Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [Radiometric and Geometric Consideration for image sensor receiver]

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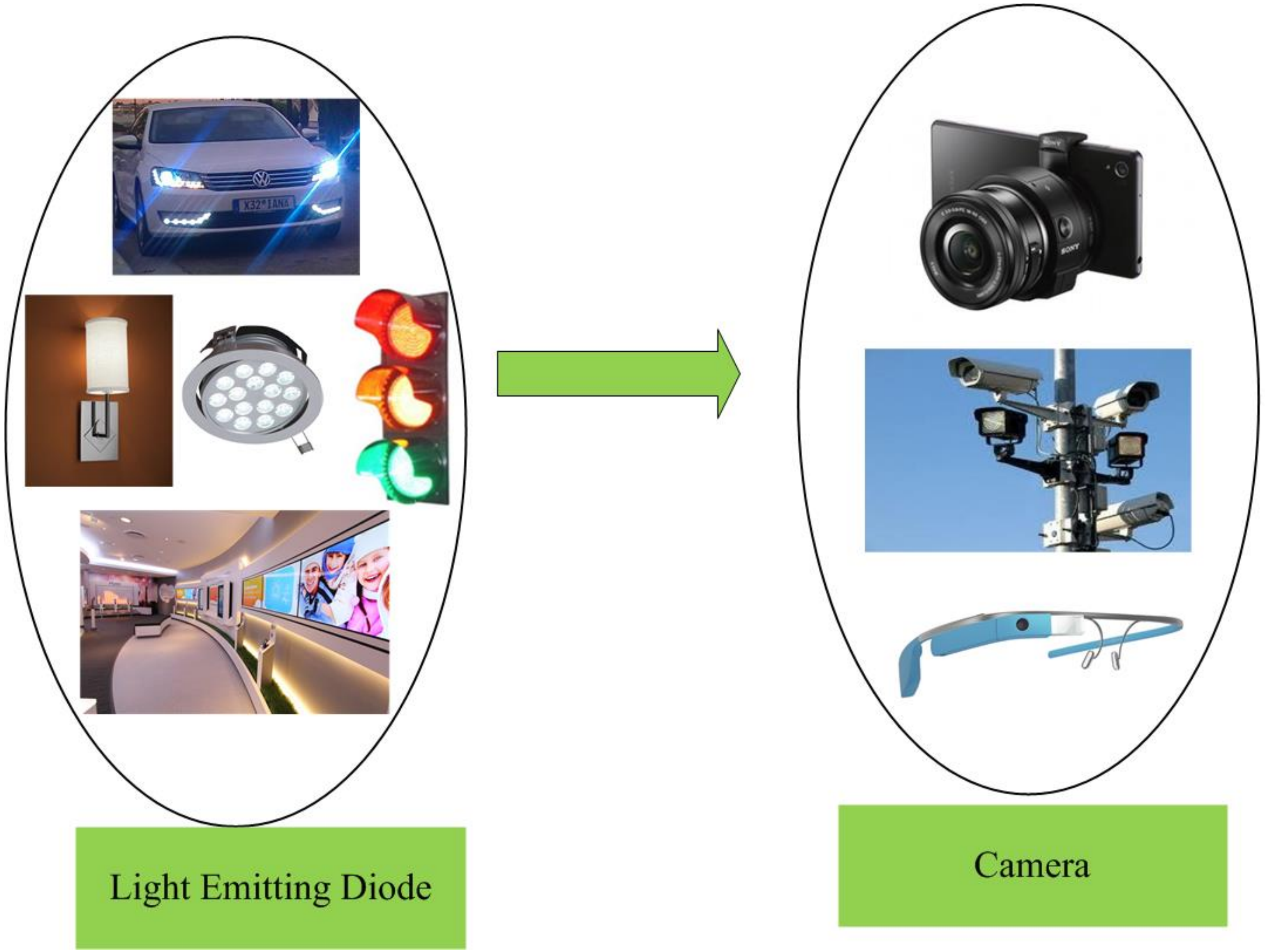
Re: []

