電腦視覺與應用
Computer Vision and Applications

Lecture02-2 Pinhole camera Supplementary Practice

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This is one example to help you to understand the following equation

homogenous 2D point on image (unit: pixel)

General form: $\mathbf{x}_{img} = \mathbf{K}[\mathbf{R}|\mathbf{t}]\mathbf{X}_{world}$

3D point in Euclidean space (says world coordinate)

Camera intrinsic parameter

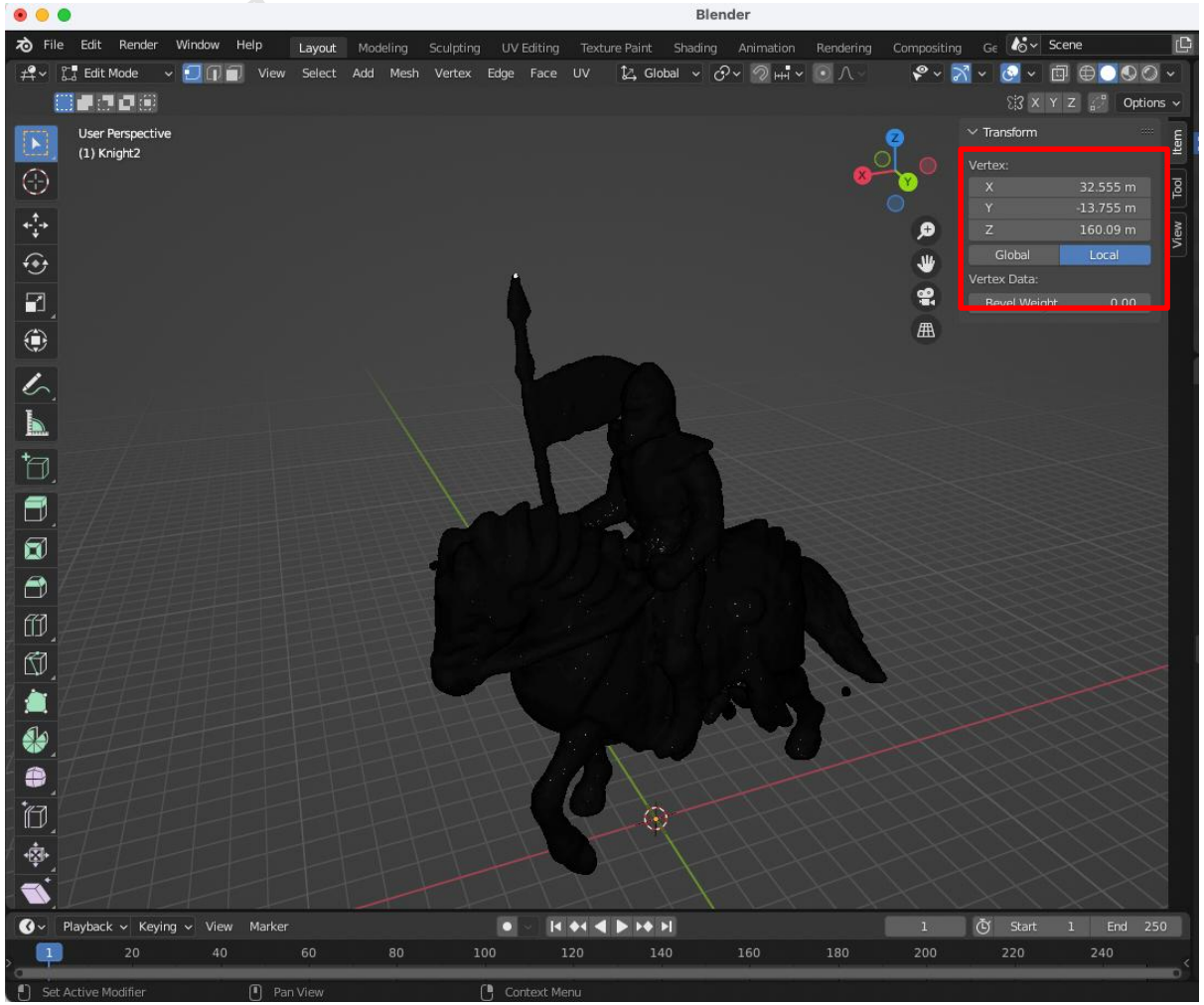
Camera transformation in this Euclidean space, says extrinsic parameter (inverse to camera position and orientation)

