Computer Processing of Pictorial Information Homework 2

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Fig. 1: Image for calculating vanishing points and door's height.

I. Introduction

This homework aims to estimate the height of the A.V. Williams building's door. We took a picture of it with a person as the reference object in the scene.

II. Method

In this section, we describe the pipeline of our estimation. We are given an image contains target and a reference object, as shown in Fig.1. Note that we need to contain the brick on the floor in order to find vanishing points at X and Y direction.

A. Pipeline

The whole pipeline is described as following

1) Compute two vanishing points, v_x, v_y, at X's and Y's direction by finding the intersection of two parallel lines on the ground.
2) Draw the horizon, that is, the line go through two vanishing points.
3) Compute the vanishing point v_z at Z direction by finding the intersection of two parallel vertical lines.
4) Draw a line from the bottom of the reference object b_0 to the bottom of the target B and find the intersection v of this line and horizon.
5) Draw a line from v to the head of the reference object t_0 and find the intersection t.
6) Utilize cross ratio and single view meterology[1] to calculate the target's height.

B. Derivation of height estimation

Using cross ratio and single view meterology[1], we can have the following equation

$$\frac{b-t}{b-r}\frac{v_z-r}{v_z-t} = \frac{B-T}{B-R}\frac{V_z-R}{V_z-T} \tag{1}$$

where b, t, r, v_z are defined as in Fig.2 and the upper case is the corresponding points in the world. If the vanishing points at Z direction in the world is at infinite, we have

$$\frac{V_z-R}{V_z-T} = \frac{\infty-R}{\infty-T} \simeq 1 \tag{2}$$

Substitute into Equation.1, we get

$$\frac{b-t}{b-r}\frac{v_z-r}{v_z-t} = \frac{B-T}{B-R}\frac{V_z-R}{V_z-T} = \frac{B-T}{B-R} = \frac{h_{ref}}{h_t} \tag{3}$$

and

$$h_t = h_{ref}\frac{b-r}{b-t}\frac{v_z-t}{v_z-r} \tag{4}$$

III. Result

From Fig.3, we can get following results,

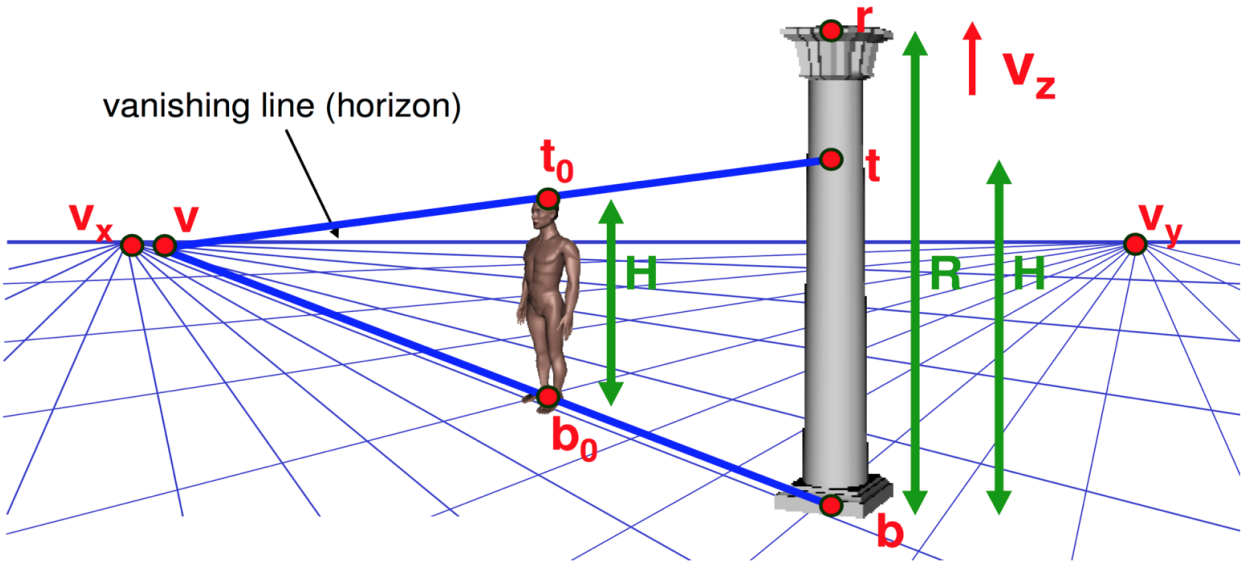

Fig. 2: Formation of the problem. The man is the reference object and the pillar is the target to estimate.

$$
\begin{aligned}
V_x &= [1091.7, 1569.5] \\
V_y &= [-127500, 14560] \\
V_z &= [2573, -27939] \\
Horizon: \ y &= -0.101x + 1679.8 \\
V &= [-497.3, 1730] \\
t &= [463.6, 1660.1]
\end{aligned} \tag{5}
$$

Using Eq.4 and $h_{ref} = 1745mm$, we get

$$h_t = 3414.6mm \tag{6}$$

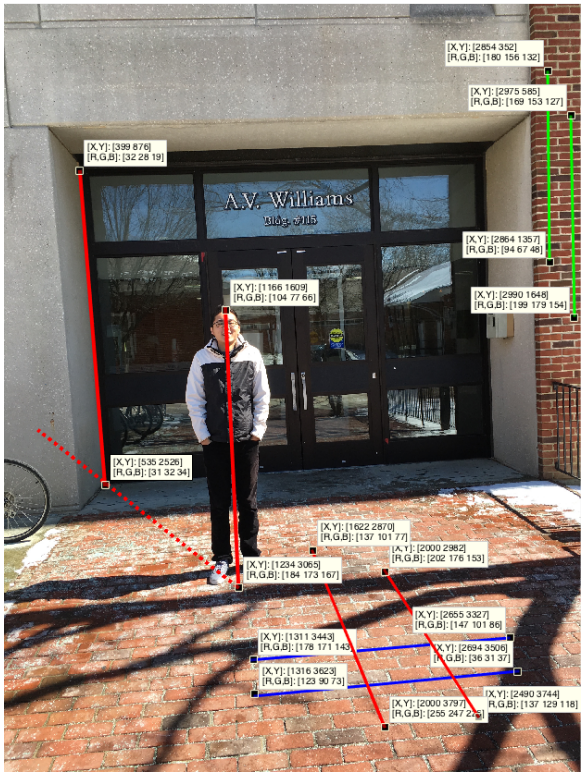

Fig. 3: Image for calculating vanishing points and door's height.

IV. Acknowledgement

Special thanks Wei-An Lin for discussion and the Fig.2 is credited by slides of UPenn CIS580.

References

[1] A. Criminisi, I. Reid, and A. Zisserman. Single view metrology. *International Journal of Computer Vision*, 40(2), 2000.