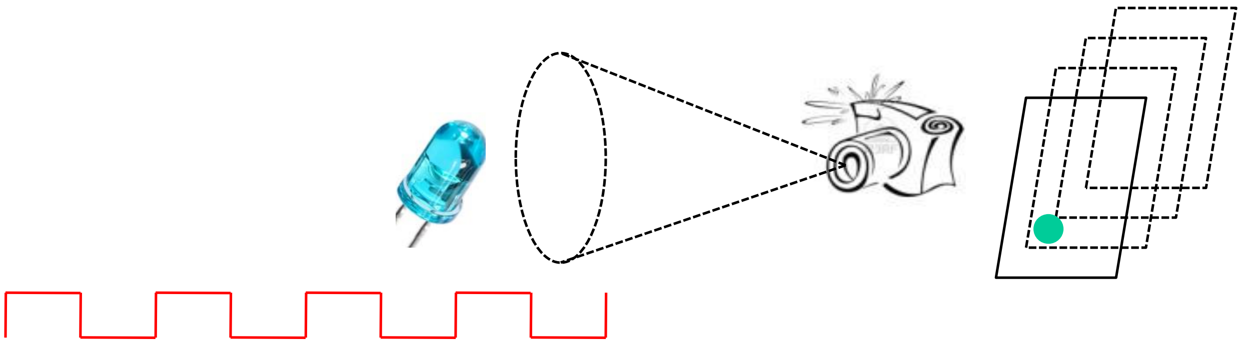
Abstract: [This document present radiometric and geometric consideration for image sensor receiver]

Purpose: [Contribution to IEEE 802.15.SG7r1]