Please download the material

- Download 3D ply file (Knight2.ply), and practice it by yourself
- In the enclosed zip, there is one photo called “Photo.jpg” and its corresponding camera parameter (in a virtual 3D environment)

```
Intrinsic parameter
1008.303162 0.000000 561.500000
0.000000 1008.303223 428.000000
0.000000 0.000000 1.000000
Extrinsic parameter
-0.999688 -0.023195 -0.009252 -10.240249
0.007737 0.064585 -0.997882 82.185707
0.023743 -0.997643 -0.064385 225.871841
```

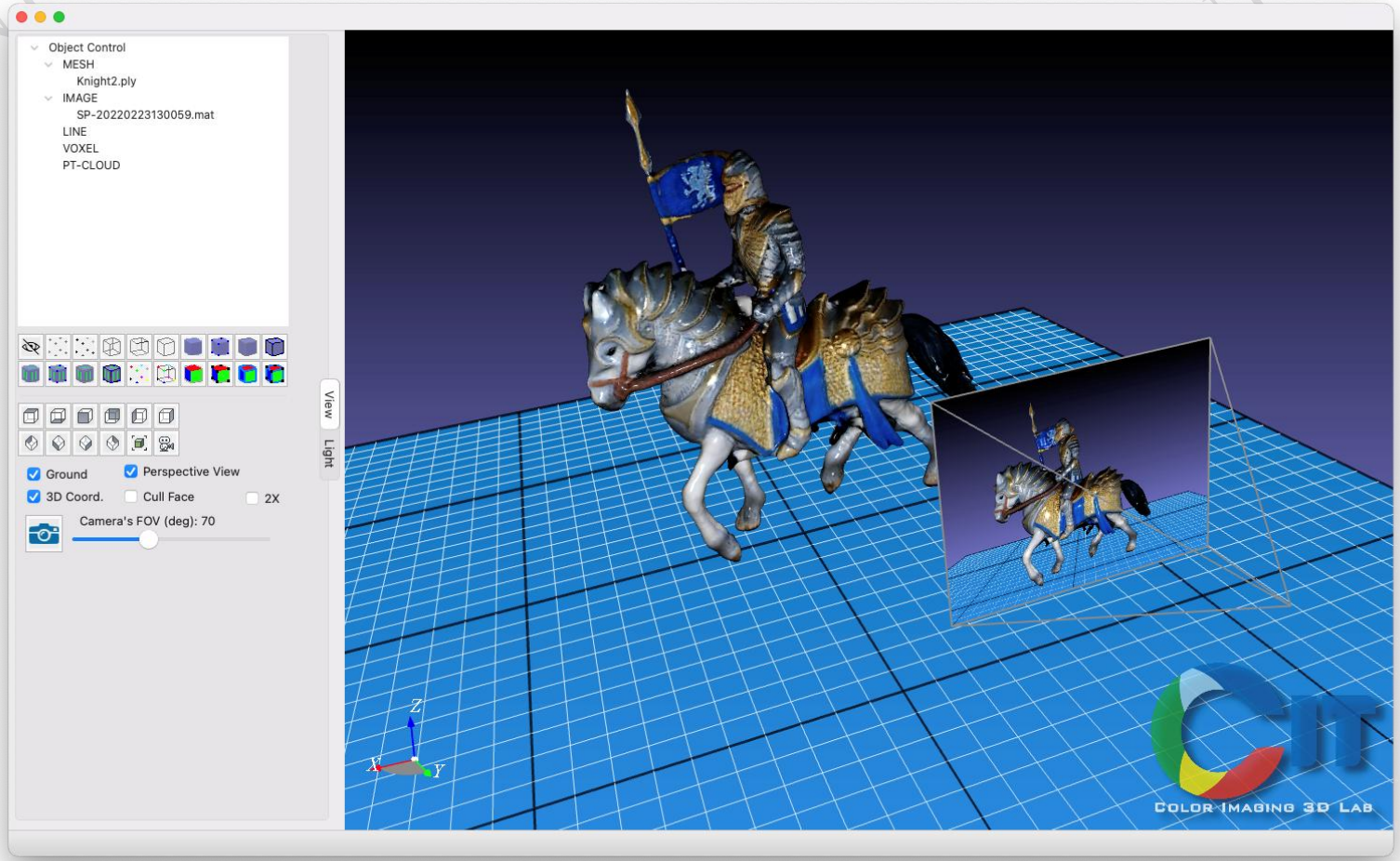
Try to retrieve the 3D coordinate of one vertex on the model.



