3D TV by electro-holography
--Fast hologram calculation by networking--

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Recently, a study of Virtual-Reality becomes active. Expectation to 3-D reproduction technology rises with it. Electro-holography using Spatial-light-modulator attracts attention, because natural 3-D animated image is provided. It is important to execute hologram calculation at high speed to realize the real time electro-holography. In other words, a higher-speed computer and a study of calculation algorithm becomes an important subject. This time, we realized to fast calculation of Fresnel-Hologram by networking technology.

1. Introduction

We have been developing 3D TV by eye-lens type electro-holography using liquid crystal devices (LCD) [1]~[3], there calculation time of the computer generated hologram (CGH) is important. Recently several methods are proposed [4]~[6]. In this point real time calculation is not still realized. We pay attention to the matter that parallel calculation of hologram is possible at the hologram plane. Therefore we consider about fast hologram calculation by computer networking

2. Parallel hologram calculation

At the optical set-up in Fig.1 intensity distribution on the hologram plane is shown as next equations.

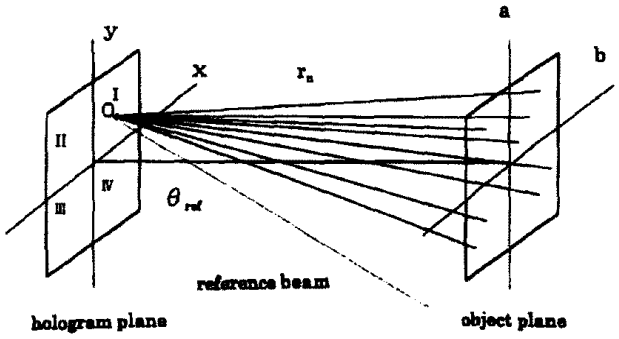

Fig 1 Fresnel Hologram

$$\omega_0 = \sum_n A_n \exp\left(i2\pi \frac{r_n}{\lambda}\right) \quad \text{-------- (1)}$$

$$\omega_r = \frac{2\pi x}{\lambda}\sin\theta_{ref} \quad \text{-------- (2)}$$

$$r_n = \sqrt{(x-a)^2 + (y-b)^2 + z^2} \quad \text{-------- (3)}$$

$$I(x,y) \equiv |\omega_0 + \omega_r|^2 \qquad \text{-------(4)}$$

From this equation zero order term is omitted . then

$$I(x,y) = 1 + 2\sum_n A_n \frac{\cos(kr_n)}{r_n} \qquad \text{------ (5)}$$

This equation is used for calculation. 3D object is composed of many point sources and hologram area is devided into many small blocks. This small block data is calculated with each computer and parallel computing can be possible. This is shown in Fig.1

3. Networking

For mutual connection of computer networking is used in stead of bus line and back plane. Each computer is independent from other computer and all network is controlled as shown in Fig.2. By this mutual connection procedure many command can be excuted in same time.

This time we consider the calculation time in next situation.

(1) The number of point source are 1~70 points.

(2) hologram size is 512×512, 1024×1024, 2048×2048 sample points

(3) The number of computer are 1~64 workstations

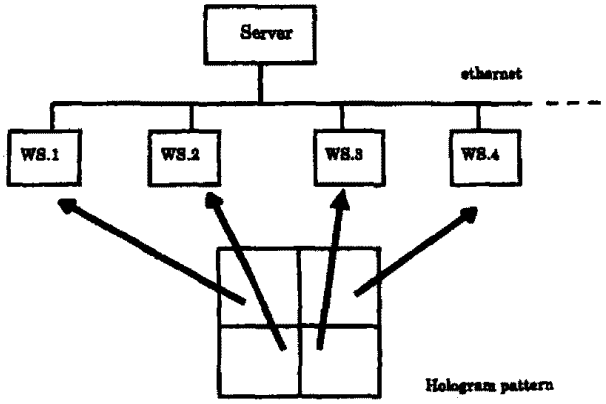

Fig.2 Network computing model

4. Network technology

Network is composed of seven layers which has standard decided by ISO. The specification of this method is shown in Table 1. The specification of computer is shown in Table 2.

