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DEVELOPMENT OF SUPER LARGE SIZE LASER DIGITIZER SYSTEM

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ABSTRACT

Recently, the CAD/CAM system to automatically design and process are used in almost every industry world[1].
We designed an original digitizer system to digitize a real size car drawing.
We succeeded in the development of super large size Laser Digitizer System (LDS) which has input area of 2m by 6m, resolution of 0.1mm and accuracy of ±0.5mm.
This Laser Digitizer System can use in design of cars,ships,planes and big maps. Also can use in sensing the position of nozzle head of laser processing system, and so on.

1. INTRODUCTION

Following the instructions[2] of respectable REV.SUN.M.MOON, we have been researching and developing original computer hardware and software to unify human and computer.
The center of our results is input device what we call digitizer.The features of our digitizer is cordless cursor and cordless stylus pen[3].
Now,the present digitizer has weak point which the size of digitizer is limited,the max was B_2 size as yet.
But, they have been waiting for a larger size digitizer for digitizing the drawing of larger size machine and device.
We developed a large size digitizer used laser technology for digitizing real size car drawing.
Namely,we succeeded in the development of real size digitizing system for car drawing with 2m by 6m rectangular size. We call it super large size Laser Digitizer System (LDS).
In this paper, we describe the principle, the apparatus,the key technology of Laser Digitizer System and the digitizing example of real size car drawing.

2. PRINCIPLE

The position coordinates in this system is obtained through the following formulas (1) and (2) of triangulation.

$$x = \frac{L\tan\theta_2}{\tan\theta_1+\tan\theta_2} \quad \cdots \ (1)$$

$$y = \frac{L\tan\theta_1\tan\theta_2}{\tan\theta_1+\tan\theta_2} \quad \cdots \ (2)$$

Three positions of this triangulation are respectively the position of A(0, 0), B(L, 0) (distance L) and P(x, y) ($\angle BAP=\theta_1$, $\angle ABP=\theta_2$) (see Figure 1)

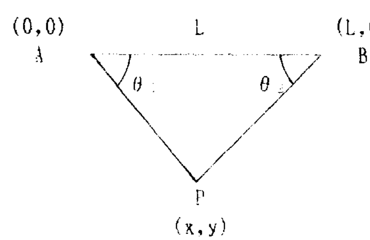

Figure 1 Principle of LDS

In other words, we calculate two formulas (1), (2) in three positions A,B,P.
According to the principle,position coordinates of P(x, y) is determined only by triangle A,B,P.
If this triangle A,B,P is enlarged, digitizer input area enlarges too. Therefore,we can create a larger size digitizer.

3. APPARATUS

A schematic drawing of this system is shown in Figure 2. And the specification of this system is shown in Table 1.

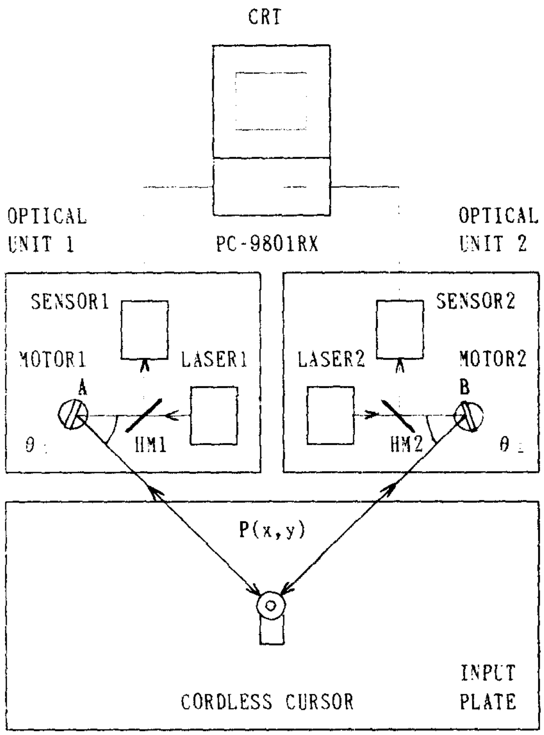

Figure 2 Schematic drawing of LDS

Table 1 Specification of LDS

a.Laser	Semiconductor
Oscillation	Continuous Wave
Wavelength	810nm
Output Power	40mW(Max)
b.Motor	Airbearing
Speed	2400rpm
Jitter	0.000001
c.Sensor	Si-Avalanche PD
Aperture	0.5mmϕ
Quantum efficiency	0.77
rise time	750ps
Multiplication	1000
d.Counting clock	36MHz
Resolution	0.0002°

This system consists basically of two optical units, one reflective cordless cursor, a set of personal computer and an input plate.