Optical Camera Communications



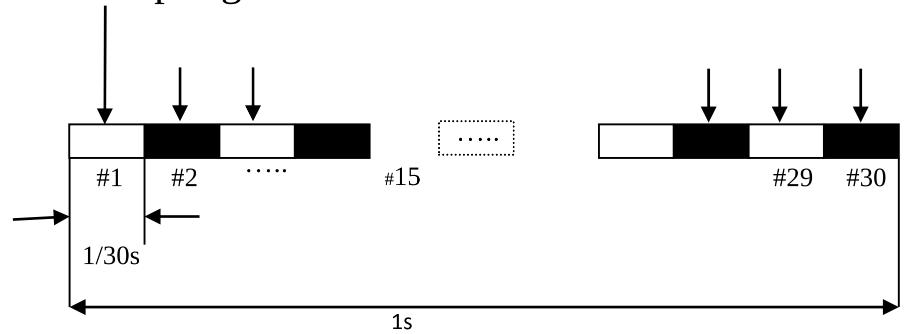
Optical Camera Communications



Frame rate only 30 frames/sec

Data is send at the rate than 100 hz to avoid flickering

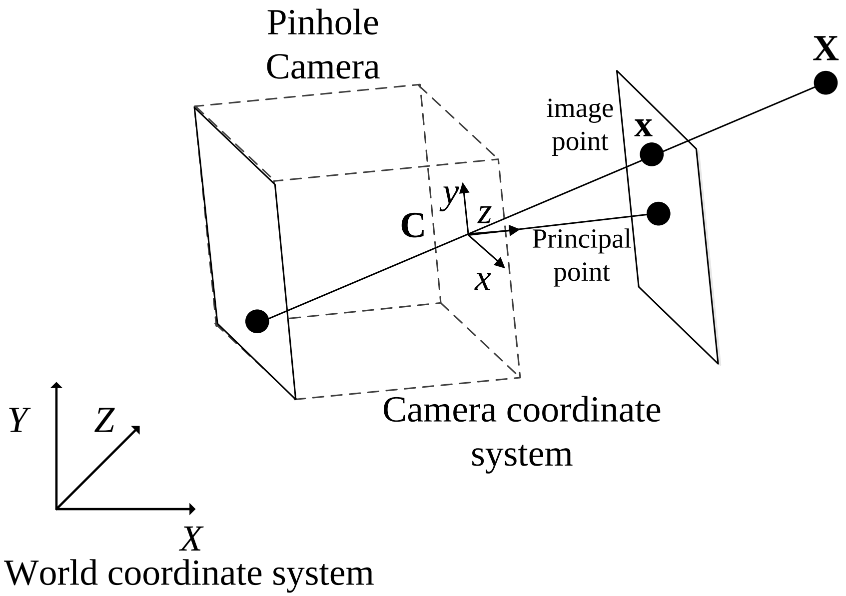
Frame sampling



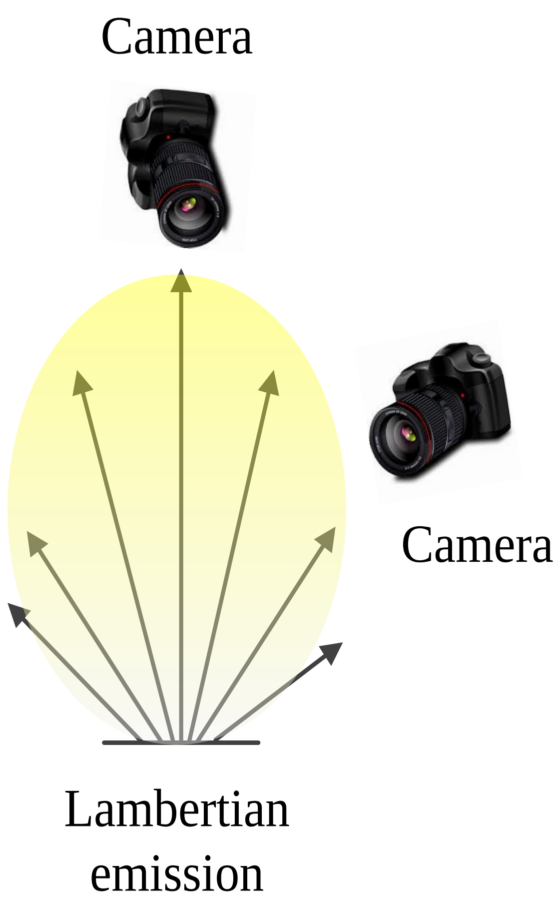
Camera Geometry (pin hole camera model)

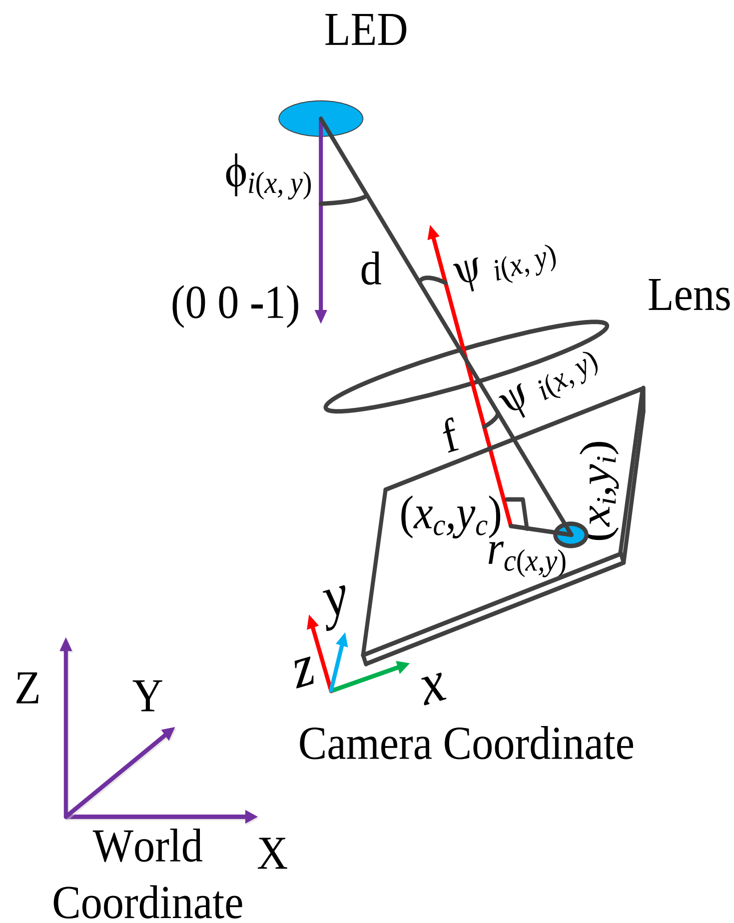
$$\mathbf{x} = KR[I \,|\, -\mathbf{C}]\,\mathbf{X}$$

- **C** is the camera position in world coordinate system
- **X** is any point in world coordinate system
- **x** is image point of **X**
- *R* is rotation matrix between world coordinate and camera coordinate



