하계학술대회
논문86-12-1

The measurement of vision system for many line-like objects

이 한 식 충북대학교
오 충 환* 충북대학교

1. Introduction

We had repoted a method which uses shadow information with one point light source, to measure the three-dimention measurement position of wire tips. However, a disadvantage of this method is that it cannot determine the pair, the image of the tips and corresponding shadow of this tips, when the lens focus, the point light source and more than one tip are in the same plane. therefore, it was difficult to measure the three-dimension measurement position of terminals in some case. In order to measure the three-demension measurement position of many line-like objects,a new vision system which use two point light sources has been developed. An algorithm that uniquely determines the corresponding pair of terminals is also developed. We also obtain a general method to measure the three-dimension measurement position of wire tips. The accuracy of mesurement is also improved, because the three-dimension measurement position of the terminals is calculated by the cross-point of three lines.

According to the corresponding pairs of the terminals, we determine the corresponding pairs of the line. Based on the fact that the corresponding image pair of the points on the line and the image of the point light source are collinear, we can calculate the 3-D position of any point on the line , and then the orientation of the line.

Finally, the experimental results are shown.

2. In case of a point light source.

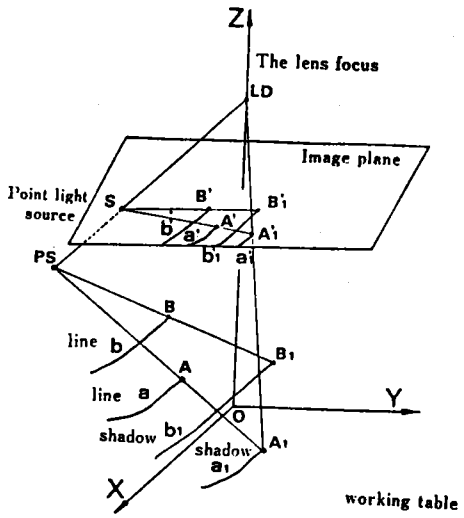


Fig. 1 Principle of measurement

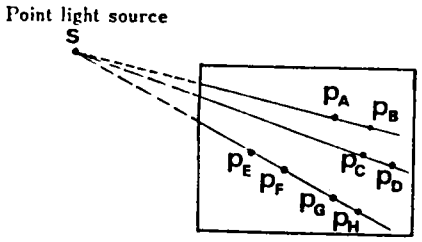


Fig. 2 Finding correspondence of each of line-like objects to their shadow

3. In case of two point light source.

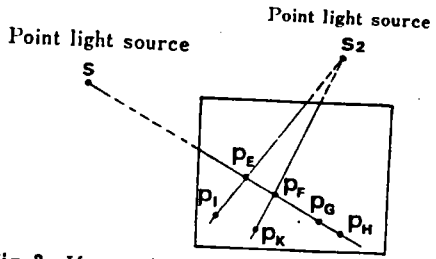


Fig. 3 If two (or more) terminals P_E, P_F and the illuminant source S are aligned with a line in image, the source S_2 is used to find correspondence of the terminals P_E and P_F to their shadows P_I and P_K

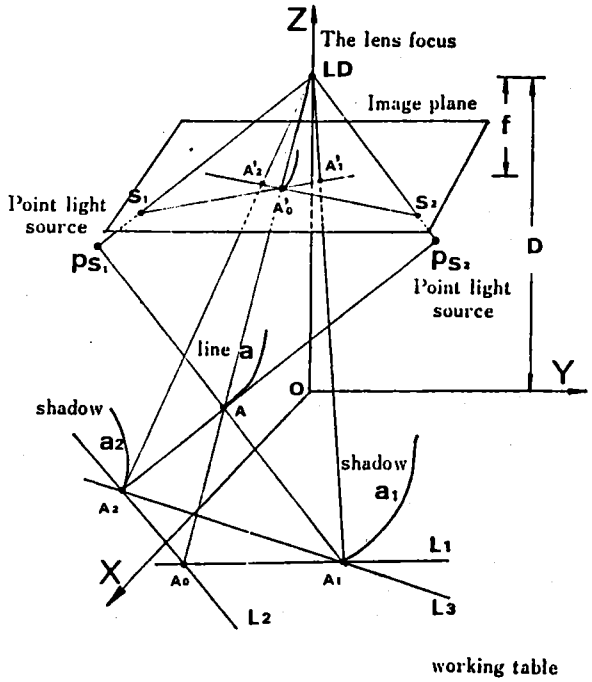


Fig. 4 Relation between the terminals and lines L_1, L_2, L_3

$$[L_{1ij}]=\begin{cases}1 & \text{Shadow point J is co-sub imagei}\\ 0 & \text{Except}\end{cases}$$