The light source in the optical unit is semiconductor laser[4]. This laser has wavelength of 810nm(infrared),oscillation of continuous wave, max output power of 40mW. We usually use 12mW.

The laser bean is collimated by lens, scanned by rotating plane mirror installed in notor over the input plate.

The notor has airbearing,therefore is especial in accuracy of rotation jitter[5]. The jitter is 0.000001 at the rotation speed of 2400rpm.

The scanning laser bean is reflected by column mirror at the top of cursor. Especially, this column mirror is a retro-reflective mirror[6].

The reflected laser bean returns to rotating plane mirror in a moment,is bent by half mirror, goes to sensor which converts optical energy into electric energy.

The sensor is a Si-avalanche photo diode[7],has aperture of 0.5mmϕ, quantum efficiency of 0.77, rise time of 750ps and multiplication of 1000.

Reflected laser beam is detected as an electric pulse at a high speed by this sensor. This pulse is amplified properly,converted analog data into digital data and counted by 36MHz counter circuits. Consequently,angle resolution is 0.0002°.

The counted value is processed by a PC-9801RX personal computer and shown on CRT.

The angle θ is obtained by formulas (3).

$$\theta = \frac{2t}{T} \times 360 \quad \cdots \quad (3)$$

t : time which laser goes to a place and back to cursor
T : time which plane mirror rotates 360°

This θ is obtained from right and left optical unit, respectively θ_1, θ_2. We get the position coordinates of P(x, y) from formulas (1) and (2) using these θ_1 and θ_2.

We named this method a "Light Give And Take Style-Triposition Measuring Method"(LIGATS-TMM).

The LDS has the merit of free input area and high accuracy by using cordless cursor because of adopting the LIGATS-TMM.

4. KEY TECHNOLOGY

To develop the super large size LDS,high technology in optics, mechanics, electronics had to be united.

For example, we had had to measure the angle θ_1, θ_2 in Figure 2 up to 0.0001',for this system has the specification of resolution of 0.1 mm and accuracy of ±0.5mm in 2m by 6m input area.

By reason of this,we used the airbearing motor which has 0.000001 rotation jitter. This motor is used in mastering of Compact Disk.

And we needed the mirror at the top of cursor which if cursor is tilted a few angle, reflected laser beam always returns to optical unit.

So, we used a retro-reflective column mirror to reflect laser beam. This retro-reflective mirror is used as reflector of bicycle usually. By this mirror, we can use the cursor freely, if cursor is tilted and input plate is uneven.

5. DIGITIZING EXAMPLE

Figure 3 shows the appearance of super large size LDS.
The purpose of this system is to digitize a car drawing in real size with input area of 2m by 6 m. The size of this input area is four times as large as the present largest digitizer B_0.At the same time, resolution of 0.1mm and accuracy of ±0.5mm were realized in this input all area.

A designer gets on the input plate, moves the cursor along the line on the real size car drawing and pushes a cursor switch to digitize the position at his option.
In this case, positioning operation was very easy. It only took us two or three hours in all car drawing.

A simple CAD software in this operation was also developed for tracing a real size car drawing. The features of this software has screen mode of menu and design,zoom mode and curve mode of spline function.

The example of a side view real size car drawing is shown in Figure 4. This car drawing is drawn on the 1.5m by 5 m film sheet. We could digitize this whole car drawing in all by LDS.
The digitizing example of this side view car drawing is shown in Figure 5. In this Figure 5, "X=,Y=" shows the position coordinates.