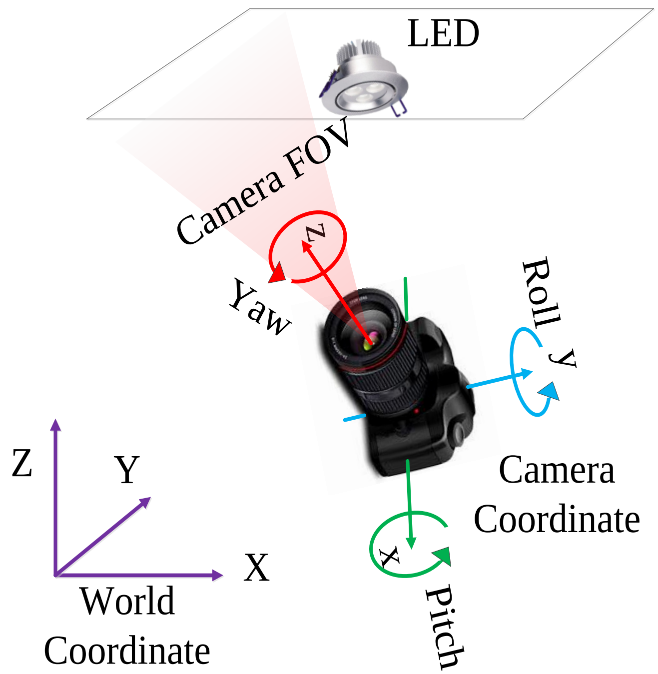
Camera Radiometry (Lambertian model)



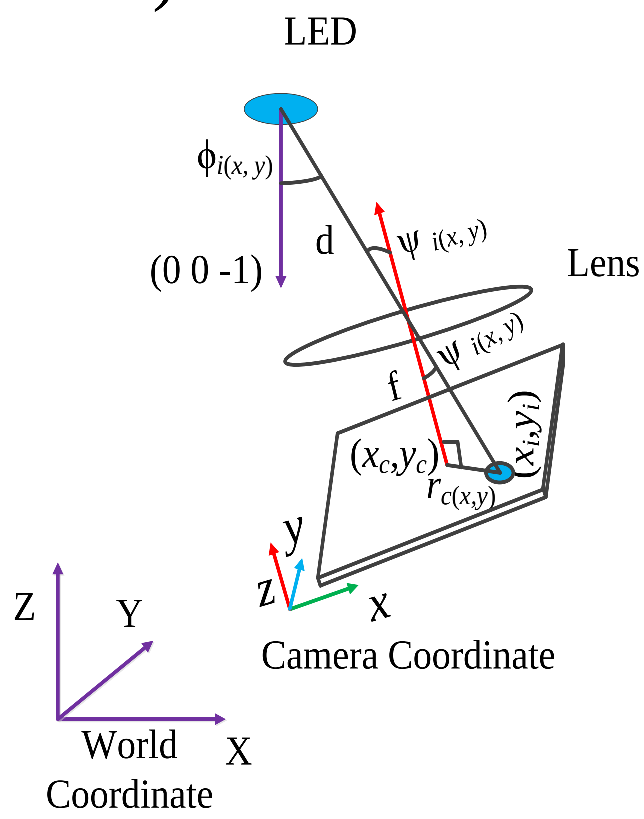


- ❑ It determines the object image intensity in an imaging plane

Camera Radiometry and Geometry (Combine approach)