Read out the vector.
$[x, y, z]$= [32.56, -13.76, 160.09]

How to read the 3D corrdinates of vertexes on a model (video clip)

If you already know camera paramter (intrinsic and extrisic parameters), try to verify projected 2D point on the image.

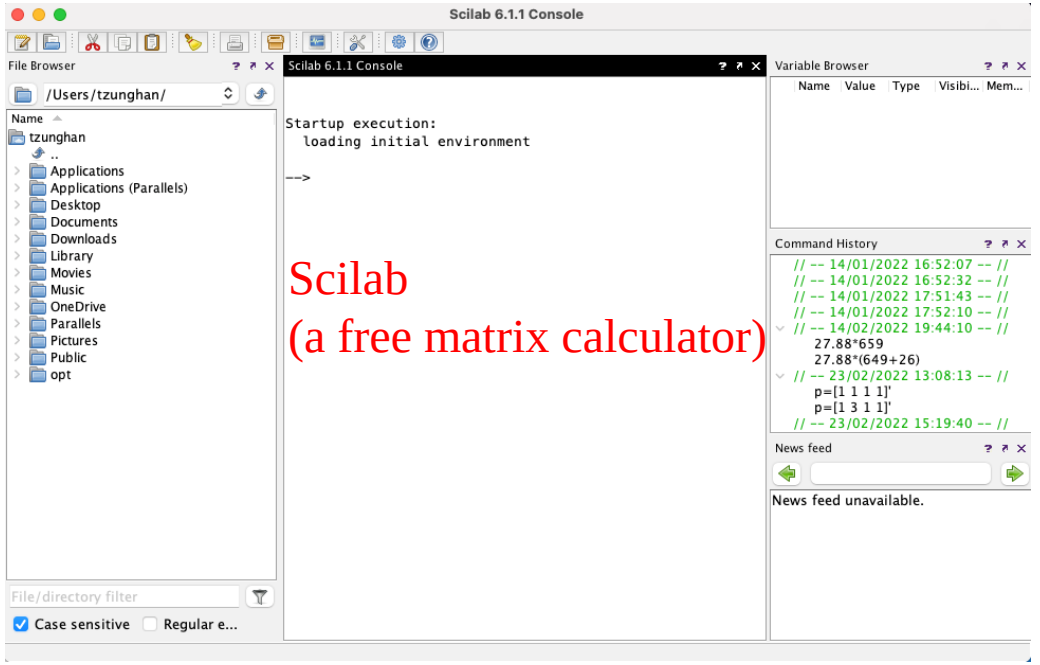


Open a calculator (matlab or scilab) to verify it.

