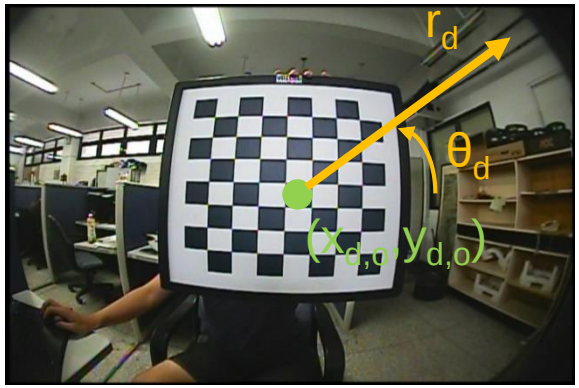
HW3 -1

- Unwarp the distorted image of fish-eye camera

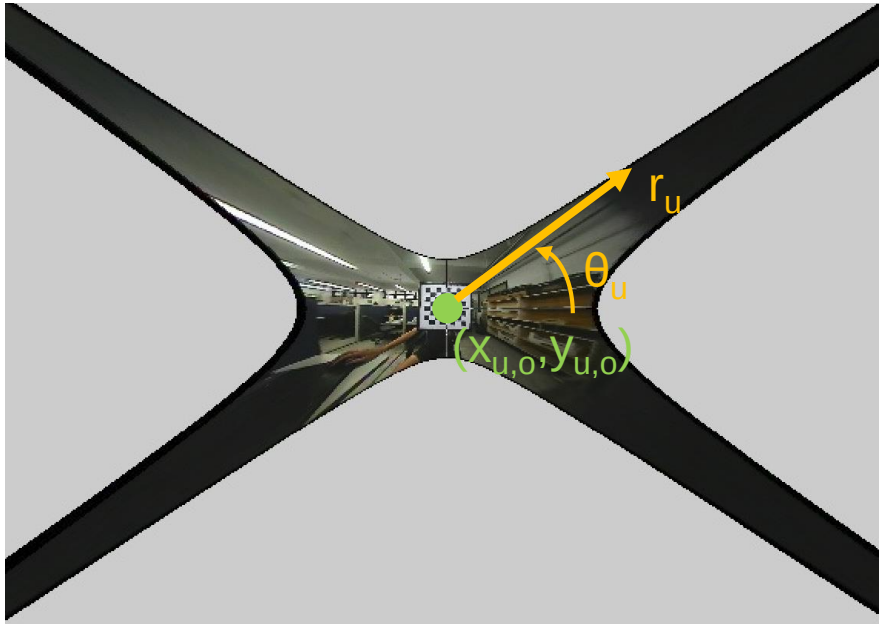
(x_d,y_d) coordinate

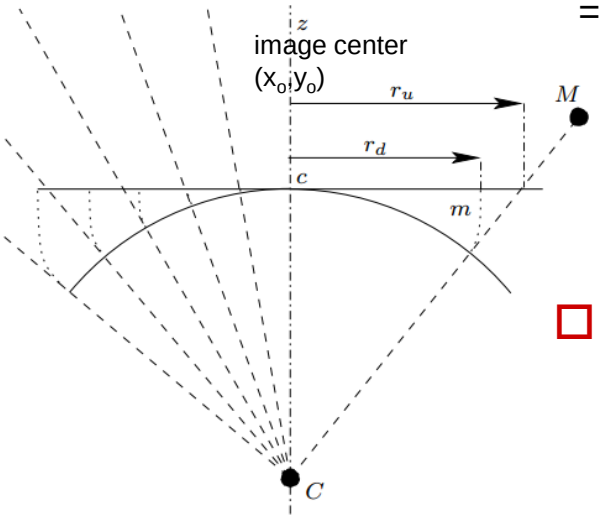


$$r_u = \frac{\tan(r_d\ \omega)}{2\tan\frac{\omega}{2}}$$

ω: distortion coefficient
= 0.0036

(x_u,y_u) coordinate





- A circular coordinate is used to describe the image

$$r = \sqrt{(x-x_o)^2+(y-y_o)^2}$$

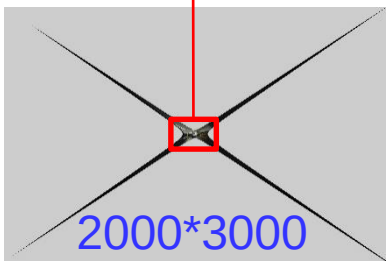
$$\theta = \tan^{-1}\left(\frac{y-y_o}{x-x_o}\right)$$