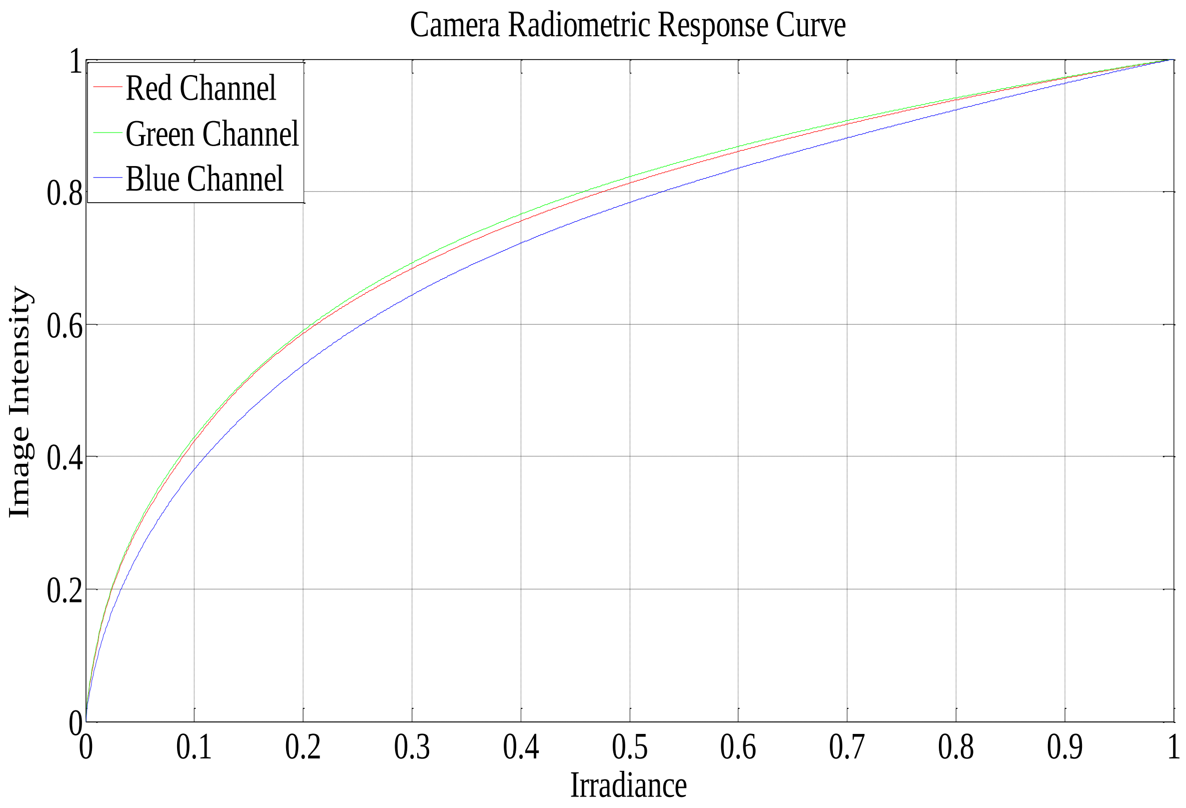


(a)



(b)

Camera Radiometric Response (Irradiance to image intensity)

