Integrated 64-Channel Optoelectronic Interconnects and Application to Digital Halftoning Image Processor

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ABSTRACT:

To meet the challenge of increasingly higher data volume and processing requirements in military and national security applications, multi-channel optoelectronic (OE) and photonic smart image processors based on optical interconnect technology offer a promising solution because of its unique capability of high-bandwidth, parallel data, and image transmission and processing. The OE smart image processor comprises an integrated array of individually controlled transmission channels and receiving channels.

We designed and fabricated the multi-channel OE processor using 8x8 850-nm VCSEL and InGaAs p-i-n photodetector (PD) arrays. We integrated 64-channel OE image processor in a free-space configuration. The PC board mounted VCSEL transmitter and photoreceiver arrays were optically aligned. Optical image processing was carried out utilizing a diffractive optical element (DOE) device for the fan-out/fan-in interconnection processing functionality. The DOE was fabricated on a transparent quartz substrate with 8-level structural features. When a single VCSEL transmitter channel is aligned to a DOE unit, the transmitted beam delivered a 7x7 diffractive pattern at the back focal-plane of the DOE.

This integrated interconnects were investigated in an OE processing architecture as a digital halftoning image processor. In our experiment, an initial gray-scale image is loaded into the computer for processing by the digital halftoning system. The error by individual pixel is computed with a threshold function and transmitted using the analog channels to the VCSEL array. The VCSELs lase according to the input pattern from the controlling computer. The light output from the VCSEL array was incident upon the diffractive optical element which fans the individual channels out in the 7x7 pattern onto the detector array. The intensities from the various DOE outputs combined through the superposition principle and formed the diffused error output. This error output was then read into the computer and formed the new image. This process was iterated until the image was deemed of appropriate quality. The parallel nature of this optical system demonstrated the potential of very high-speed and high-throughput parallel information processing.

KEY WORDS: VCSEL, photodetector, digital halftoning, optical interconnect, diffractive optical element (DOE), image superposition.

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