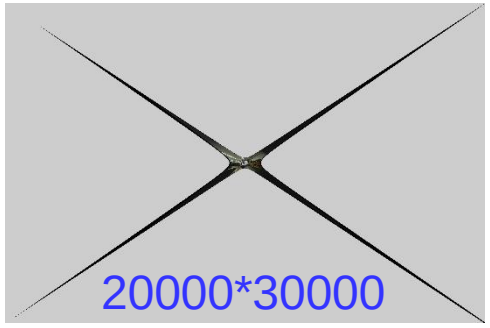
HW3 -1

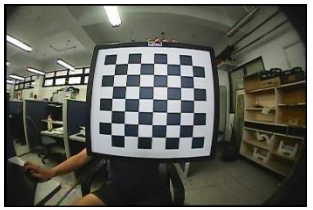
- First, transfer the pixels (x_d,y_d) in distorted image with size H_d*W_d by forward warping to get the size H_u*W_u of undistortion image (x_u,y_u)
  - $(x_{d,o},y_{d,o})$ =(360,240), W_d=720, H_d=480
  - $x_{max}=\max(r_u\cos\theta_u)$, $y_{max}=\max(r_u\sin\theta_u)$;
    $(x_{u,o},y_{u,o})=(x_{max},y_{max})$, $H_u=2x_{max}$, $W_u=2y_{max}$
- If the range of undistortion image (x_u,y_u) is too large, you can resize it to a smaller one (x_u',y_u') with size $H_u/r1 * W_u/r2$
  - E.g. r1=r2=10: $x_u'=x_u/10$, $y_u'=y_u/10$
- Create an image with intensity=(128,128,128) and size $H_u/r1*W_u/r2$
  - Then, use inverse warping to get the undistortion image:

(x_u',y_u') ⇨ (x_u,y_u) ⇨ (r_u,θ_u) ⇨ (r_d,θ_d) ⇨ (x_d,y_d)

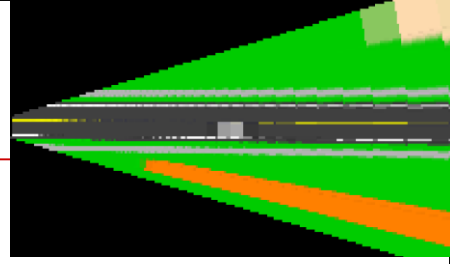
$$r_d = \frac{1}{\omega}\tan^{-1}(2\,r_u\tan\frac{\omega}{2})$$





