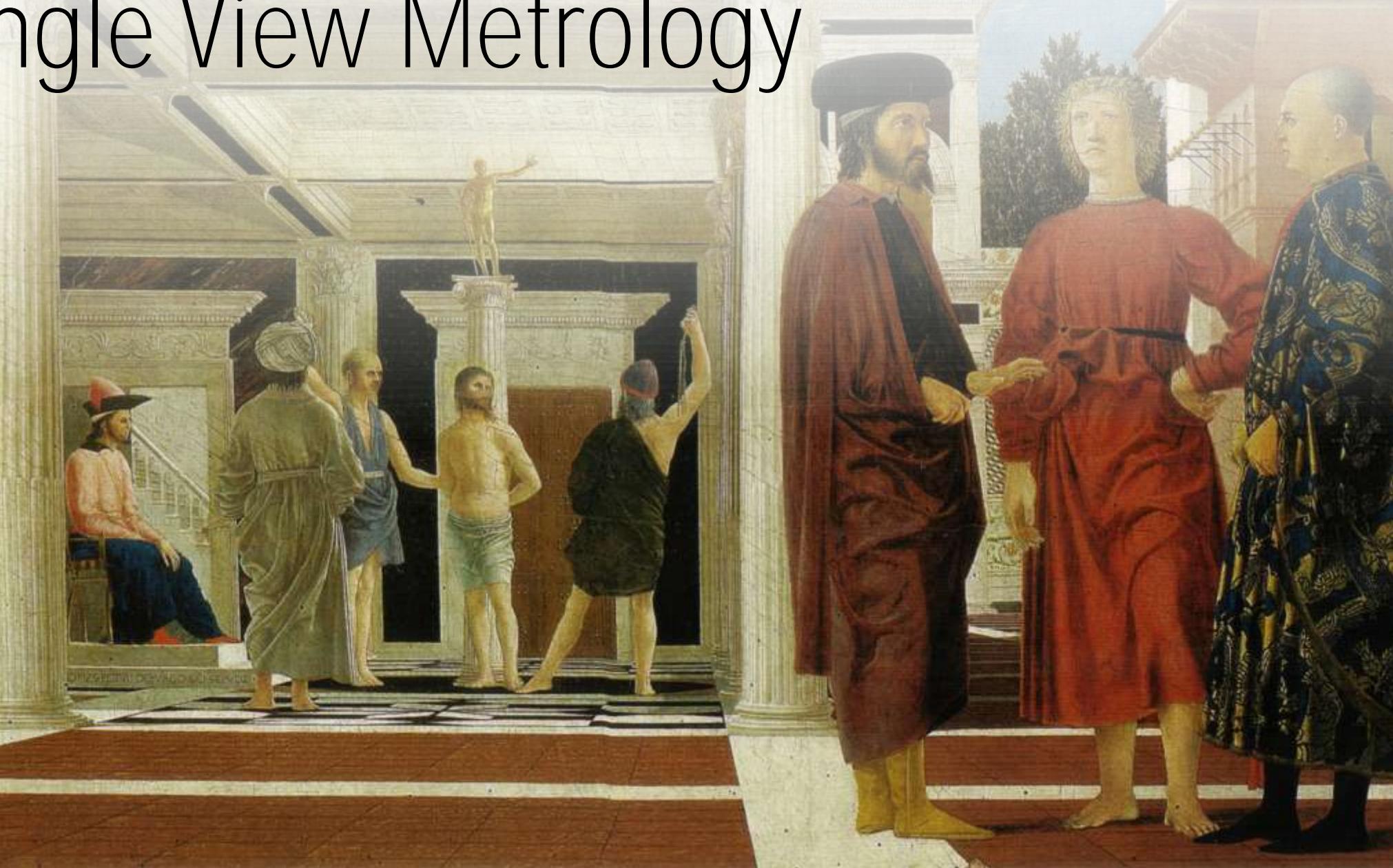


Single View Metrology





Criminisi et al. "Single View Geometry", ICCV 1999



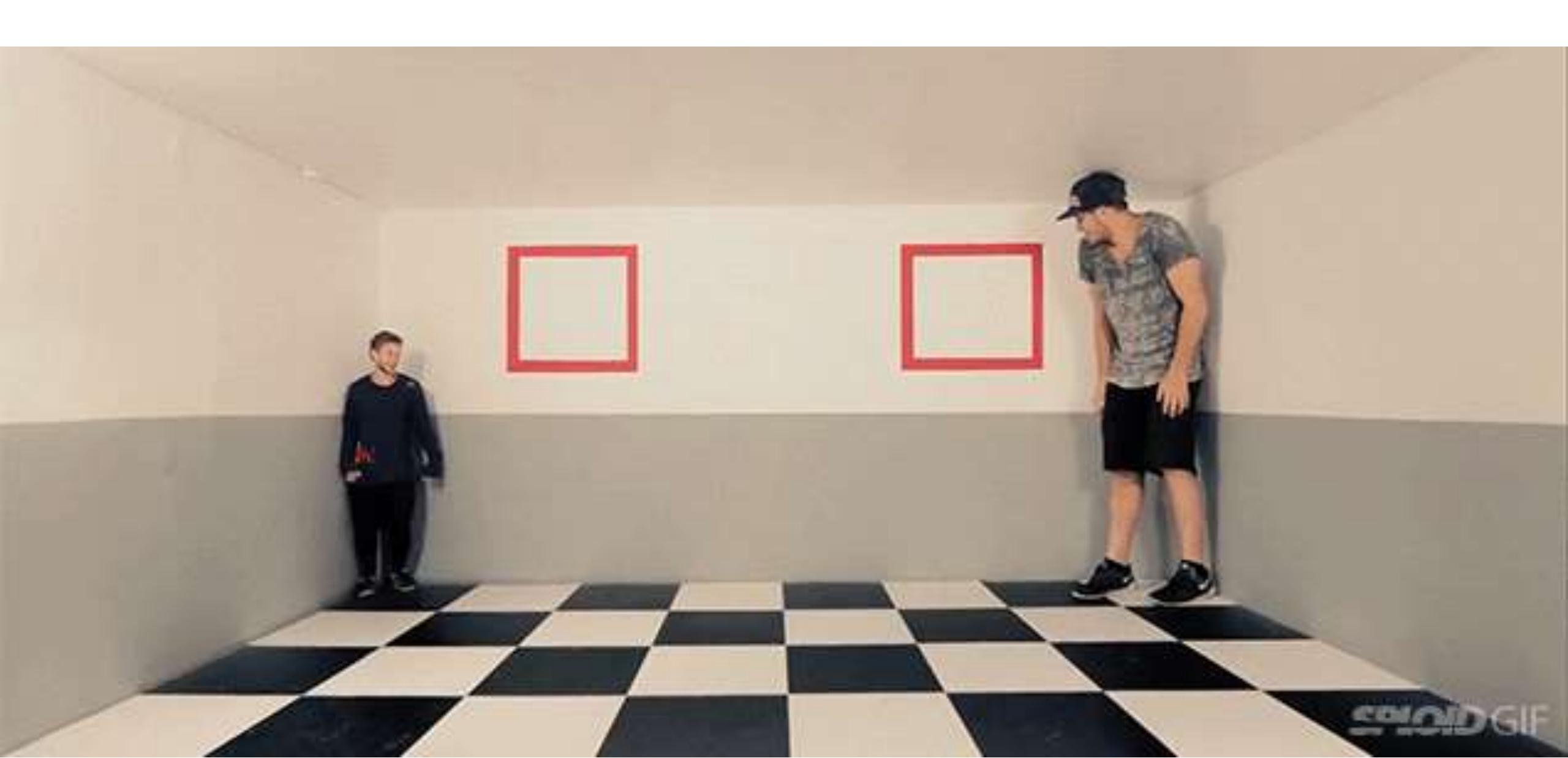
Criminisi et al. "Single View Geometry", ICCV 1999



Criminisi et al. "Single View Geometry", ICCV 1999

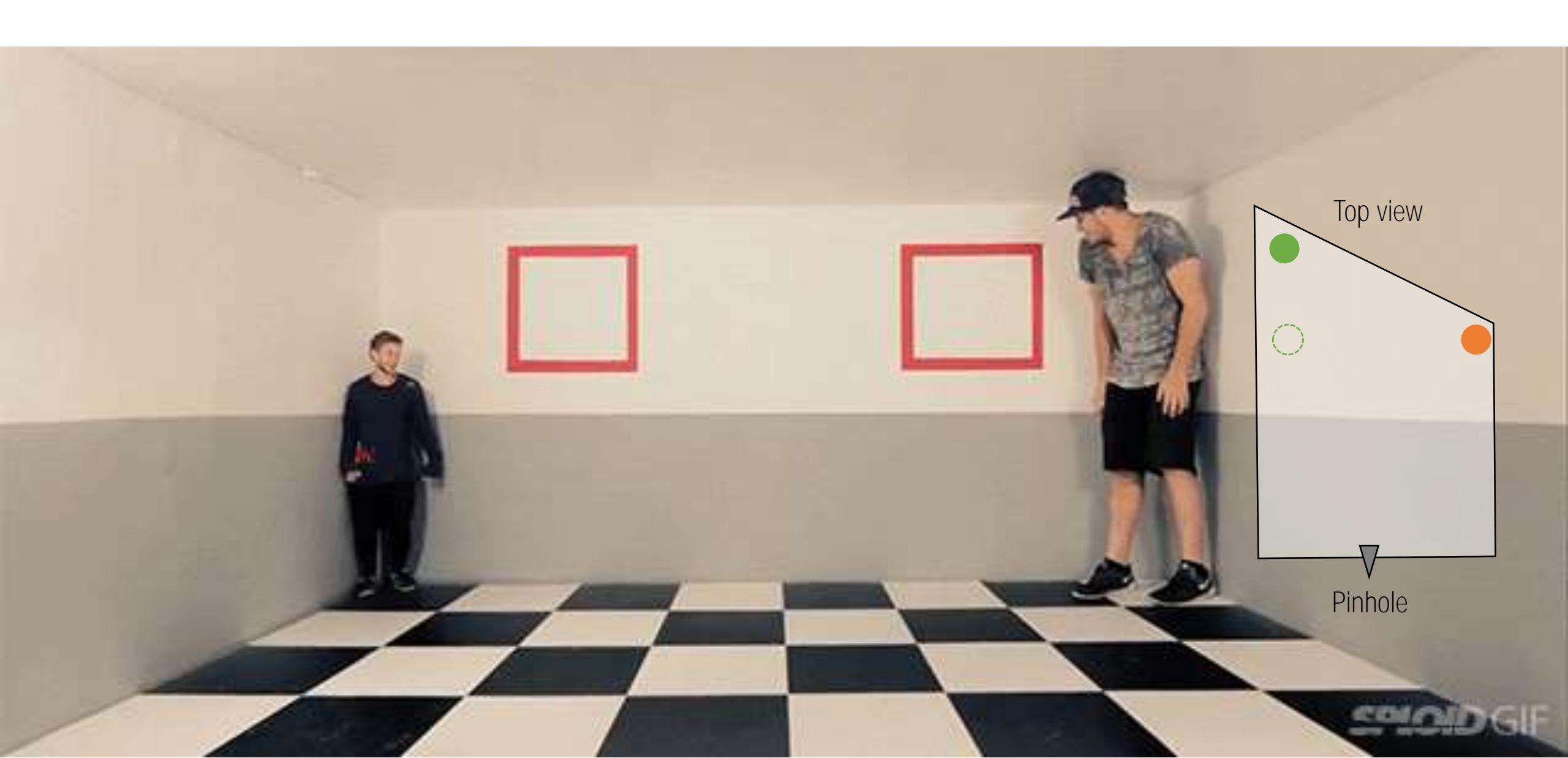


Hoiem et al. "Automatic Photo Pop-up", SIGGRAPH 2005



solidGIF

Ames room



Top view

Pinhole

solidGIF

Ames room

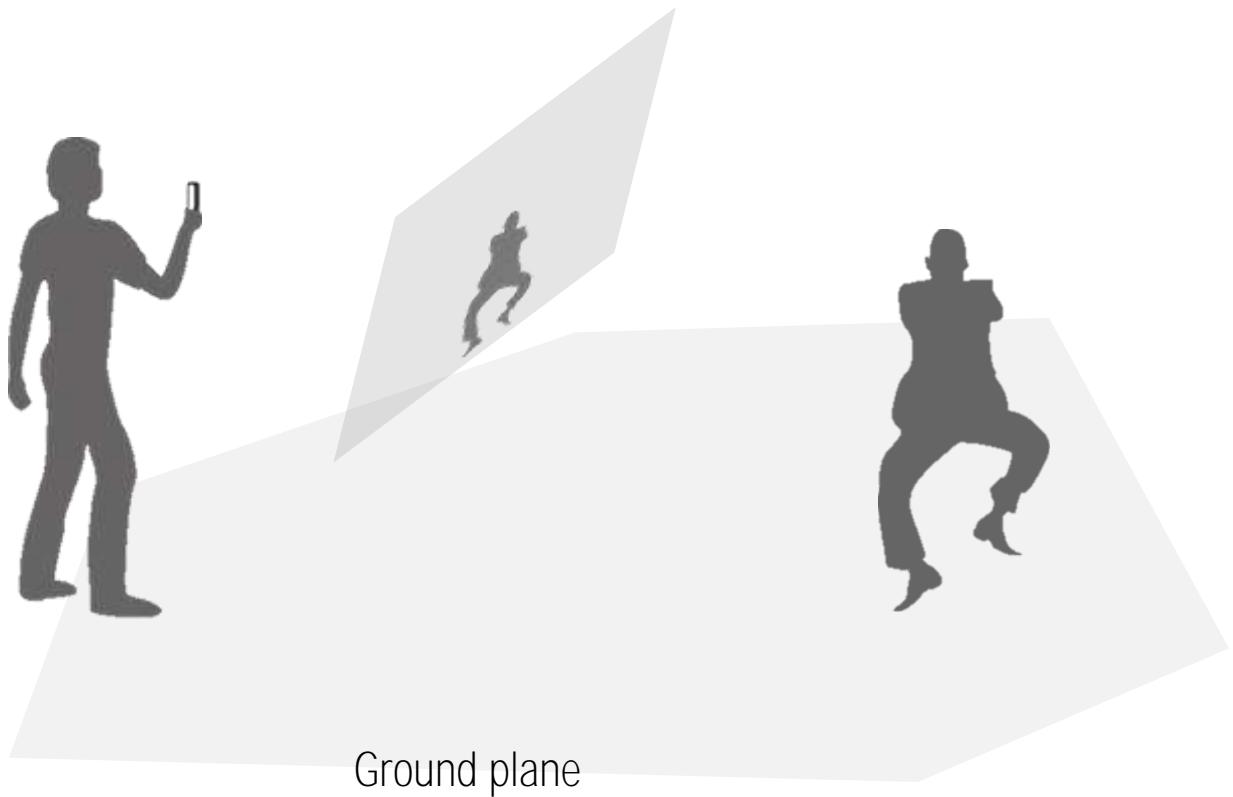
MLPS-St. Paul International Airport

Vanishing line

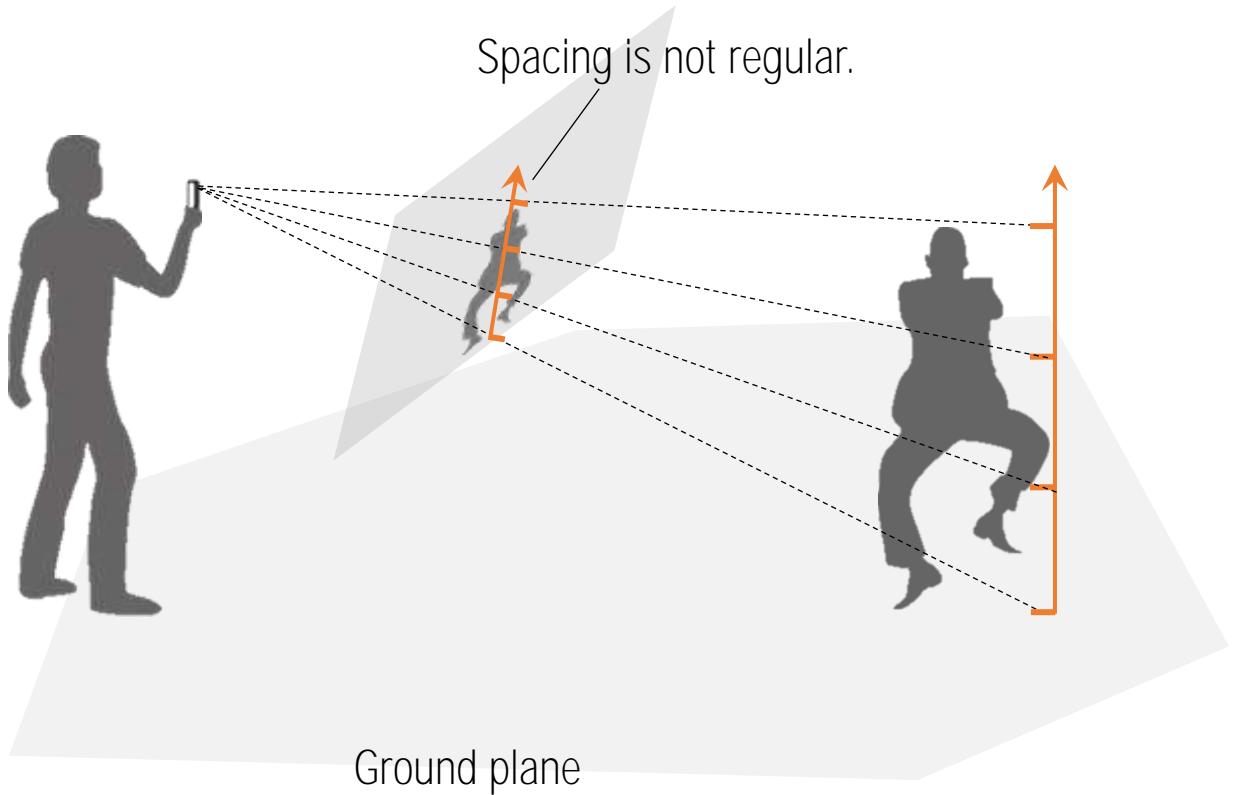


Distance cannot be trusted.

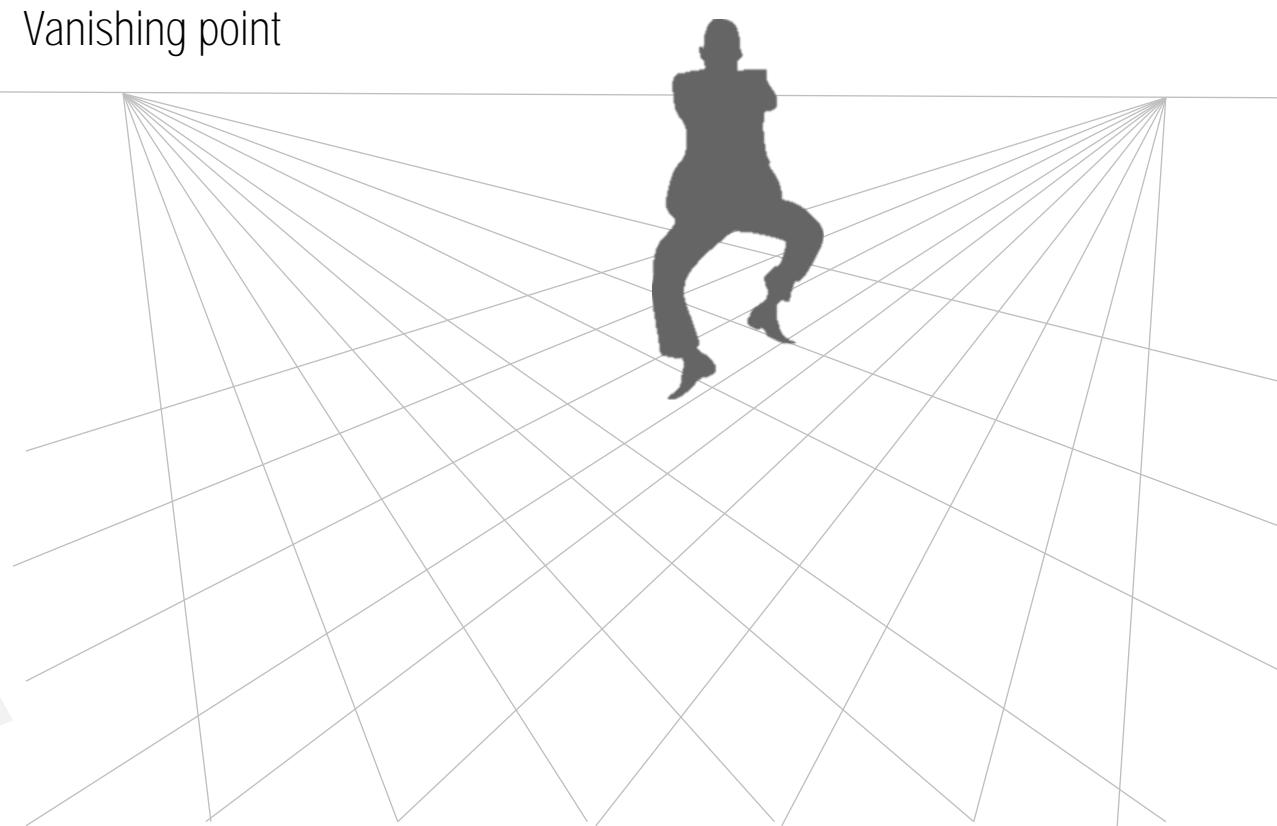
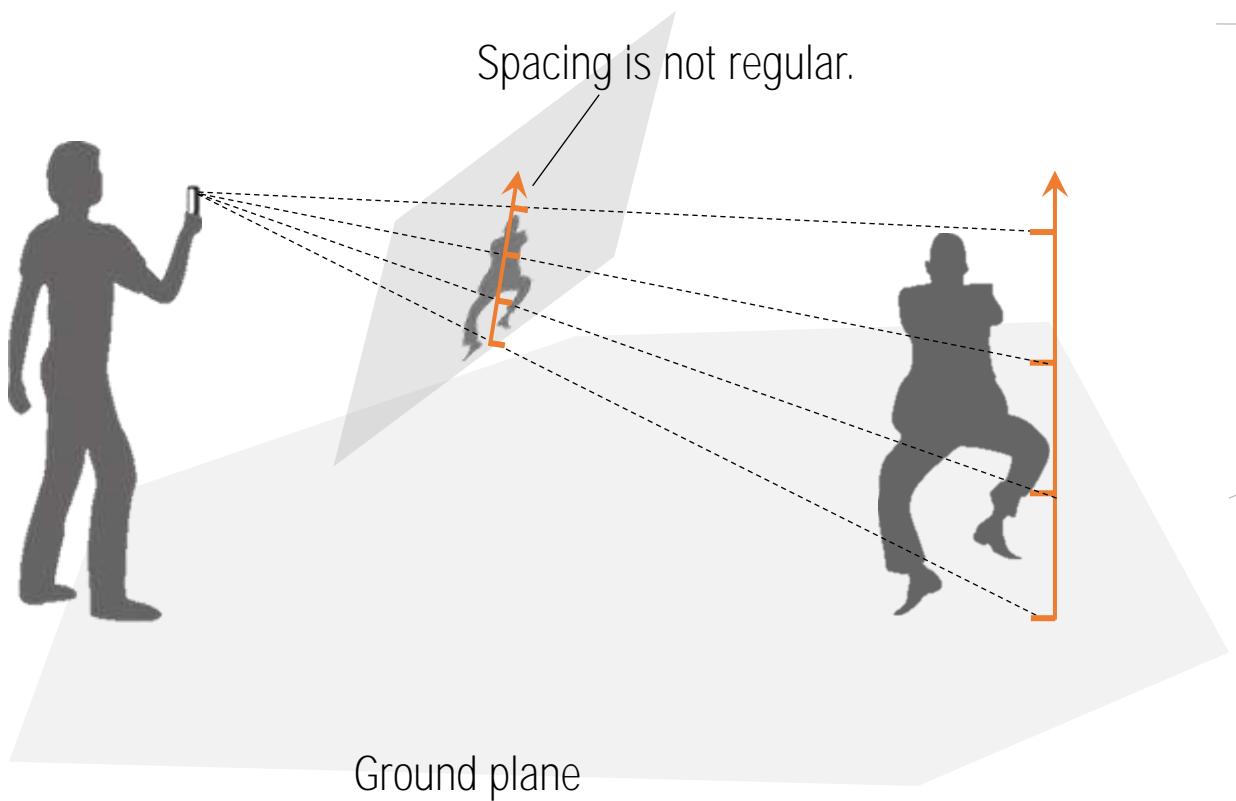
Height from Image