Table.1 Network technology

ISO		procedure
7	application	NFS
6	presentation	XDR
5	cession	RPC
4	transport	TCP
3	network	IP
2	data-link	
1	physical layer	Ethernet

Table 2 Spesification of computer

	SUN SPARC StationClassic	HEWLETT PACKARD HP9000/755
CPU	microSPARC (50MHz)	PA-RISC7100 (99MHz)
Memory	32 (Mbytes)	64 (Mbytes)
HDD	207 (M bytes)	2 (G bytes)
Ethernet	10Base-T	10Base-T

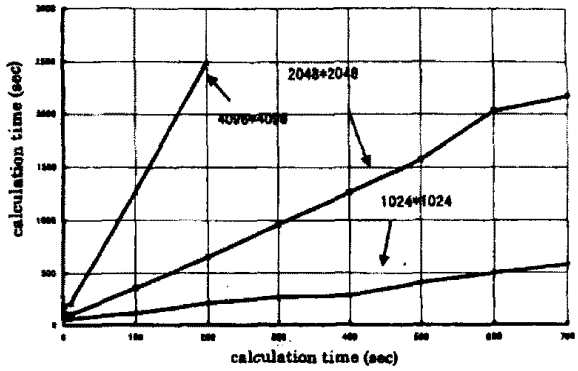

Fig4 Calculation time by number of point source (parameter is hologram size)

5. Results and consideration

Maximum 64 workstations are used to calculate the hologram pattern. The comparison of calculation time according to the number of the point source and number of computer are shown in Fig.3~Fig.5.

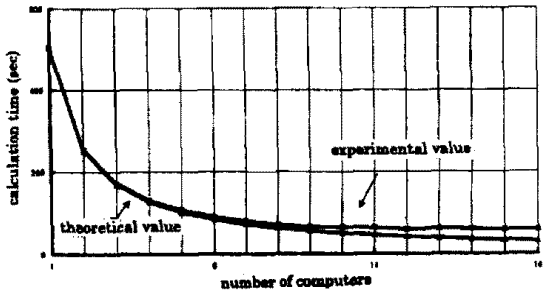

Fig5 Calculation time by number of computer

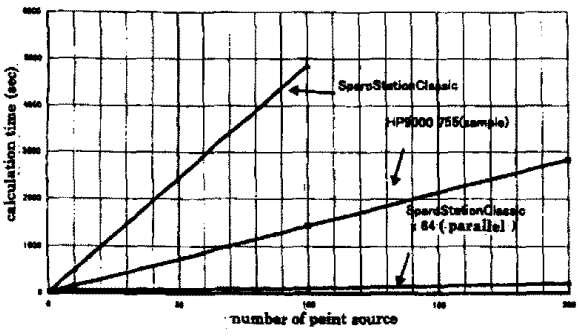

Fig3 Calculation time by number of point source (parameter is a number of computer)

Next matters are made cleared

(1) In the case of the parallel calculation according to 64 workstations calculation time becomes very short.

(2)Calculation time increases corresponding to the hologram size.

(3) Calculation time increases corresponding to the number of the point source.

(4) The difference between theoretical calculation time and the real ones becomes large proportionally to the number of the computer . This is because the load of the network becomes large.

hologram pattern and the reconstructed image are shown in Fig.6~7, there the hologram is image type Fresnel hologram

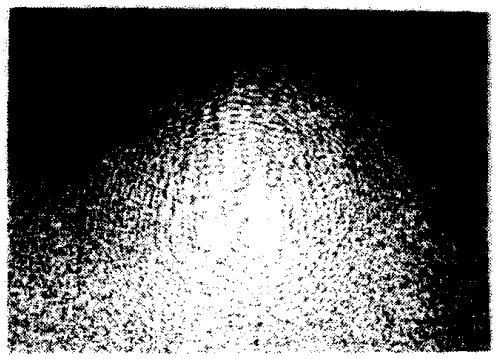

Fig.6 Hologram pattern

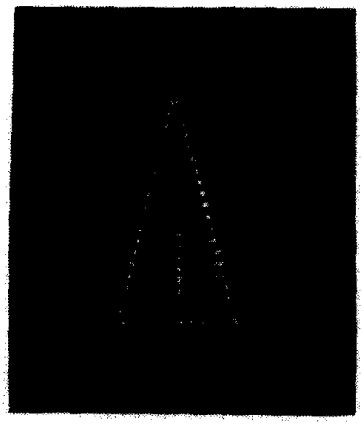

Fig.7 Reconstructed image

6. Conclusion

This time we considered about fast calulation of Fresnel hologram using networking of many computers. and made clear that this parallel computer networking method is very effective for hologram calculation.

But more fast calculation method is necessary to realize 3D TV. From now on we consider to improve the hologram calculation

References

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