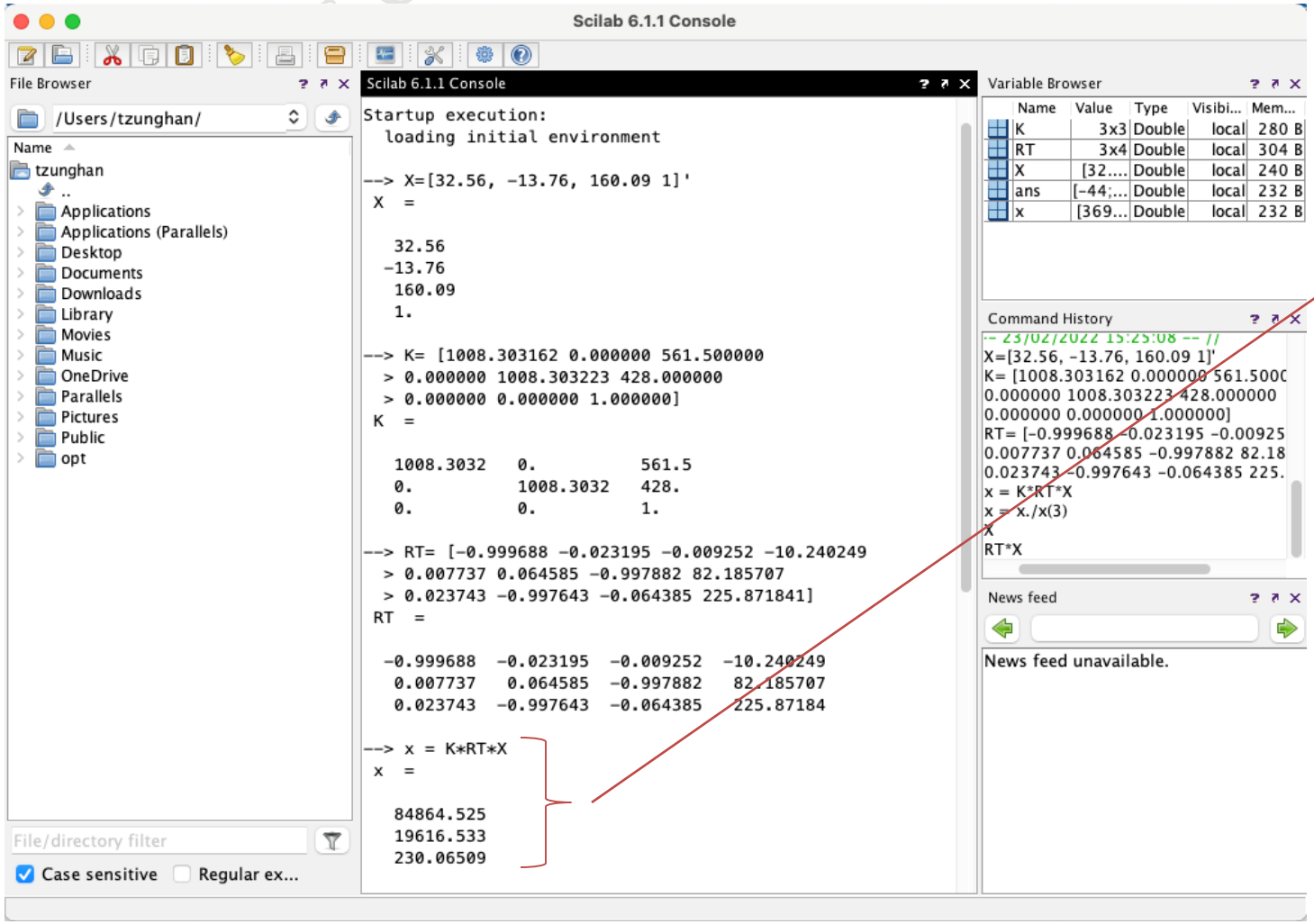
- Take scilab as an example. And assume
  - 3D point **X**=[32.56, -13.76, 160.09 1]’ (a readout point from blender)
  - Intrinsic parameter