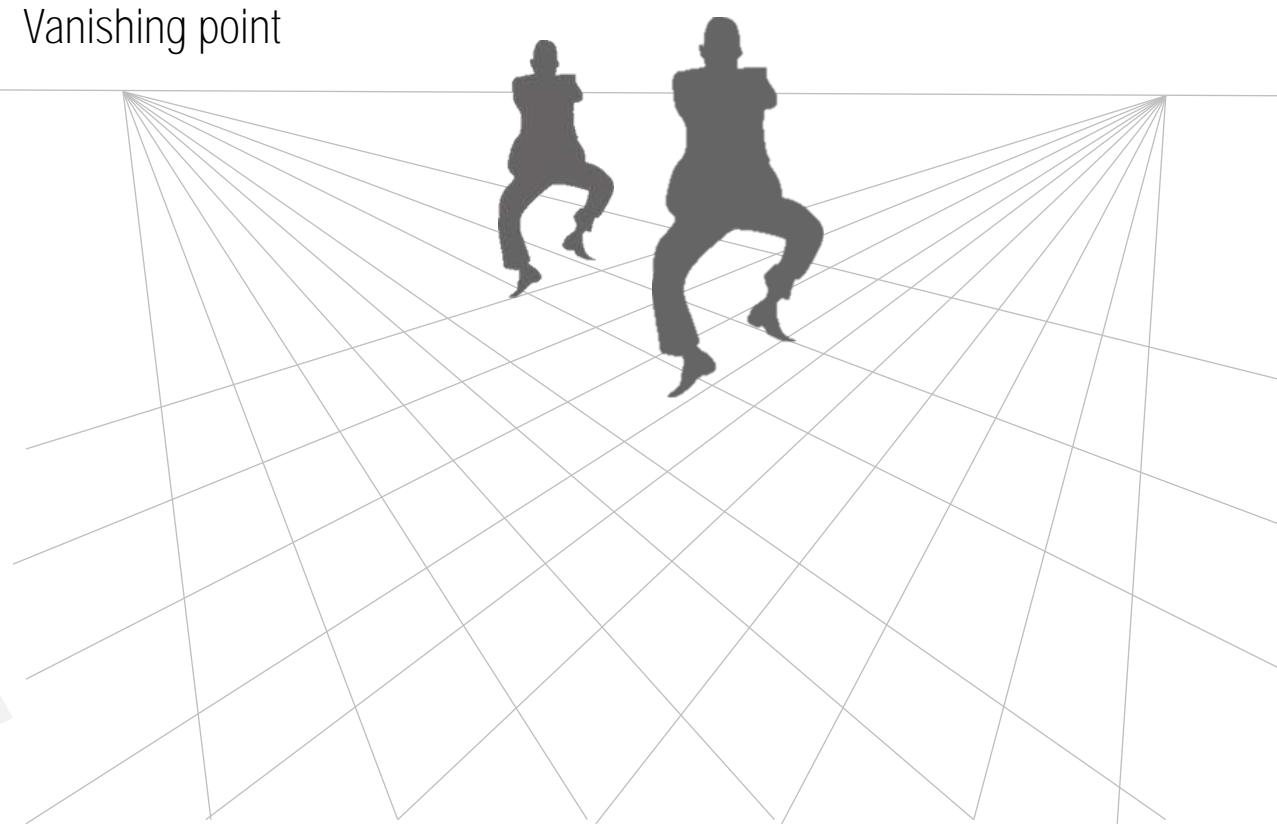
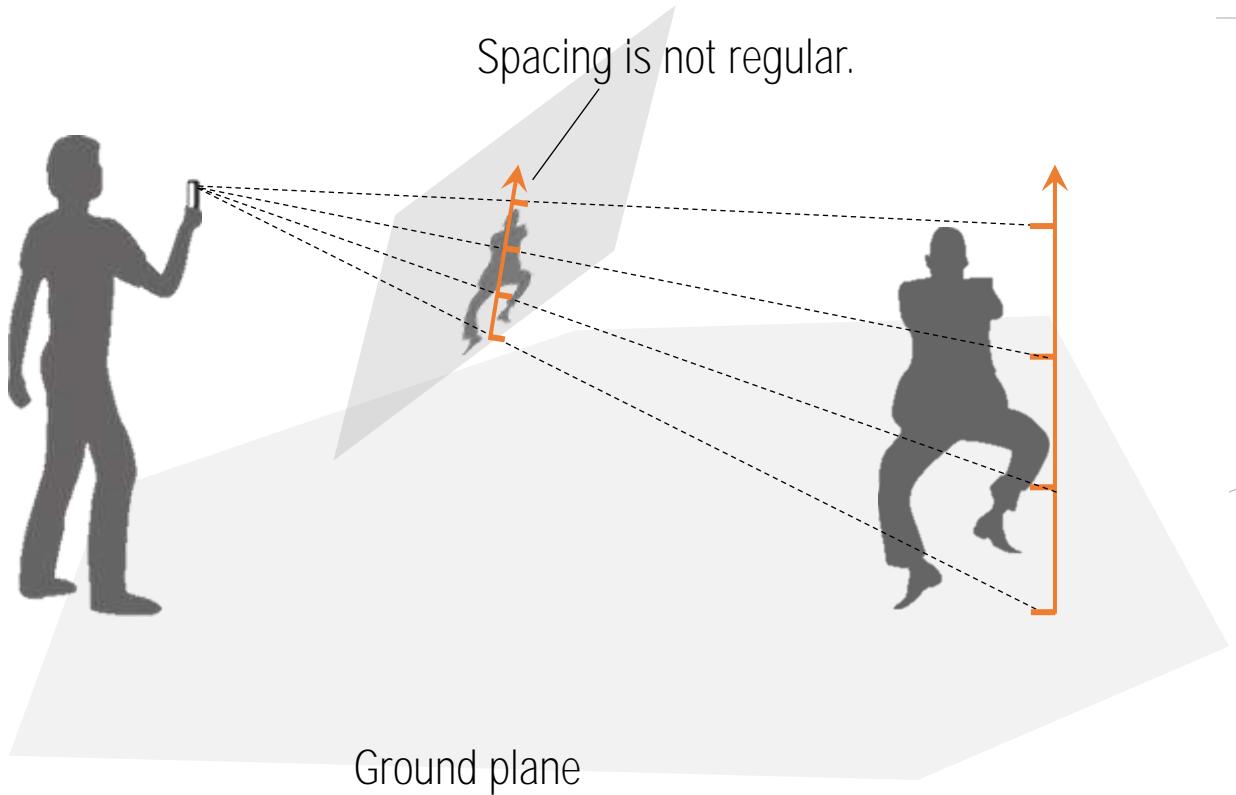
Height from Image



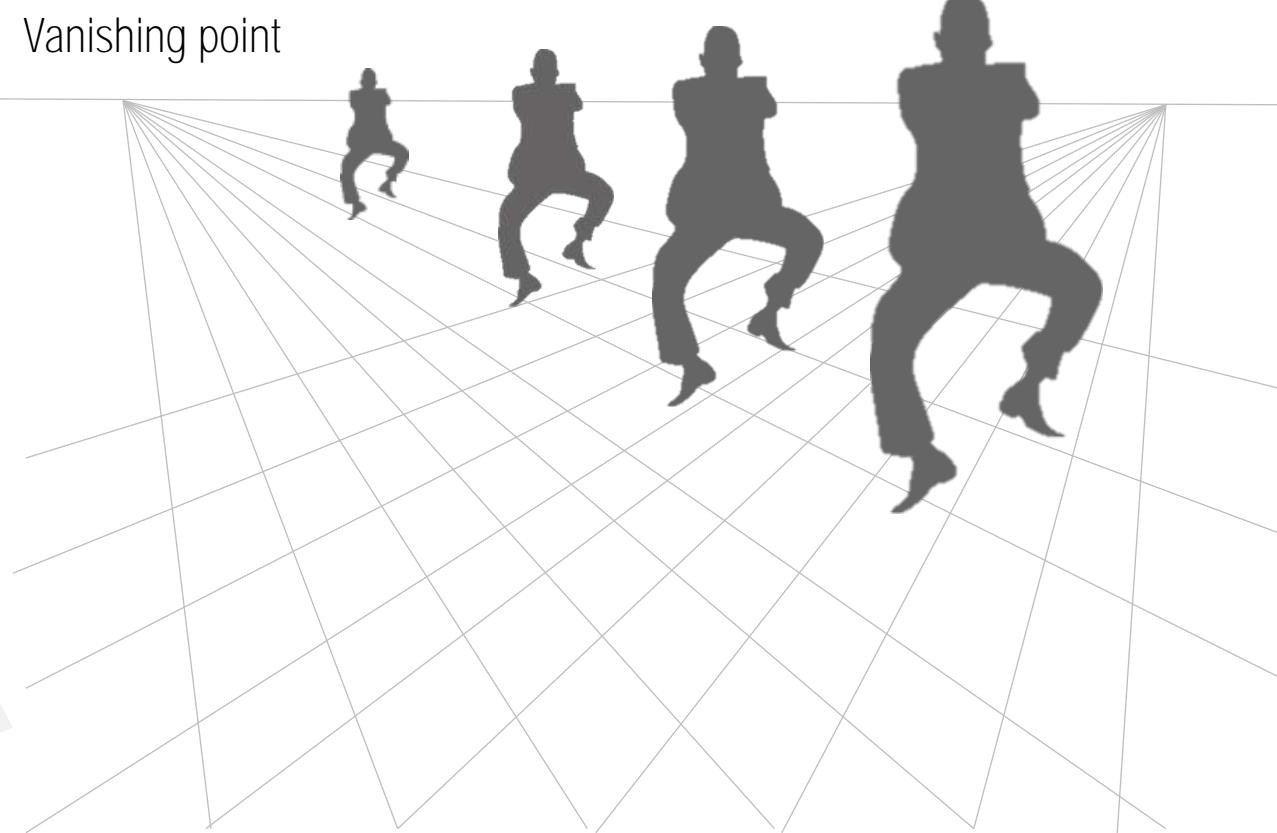
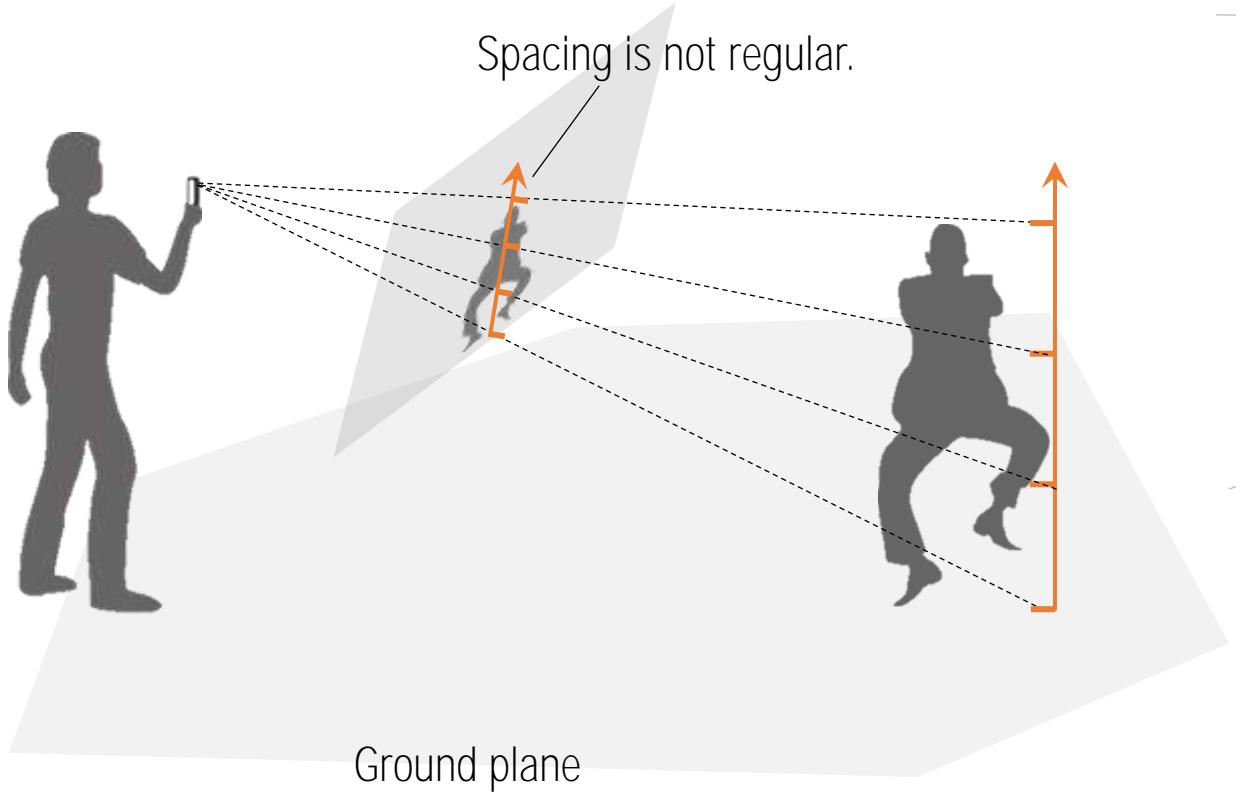
Height from Image



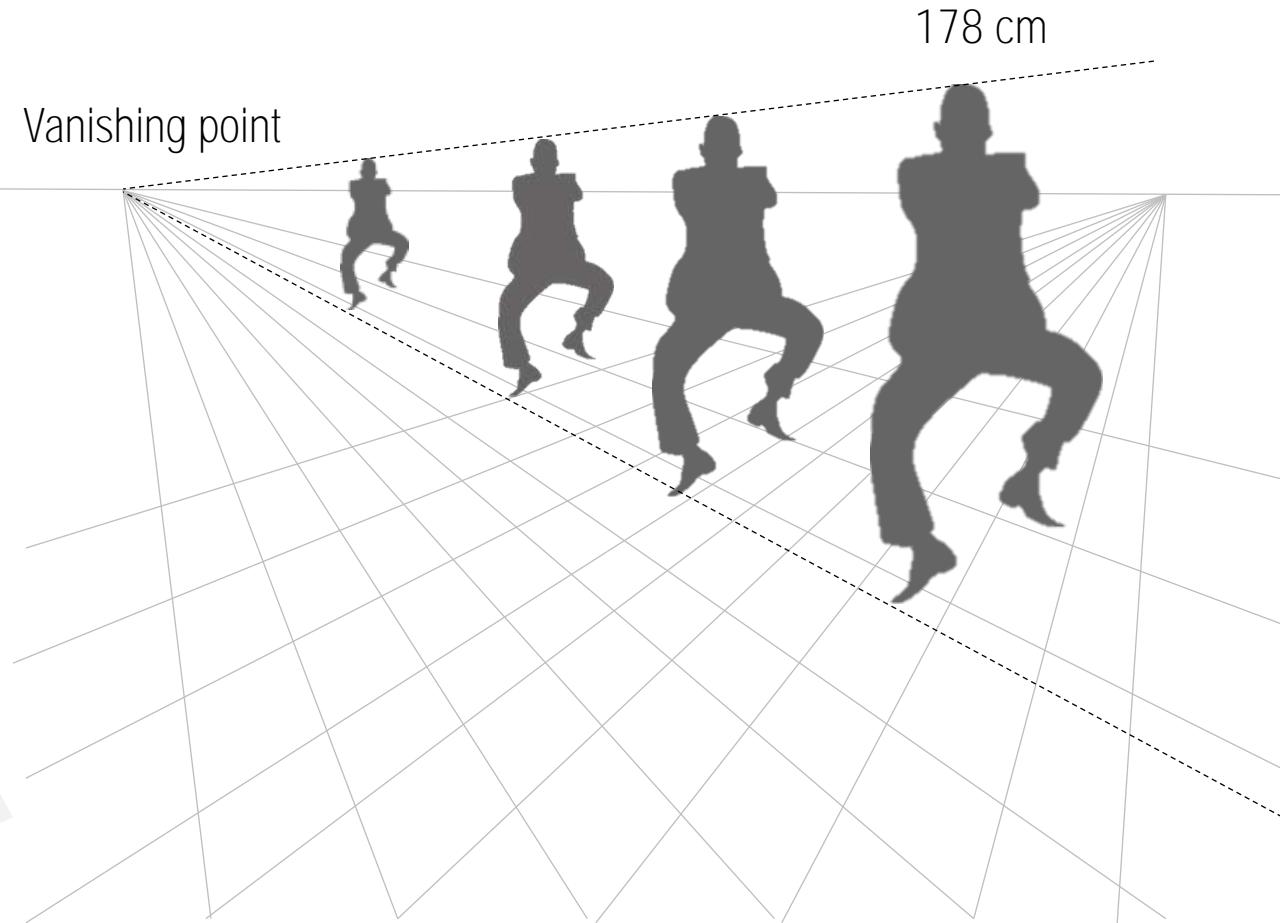
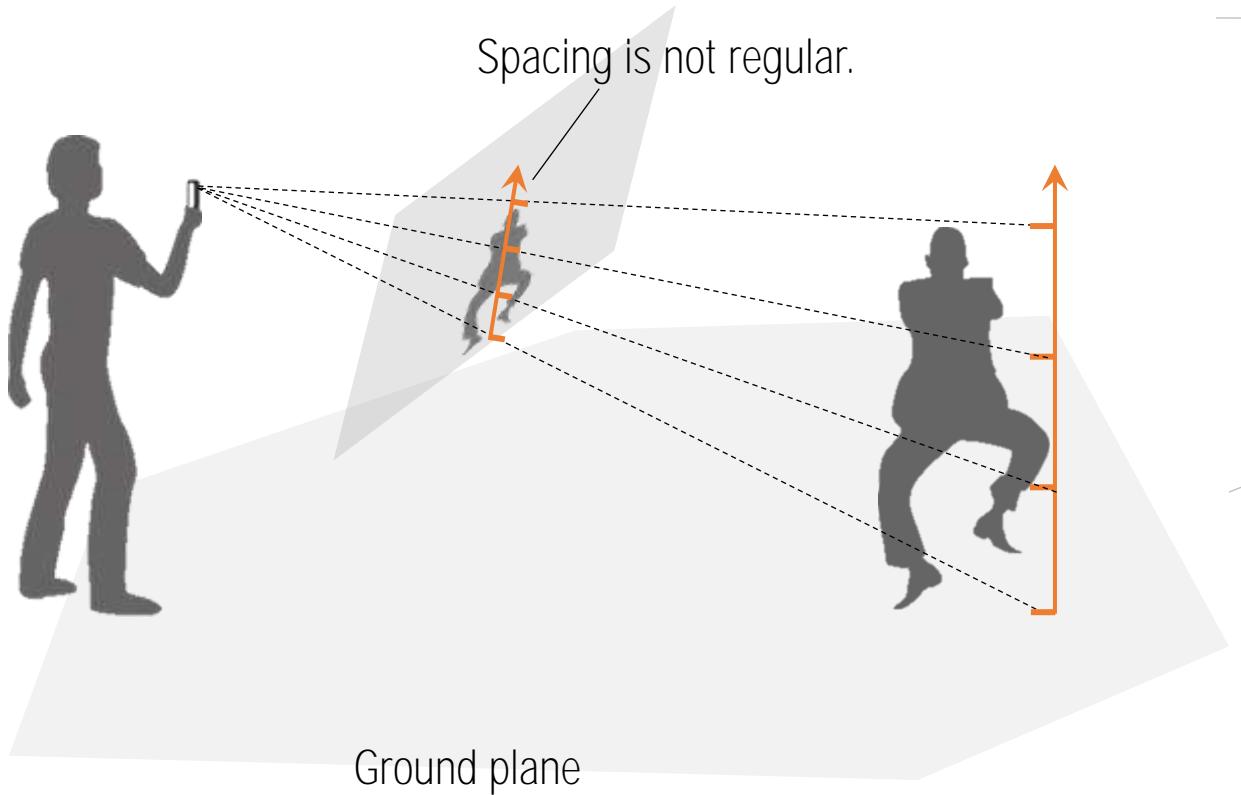
Height from Image



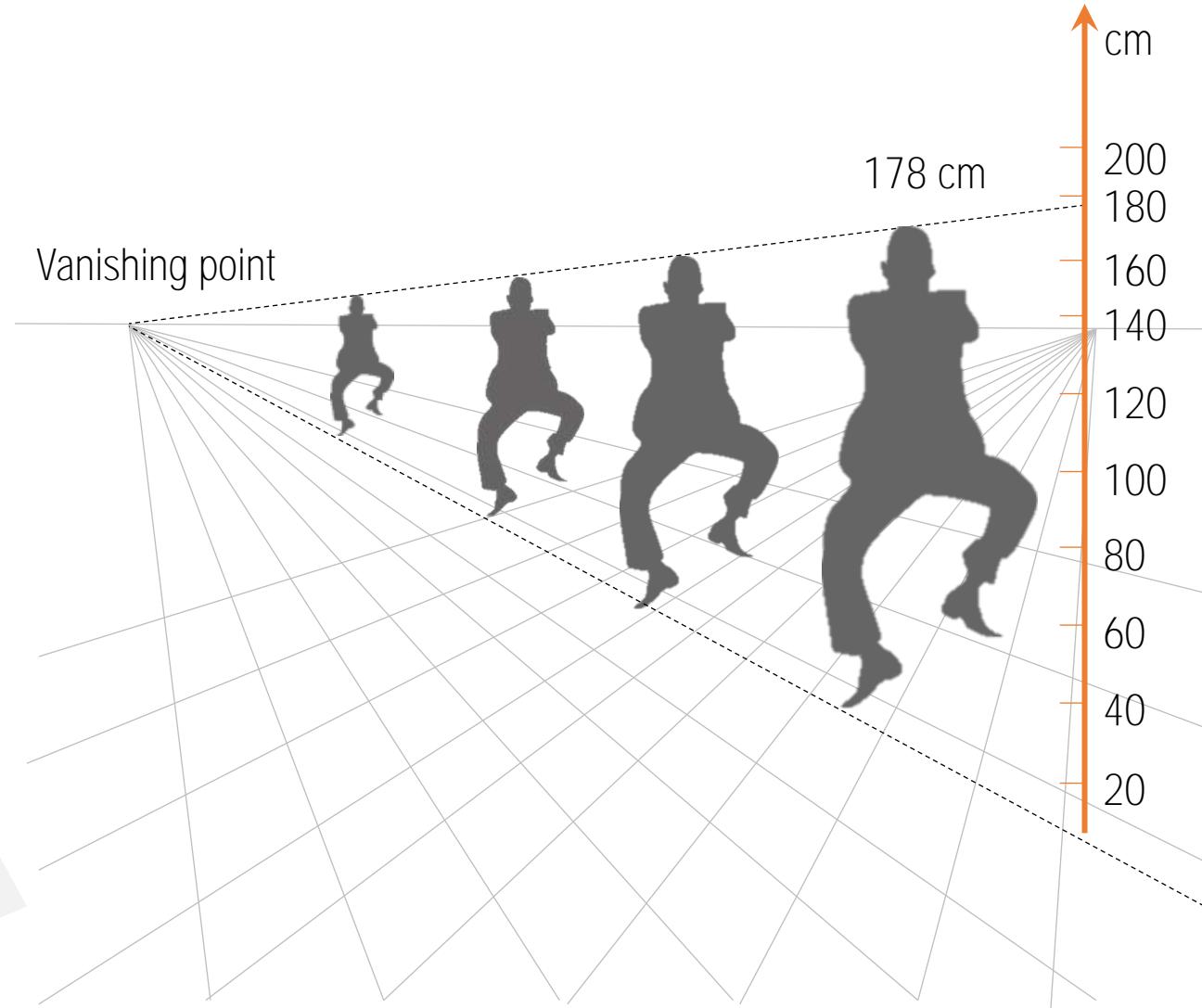
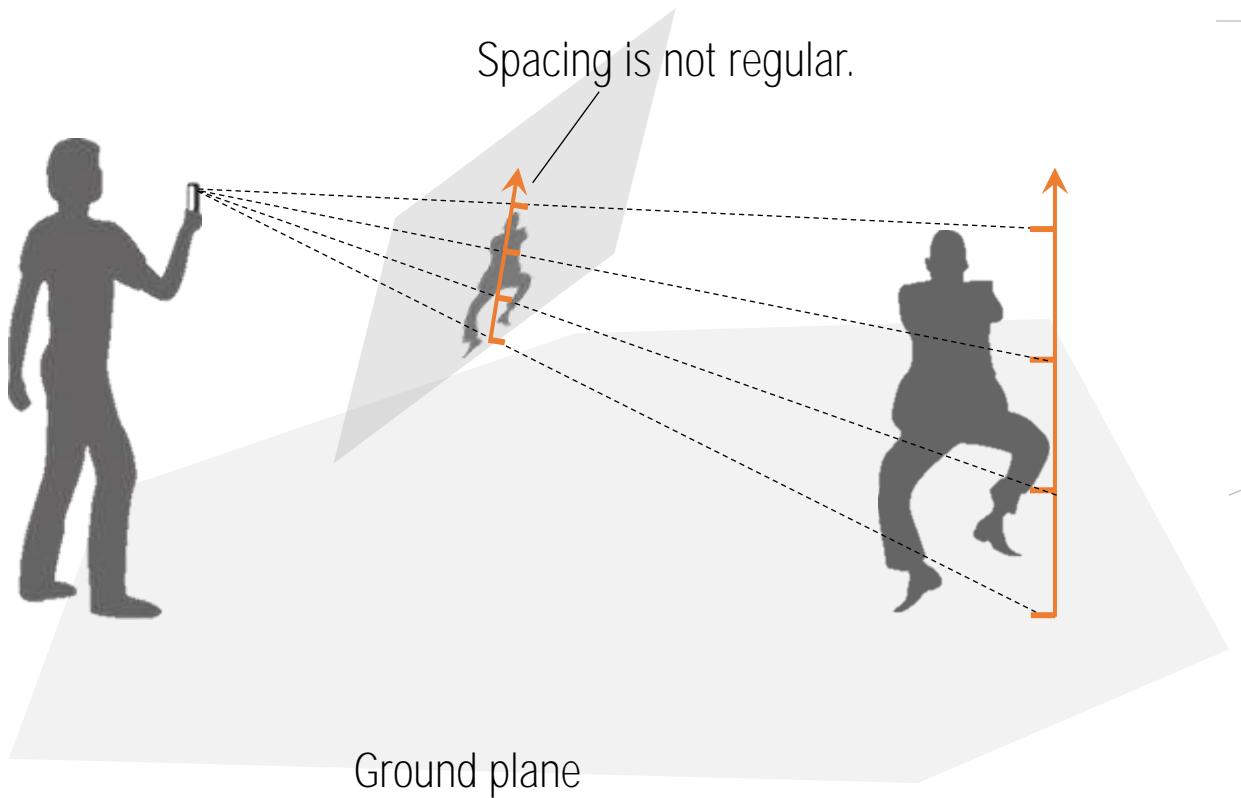
Height from Image



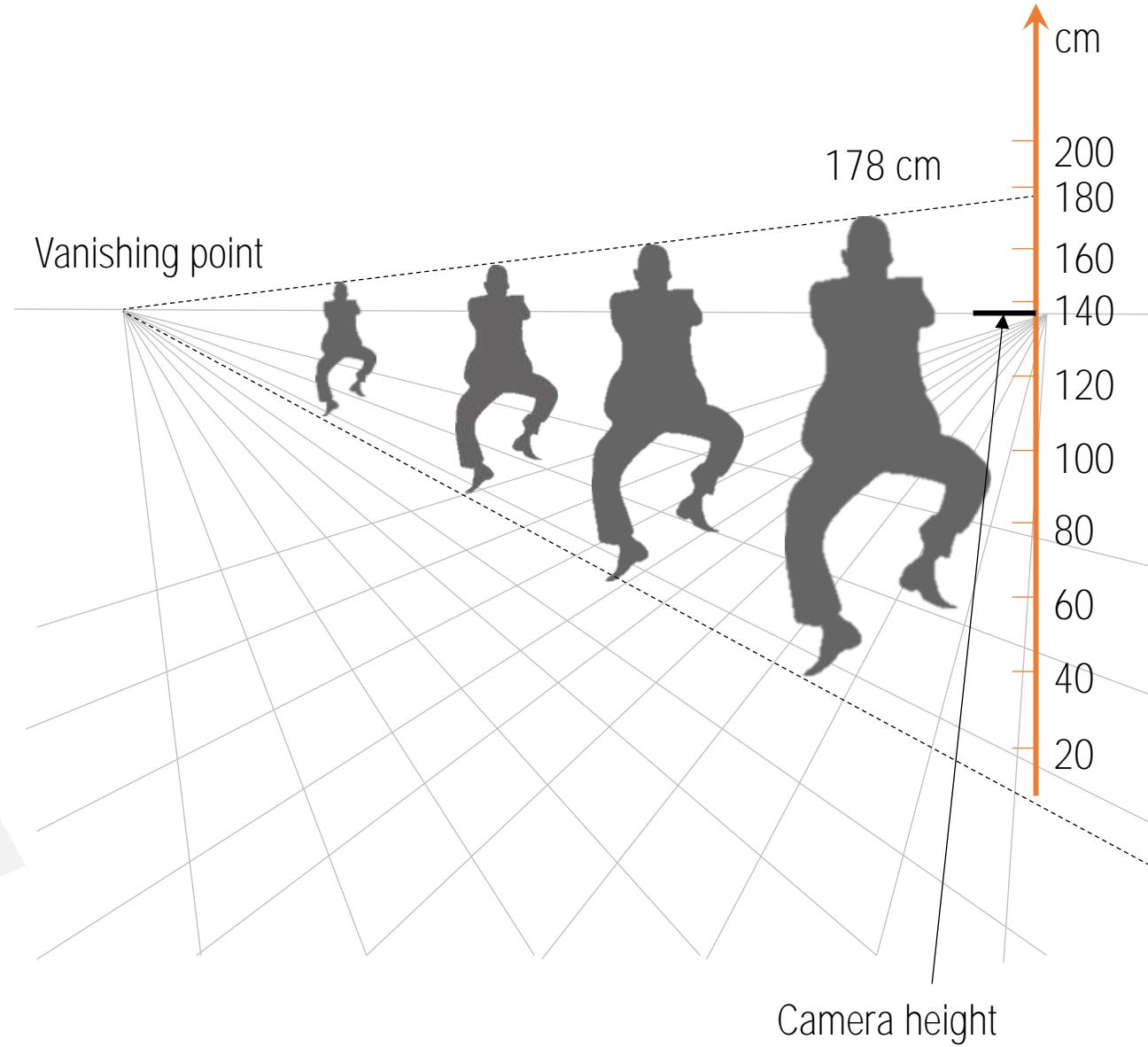
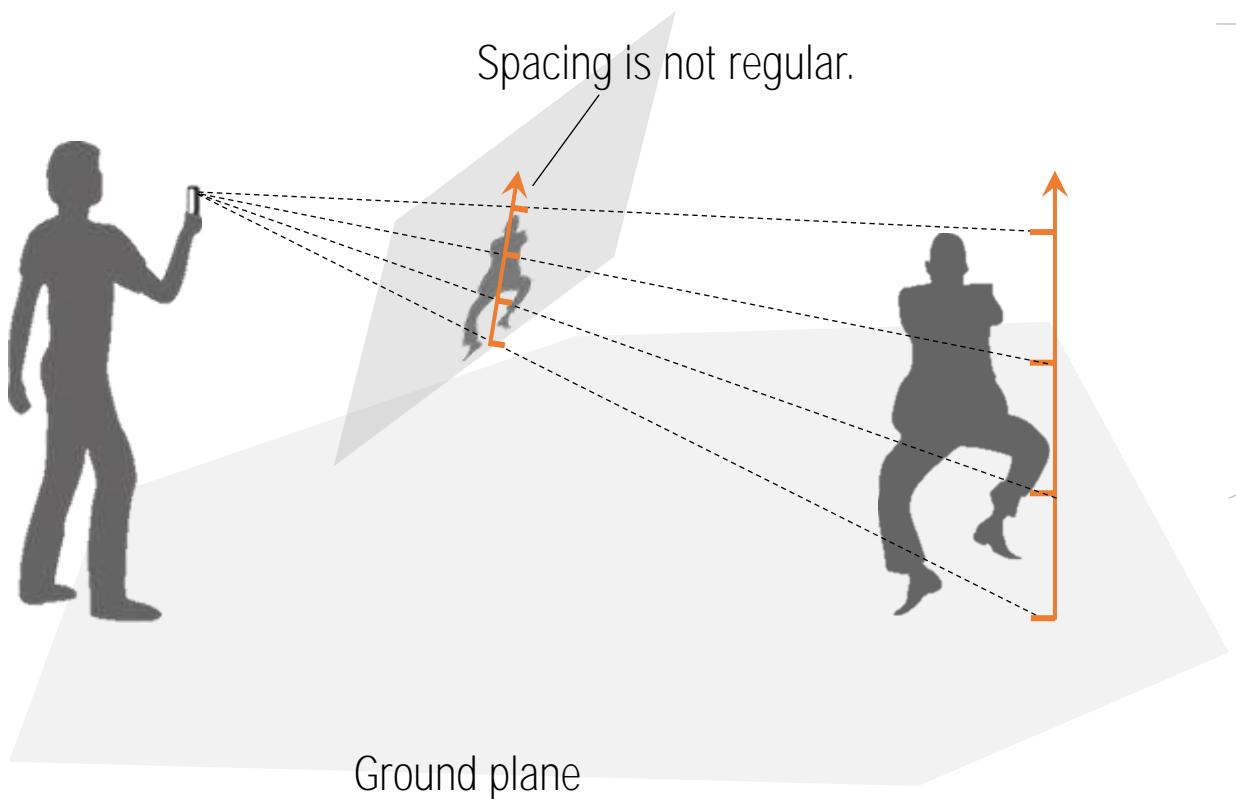
Height from Image