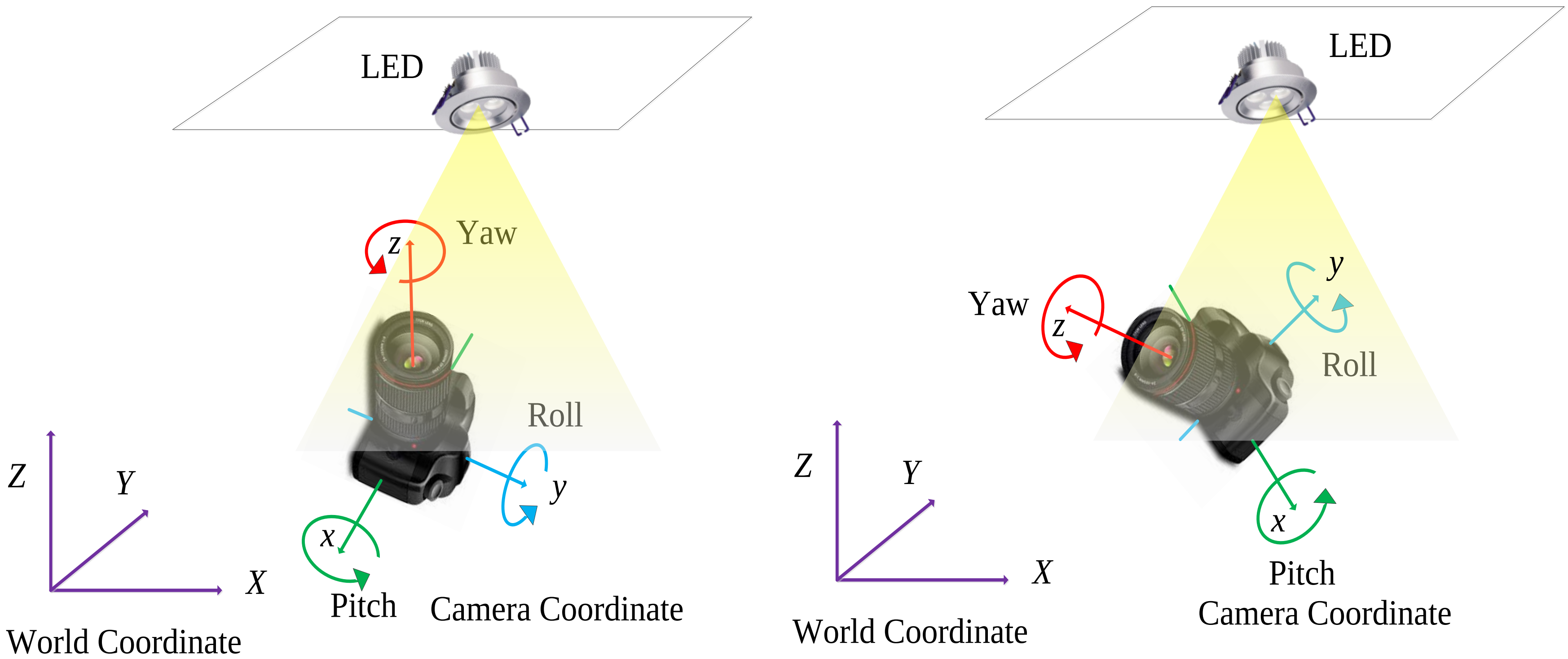


- Image sensor nonlinearly response to irradiance and generate image intensity values or pixel values

Simulation Parameters

Parameters	Value
LED position (Center of the circular LED)	[1700 1900 3500]
LED diameter	170 mm
Half Power emission, ϕ	70 deg
Transmit power, P_t	1500 mw
Focal length	1.4 or 3 mm
Image size	3250×2450
Camera Principal point (x_c, y_c)	[1625 1225]
Skew	0
Pixel edge length, s	7.1e-3 mm

Effect of camera rotation (Out of Focus issue)



(a) (b)

Effect of camera rotation (Out of Focus issue)