$$1\le i, j\le n \qquad (1)$$

$$L_{1ij}=1,\ L_{2ik}=1,\ L_{3jk}=1 \qquad (2)$$

$$\begin{aligned}
&X_1=X_{A0}, && Y_1=Y_{A0}, && Z_1=Z_{A0}\\
&X_2=X_{A1}, && Y_2=Y_{A1}, && Z_2=Z_{A1}\\
&X_3=X_{A2}, && Y_3=Y_{A2}, && Z_3=Z_{A2}\\
&L_1=X_D-X_{A0}, && M_1=Y_D-Y_{A0}, && N_1=Z_D-Z_{A0}\\
&L_2=X_{S1}-X_{A1}, && M_2=Y_{S1}-Y_{A1}, && N_2=Z_{S1}-Z_{A1}\\
&L_3=X_{S2}-X_{A2}, && M_3=Y_{S2}-Y_{A2}, && N_3=Z_{S2}-Z_{A2}
\end{aligned}$$

$$\frac{(X-X_i)}{L_i}=\frac{(Y-Y_i)}{M_i}=\frac{(Z-Z_i)}{N_i} \quad (i=1.3) \qquad (3)$$

$$\left.\begin{aligned}d_i^2=&[(X_c-X_i)^2+(Y_c-Y_i)^2+(Z_c-Z_i)^2]\\ &-[L_i\cdot(X_c-X_i)+M_i\cdot(Y_c-Y_i)\\ &+N_i\cdot(Z_c-Z_i)]^2/(L_i^2+M_i^2+N_i^2)\end{aligned}\right\} \qquad (4)$$

$$L=\sum_{i=1}^{9} d_i^2 \qquad (5)$$

4. Line of 3-dimension coordinates.

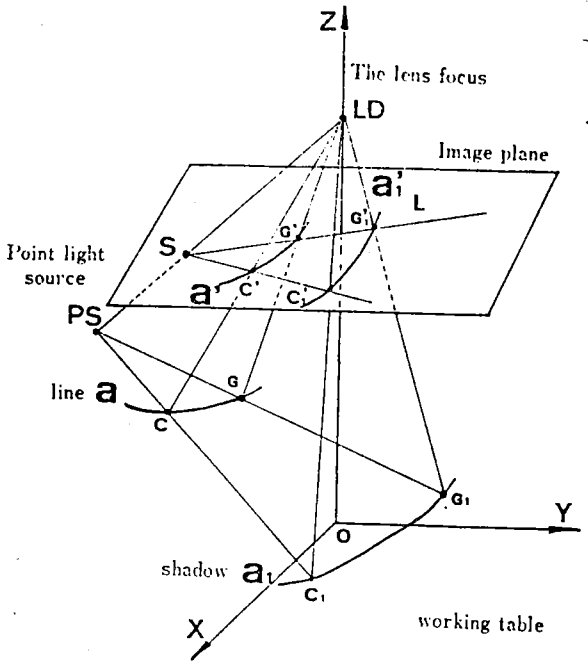


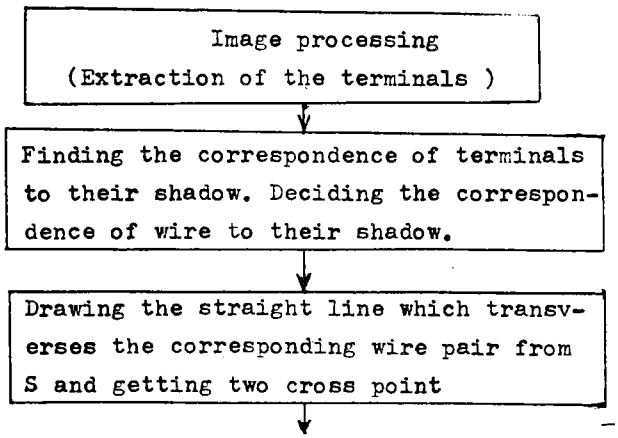
Fig. 5 (a) The 3-D measurement of the point on the line-like object

Table 1 The position of the point light source and the focus of the TV-camera

(unit : mm)

	X	Y	Z
Point Light Source 1	−1,513.0	952.0	1,500.0
Point Light Source 2	1,950.0	831.0	1,370.0
Focus of the TV-camera	16.4	−42.5	812.0

5. Line direction.



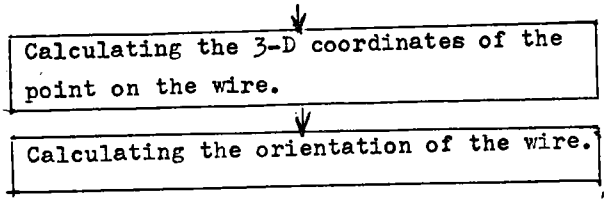


Fig.5(b) The flow chart of 3-D measurement of the point on the line-like objects.