Height from Image



Height from Image



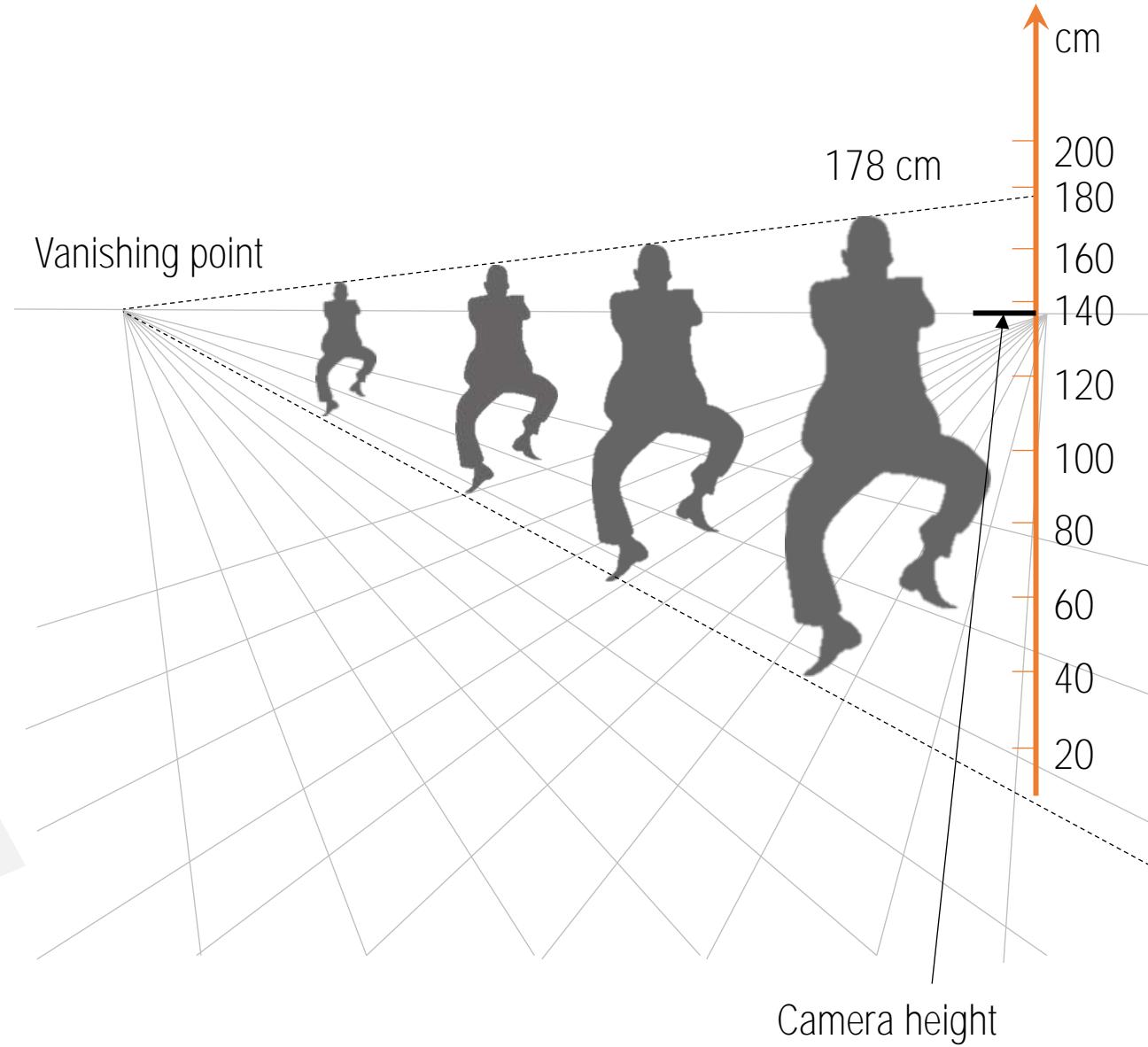
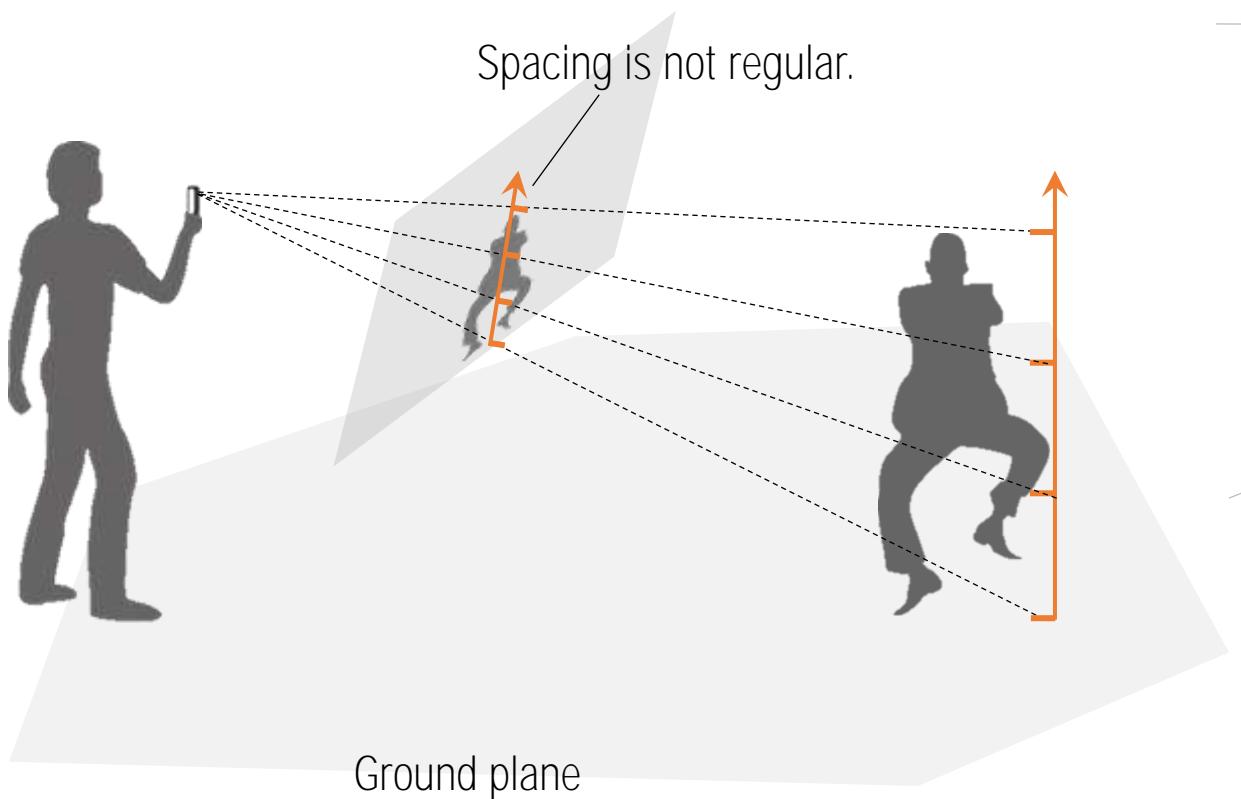
Where was I (how high)?



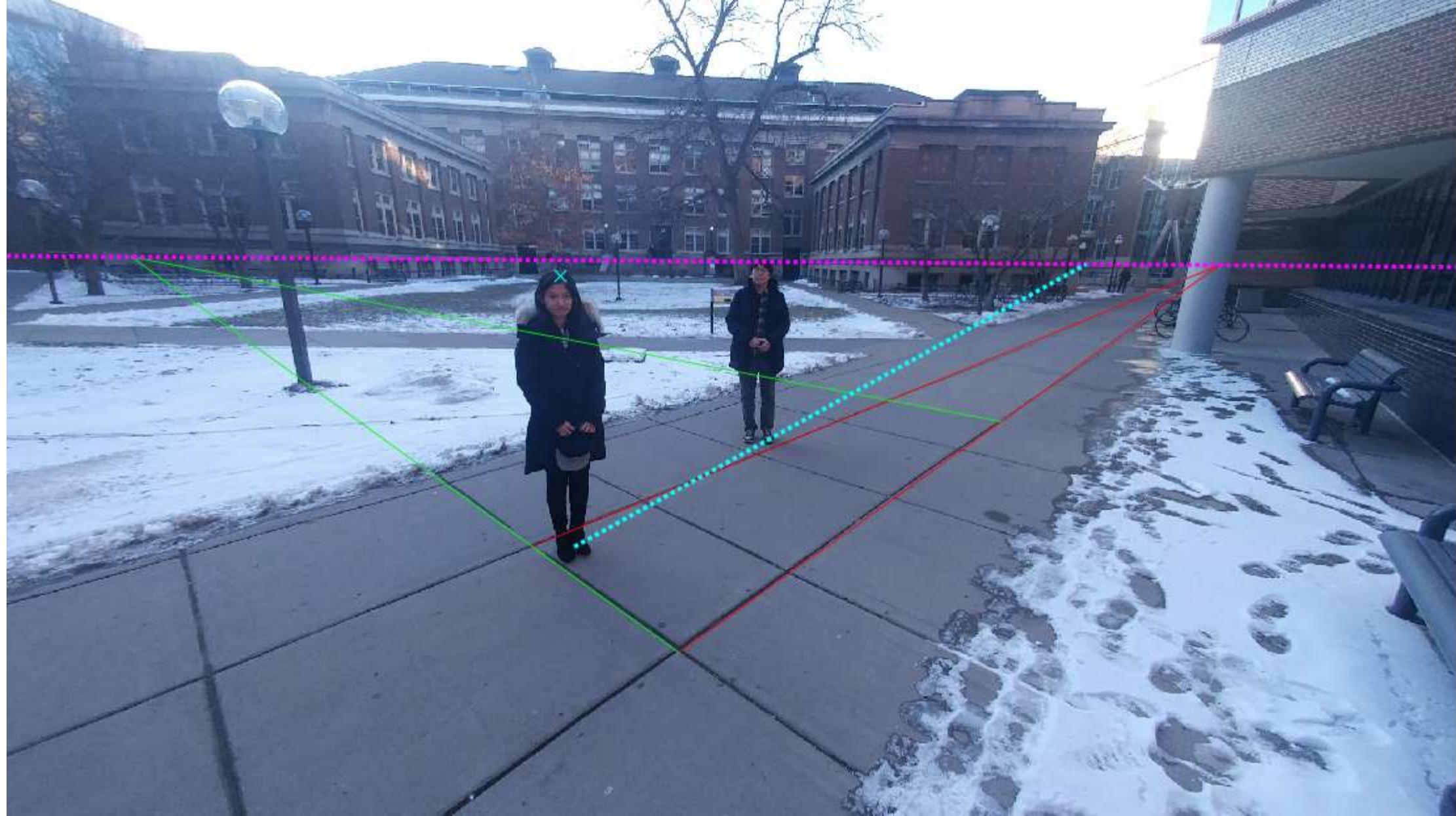
Taken from my hotel room (6th floor)

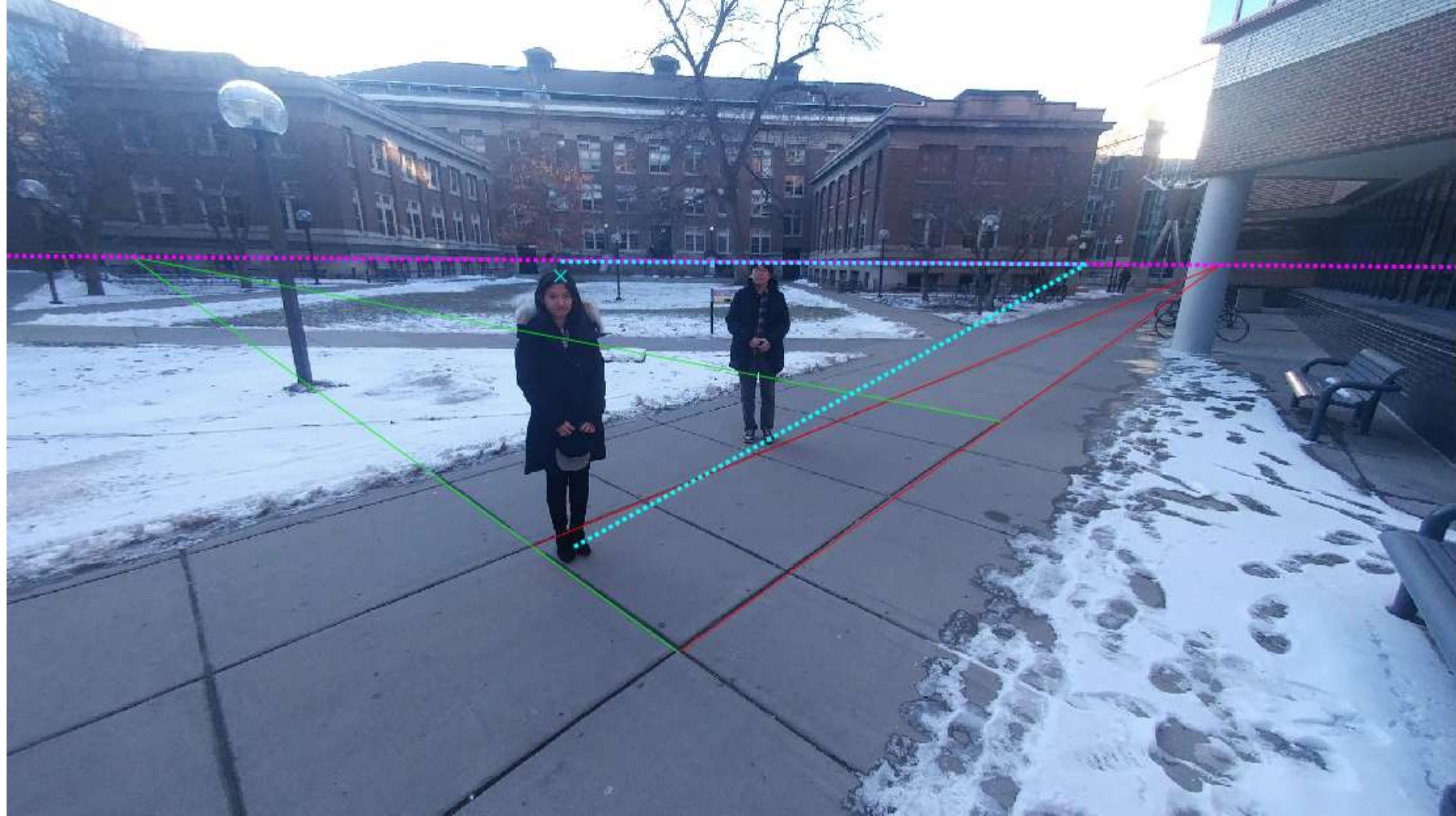
Taken from beach

Height from Image







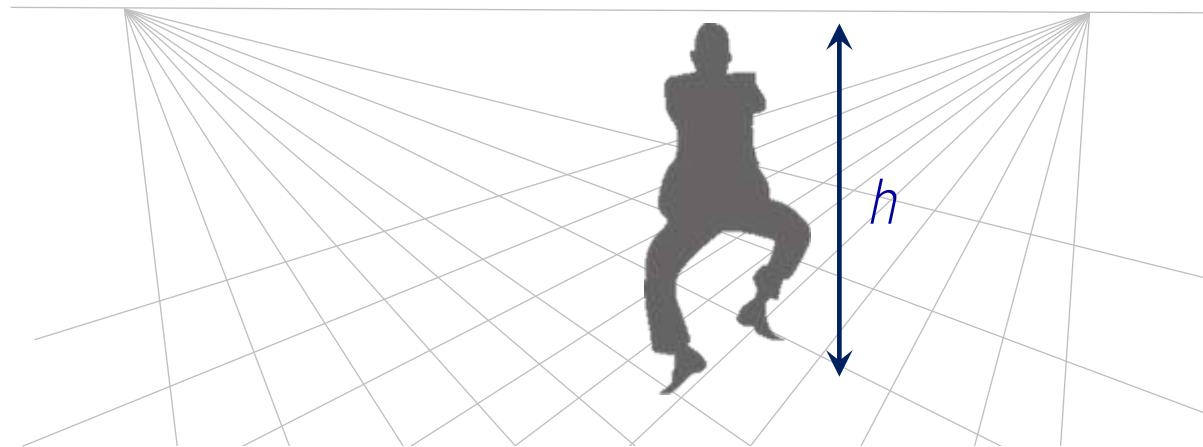
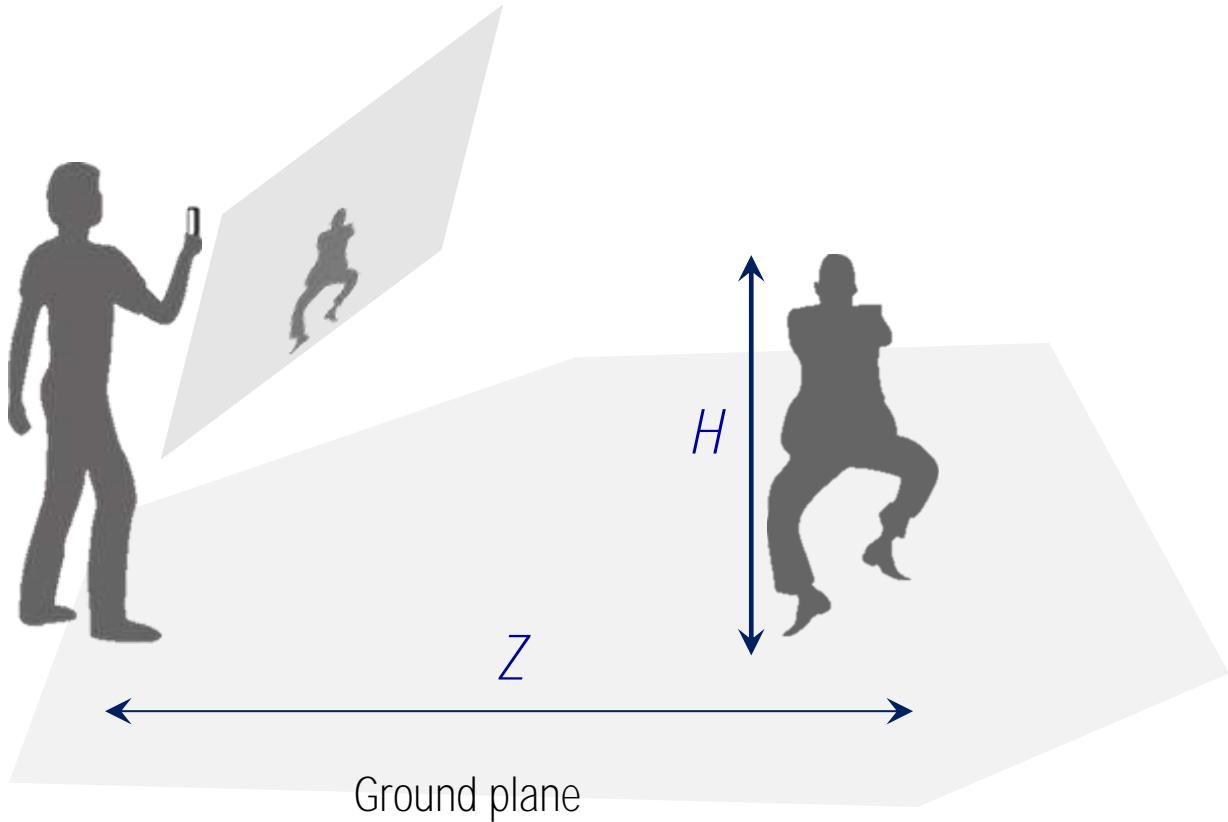




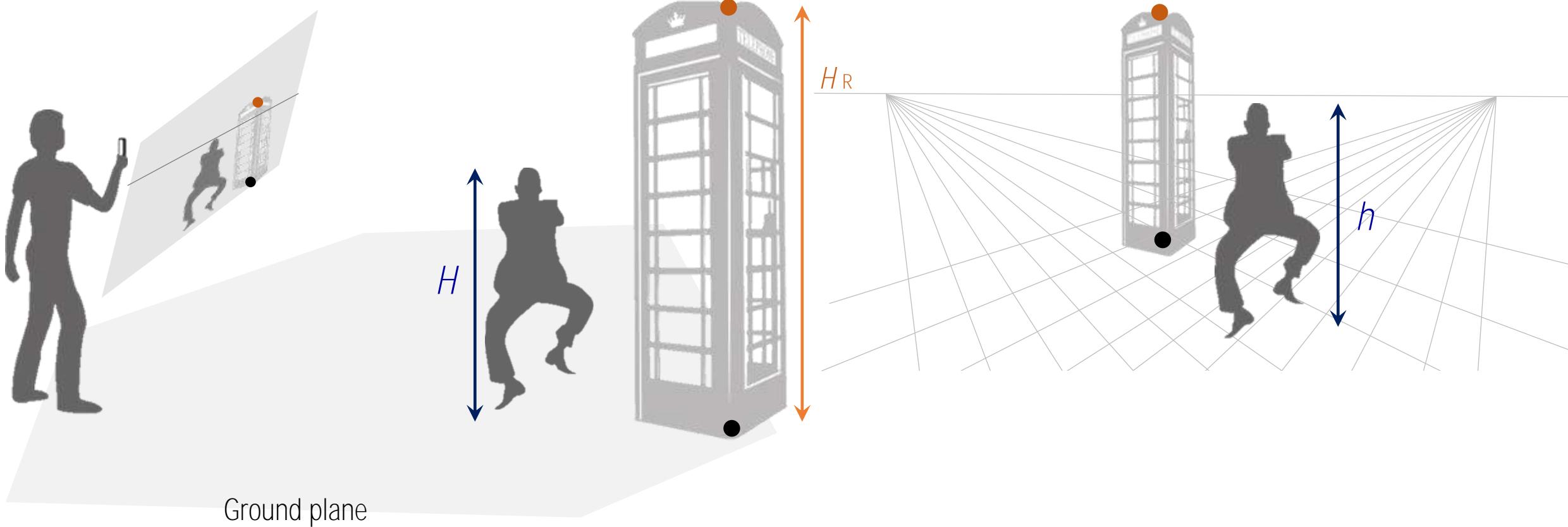
Height from Image

It is impossible to compute the height.