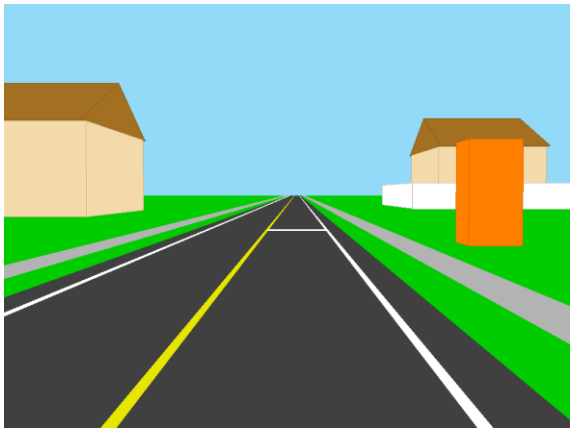


HW3 -2



- Transfer the road image to bird's eye view by inverse perspective mapping

(u,v) image coordinate



$\alpha = 15\pi / 180$

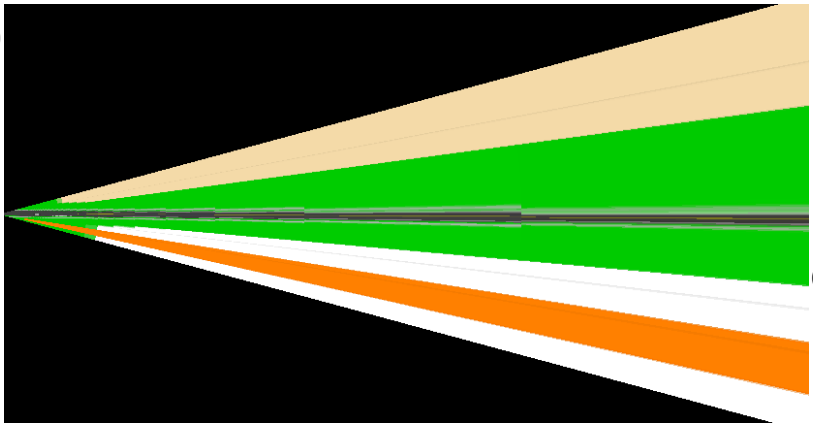
$dx = 4$

$dy = -10$

$dz = 5$

$\gamma_0 = 0$

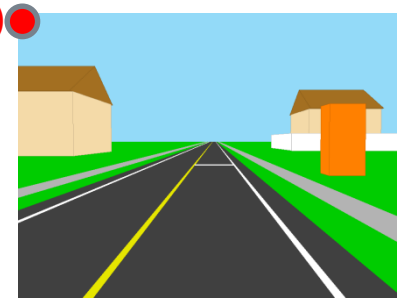
$\theta_0 = 0.025$



(x,y) world coordinate

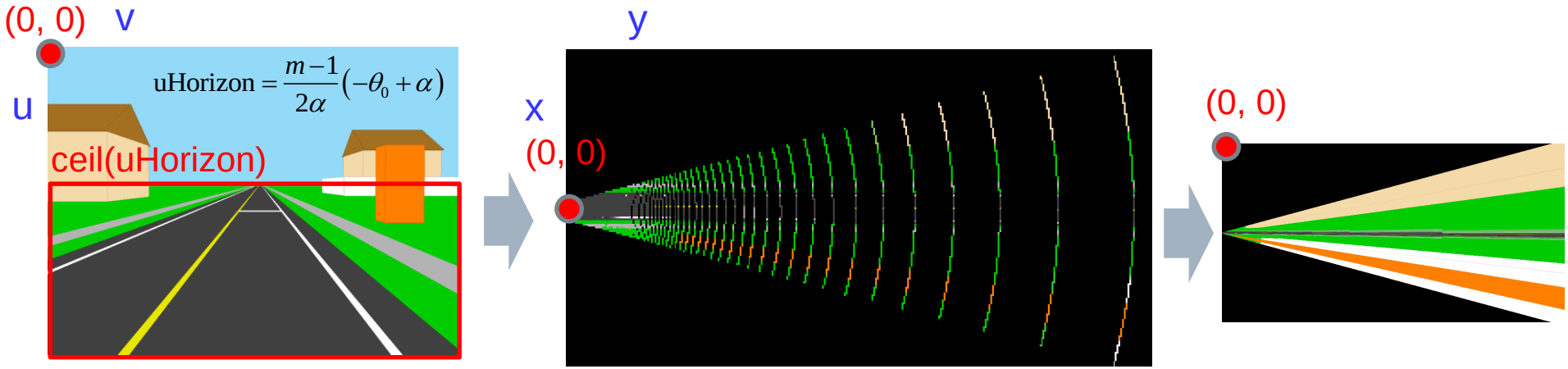
- Refer to "BertozziAndBroggi_IPM.pdf"
  - Hint
    - Image origin at left-top

(0, 0)



HW3 -2

- First, transfer the pixels (u,v) in [uHorizon:Height-1, 0:Width-1] by forward warping (Image to World) to get the range [x_{min}:x_{max},y_{min}:y_{max}] of IPM image (x,y)
  - The values of x and y may be negative
- If the range of IPM image (x,y) is too large, you can resize it to a smaller one (x',y') with size (x_{max}-x_{min})/r1 * (y_{max}-y_{min})/r2
  - E.g. r1=r2=100: x'=(x-x_{min})/100, y'=(y-y_{min})/100
- Then, use inverse warping (World to Image) to get the IPM image: (x',y') ⇨ (x,y) ⇨ (u,v)



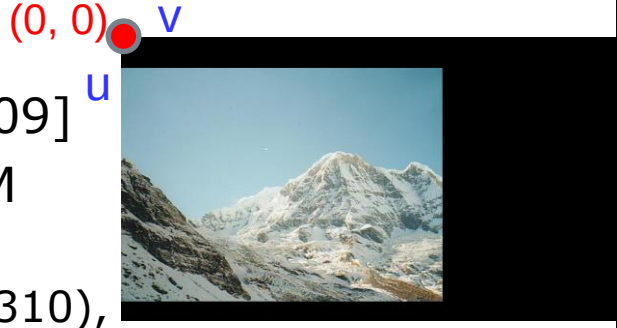
(u,v)
image coordinate

(x,y)
world coordinate

(x',y')
IPM image coordinate

HW3 - Bonus

- Image stitching with the projective transform
  - Refer to "Projective mappings for image warping,pdf"
    - Create an image with size 900*480
    - Paste the left image at [80:449, 0:509]
    - Evaluate the transformation matrix M by Eq.(3) or Eq.(4)
      - Set $(x_0,y_0)=(130,250)$, $(x_1,y_1)=(470,310)$, $(x_2,y_2)=(475,900)$, $(x_3,y_3)=(0,770)$
    - Use inverse warping ($P_s=P_dM_{ds}$) to transfer the original (u,v) coordinate to the desired (x,y) coordinate
      - Hint: i=1, w=1, (u,v)=(u'/q,v'/q)




left image

right image

HW3

- Requirements
  - Programs
    - C or C++ source code with .exe file (You are NOT allowed to use any library, such as OpenCV)
  - Report
    - Describe the employed source code editor and how to execute your program (input/interface/output)
    - Introduce your work, method, and discussions
    - With all of the images or results
  - Upload to i-school Plus
  - You are NOT allowed to use any library, such as OpenCV
    - Except the R/W image
    - You can also use .raw to complete your work