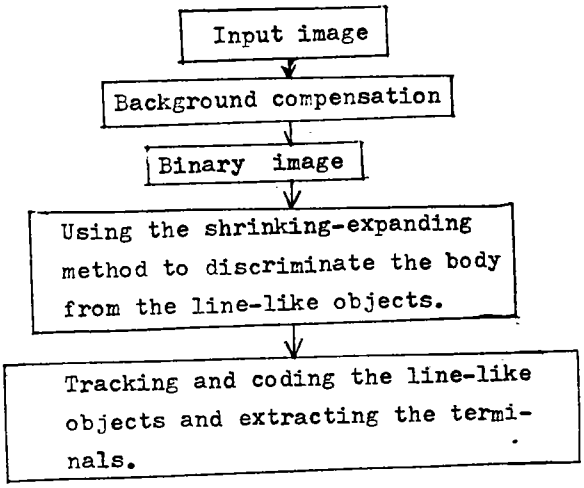


Fig.6 Procedure of image processing.

$$L_i=(x_i-x_{i-1})/l \qquad (6)$$

$$M_i=(y_i-y_{i-1})/l \qquad (7)$$

$$N_i=(z_i-z_{i-1})/l \qquad (8)$$

$$l=\sqrt{(x_i-x_{i-1})^2+(y_i-y_{i-1})^2+(z_i-z_{i-1})^2} \qquad (9)$$

6. System composition and it's experimental result.

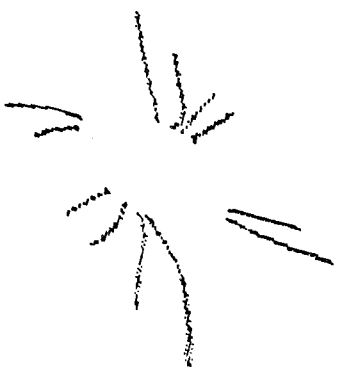


Fig.7 Extraction of the line-like objects.

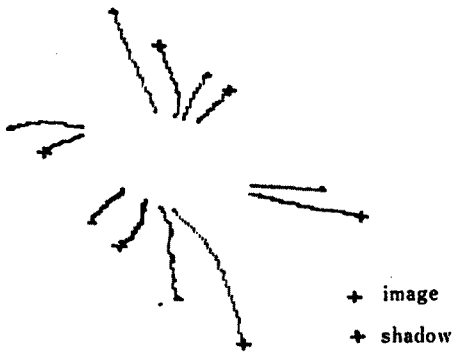


Fig.8 Extraction of the terminals of the line-like object for image 1.

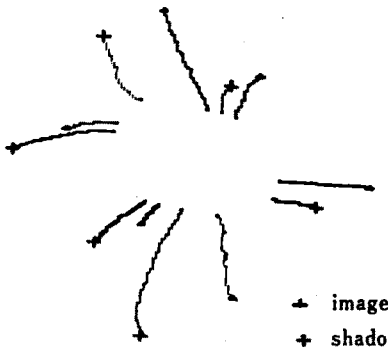


Fig.9 Extraction of the terminals of the line-like objects for image 2

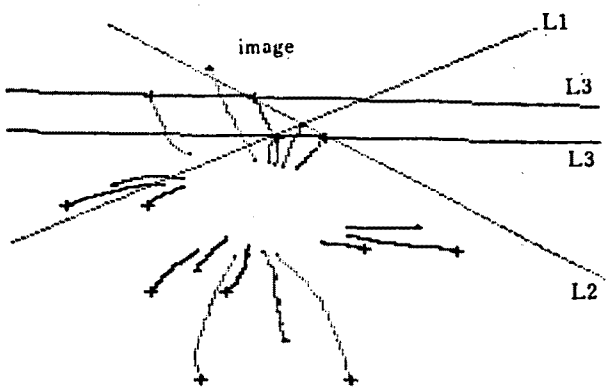


Fig.10 Determinig the image and their corresponding shadow.

7. Concluding Remarks.

We implemented measure the three-Dimension Measurement position of many line-like objects, a new vision system which use two point light sources has been developed.

An algorithm that uniquely determines the corresponding pair of terminals is also developed. Therefor we obtain a general method to measure the three-dimension position of wire tips. The accuracy of mesurement is also improve, because the three-dimension posion of the terminals is calculated by the cross-point of three lines.

References.

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