3D Computer Vision
Final Project Presentation

Estimation of Single Camera Location

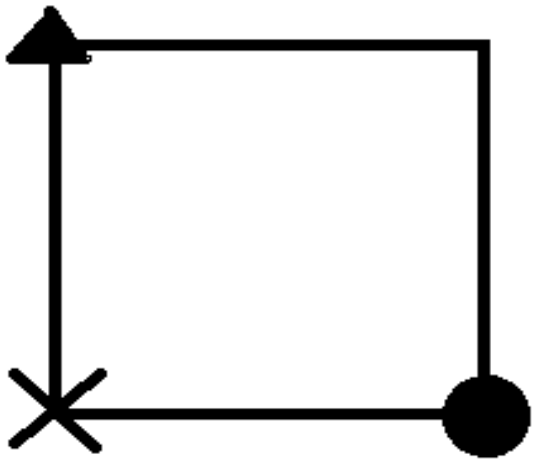
Bodong Zhang

Camera Location

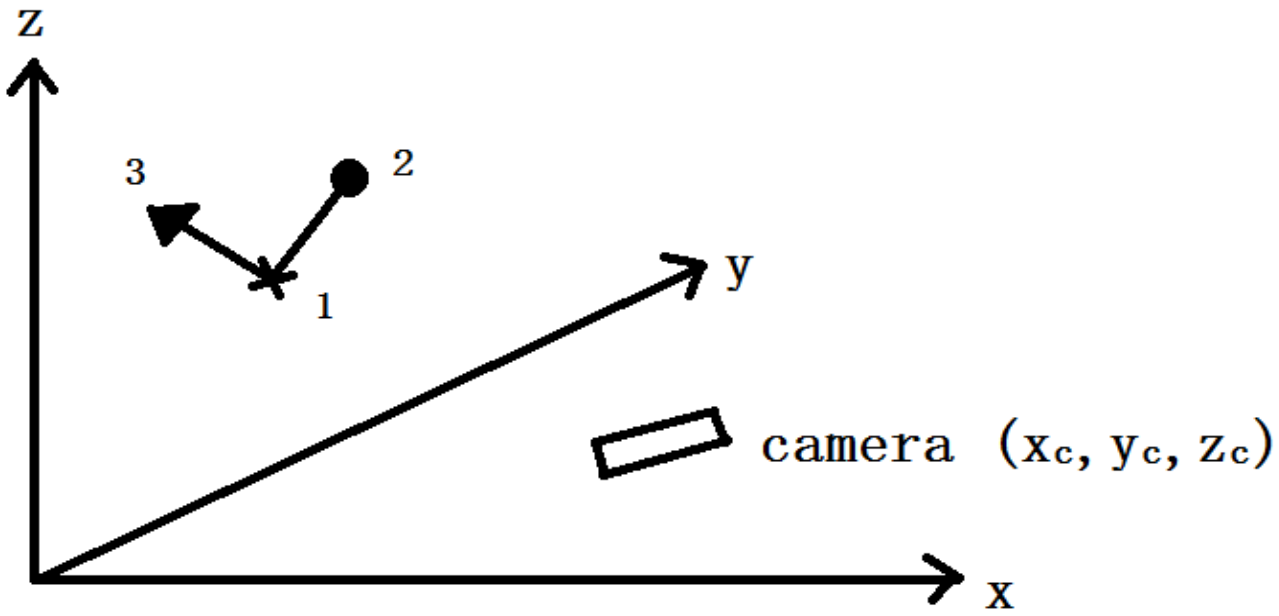
- Take a photo of special graph
- Estimate the 3D coordinates of camera

Standard Square

- The camera will take a photo of a square lying on flat ground,
- Use information of three points to estimate 3D coordinates
- Regardless of position