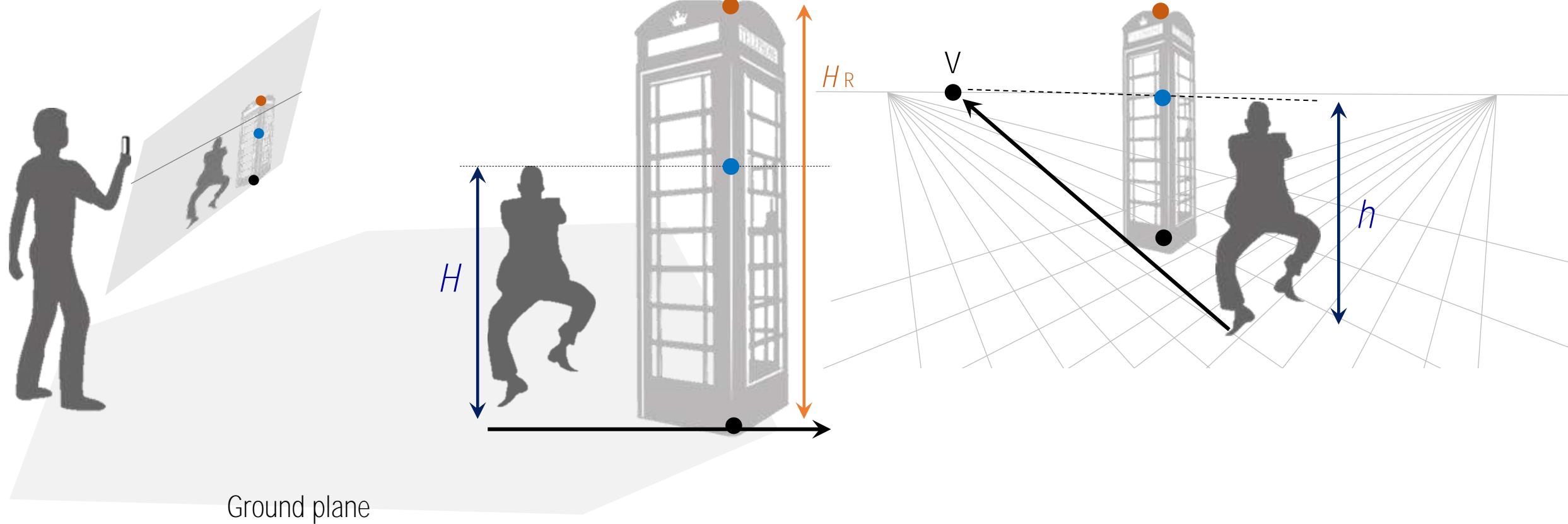
$$h = f \frac{H}{Z}$$



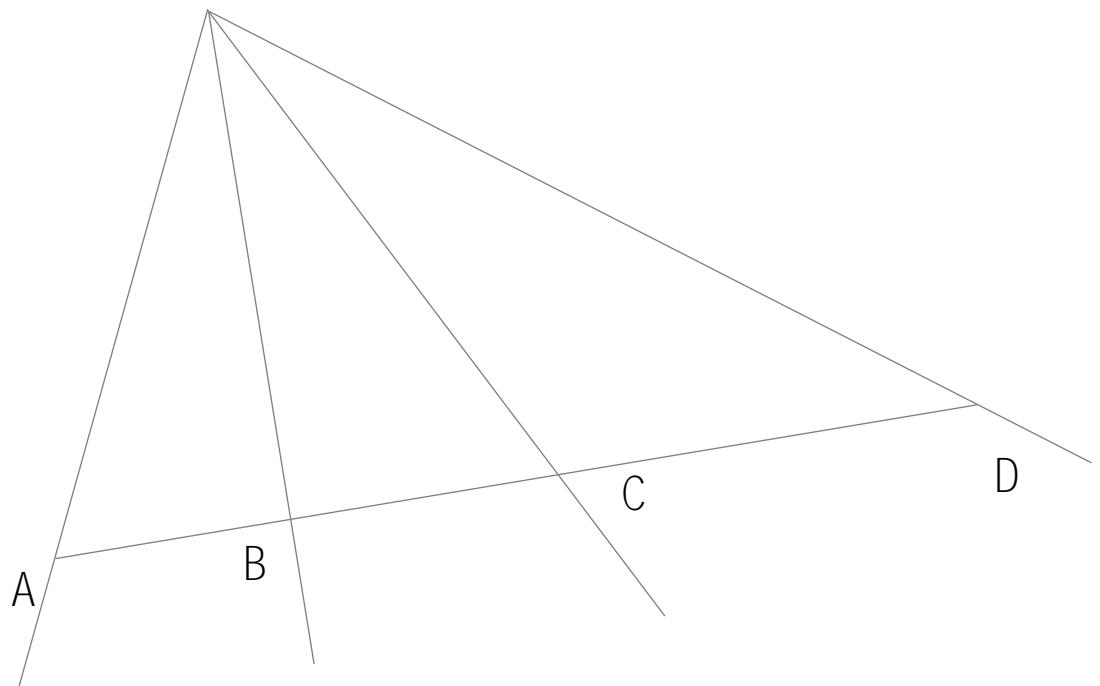
Height from Image



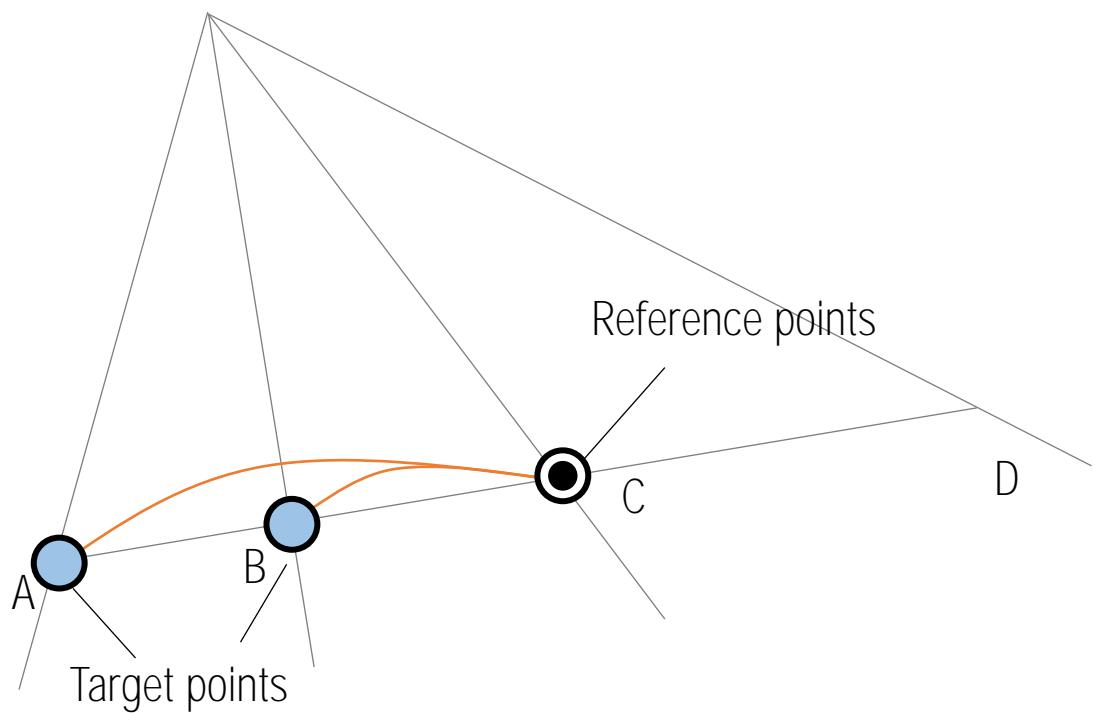
Height from Image



Cross Ratio

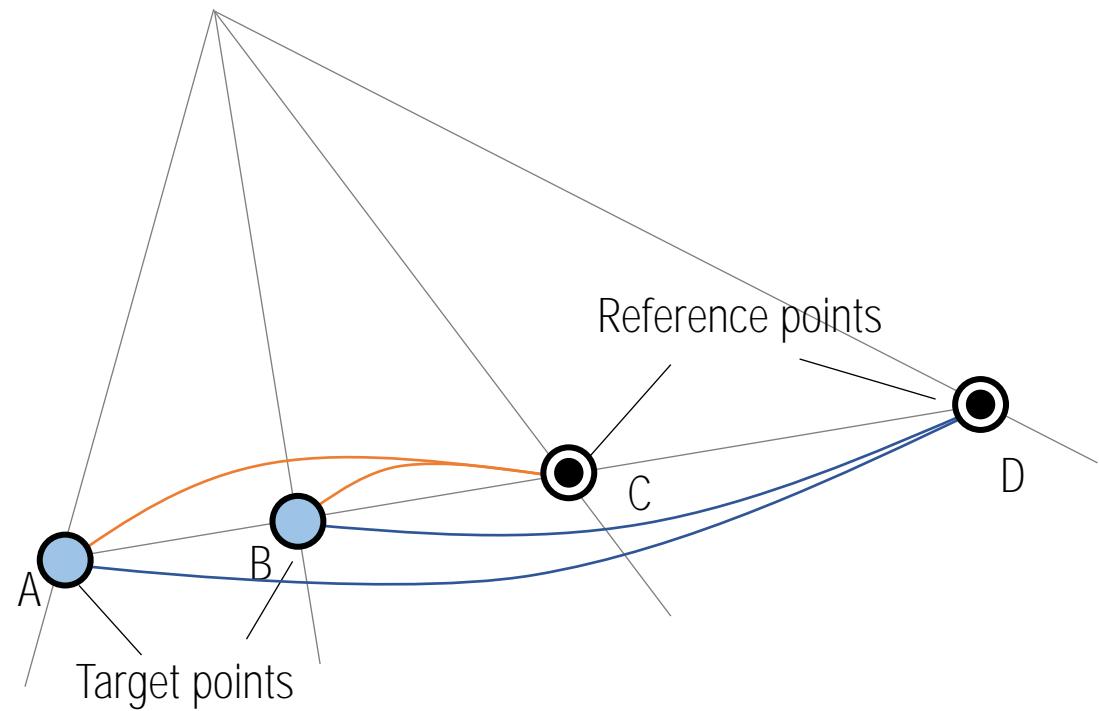


Cross Ratio



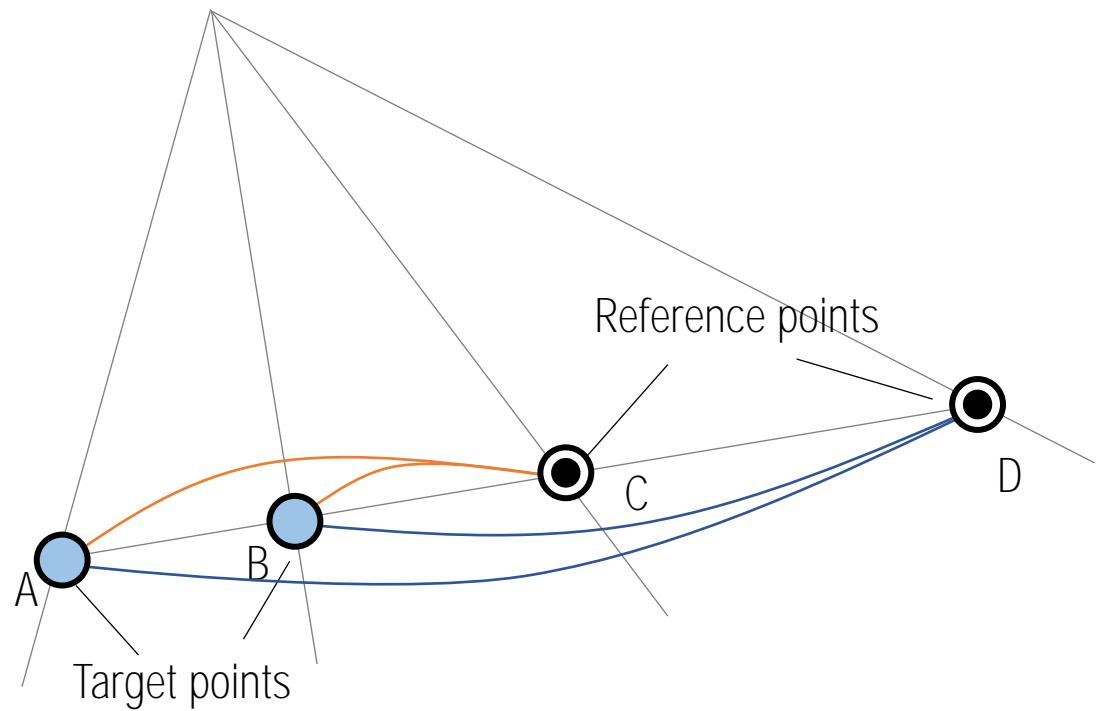
$$\frac{AC}{BC}$$

Cross Ratio



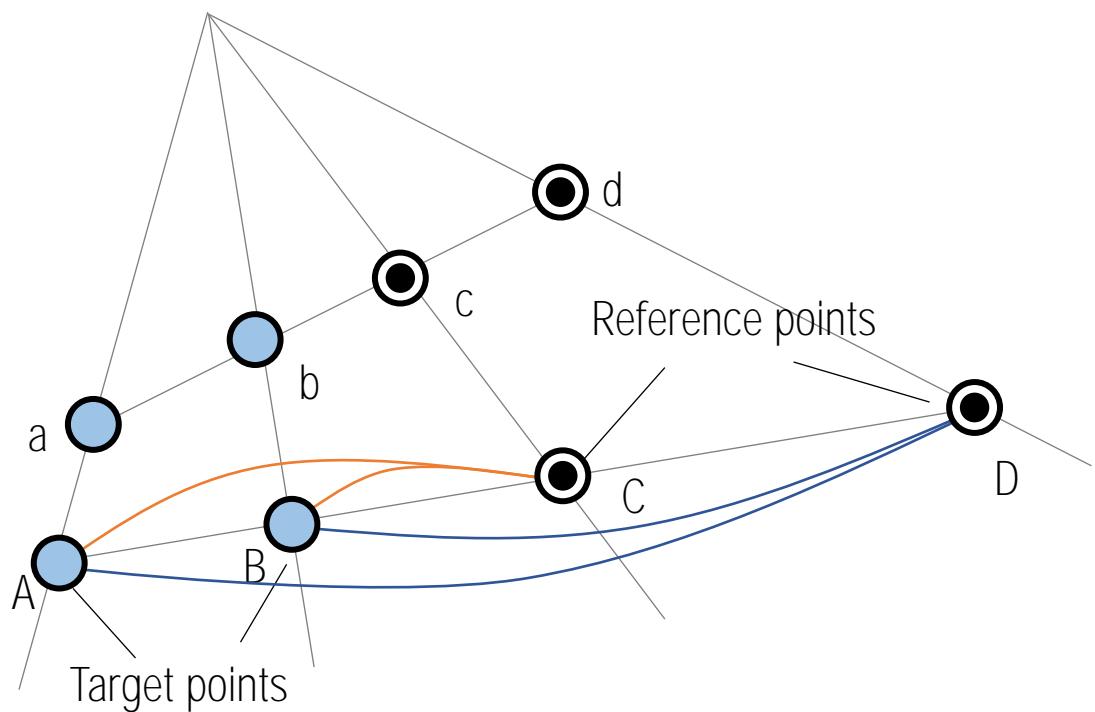
$$\frac{\overline{AC}}{\overline{BC}} \frac{\overline{BD}}{\overline{AD}}$$

Cross Ratio



$$\frac{\overline{AC}}{\overline{BC}} \frac{\overline{BD}}{\overline{AD}}$$

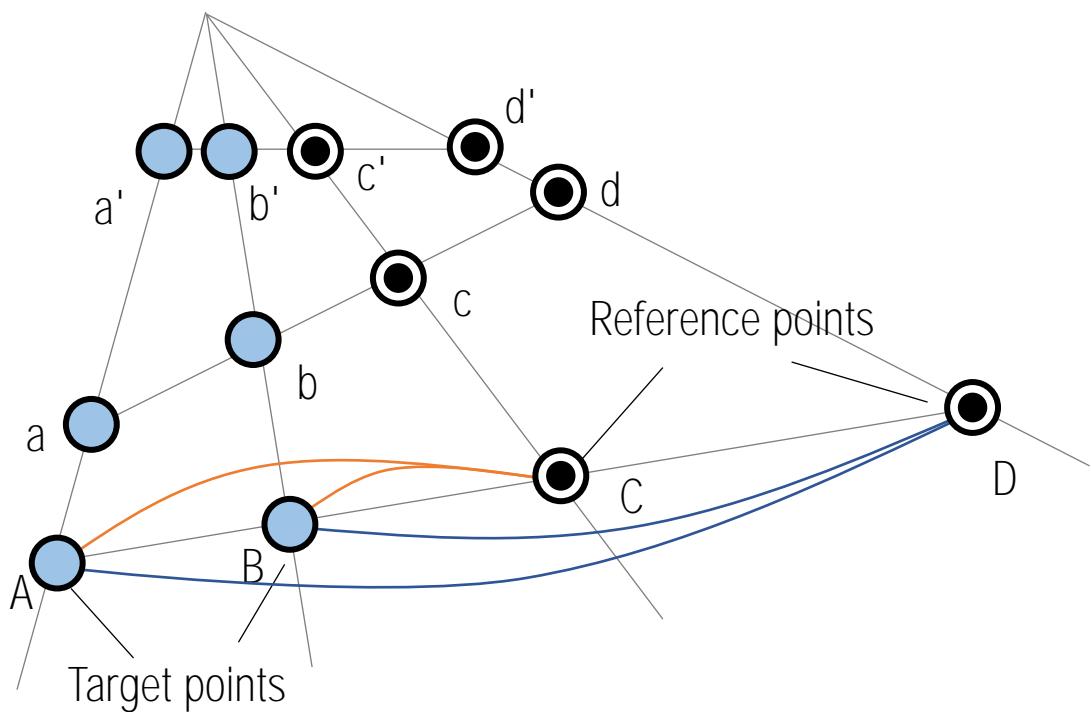
Cross Ratio



$$\frac{\overline{AC} \ \overline{BD}}{\overline{BC} \ \overline{AD}} = \frac{\overline{ac} \ \overline{bd}}{\overline{bc} \ \overline{ad}}$$

Cross ratio (perspective transformation invariant)

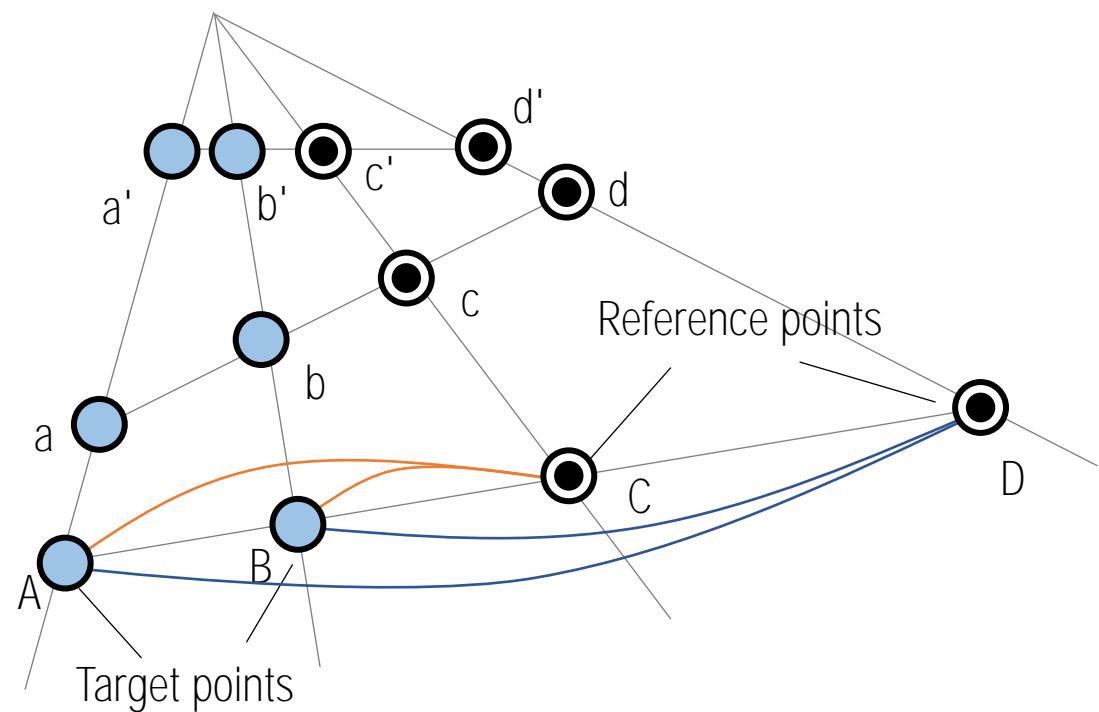
Cross Ratio



$$\frac{\overline{AC} \overline{BD}}{\overline{BC} \overline{AD}} = \frac{\overline{ac} \overline{bd}}{\overline{bc} \overline{ad}} = \frac{\overline{a'c'} \overline{b'd'}}{\overline{b'c'} \overline{a'd'}}$$

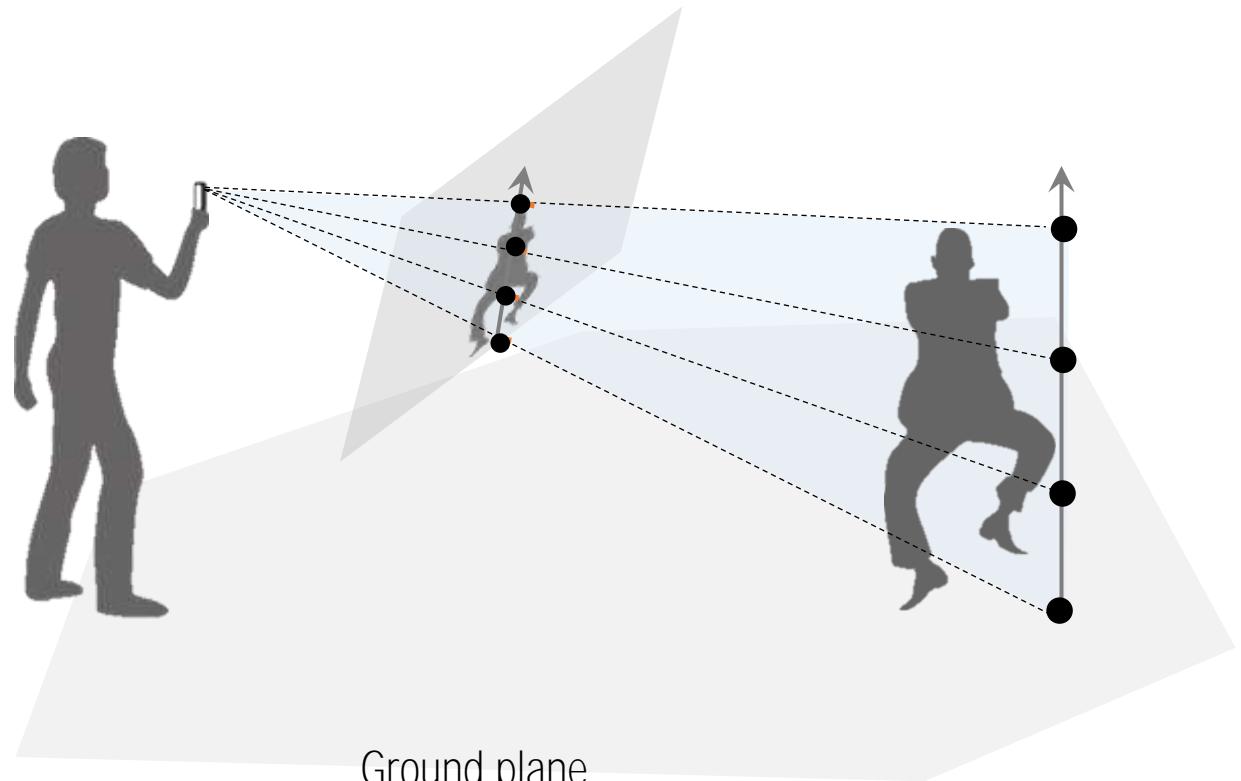
Cross ratio (perspective transformation invariant)

Cross Ratio



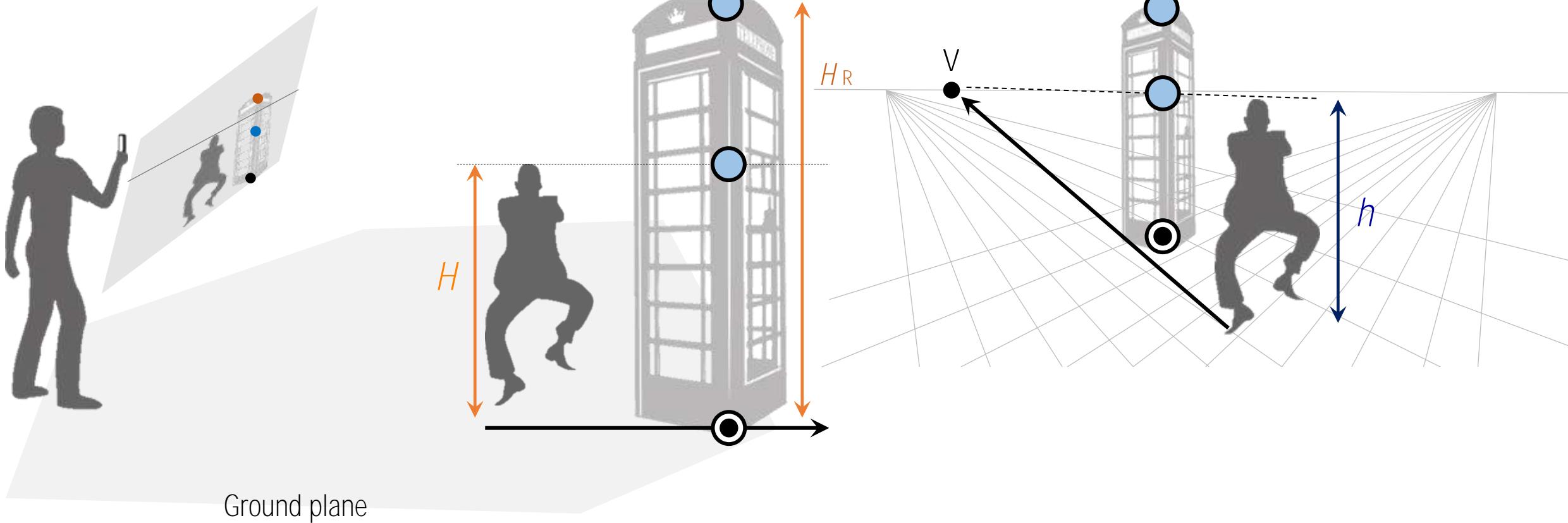
$$\frac{\overline{AC} \ \overline{BD}}{\overline{BC} \ \overline{AD}} = \frac{\overline{ac} \ \overline{bd}}{\overline{bc} \ \overline{ad}} = \frac{\overline{a'c'} \ \overline{b'd'}}{\overline{b'c'} \ \overline{a'd'}}$$

Cross ratio (perspective transformation invariant)

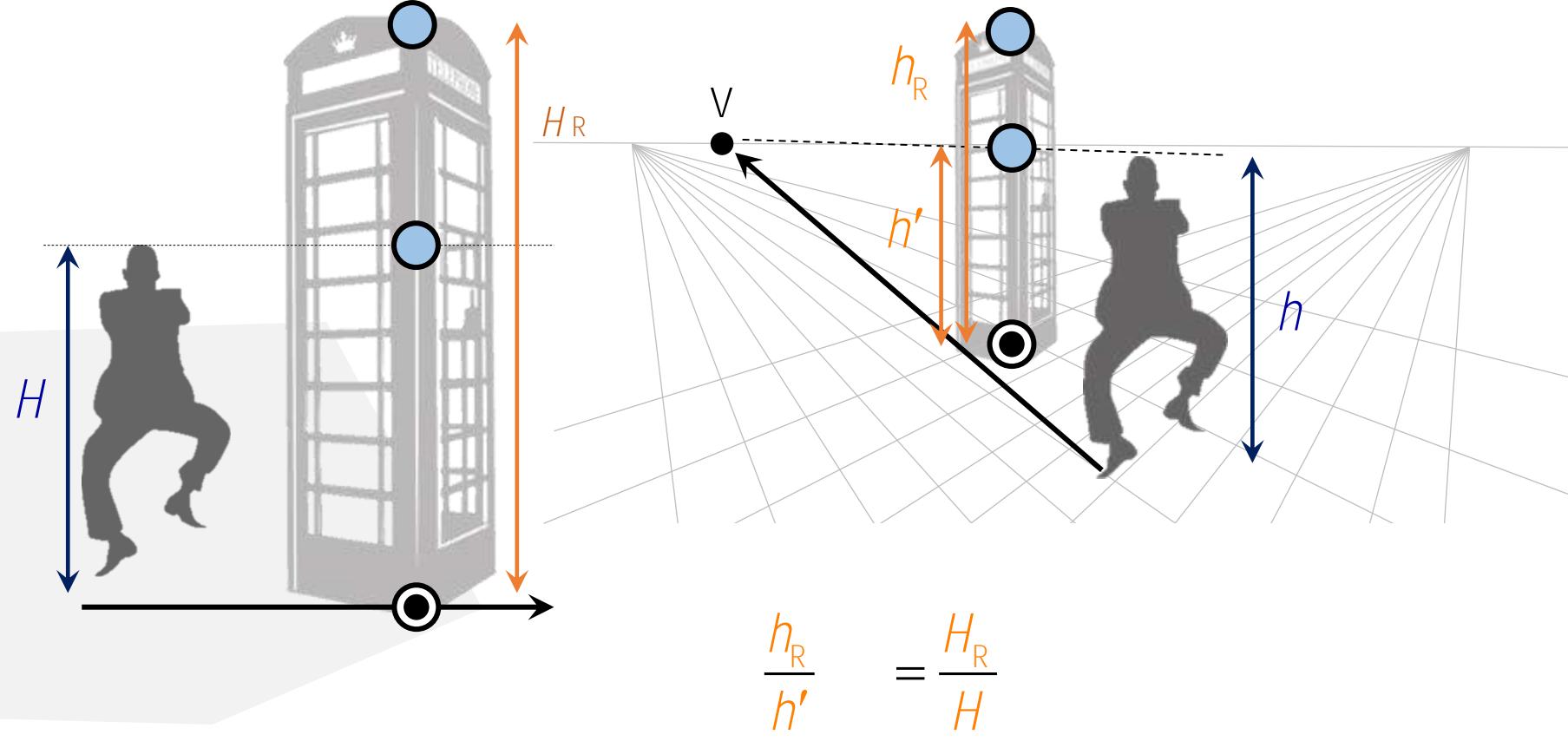
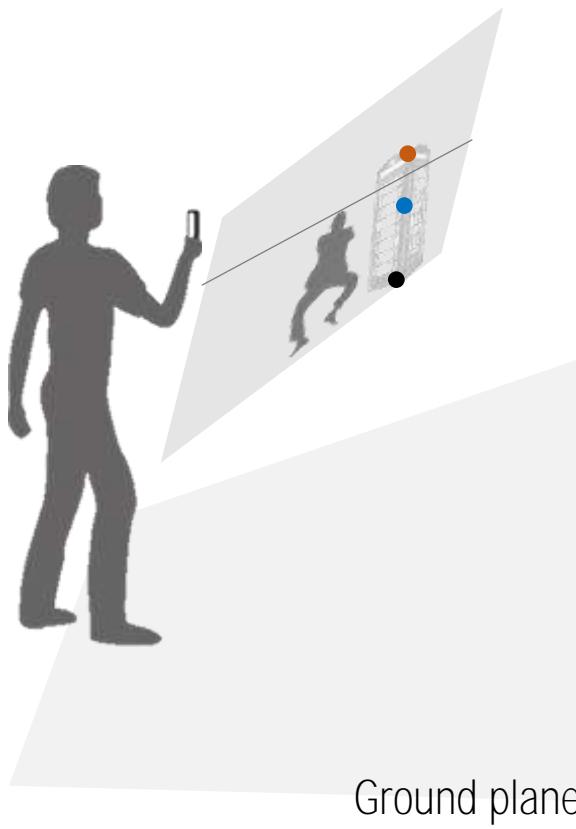


