CMSC 733: HW2: Estimating Height From A Single Image

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***Abstract*—Estimating height from a single image using cross ratio method and single view metrology**

I. Introduction

The groundtruth has been established (by measuring the door!) and was found to be approximately 97 inches or approximately 240 cm.

1) Verifying Parallel lines: Due to the sloping ground and raw distorted quality of the image, taking 2 sets of parallel lines do not converge to the same vanishing point.

2) Computing Horizon Line: The horizon line is the line of intersection between the image plane and the plane **C**. The plane **C** is the plane that is parallel to the referece plane (ground) and contains the camera center. For our image, that plane also passes through our eyes as long as we are looking into the camera.

The following image shows the horizon(green line)

Figure 1. Horizon Line

3) Compute Vanishing Point: This can easily be computed by intersecting two parallel lines that are in the same directions as the reference direction. This is the direction perpendicular to the reference plane through the camera center.

The magenta lines on the facade indicate the parallel lines chosen to compute the vanishing point. Using basic geomtery of two intersecting lines, we calculate the vanishing point and draw a vertical line through it. (blue)

The two points chosen on each magenta line are:

Line 1: [319 ,499] and [338 ,1735] and Line 2: [2699, 536] and [2668 ,1752].

Using the two point form of the line we calculate the equations of both lines as

$$y = 65.0526x - 20253$$

and

$$y = -39.2258x + 106410$$

From here, we can get the vanishing point as [1214.6, 58762]

Figure 2. Vanishing Point and Reference Direction. The blue line is the vertical line through the camera center (point of intersection between the green and blue line)

The intersection point of the blue line reference direction(blue) and the horizon(green) gives the camera center which is at row number 971 as shown in figure 2.

4) Estimating Height of Door: Following the method described in [1] , we require two more planes for the cross ratio, π and $\pi^{'}$. These two planes bound our reference height. In our case, that is our own height. The two planes go through the top of our head and through the bottom of our feet described in figure 3. (red)

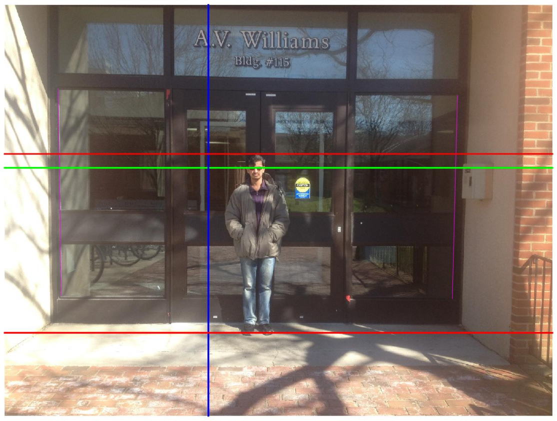

Figure 3. Original Planes shown in red. x and $x^{'}$ are points of intersection between the red lines with the blue line

We apply the cross-ratio formula ,

$$\frac{Z}{Z_c} = \frac{d(x^{'}, c)d(x, v)}{d(x, c)d(x', v)}$$

where Z is the height of the reference object, x is the point on the ground plane π that lies on the reference direction line and $x^{'}$ is defined similarly. Our aim is to find Z_c, that is, the height of the camera in the real world. We get $x, x^{'}, c$ from the points of intersection of the red and green lines with the vertical blue line.

My height is $Z = 175$ cm. Plugging into the formula, we get $Z_c = 160.83$cm.

Using this value, we repeat the process, instead this time, we replace our planes π and $\pi^{'}$. The new planes are shown in yellow in figure 4.

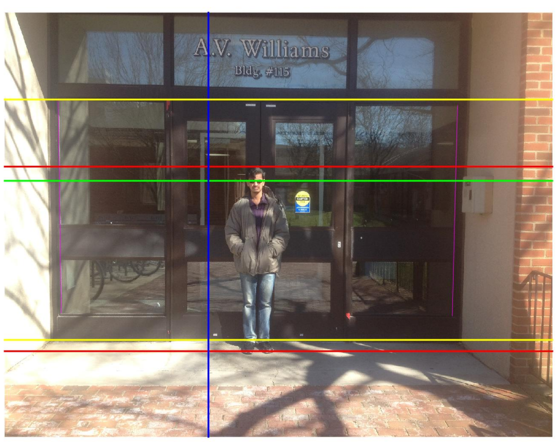

Figure 4. New Planes shown in yellow. x and $x^{'}$ are points of intersection between the yellow lines with the blue line

The points of intersection of these new planes with the vertical blue line can be easily calculated. Using the values for Z_c and c that we calculated above, we use the formula

$$\frac{Z}{Z_c} = \frac{d(x^{'}, c)d(x, v)}{d(x, c)d(x^{'}, v)}$$

to get Z = 241.0418 cm and the original height is approximately **240cm**.

References

[1] Antonio Criminisi, Ian Reid, and Andrew Zisserman. Single view metrology. *International Journal of Computer Vision*, 40(2):123–148, 2000.