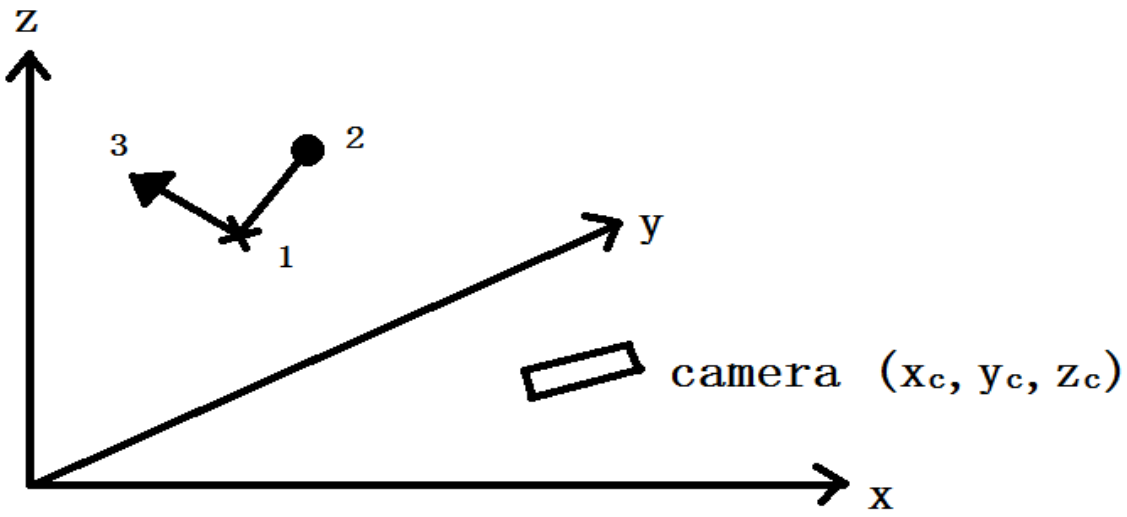


- The position and direction of calibrated camera in coordinate system are stable and will never change, but the location of square will always change if camera moves in the real world.



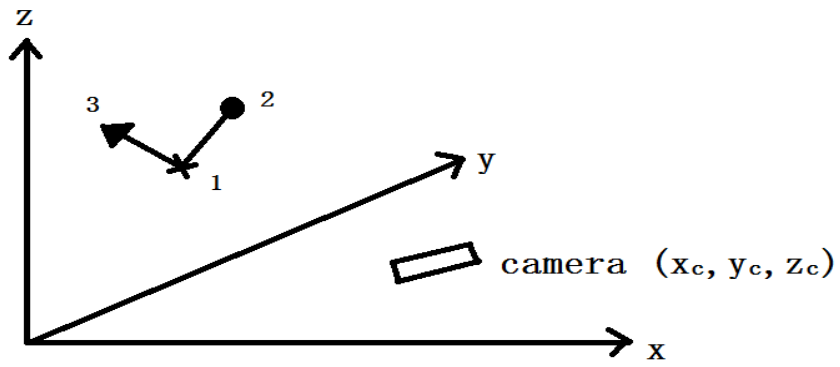
Camera

- Should be calibrated
- $z*u=m_1*P$
- $z*v=m_2*P$
- $z=m_3*P$
- Where P=[x y z 1]'



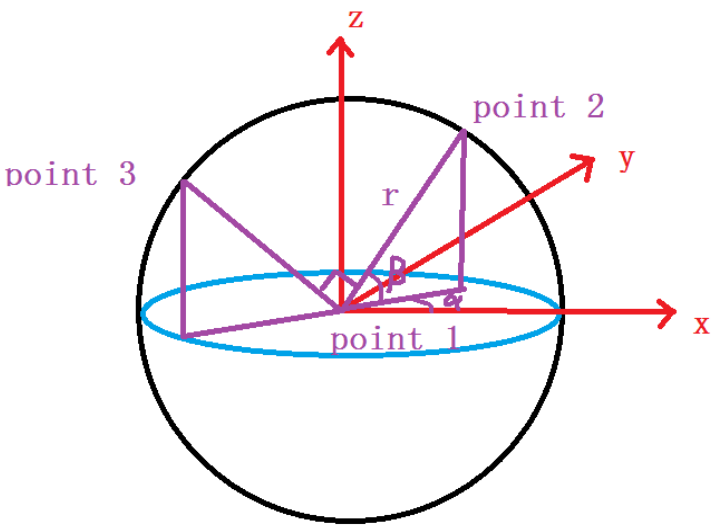
Method

- Estimate the coordinates of three points on the corner of square.
- Assume three points are
- (x1, y1,z1)
- (x2,y2,z2)
- (x3,y3,z3)
- $z*u=m_1*[x\ y\ z\ 1]'$
- $z*v=m_2*[x\ y\ z\ 1]'$ Linear equations
- x, y, z are unknowns