Ground plane

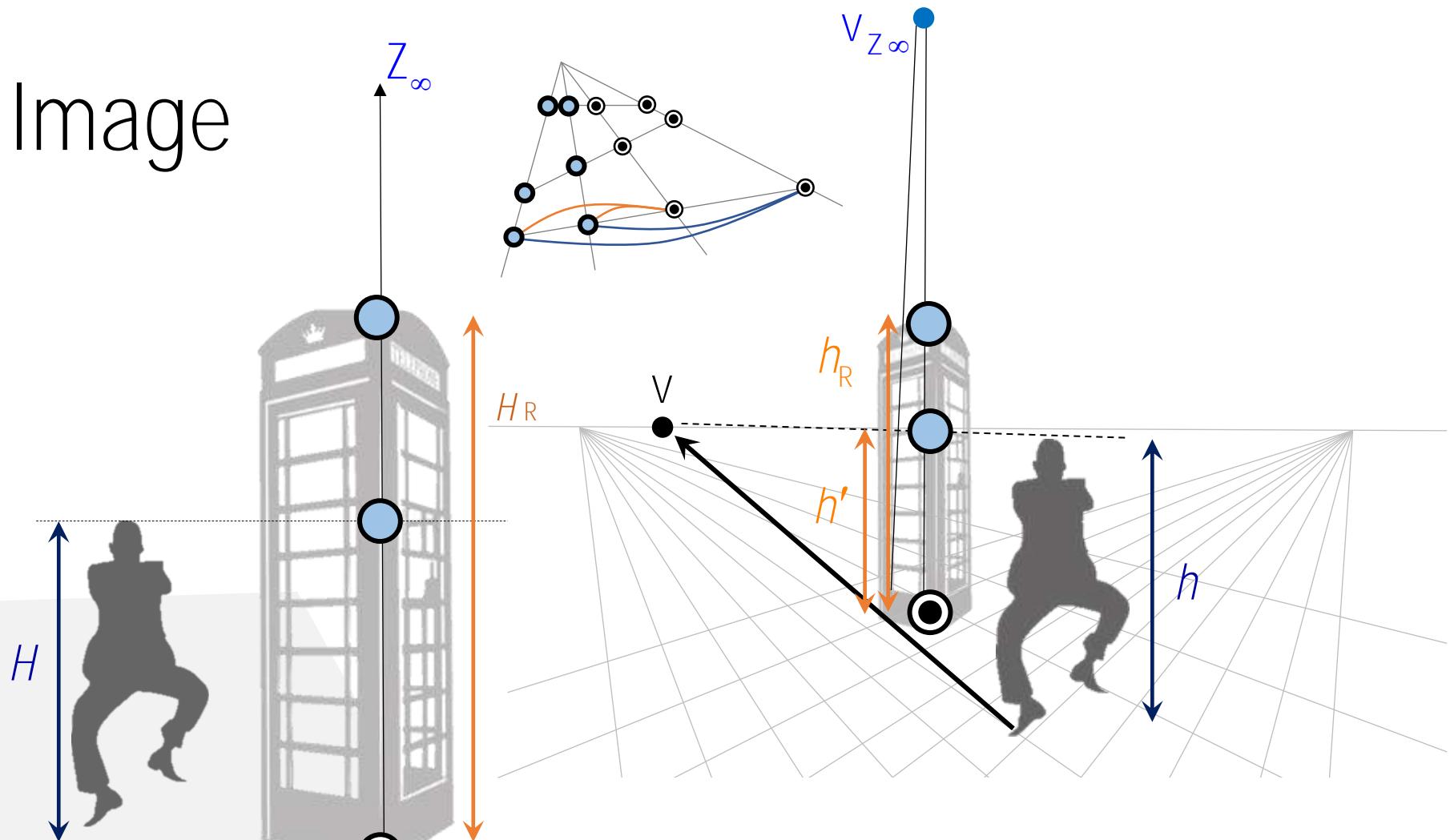
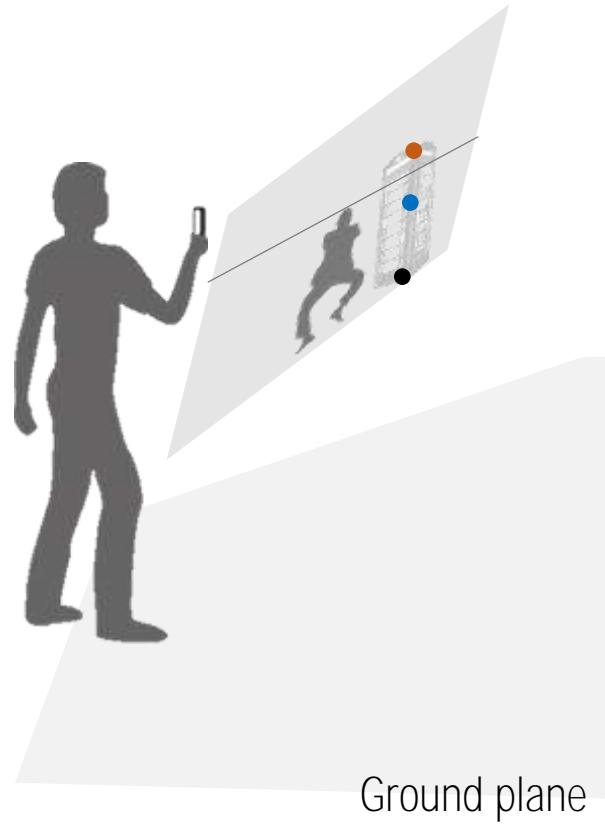
Height from Image



Height from Image

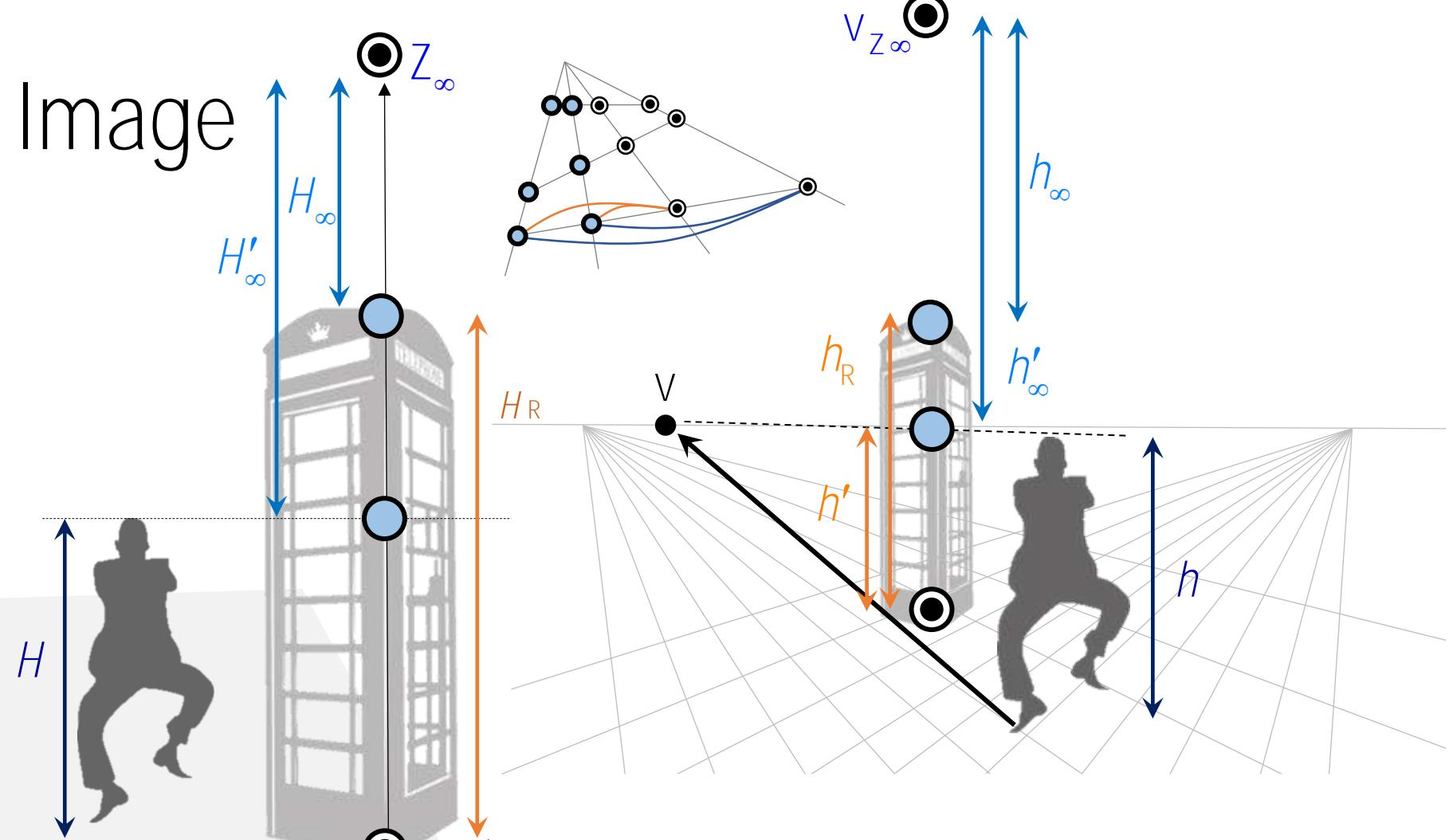
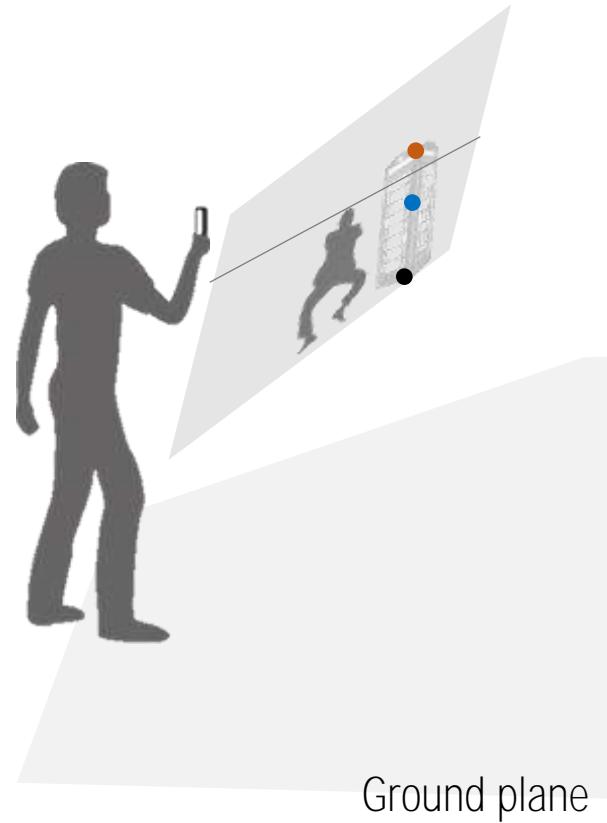


Height from Image



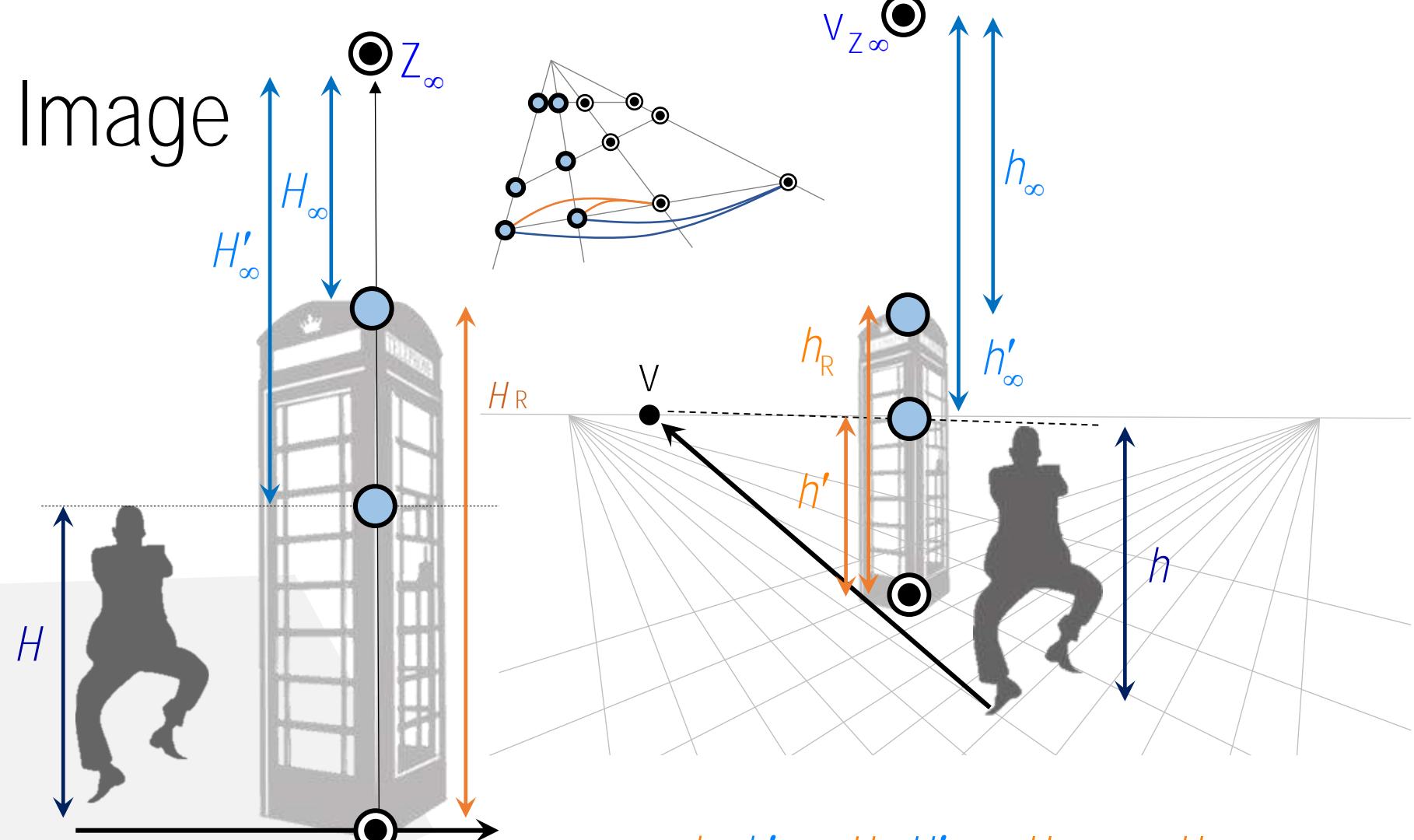
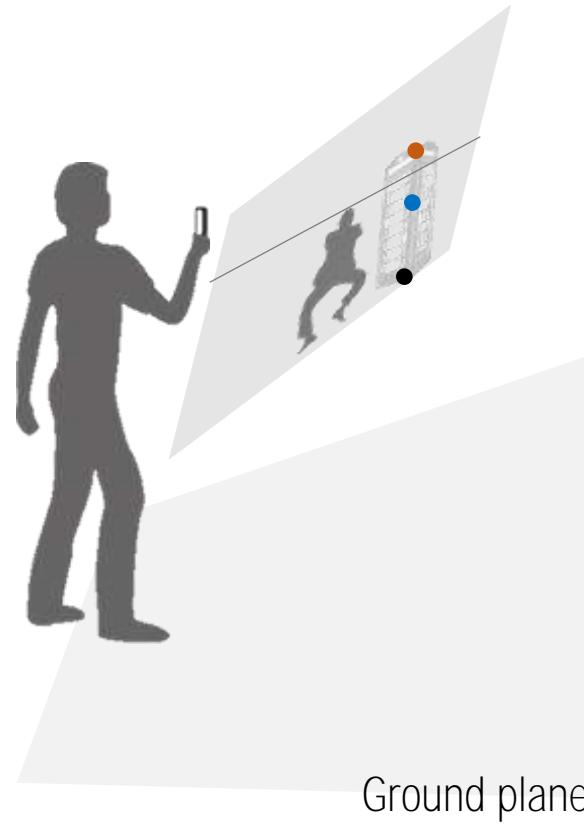
$$\frac{h_R}{h'} = \frac{H_R}{H}$$

Height from Image



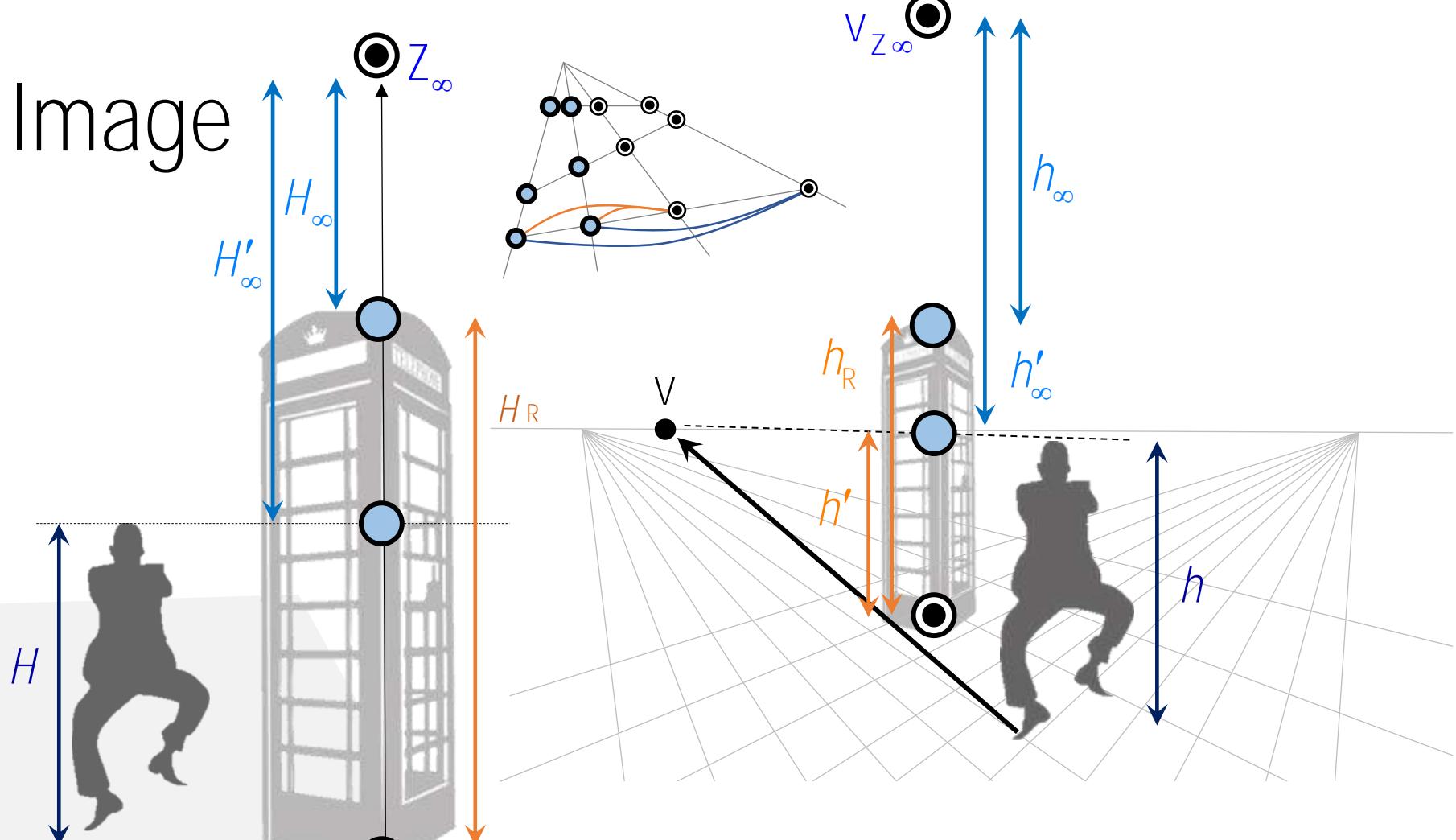
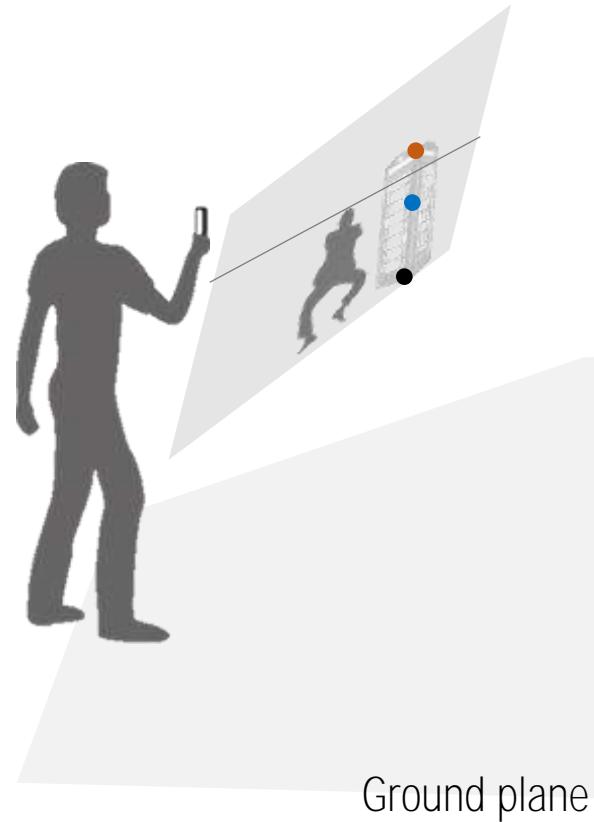
$$\frac{h_R}{h'} \frac{h'_\infty}{h_\infty} = \frac{H_R}{H} \frac{H'_\infty}{H_\infty}$$

Height from Image



$$\frac{h_R}{h'} \frac{h'_\infty}{h_\infty} = \frac{H_R}{H} \frac{H'_\infty}{H_\infty} = \frac{H_R \infty}{H \infty} = \frac{H_R}{H}$$

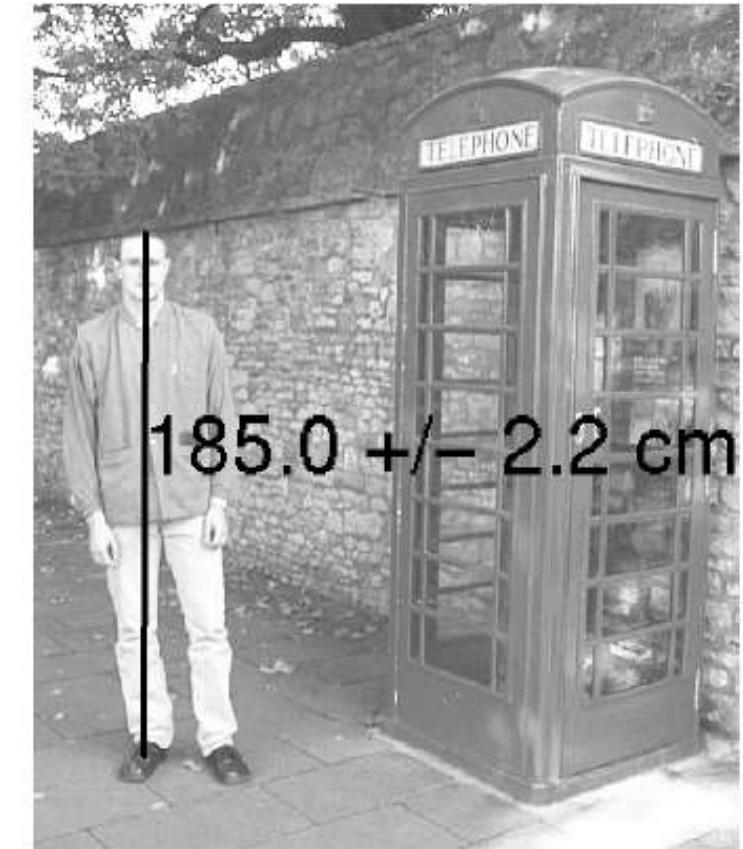
Height from Image



$$\frac{h_R}{h'} \frac{h'_\infty}{h_\infty} = \frac{H_R}{H} \frac{H'_\infty}{H_\infty} = \frac{H_R \infty}{H \infty} = \frac{H_R}{H}$$

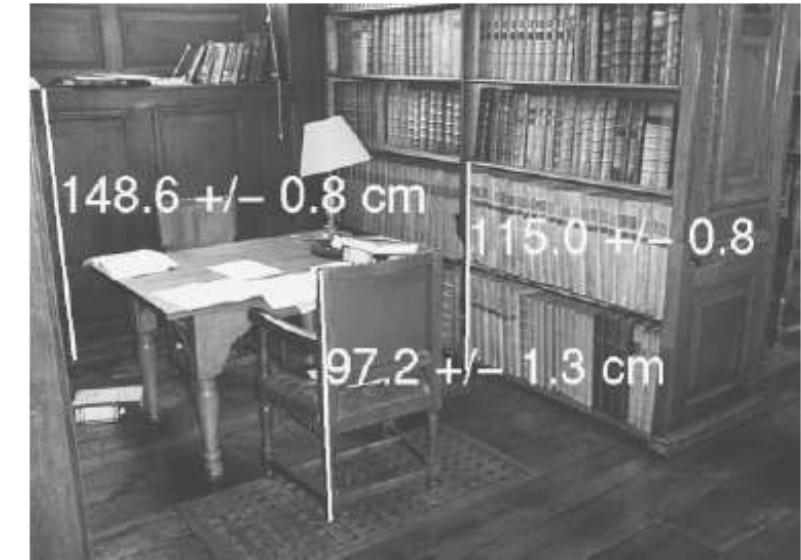
$$\rightarrow H = H_R \frac{h' h_\infty}{h_R h'_\infty}$$