    K= [1008.303162 0.000000 561.500000
    0.000000 1008.303223 428.000000
    0.000000 0.000000 1.000000]
  - Extrinsic parameter

    RT= [-0.999688 -0.023195 -0.009252 -10.240249
    0.007737 0.064585 -0.997882 82.185707
    0.023743 -0.997643 -0.064385 225.871841]



Calculating the projected 2D point by $\mathbf{x}_{img} = \mathbf{K}[\mathbf{R}|\mathbf{t}]\mathbf{X}_{world}$



(homogenouns 2D point)

```
x  =

   84864.525
   19616.533
   230.06509
```

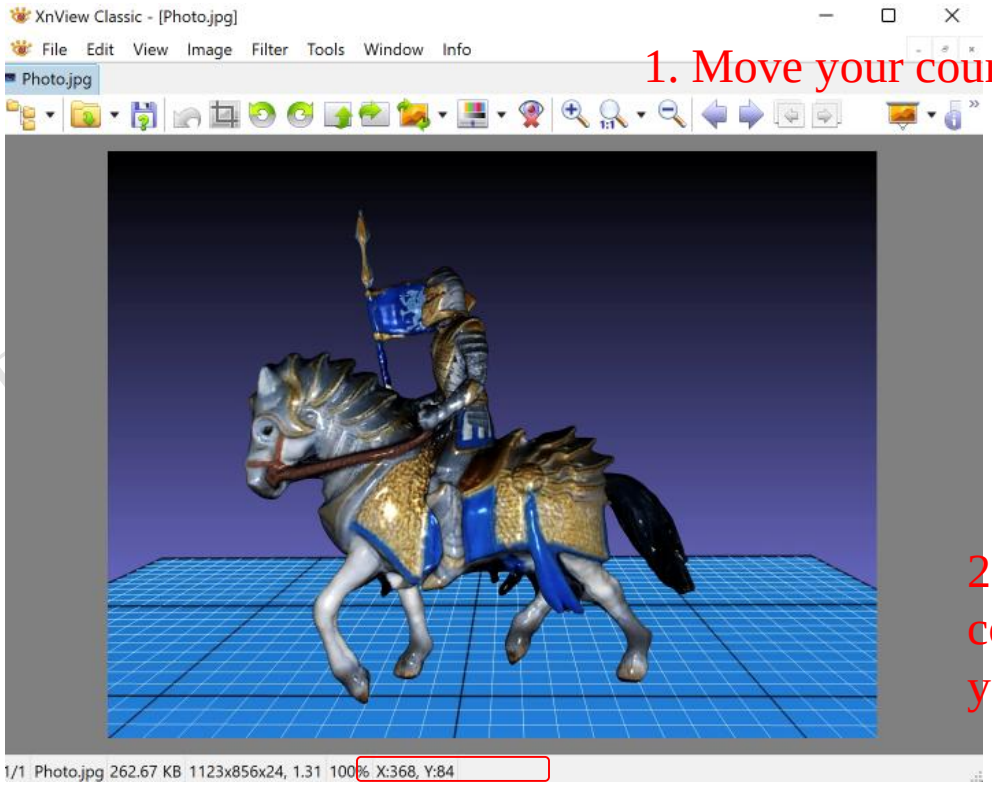
(normalize it)

```
--> x = x./x(3)
 x  =

   368.87181
   85.265145
   1.
```

Using image viewer to verify the correctness

- For example in XnView software, move your cursor to the position where you read out in blender.
- If you got a correct anwser, try to verify for other 3D points.



1. Move your coursor to this position

2. Read the coordinate value and compare it with the output from your calculator

By the way…

```
--> X
 X  =

   32.56
  -13.76
   160.09
   1.
```

A 3D point which is defined in world coordinate

```
--> RT*X
 ans  =

  -43.952080
  -78.201995
   230.06509
```

The same 3D point but it is defined in the camera coordinate

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