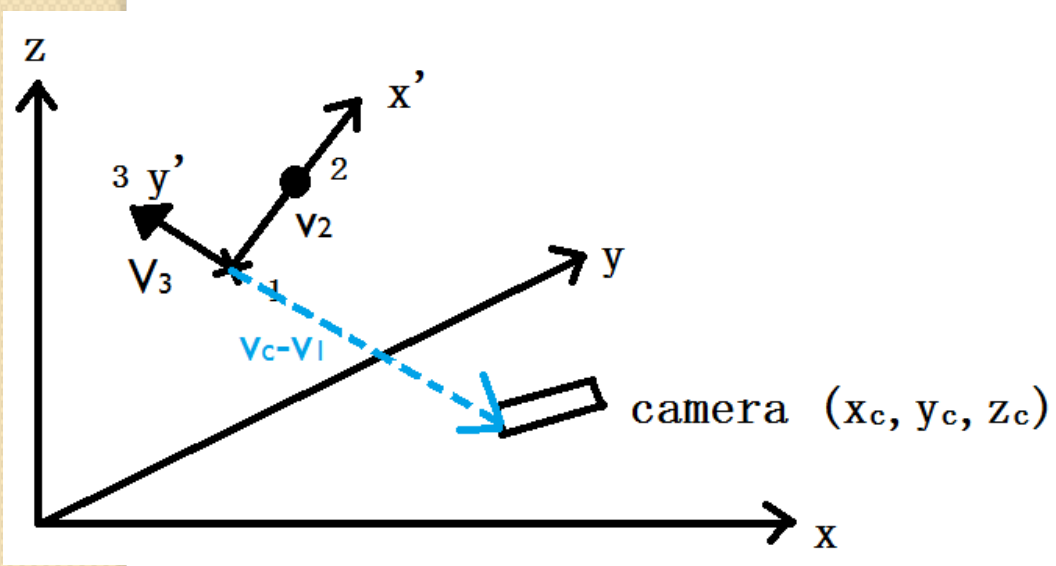
Nine equations, nine unknowns

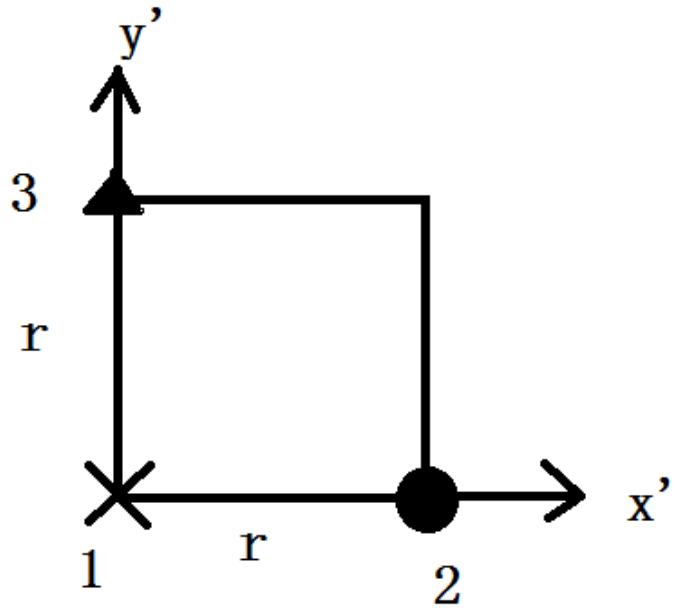
- Unknowns: x1 y1 z1 x2 y2 z2 x3 y3 z3
- z1*u1=m1* [x1 y1 z1 1]'
- z1*v1=m2* [x1 y1 z1 1]'
- z2*u2=m1* [x2 y2 z2 1]'
- z2*v2=m2* [x2 y2 z2 1]'
- z3*u3=m1* [x3 y3 z3 1]'
- z3*v3=m2* [x3 y3 z3 1]'
- (x2-x1)^2+(y2-y1)^2+(z2-z1)^2=r^2
- (x3-x1)^2+(y3-y1)^2+(z3-z1)^2=r^2
- (x2-x1)*(x3-x1)+(y2-y1)*(y3-y1)+(z2-z1)*(z3-z1)=0



Calculate camera coordinates

- vector v2=point2-point1,
- vector v3=point3-point1
- vector v_c=(xc,yc,zc)
- coordinate x' of camera is $(v_c-v_1)\bullet v_2/r$
- coordinate y' of camera is $(v_c-v_1)\bullet v_3/r$
- coordinate z' of camera is $(v_c-v_1)\bullet(v_2\times v_3)/(r*r)$





Experiments (set r=150mm)