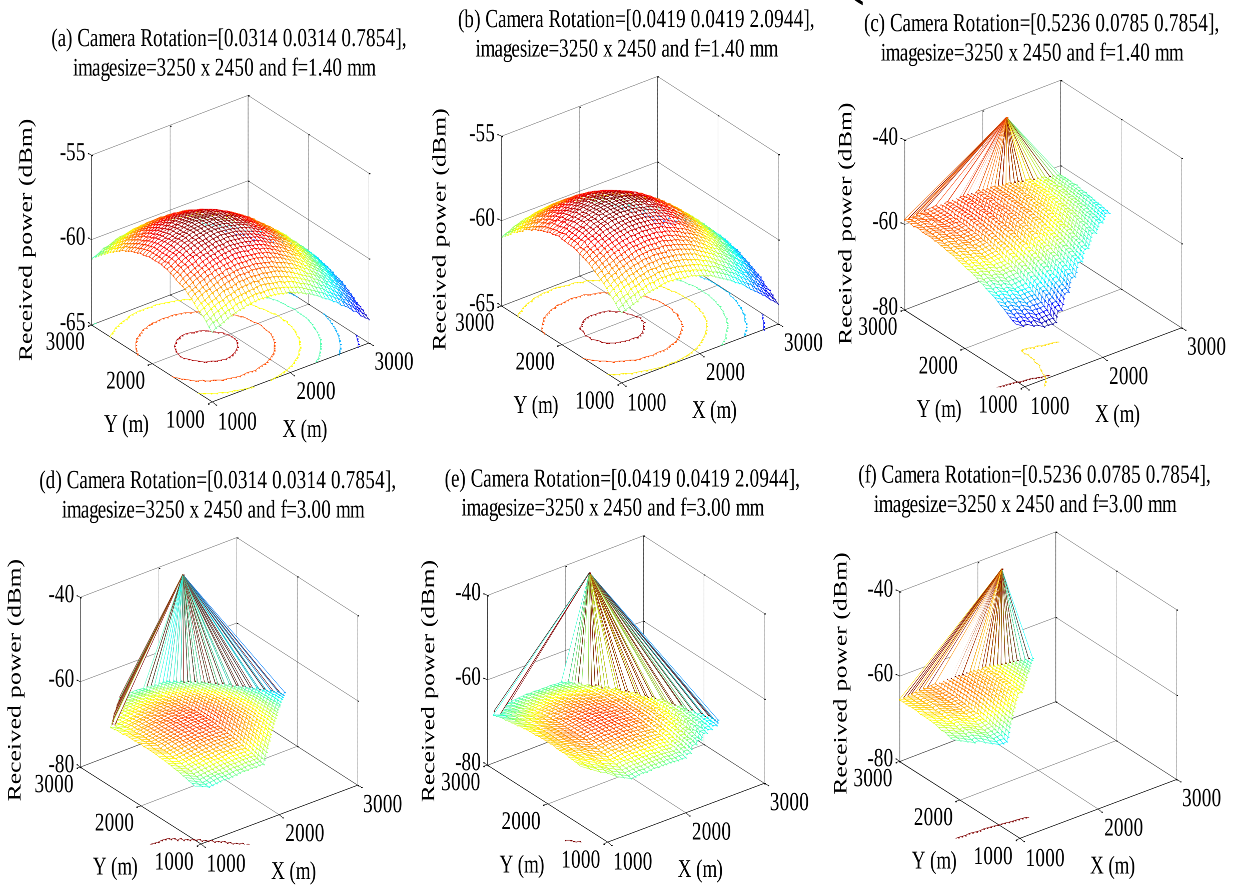


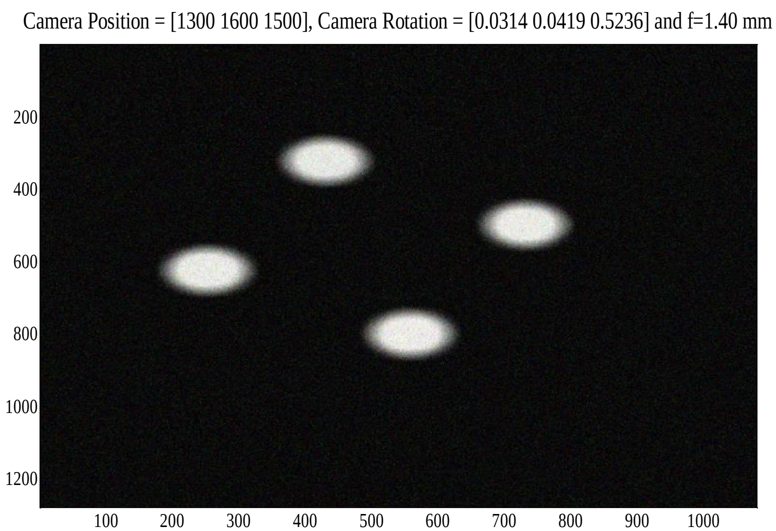
Fig 3. Receive power across the room (4 m2) for different rotation and focal length of a camera, where receiving plane height Z = 1500 mm.

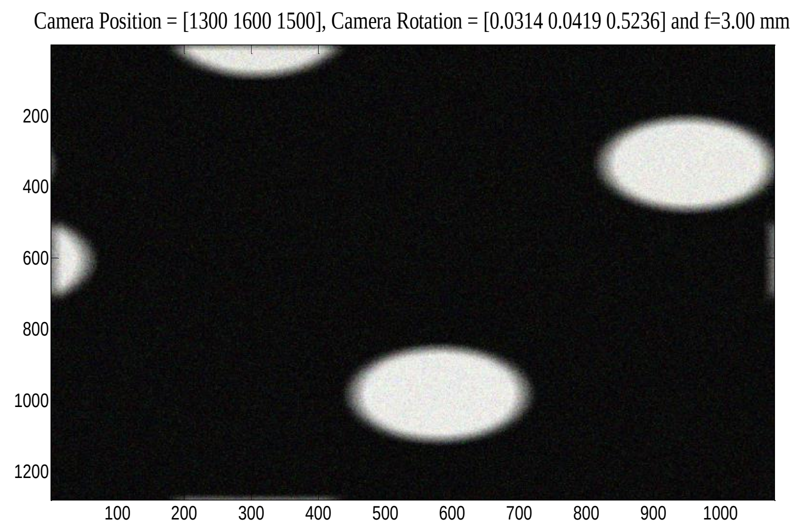
- ❑Indoor automated guided vehicle – need to preprogrammed in order to ensure received signal
- ❑Camera geometry is needed to ensure that

Simulation Parameters

Parameters	Value
LED position (Center of the circular LED)	[1200 1400 3500] (LED 1) [1700 1400 3500] (LED 2) [1700 1900 3500] (LED 3) [1200 1900 3500] (LED 4)
LED diameter	170 mm
Half Power emission, ϕ	70 deg
Transmit power, P_t	1500 mw
Focal length	1.4 and 3 mm
Image size	1280×1080
Camera Principal point (x_c, y_c)	[640 540]
Skew	0
Pixel edge length, s	7.1e-3 mm

