Compact optical interconnection module for OCULAR-II: a pipelined parallel processor

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over 2π as shown in Fig. 4. The horizontal axis shows the analog level of a VGA signal from the computer, and the vertical axis indicates the phase modulation depth using a laser whose wavelength is 532nm. An almost linear computer controlled transfer function is realized.

In this system, we have employed a SELFOC lens array (SLA) which has a short imaging distance to form a compact system instead of the 1:1-imaging lens. The SLA has a lower resolution of 10 lp/mm (@50%MTF), but has an extremely short imaging distance of 32mm. This enable us to make a compact unit. The LCD used is a 1.3inch XGA-LCD (LCX023BL, produced by SONY) which has 1024x768 pixels of 26 μm pitch horizontally and vertically. Moreover, we developed a new PAL-SLM to have a wide and linear phase modulation transfer characteristic suited for computer control. Finally, we adjusted all of the characteristics of these components such as the transfer characteristics of the LCD, the SLA, the PAL-SLM, and illumination to obtain a high diffraction efficiency. Figure 5(a) is a custom designed zooming Fourier transform lens for interconnection. The focal length is adjustable from 360mmm to 440mm by moving one of lenses as illustrated in Fig. 5(b). This function is important for matching interconnection parameters such as the pixel pitches of the VCSEL-array, the PD-array, the CGH, and for compensating for wavelength variation of the VCSEL array.

We have evaluated the performance of the optical interconnection unit by using a computer generated hologram (CGH) which has a function of fanning out a signal to four beams. The evaluated CGHs and output images are shown in Fig. 6. The CGH was created by using a simulated annealing algorithm to have optimum diffraction efficiency. The result shows that the system has sufficient diffraction efficiency for reconfigurable interconnection. The switching rate of the interconnection is limited by the refresh rate of the VGA-signal which is 60-70Hz. The main losses in the system are binarization of the CGH and the resolution of the SLA. Since we confirmed that the LCD coupled PAL-SLM demonstrates over 100 gray levels, the system can be adapted to a more advanced CGH with analog levels.

The system we have demonstrated provides reconfigurable interconnection under computer control. Since OCULAR-II is based on the concept of modularity, the system can be extended to a massively parallel system by pipelining or cascading structures [7]. We present some experimental results of practical applications to show the processing ability of the system. This system can be adapted for achieving solutions of several kinds of problems requiring high speed processing power [8].

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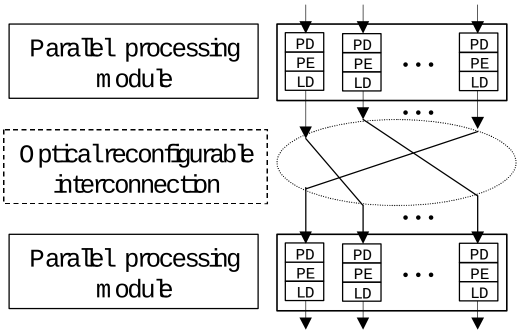


Fig. 1 System diagram

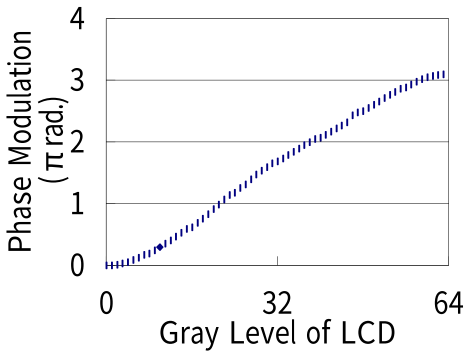


Fig.4 Transfer characteristics of LCD coupled PAL-SLM by using 1:1-imaging lens

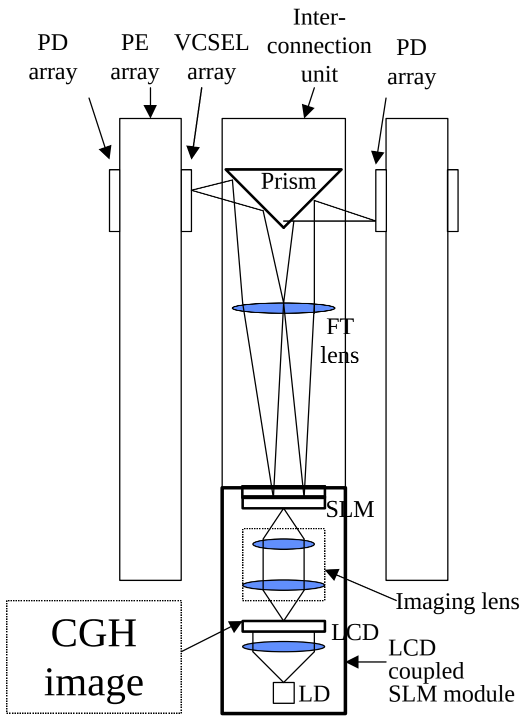
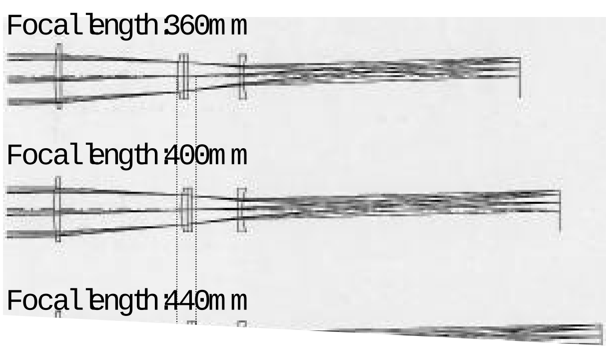


Fig.2 Inter connection unit

Fig. 5(a) Fourier transform lens



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