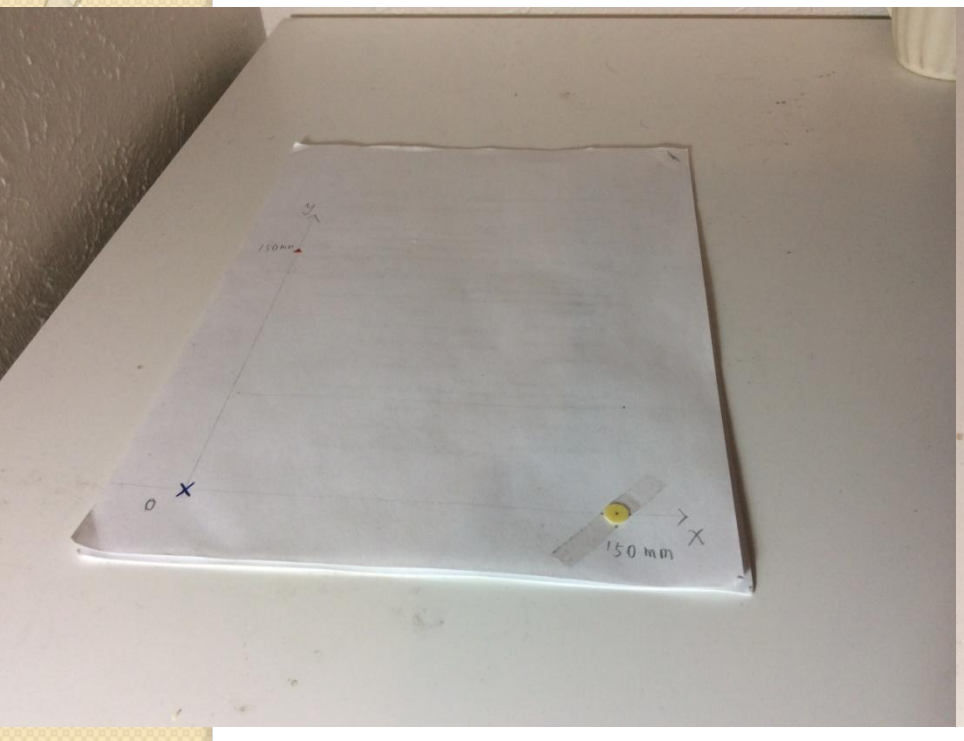
- Move in the x direction

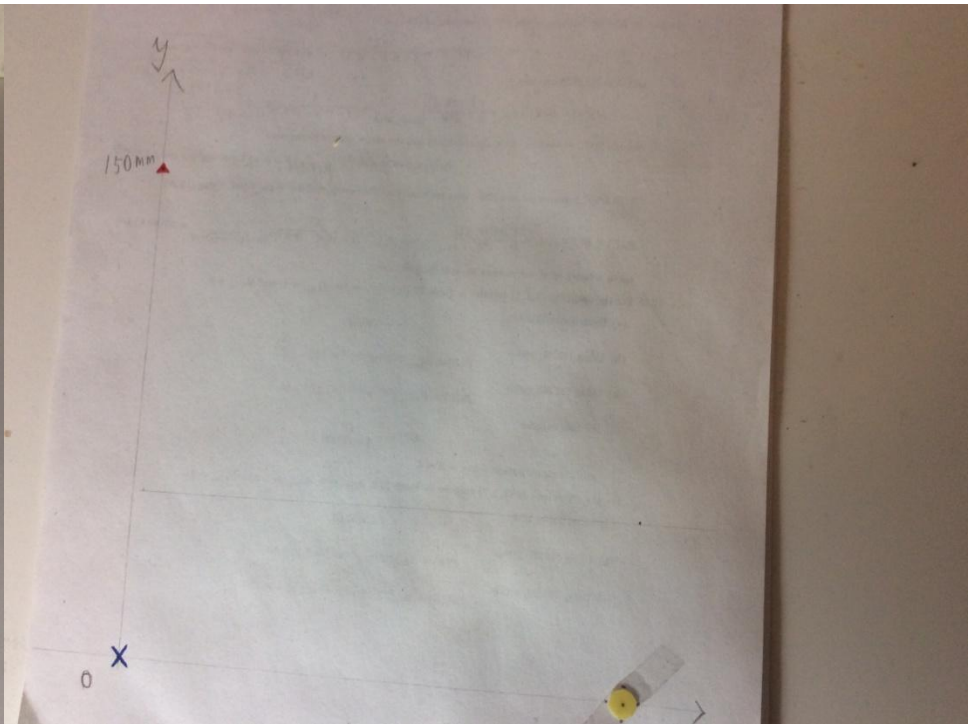
x'=-25.4428 y'=-209.8513 z'=407.3369

x'=304.7019 y'=--239.4790 z'=452.9168

Unit: mm

- Move in y direction





x'=153.2318 y'=-220.2165 z'=94.4576

x'=188.4209 y'=-69.4520 z'=108.9650

Unit: mm

- Move in z direction

x'=156.2066 y'=-150.8822 z'=367.8098

x'=113.0218 y'=-137.7923 z'=528.7847

Unit: mm

Challenge

- Sometimes not accurate in z-coordinate

x'=140.2158 y'=-183.9099 z'=280.8362

Ground truth
x'=160 y'=-160 z'=160

x'=134.4734 y'=-218.8294 z'=67.9697

Ground truth
x'=130 y'=-220 z'=210

Unit: mm

Thanks!