Simulation Results

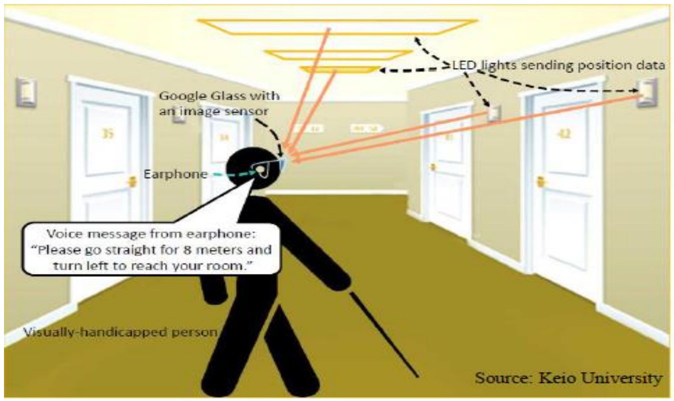


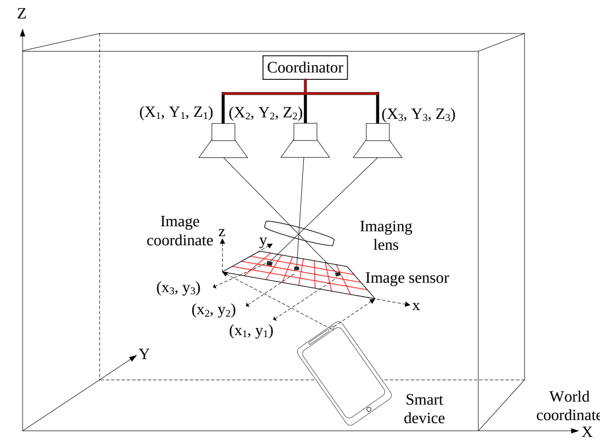


- ❑ Radiometric response curve has been used to transform LED irradiance on imaging plane into LED image intensity

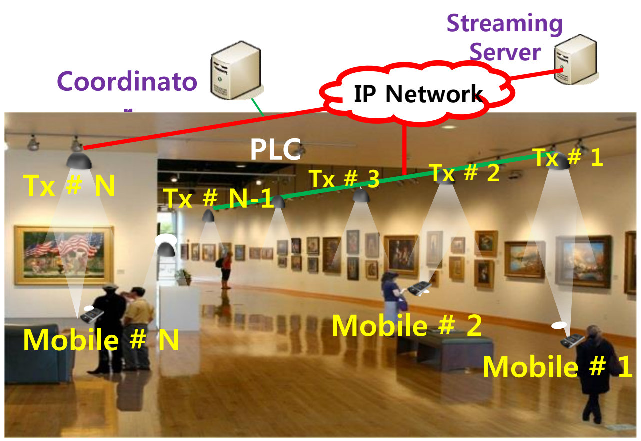
OCC Applications

Indoor Positioning and Location Based Services

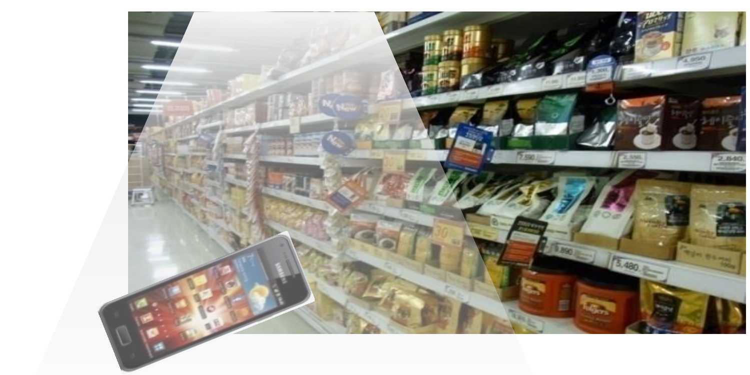




Indoor Positioning



Guiding in museum



Product Information Marketing

Conclusion

- ❖ Camera radiometry and geometry both has been considered
- ❖ Impacts on OCC from camera radiometric and geometric changes have been analyzed.
- ❖ Out of focus issues has been identified due to camera rotation
- ❖ Which can not be neglect when camera movement is intense
- ❖ Radiometric response curve has been used to transform irradiance into image intensity