Single View Metrology (Criminisi 1999)

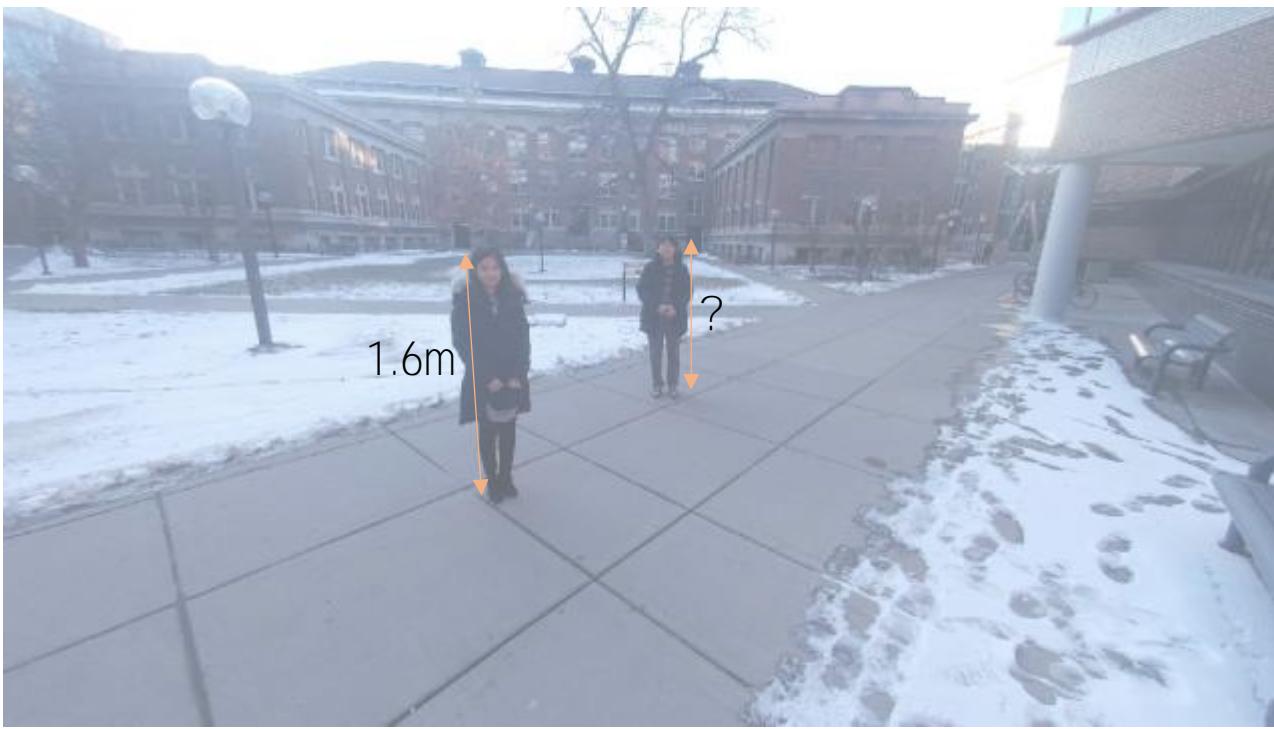


Ground truth height: 187 cm

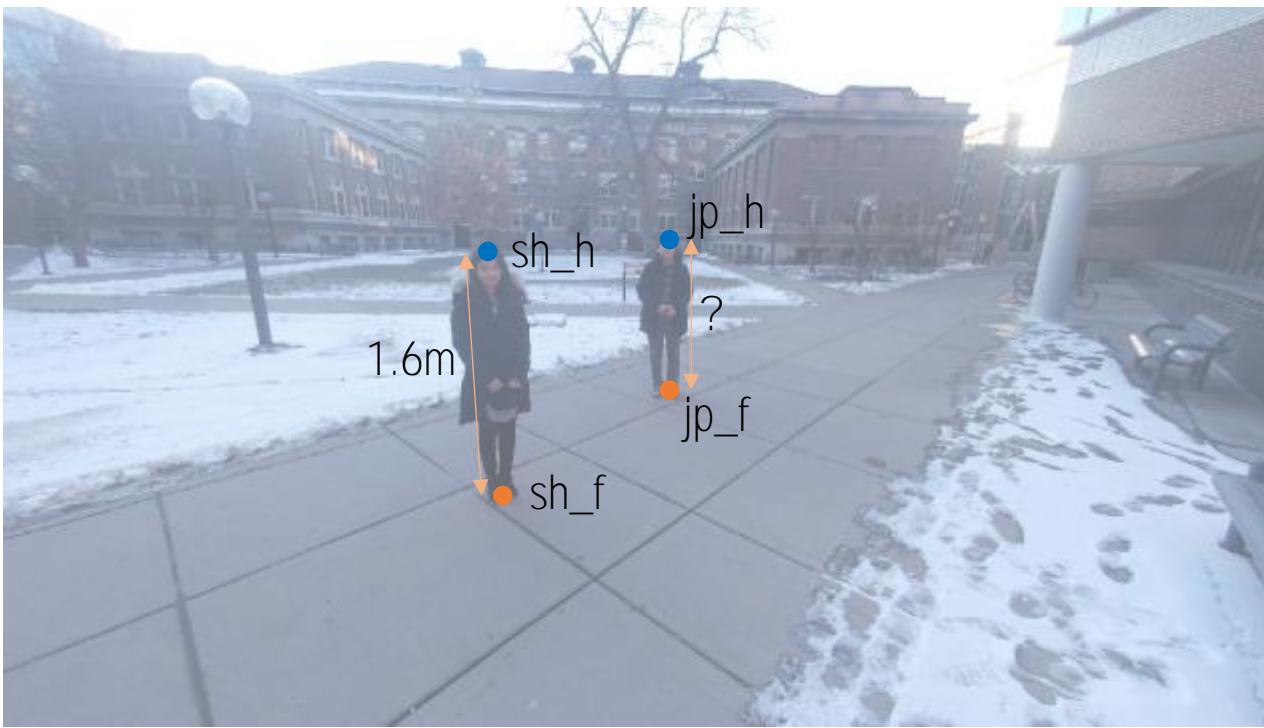
Single View Metrology (Criminisi 1999)

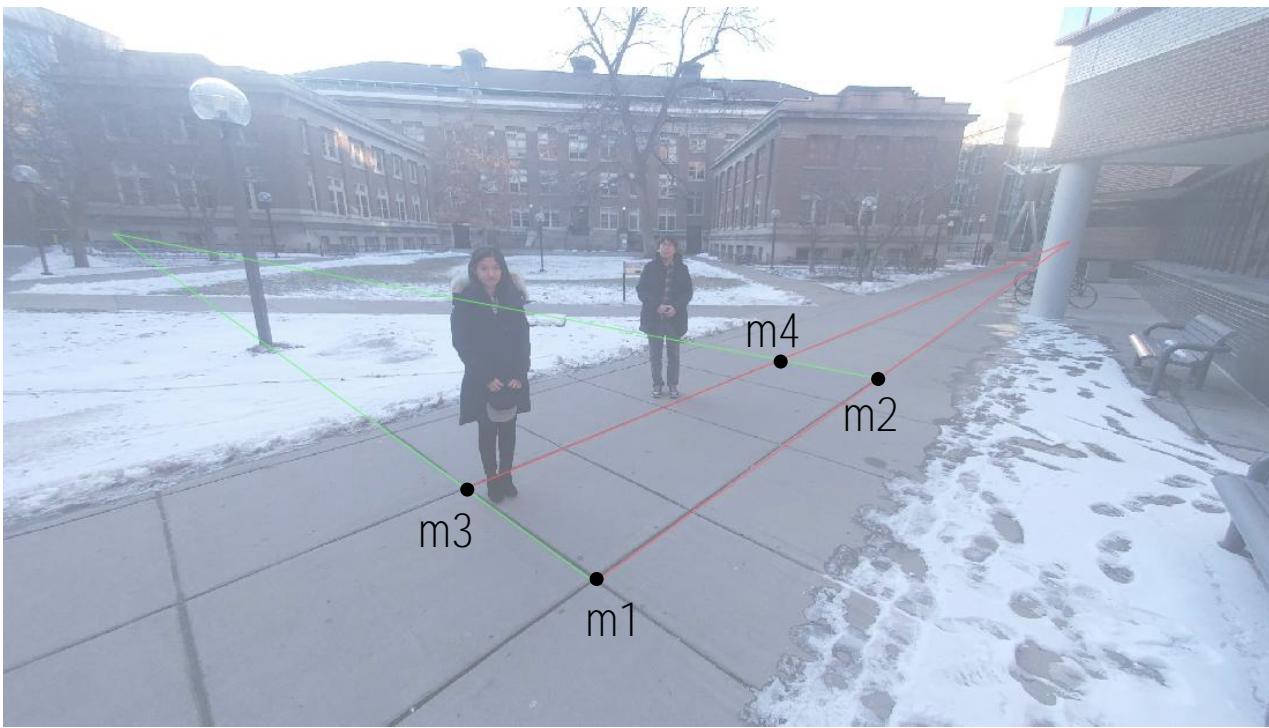


Ground truth height: 187 cm



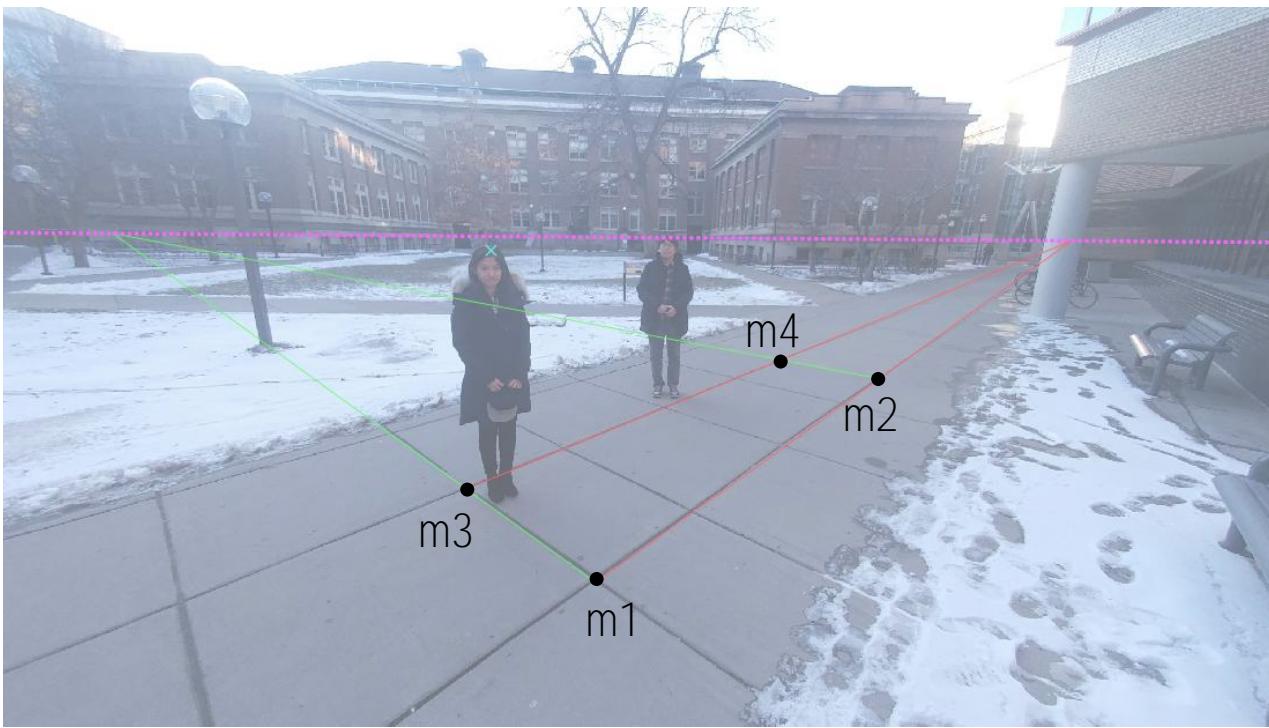
```
sh_f = [1504;1447;1];  
sh_h = [1468;730;1];  
jp_f = [1997;1175;1];  
jp_h = [1997;695;1];
```





```
sh_f = [1504;1447;1];  
sh_h = [1468;730;1];  
jp_f = [1997;1175;1];  
jp_h = [1997;695;1];
```

```
l11 = GetLineFromTwoPoints(m1,m2);  
l12 = GetLineFromTwoPoints(m3,m4);  
l21 = GetLineFromTwoPoints(m1,m3);  
l22 = GetLineFromTwoPoints(m2,m4);
```

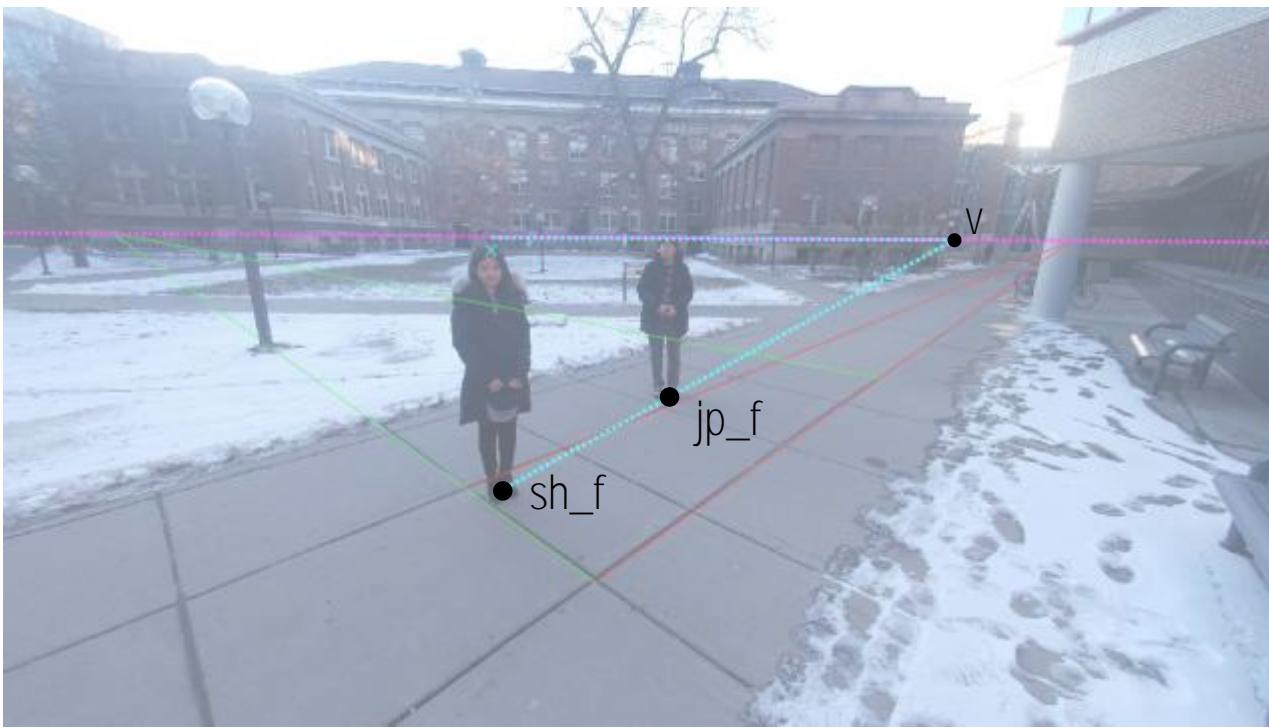


```
sh_f = [1504;1447;1];  
sh_h = [1468;730;1];  
jp_f = [1997;1175;1];  
jp_h = [1997;695;1];
```

```
l11 = GetLineFromTwoPoints(m1,m2);  
l12 = GetLineFromTwoPoints(m3,m4);  
l21 = GetLineFromTwoPoints(m1,m3);  
l22 = GetLineFromTwoPoints(m2,m4);
```

```
v1 = GetPointFromTwoLines(l11,l12);  
v2 = GetPointFromTwoLines(l21,l22);  
l = GetLineFromTwoPoints(v1,v2);
```

← Vanishing line



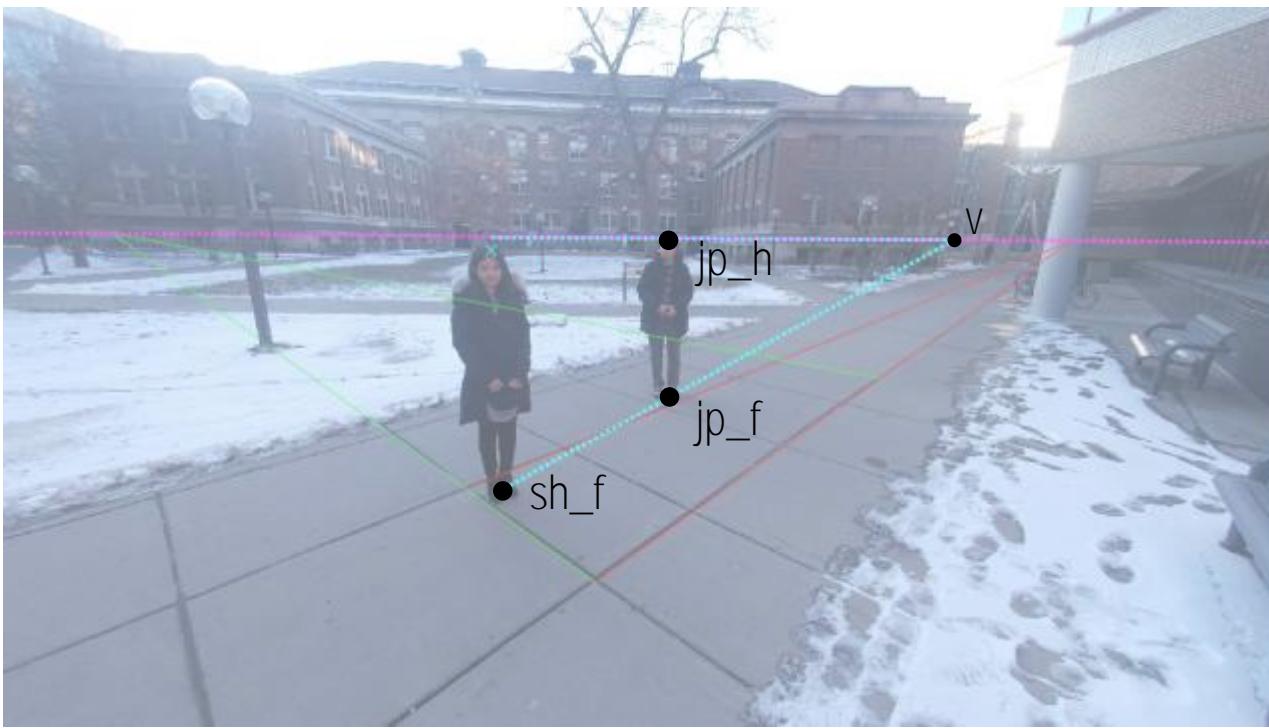
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sh_f = [1504;1447;1];  
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jp_h = [1997;695;1];
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```
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l12 = GetLineFromTwoPoints(m3,m4);  
l21 = GetLineFromTwoPoints(m1,m3);  
l22 = GetLineFromTwoPoints(m2,m4);
```

```
v1 = GetPointFromTwoLines(l11,l12);  
v2 = GetPointFromTwoLines(l21,l22);  
l = GetLineFromTwoPoints(v1,v2);
```

← Vanishing line

```
line_sh_jp_f = GetLineFromTwoPoints(sh_f,jp_f);  
v = GetPointFromTwoLines(line_sh_jp_f,l);
```



```
sh_f = [1504;1447;1];  
sh_h = [1468;730;1];  
jp_f = [1997;1175;1];  
jp_h = [1997;695;1];
```

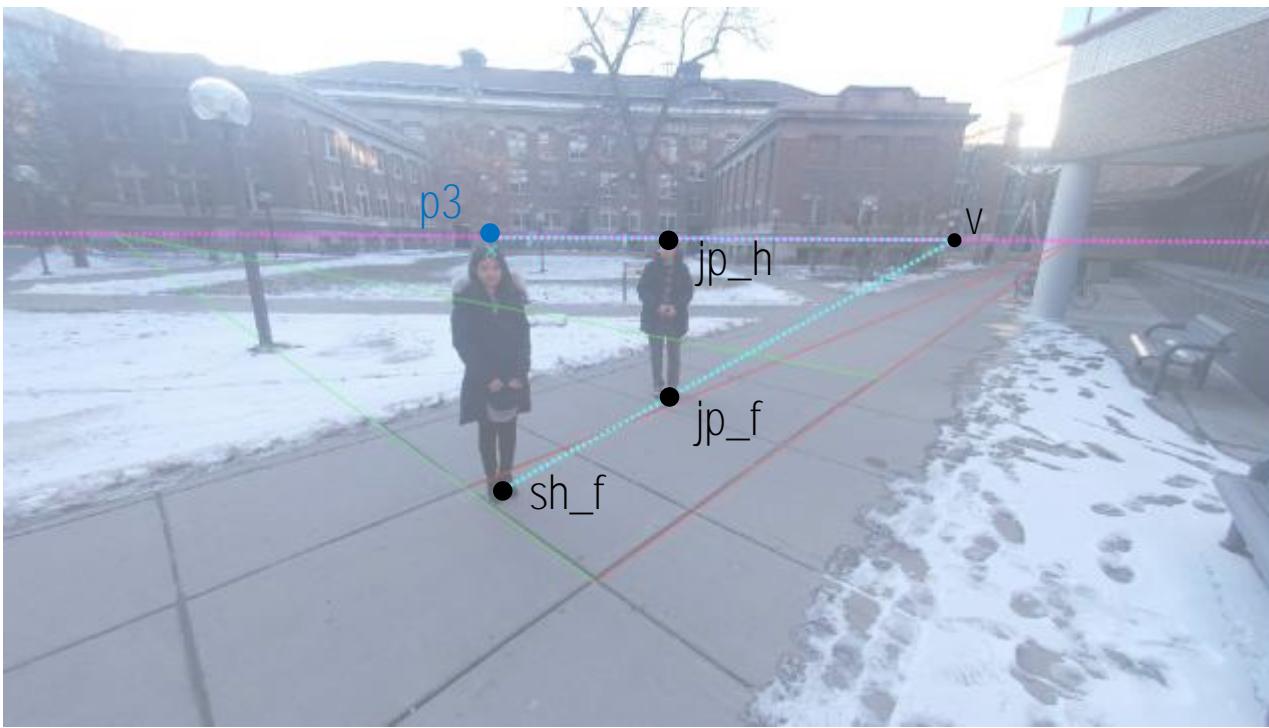
```
l11 = GetLineFromTwoPoints(m1,m2);  
l12 = GetLineFromTwoPoints(m3,m4);  
l21 = GetLineFromTwoPoints(m1,m3);  
l22 = GetLineFromTwoPoints(m2,m4);
```

```
v1 = GetPointFromTwoLines(l11,l12);  
v2 = GetPointFromTwoLines(l21,l22);  
l = GetLineFromTwoPoints(v1,v2);
```

← Vanishing line

```
line_sh_jp_f = GetLineFromTwoPoints(sh_f,jp_f);  
v = GetPointFromTwoLines(line_sh_jp_f, l);
```

```
line_jp_h_v = GetLineFromTwoPoints(jp_head, v);
```



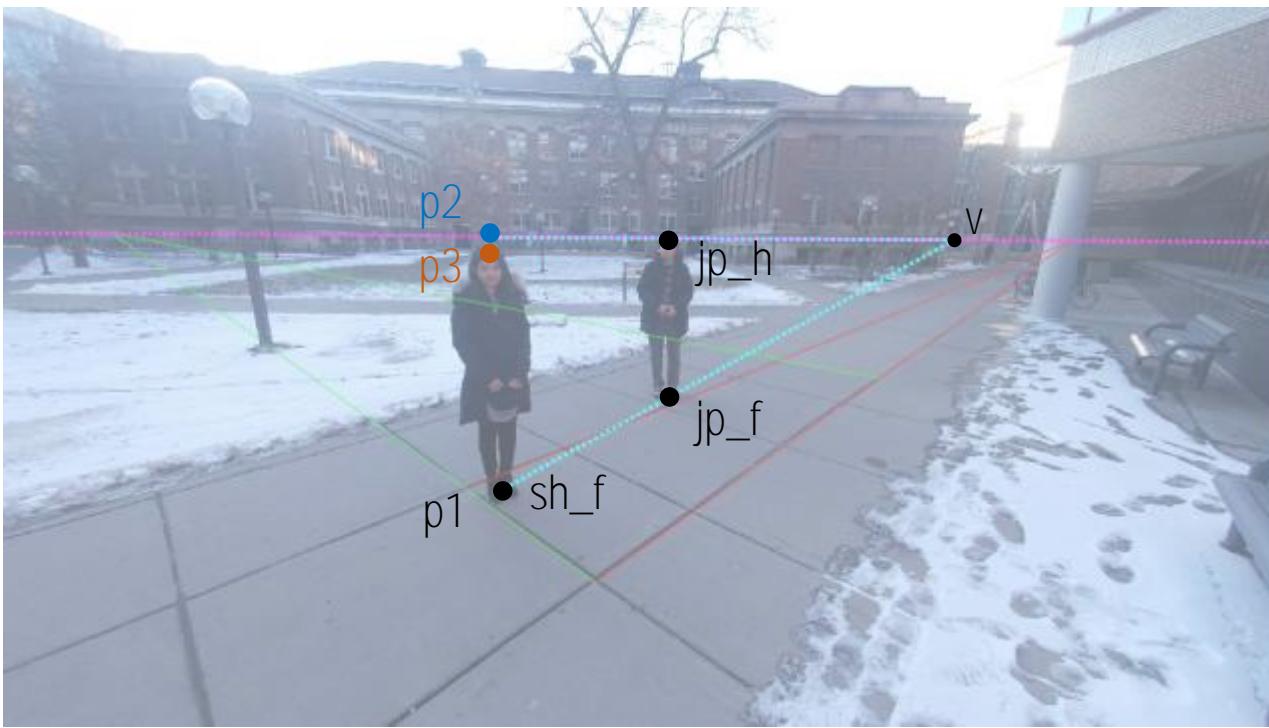
```
sh_f = [1504;1447;1];  
sh_h = [1468;730;1];  
jp_f = [1997;1175;1];  
jp_h = [1997;695;1];
```

```
l11 = GetLineFromTwoPoints(m1,m2);  
l12 = GetLineFromTwoPoints(m3,m4);  
l21 = GetLineFromTwoPoints(m1,m3);  
l22 = GetLineFromTwoPoints(m2,m4);
```

```
v1 = GetPointFromTwoLines(l11,l12);  
v2 = GetPointFromTwoLines(l21,l22);  
l = GetLineFromTwoPoints(v1,v2);
```

← Vanishing line

