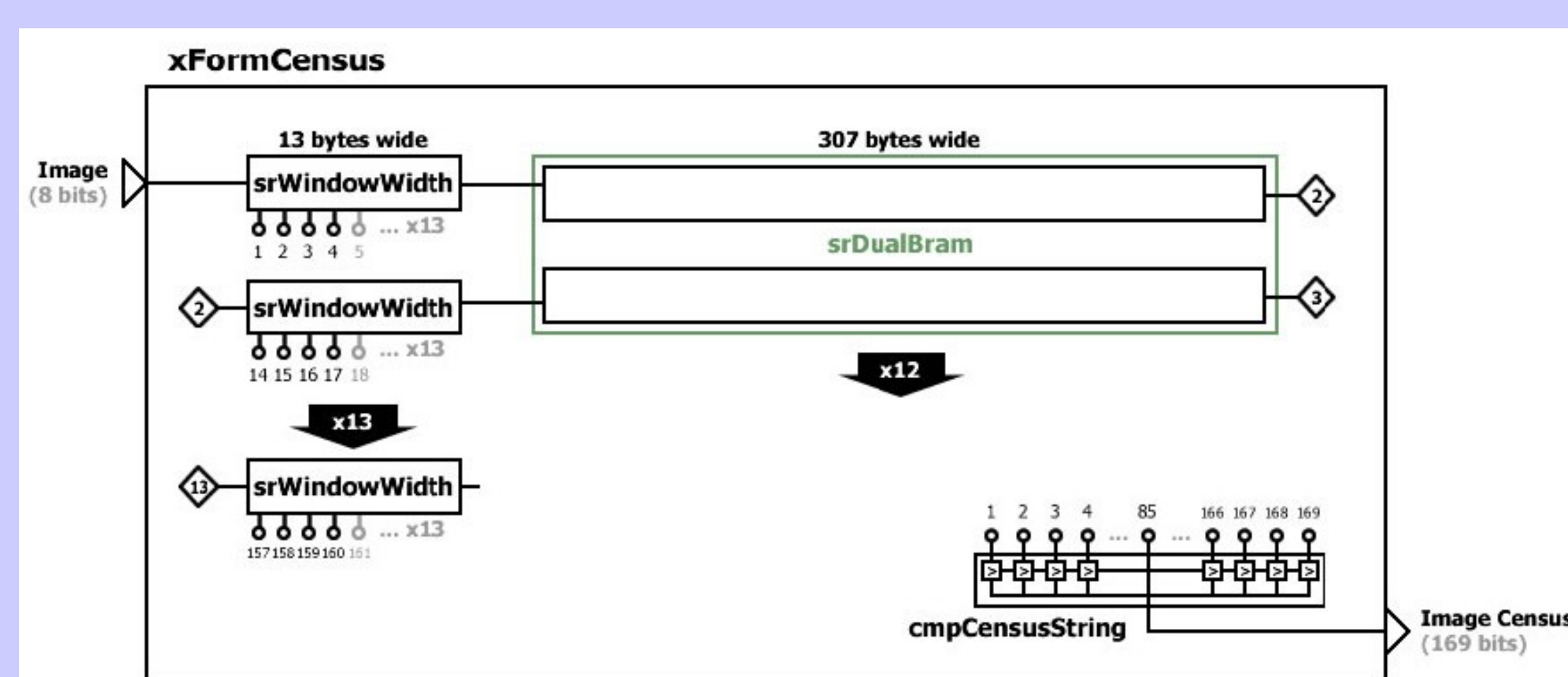

• Omnivision Imager
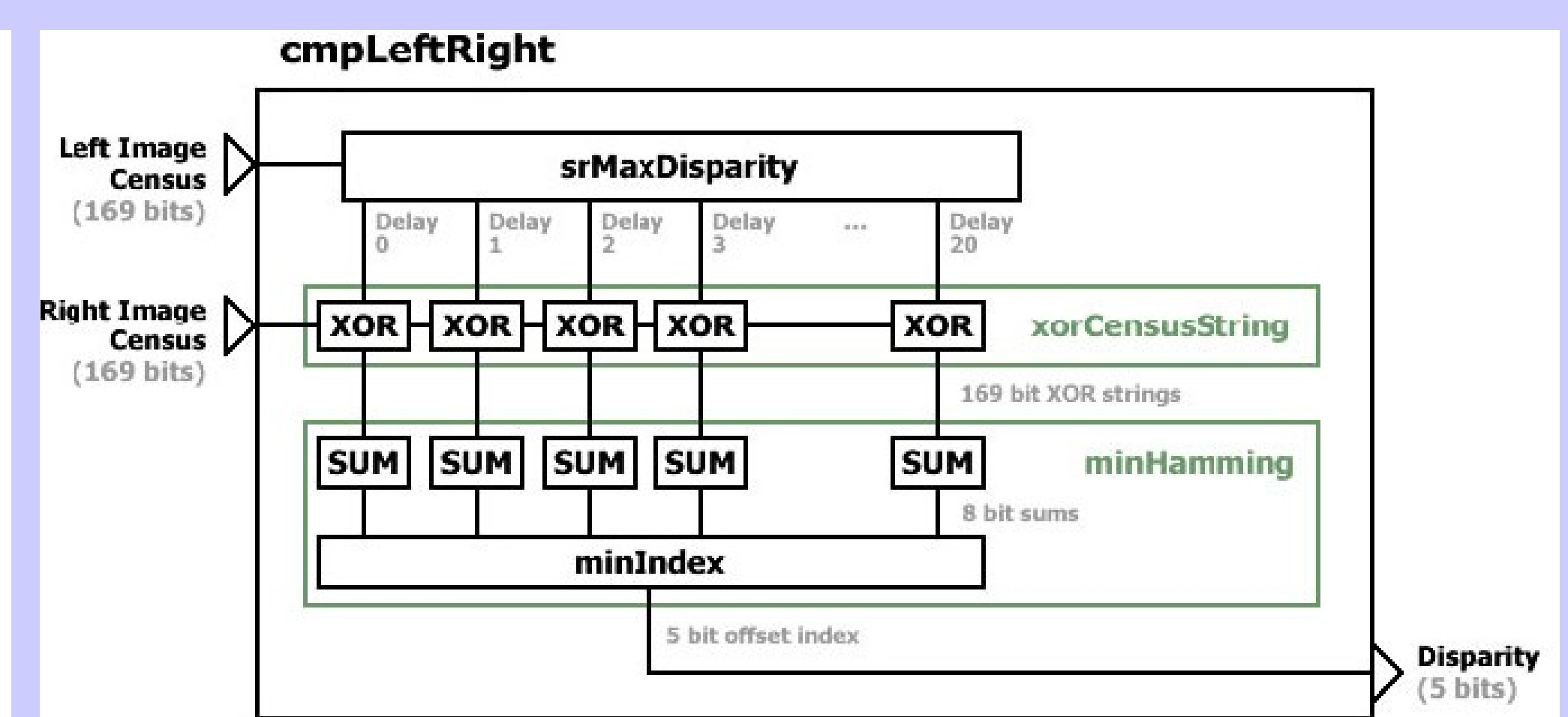
• USB Interface

Algorithm Implementation on the FPGA

Top-level Block Diagram

Census Transform Module

Hamming Distance

Image Results

Disparity

Left Camera

Disparity

Left Camera

Disparity

Left Camera

Disparity

Left Camera

JOHN DEERE