CV-Assignment 1

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1 Question 2

Estimating the dimensions using known properties of pinhole projection.
Finding Width and height of Stadium using Cross-ration.

Procedure :

1. Finding Width

Figure 1: point mapping for width

   (a) We Know that 3D world AB == CD = k and BC=44 yard
   (b) Cross ration (3D): (AC*BD)/(AD*BC) = lamda
   (c) Therefore $((k + 44) * (k + 44))/((2k + 44) * 44) = lamda = 1.0675$
   (d) Solving the Quadratic equation for finding "k"
   $k^2 + (1 - lamda) * 88)k + ((1 - lamda) * 44^2) = 0$
   $r = roots([1, (1 - lamda) * 88, (1 - lamda) * 44^2])$
   (e) Taking Positive root value as distance is positive
   (f) Therefore Width $= 2 * k + 44$
   (g) Width = 74.834 yard

2. Finding length

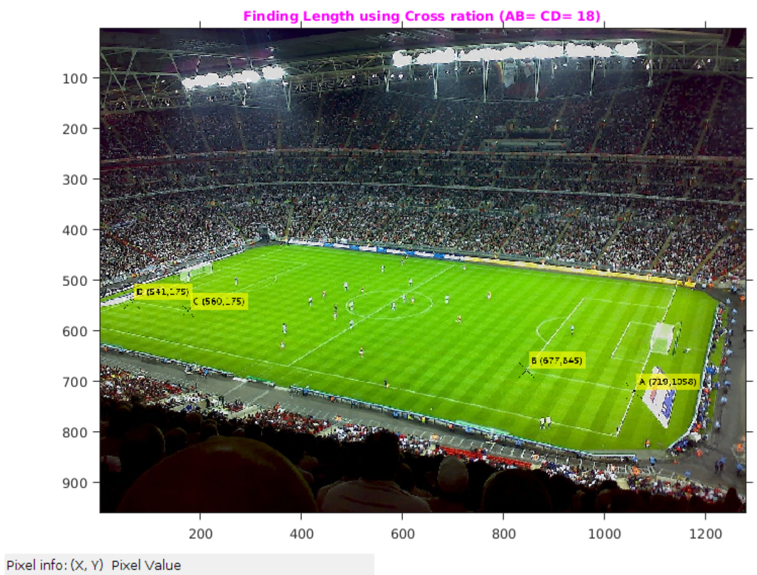

Figure 2: point mapping for length

(a) We Know that 3D world BC = k and AB = CD = 18 yard

(b) Cross ration (3D): (AC*BD)/(AD*BC) = lamda

(c) Therefore $((k + 18) * (k + 18))/((k + 2 * 18) * k) = lamda = 1.0356$

(d) Solving the Quadratic equation for finding "k"
$(1 - lamda)k^2 + ((1 - lamda) * 36)k + 18^2) = 0$
$r = roots([1 - lamda, (1 - lamda) * 36, 18^2])$

(e) Positive root value as distance is positive

(f) Therefore length $= k + 2 * 18$

(g) Length = 115.091 yard

2 Question 5

At time $t = 0$, assume the bar is at distance,

$$D(0) = D_0$$

At time $t = t$,

$$D(t) = D_0 - vt$$

The bar will reach the camera at time $t = T$. At that time, $D(T) = 0$,

$$\begin{aligned} D(T) &= D_0 - vT = 0 \\ T &= \frac{D_0}{v} \end{aligned} \tag{1}$$

Assume the focal length of camera is f, and the length of the bar in the real world is L

The length of bar on the image at time $t = 0$ is,

$$l(0) = \frac{fL}{D(0)}$$

The length of bar on the image at time $t = t$ is,

$$l(t) = \frac{fL}{D(t)} \tag{2}$$

The rate of change in the length of the bar in the image will be $l'(t)$

$$\begin{aligned} l'(t) &= \frac{dl(t)}{dt} \\ &= -fL\frac{1}{D^2(t)}\frac{d(D(t))}{dt} \\ \frac{d(D(t))}{dt} &= \frac{d}{dt}(D_0 - vt) = -v \\ l'(t) &= \frac{fLv}{D^2(t)} \end{aligned} \tag{3}$$

Taking ratio of equation 2 and equation 3,

$$\begin{aligned} \frac{l(t)}{l'(t)} &= \frac{fL}{D(t)}\frac{D^2(t)}{fLv} \\ &= \frac{D(t)}{v} \end{aligned} \tag{4}$$

which is same as equation 1

This means that we can calculate the time taken by the bar to reach the camera by just measuring the length of the bar in the image at a given time and the rate of change of length of the image of bar. Both of which can be calculated accurately from the sequences of images without have any information about the camera constant, the velocity of the bar and the length of the bar.