```
line_sh_jp_f = GetLineFromTwoPoints(sh_f,jp_f);  
v = GetPointFromTwoLines(line_sh_jp_f, l);  
  
line_jp_h_v = GetLineFromTwoPoints(jp_head, v);  
line_sh = GetLineFromTwoPoints(sh_h, sh_f);  
p2 = GetPointFromTwoLines(line_jp_head_v, line_sh);
```



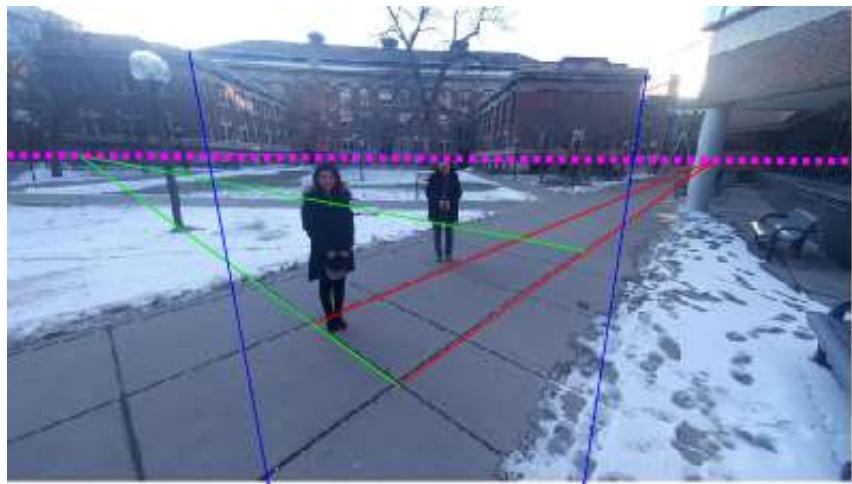
```
sh_f = [1504;1447;1];  
sh_h = [1468;730;1];  
jp_f = [1997;1175;1];  
jp_h = [1997;695;1];
```

```
l11 = GetLineFromTwoPoints(m1,m2);  
l12 = GetLineFromTwoPoints(m3,m4);  
l21 = GetLineFromTwoPoints(m1,m3);  
l22 = GetLineFromTwoPoints(m2,m4);
```

```
v1 = GetPointFromTwoLines(l11,l12);  
v2 = GetPointFromTwoLines(l21,l22);  
l = GetLineFromTwoPoints(v1,v2);
```

← Vanishing line

```
line_sh_jp_f = GetLineFromTwoPoints(sh_f, jp_f);  
v = GetPointFromTwoLines(line_sh_jp_f, l);  
  
line_jp_h_v = GetLineFromTwoPoints(jp_head, v);  
line_sh = GetLineFromTwoPoints(sh_h, sh_f);  
p2 = GetPointFromTwoLines(line_jp_head_v, line_sh);  
p3 = sh_h;  
p1 = sh_f;
```



```
sh_f = [1504;1447;1];  
sh_h = [1468;730;1];  
jp_f = [1997;1175;1];  
jp_h = [1997;695;1];
```

```
|l11 = GetLineFromTwoPoints(m1,m2);  
l12 = GetLineFromTwoPoints(m3,m4);  
l21 = GetLineFromTwoPoints(m1,m3);  
l22 = GetLineFromTwoPoints(m2,m4);
```

```
v1 = GetPointFromTwoLines(l11,l12);  
v2 = GetPointFromTwoLines(l21,l22);  
l = GetLineFromTwoPoints(v1,v2);
```

← Vanishing line

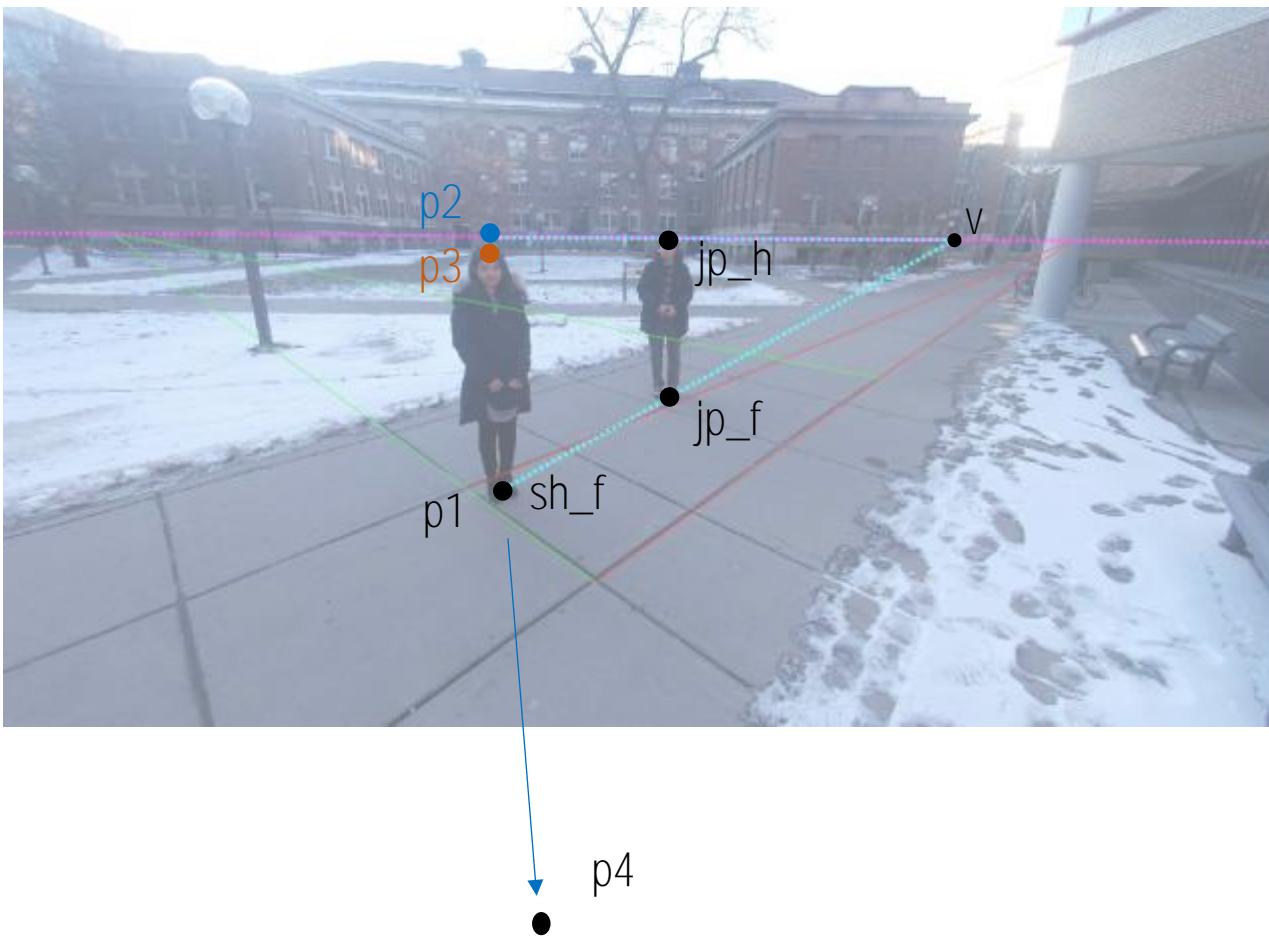
```
line_sh_jp_f = GetLineFromTwoPoints(sh_f,jp_f);  
v = GetPointFromTwoLines(line_sh_jp_f, l);
```

```
line_jp_h_v = GetLineFromTwoPoints(jp_head, v);  
line_sh = GetLineFromTwoPoints(sh_h, sh_f);  
p3 = GetPointFromTwoLines(line_jp_head_v, line_sh);  
p2 = sh_h;  
p1 = sh_f;
```

```
|l31 = GetLineFromTwoPoints(m5,m6);  
l32 = GetLineFromTwoPoints(m7,m8)  
v3 = GetPointFromTwoLines(l31,l32);  
p4 = v3;
```

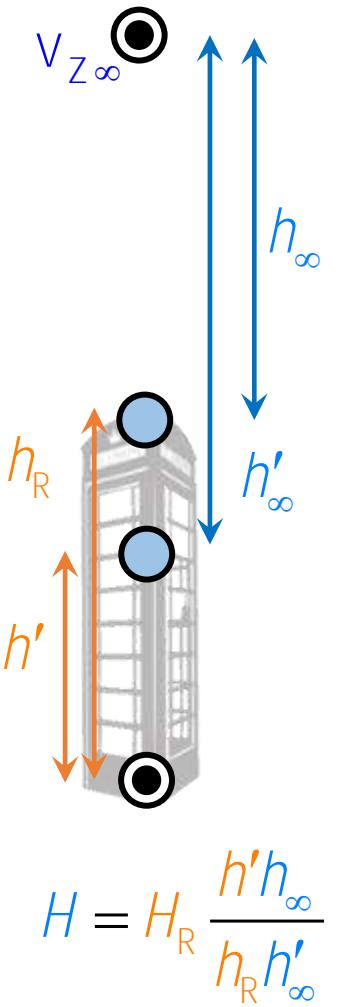
ComputeHeightFromCrossRatio.m

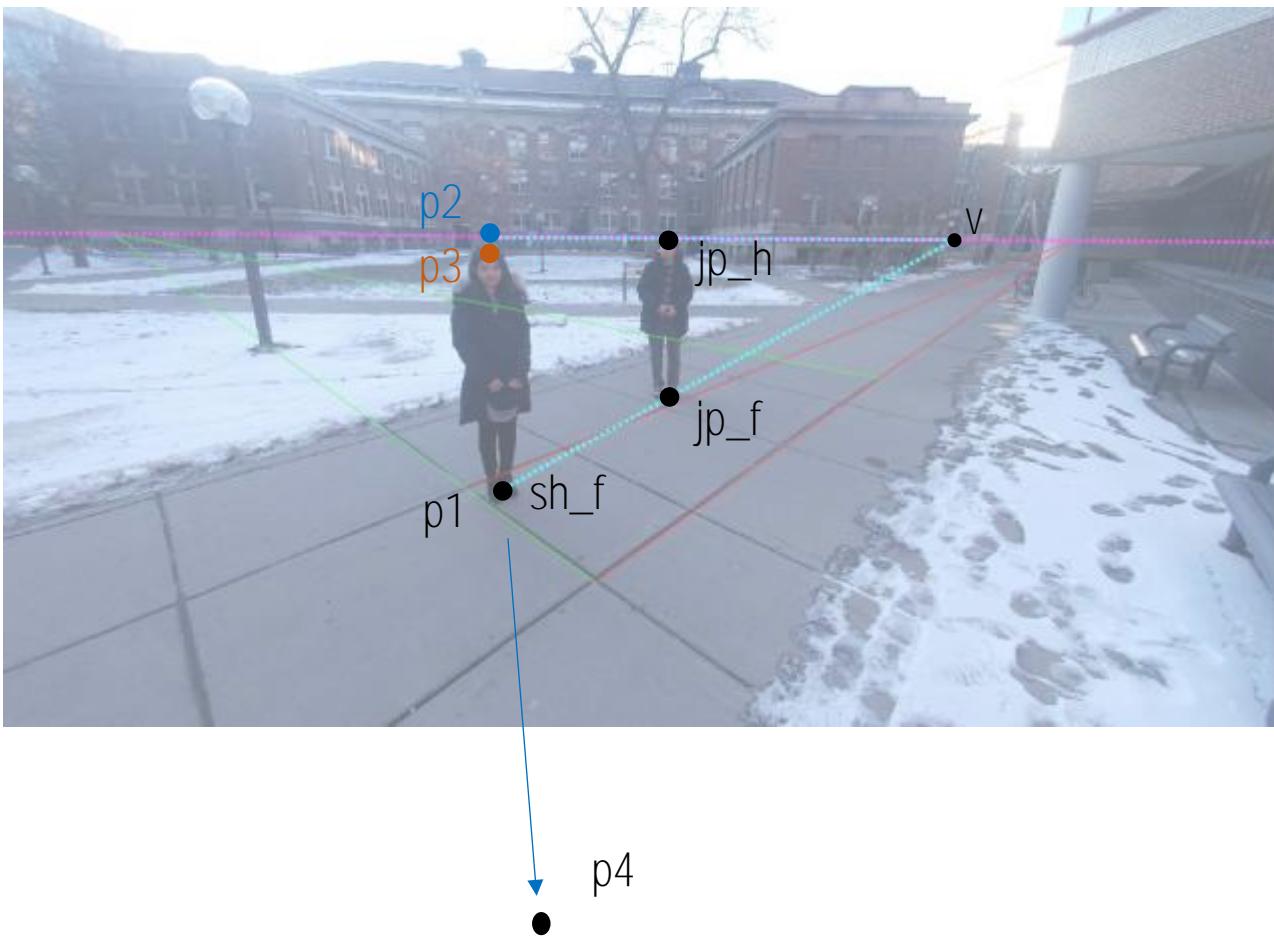
p4



```
h_prime = norm(p1-p2);  
h_R = norm(p1-p3);  
h_prime_inf = norm(p4-p2);  
h_inf = norm(p4-p3);
```

ComputeHeightFromCrossRatio.m





```

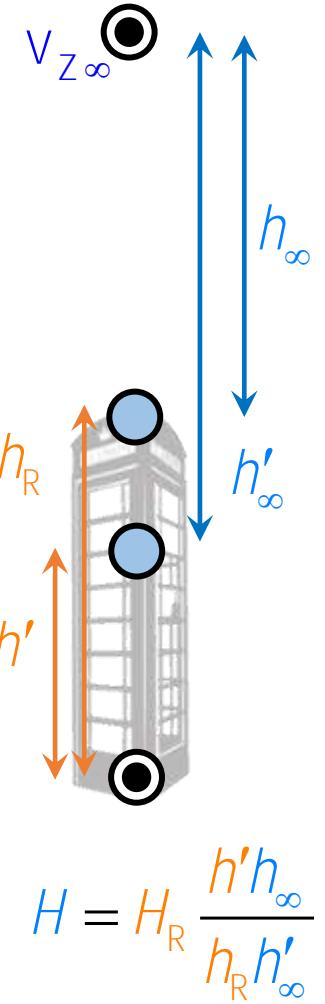
h_prime = norm(p1-p2);
h_R = norm(p1-p3);
h_prime_inf = norm(p4-p2);
h_inf = norm(p4-p3);

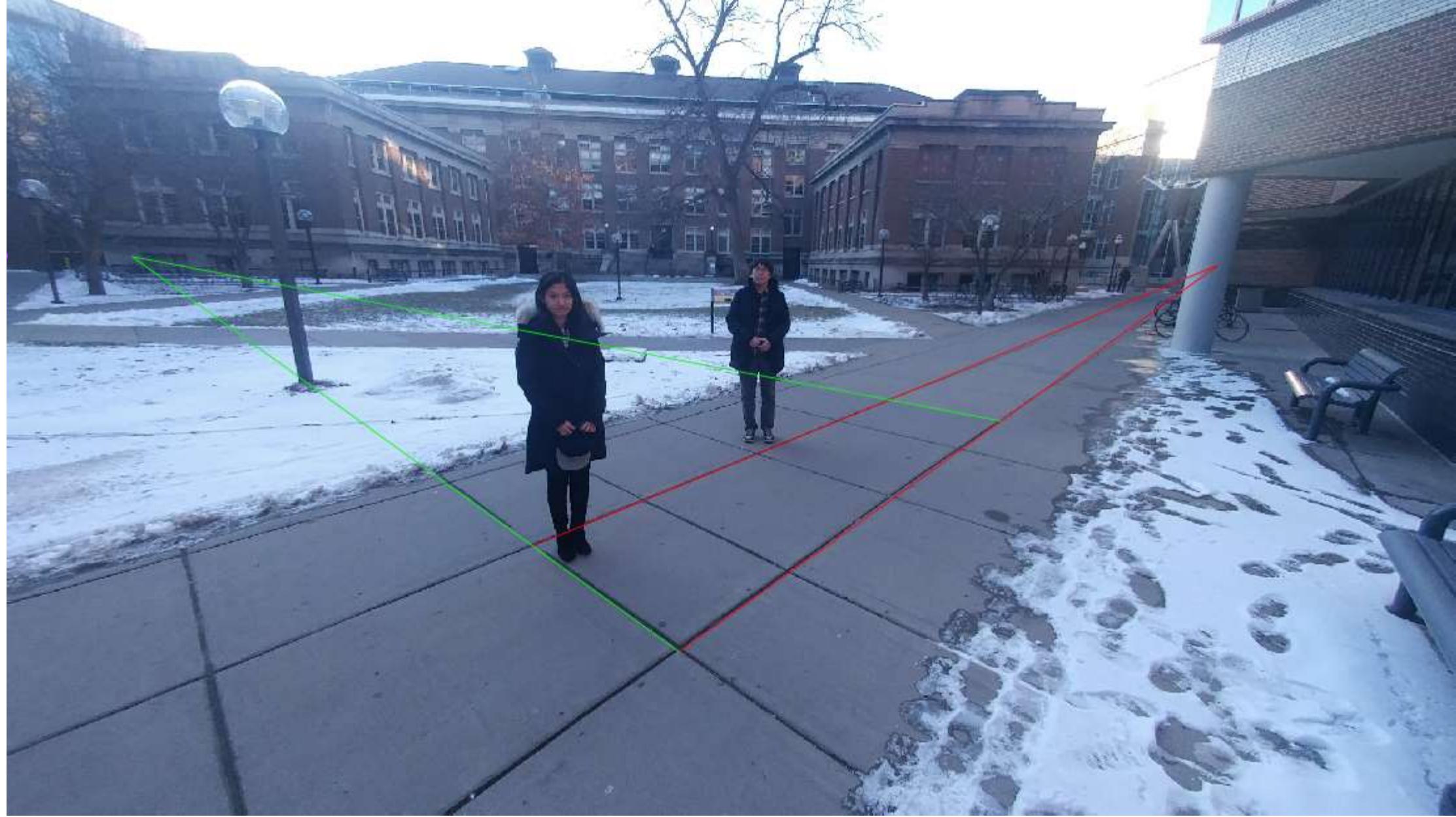
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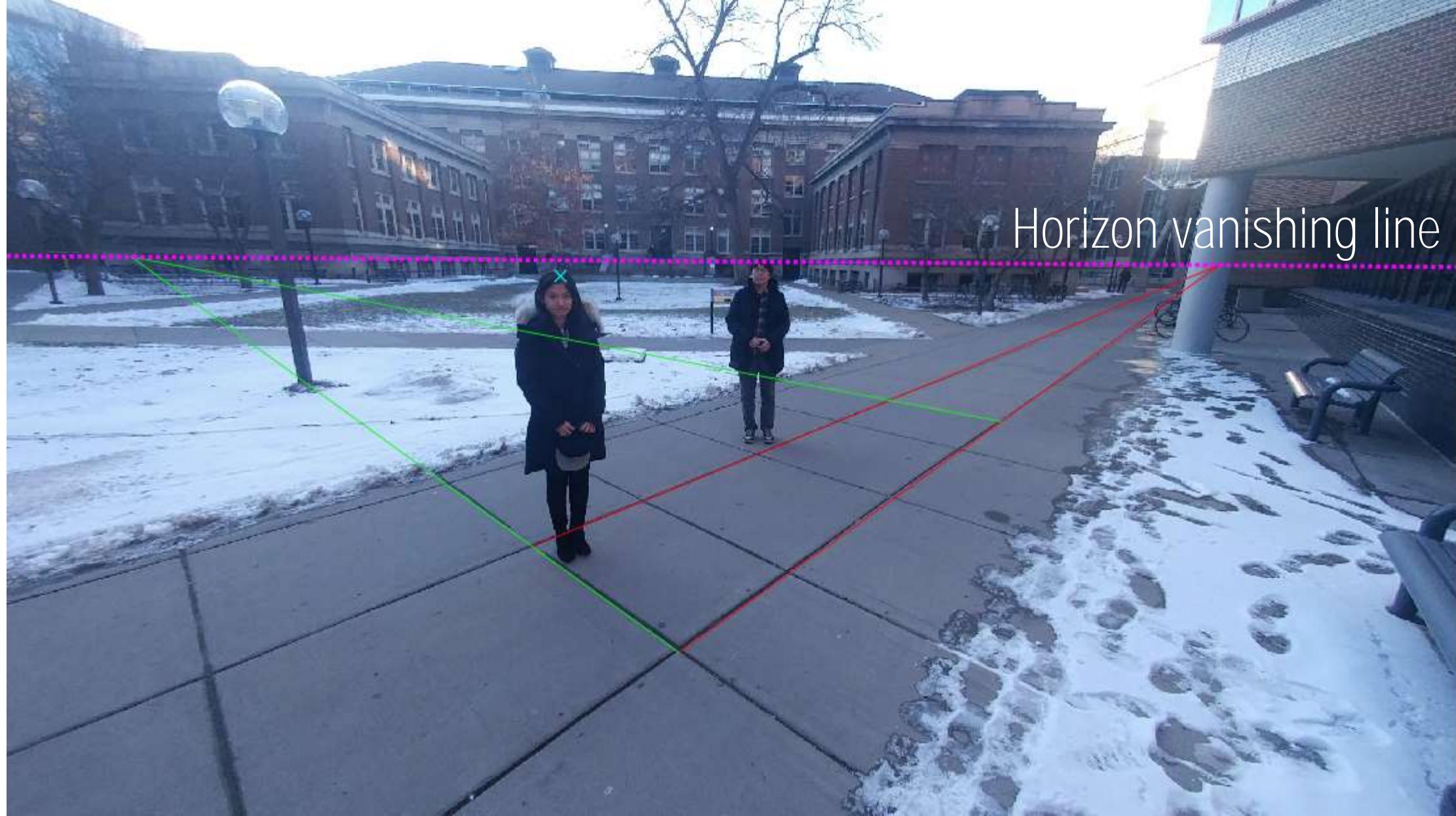
$$H = H_R * h_{\text{prime}} * h_{\text{prime_inf}} / h_R / h_{\text{inf}}$$