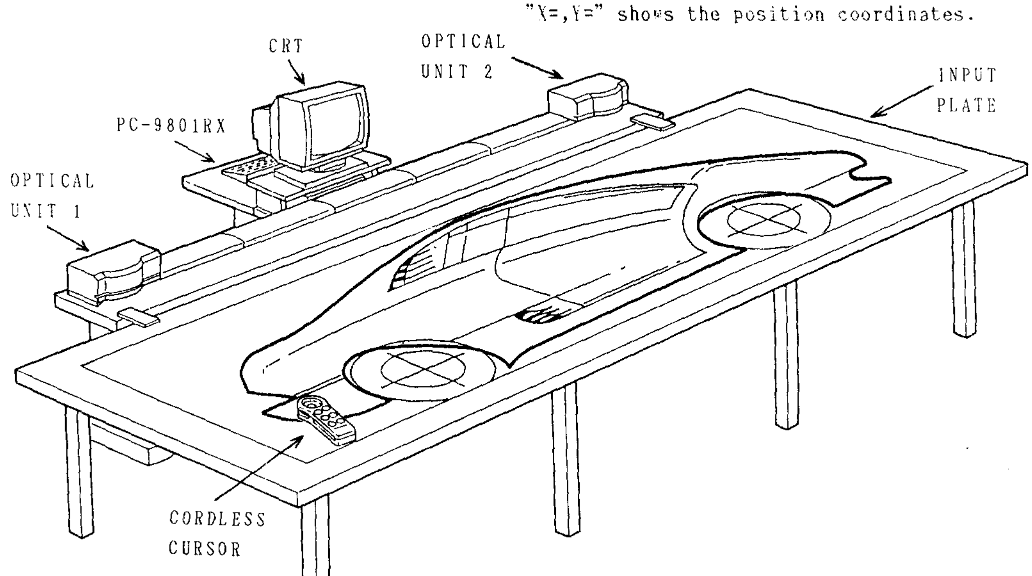

Figure 3 Appearance of super large size LDS

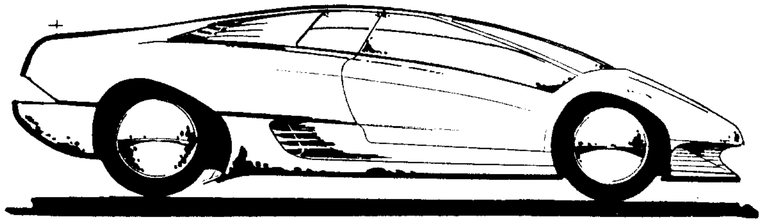

Figure 4 Example of a side view real size car drawing

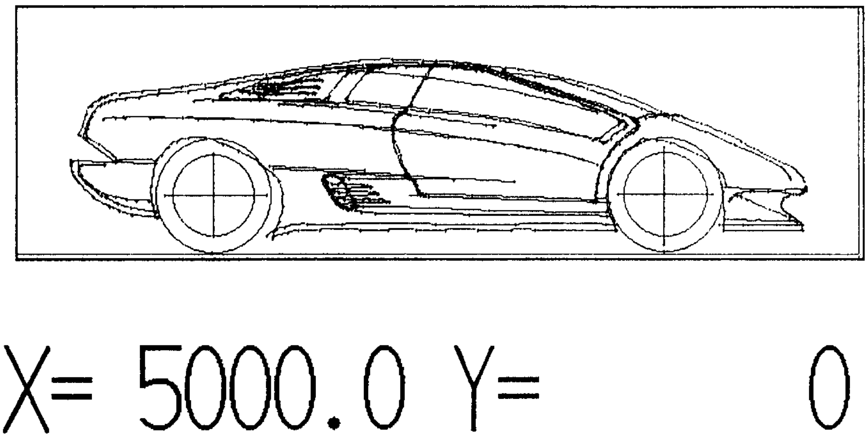

Figure 5 Digitizing exanple of side view real size car drawing

6. CONCLUSION

In this paper, we have described the method and the systen of new large size digitizer used laser technology. We naned this method a "Light Give And Take Style - Triposition Measuring Method" (LIGATS-TMM).
We succeeded in development of the super large size Laser Digitizer Systen (LDS) to digitize a car drawing in real size.

The super large size LDS has input area of 2m by 6m, resolution of 0.1mm and accuracy of ±0.5 mm. This input area with high resolution is the largest size in the world.
By using this systen, large size drawings such as cars, ships and planes can be simply digitized in real size.
When we have digitized the real size car drawing, pointing operation was very easy. It only took us two or three hours in all.

In the future, we are going to develop the LDS with larger size, higher accuracy, cheaper cost and wider application.
And we are studying 3D LDS now.

ACKNOWLEDGEMENTS

To True Parents, Mr. and Mrs. Moon we dedicate this paper in token of respect and gratitude.

REFERENCES

1) Target Industry Studies on Laser and CAD/CAM Industries, Flint-Genesee Corp., NTIS (1983)

2) Rev.Sun.M.Moon; Divine Principle, HSA-UWC (1977)

3) Timothy E. Johnson; Closer to that pen-and-paper feel, MacWEEK 24 April (1990)

4) Seniconductor laser catalog, Sharp (1989)

5) Motor catalog, Koken (1990)

6) Retro-reflector catalog, Sunitono 3M (1989)

7) Optical sensor catalog, Mitsubishi (1987)