$H =$
1.6779 Ground truth: 1.7m

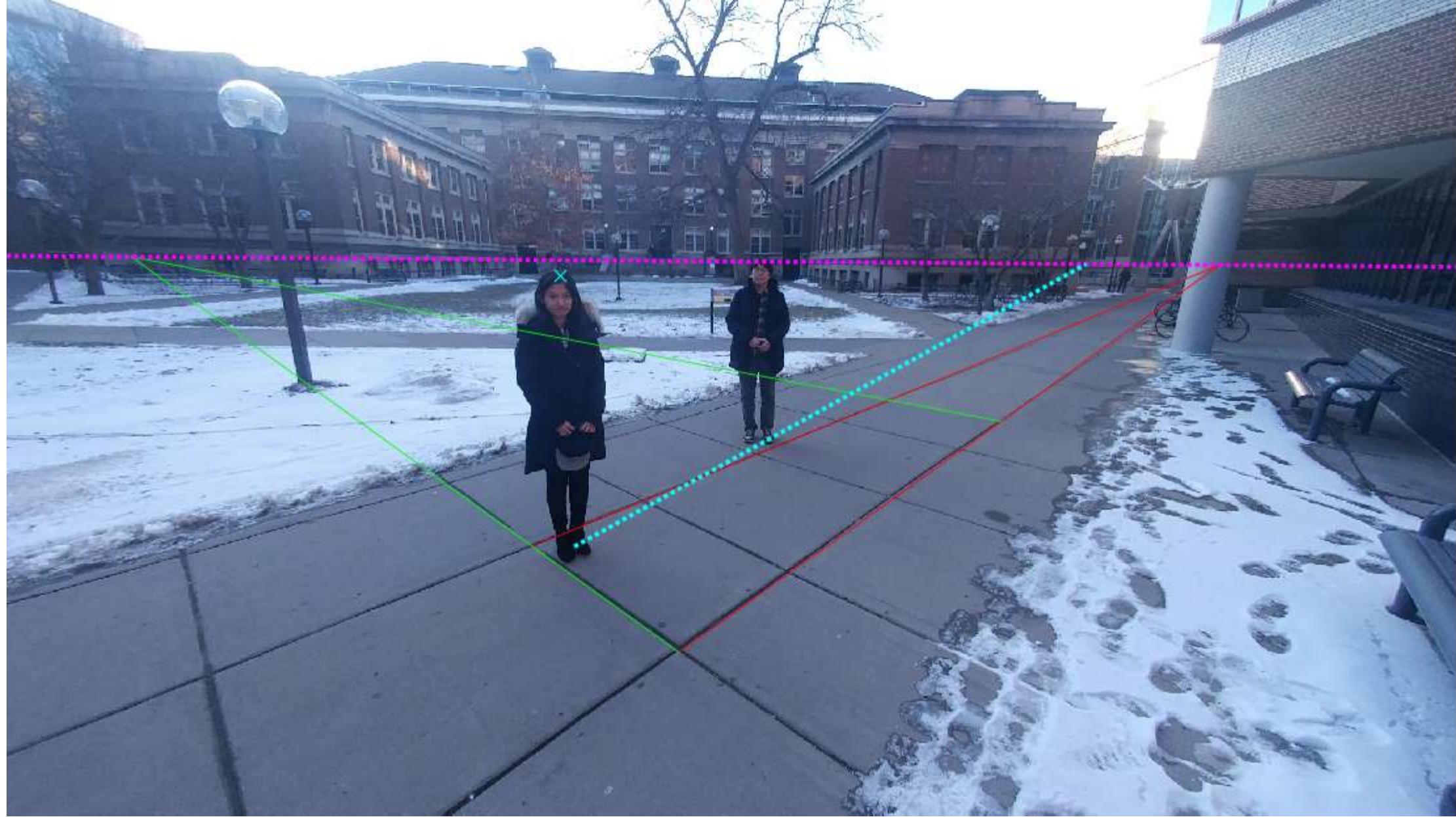
ComputeHeightFromCrossRatio.m

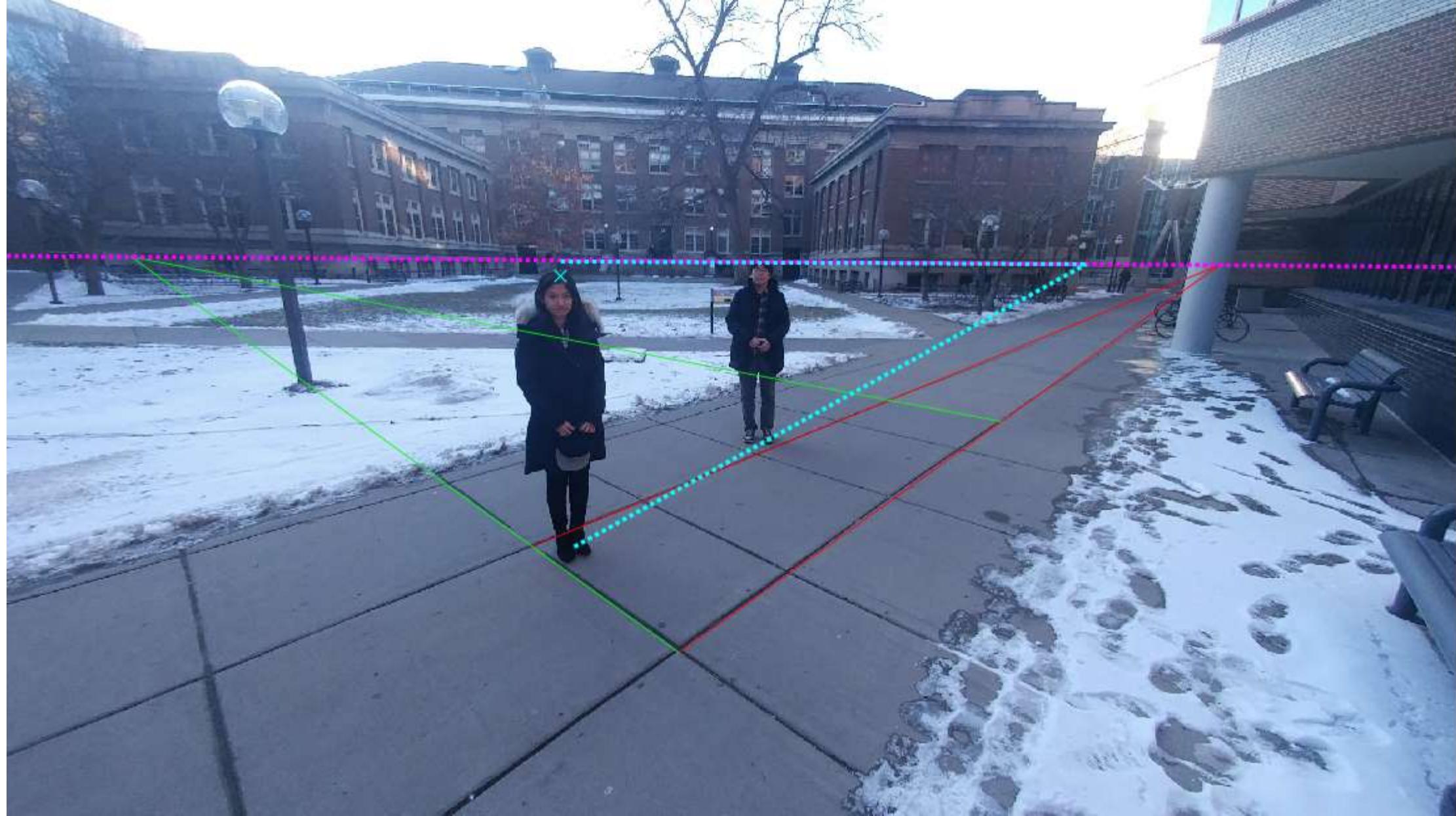




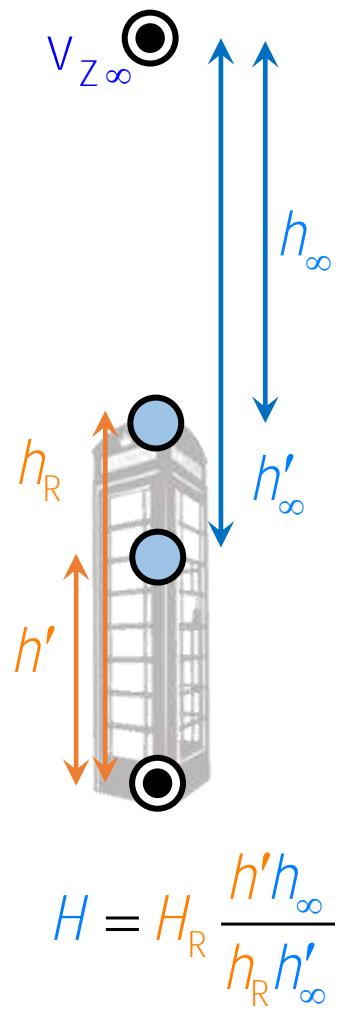


Horizon vanishing line

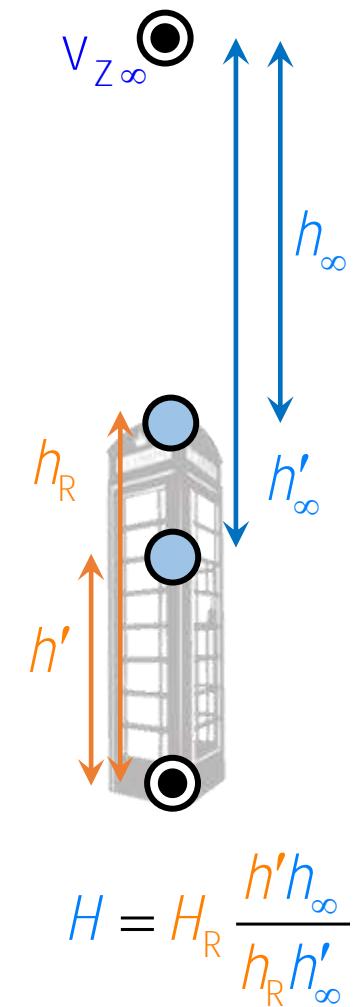




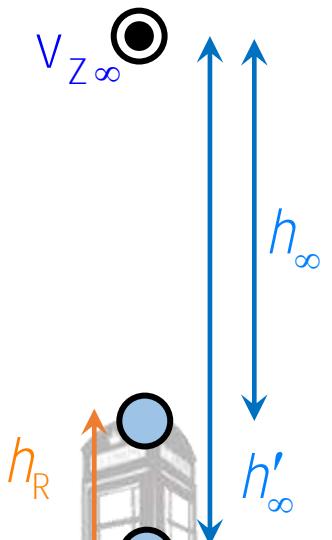
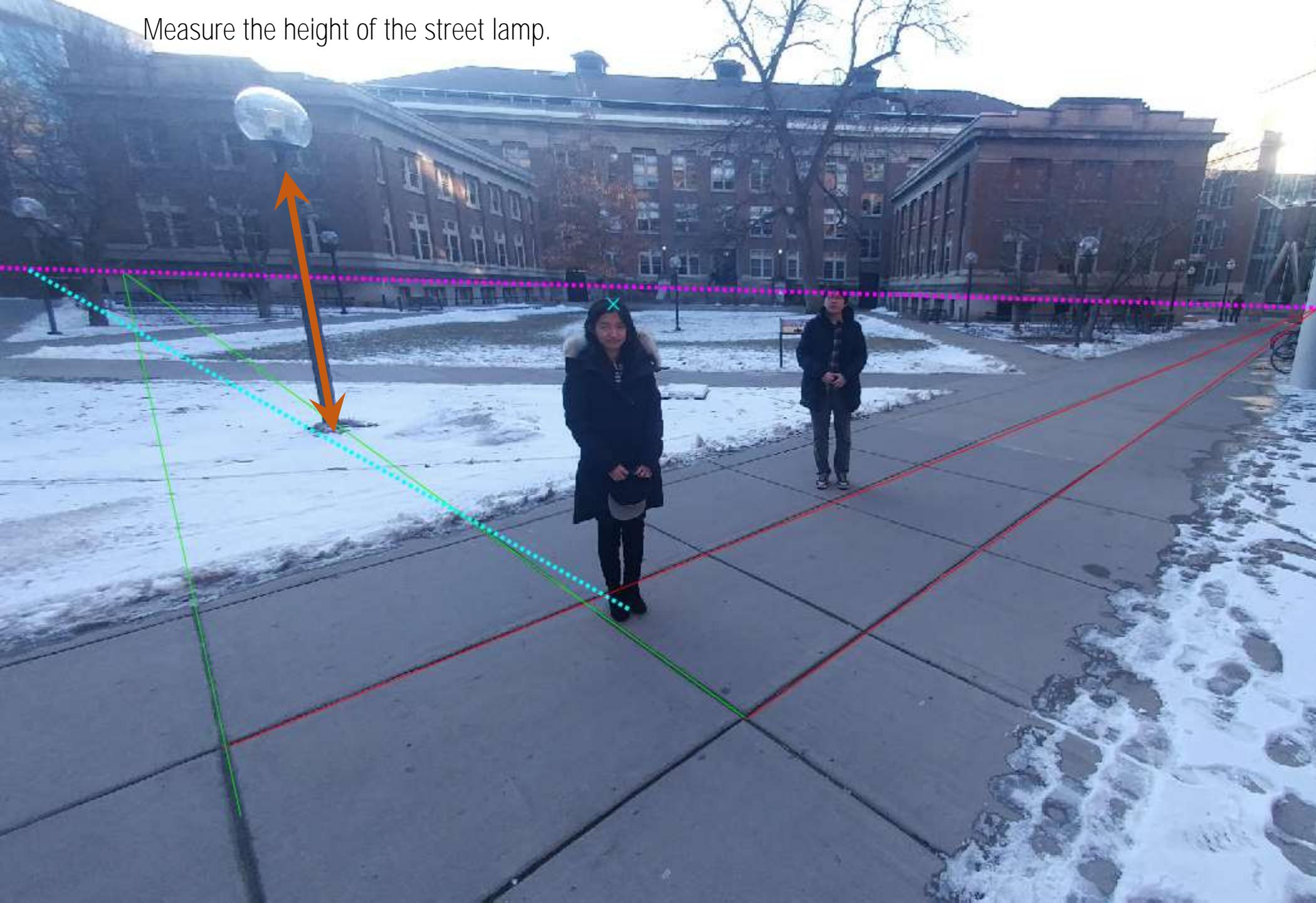




Measure the height of the street lamp.

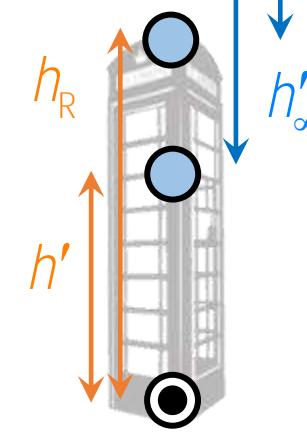
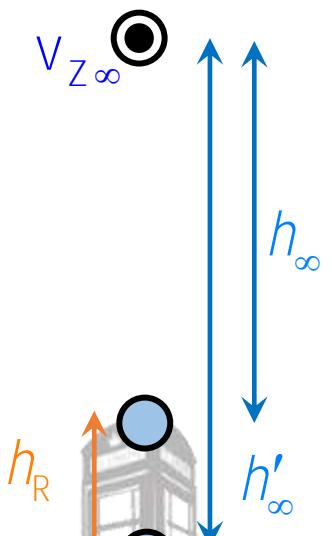
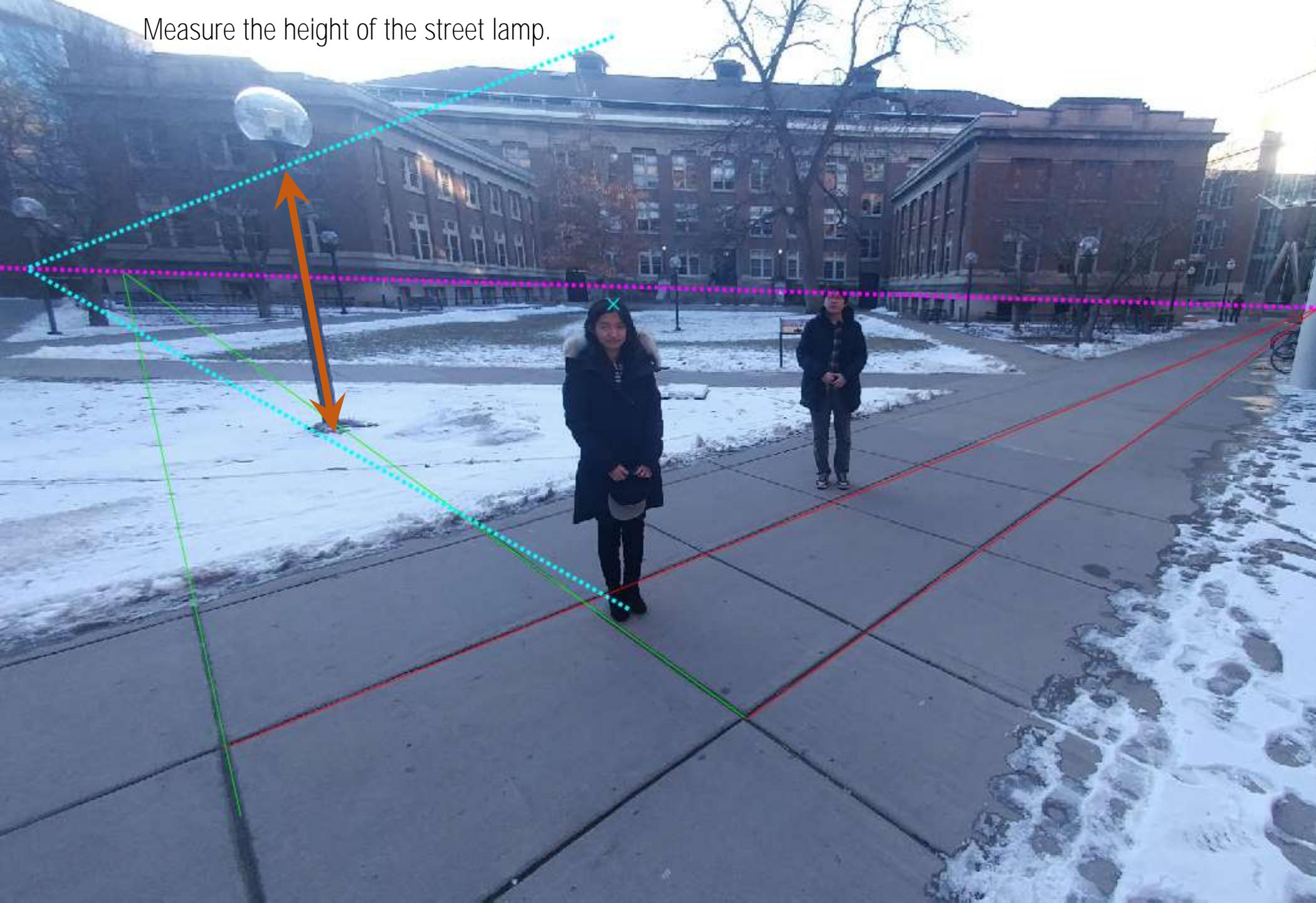


Measure the height of the street lamp.



$$H = H_R \frac{h' h_\infty}{h_R h'_\infty}$$

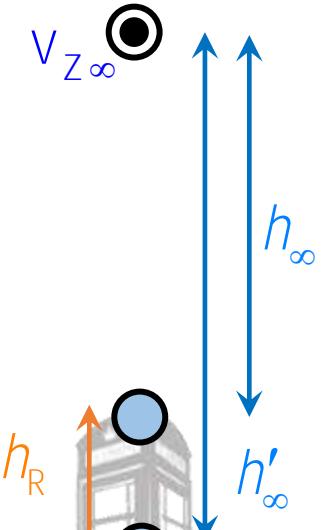
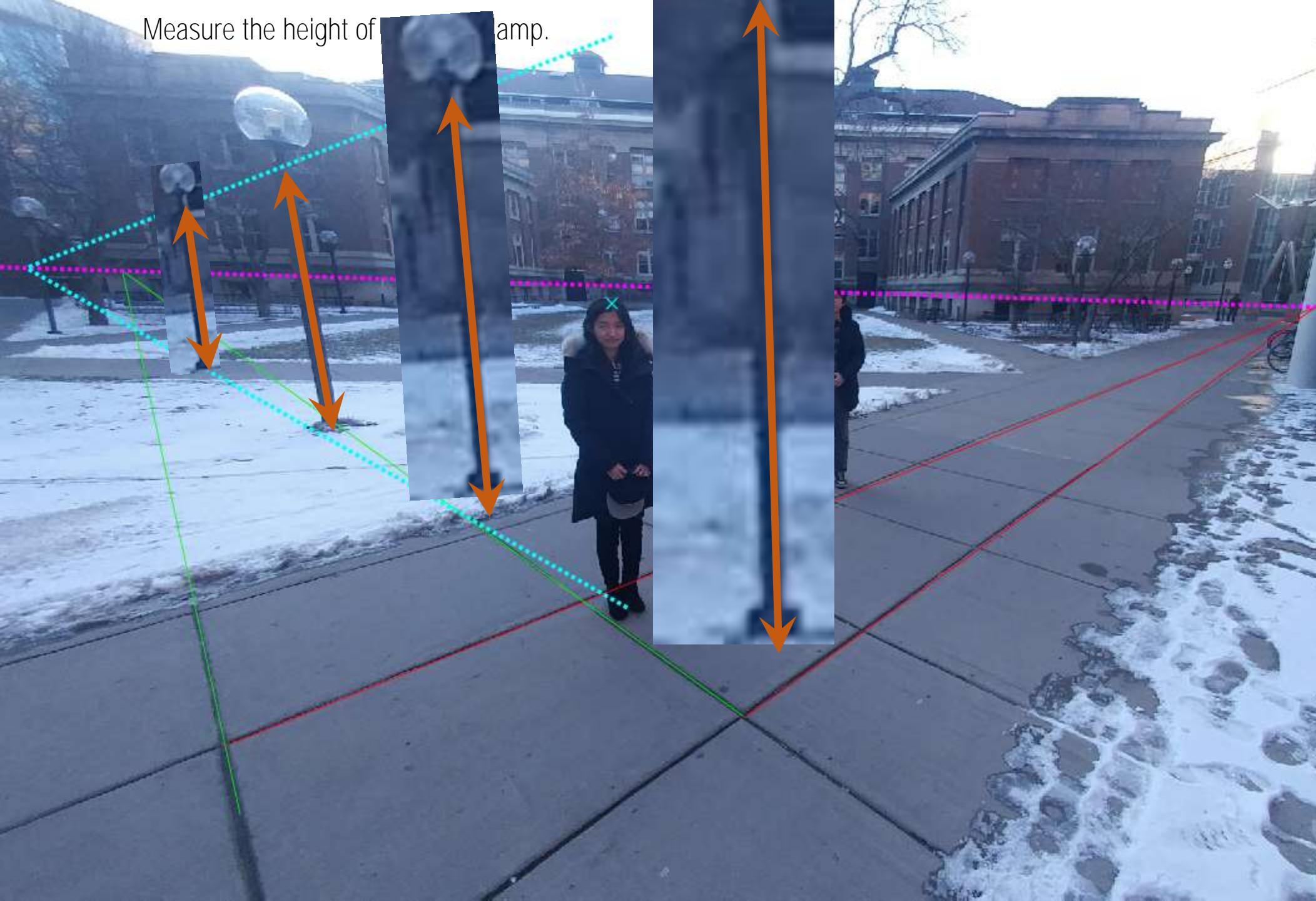
Measure the height of the street lamp.



$$H = H_R \frac{h' h_\infty}{h_R h'_\infty}$$

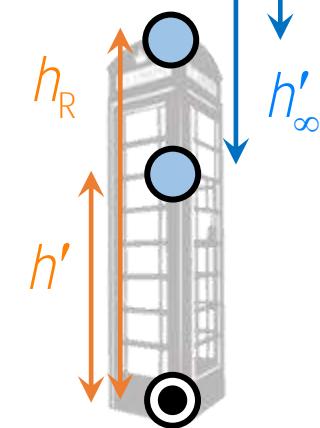
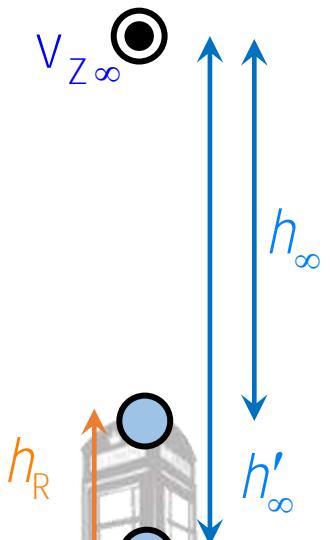
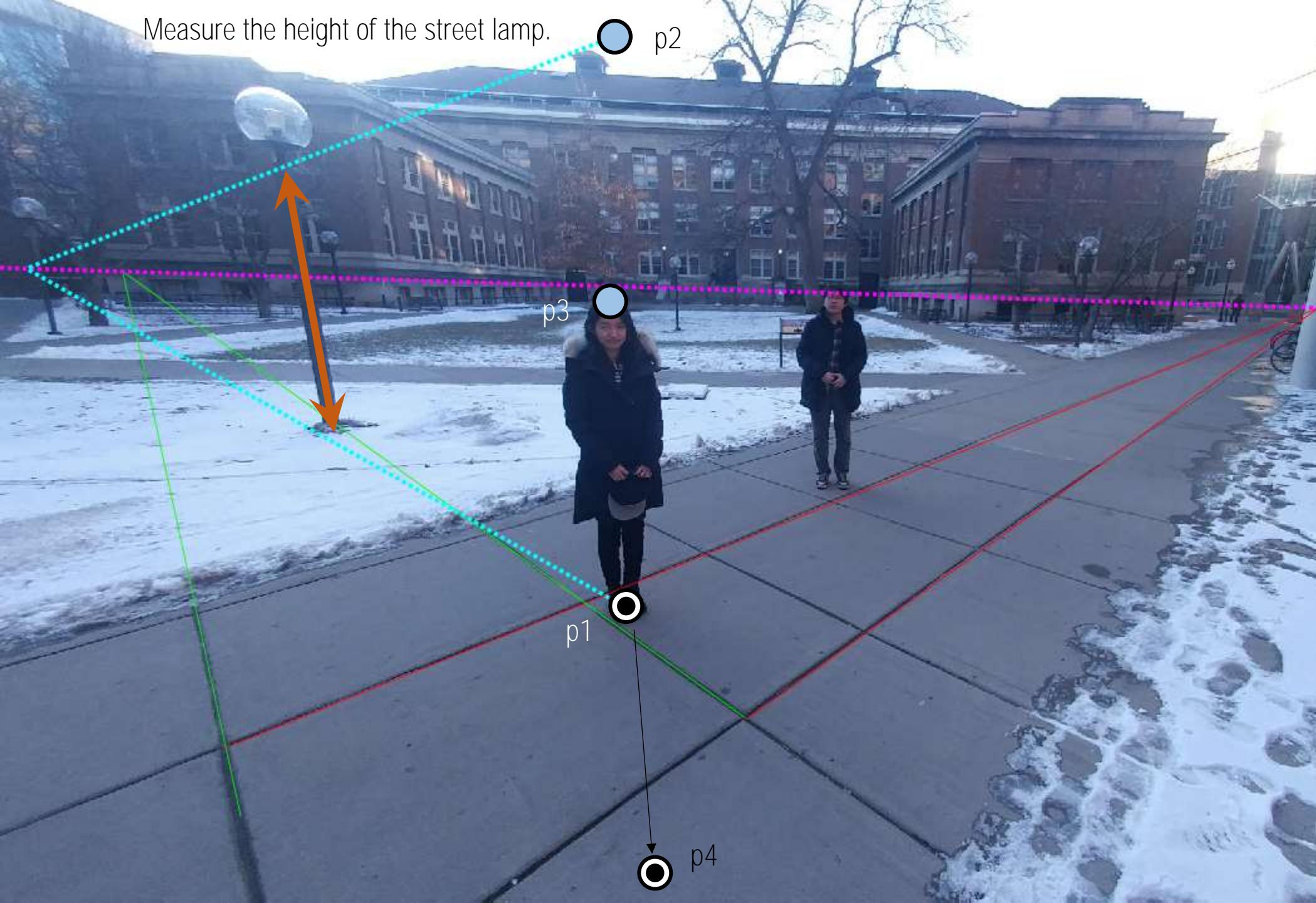
Measure the height of

amp.



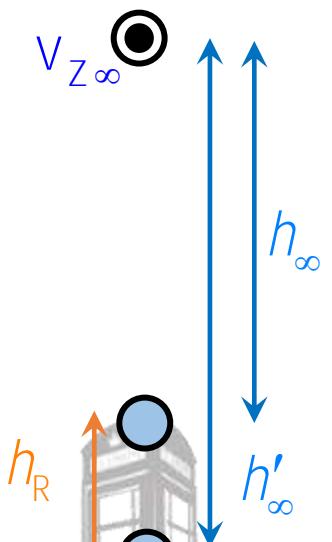
$$H = H_R \frac{h_\infty}{h'_\infty}$$

Measure the height of the street lamp.



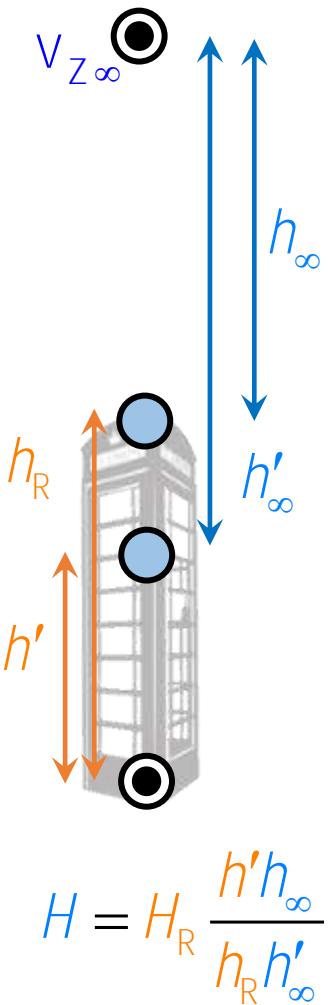
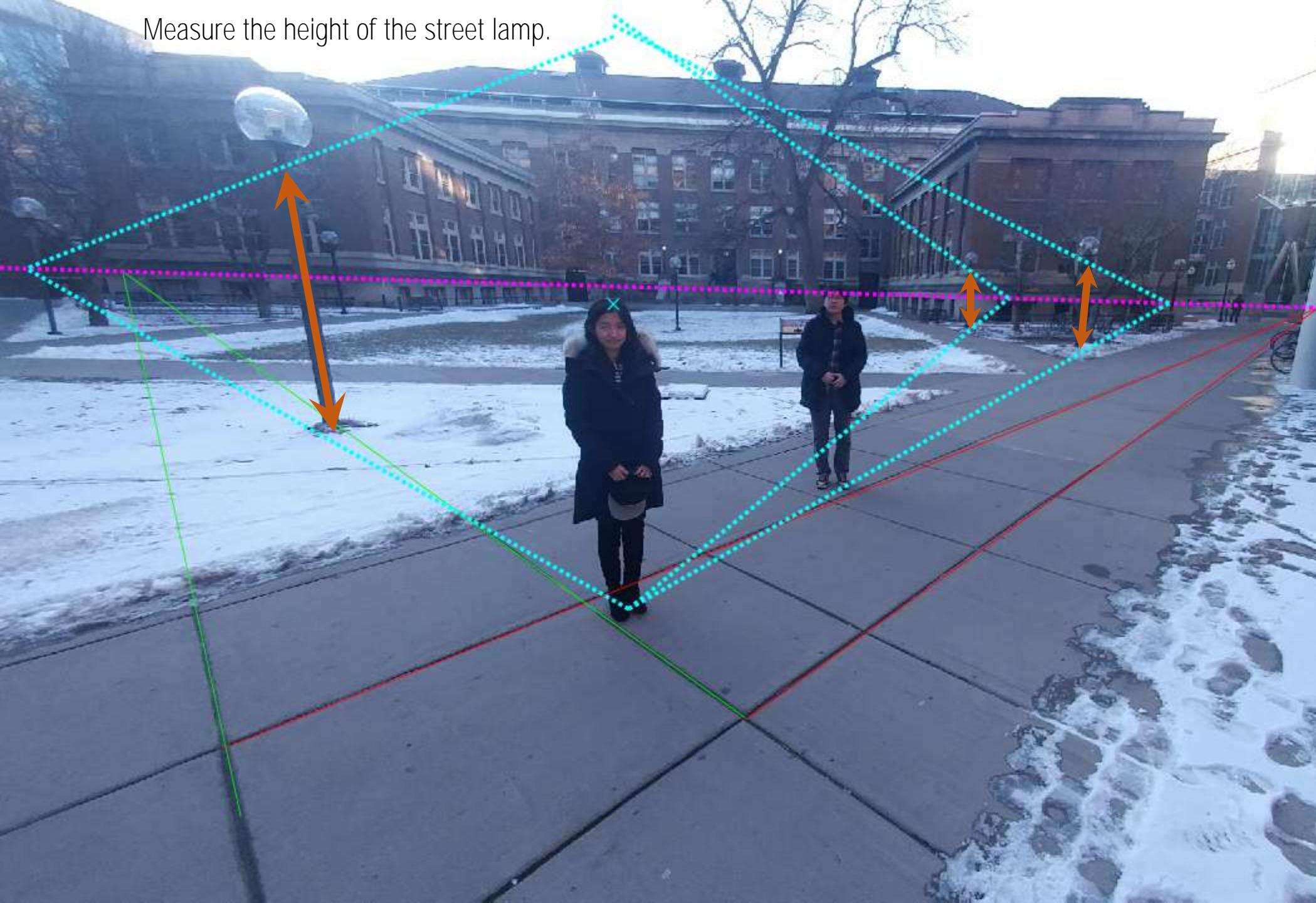
$$H = H_R \frac{h' h_\infty}{h_R h'_\infty}$$

Measure the height of the street lamp.



$$H = H_R \frac{h' h_\infty}{h_R h'_\infty}$$

Measure the height of the street lamp.



$$H = H_R \frac{h' h_\infty}{h_R h'_\infty}$$

Measure the height of the street lamp.

$H = 2.8108m$

