Problem 1

Assume that you have a camera with a resolution of 9MP where the camera sensor is square shaped with a width of 14mm. It is also given that the focal length of the camera is 15mm.

1.1 Question 1

Compute the Field of View of the camera in the horizontal and vertical direction.

The Field of View (FOV) represents how wide a camara can capture. Higher FOV will allow camera to capture larger object. FOV is the angular size of the view cone, its value is in degrees of angle and it depends upon two factors

1. Sensor width (d)
2. Focal length of camera (f)

The formula to find FOV is,

$$FOV = 2 \times \tan^{-1}\frac{d}{2f} \qquad (1)$$

In our case,

d = 14 mm
F = 15 mm

Thus,

$$FOV = 2 \times \tan^{-1}\frac{14}{2 \times 15}$$

$$FOV = 2 \times \tan^{-1} 0.466$$

$$FOV = 50.03°$$

1.2 Question 2

Assuming you are detecting a square shaped object with width 5cm, placed at a distance of 20 meters from the camera, compute the minimum number of pixels that the object will occupy in the image.

The size of an image formed on the image sensor can be found using the formula that consist of following parameters. Assuming that it has a thin lenses.

1. Height/width of object (h/w)
2. Focal length (f)
3. Distance to object (d)

We have values,

h/w = 5 cm (As object is square)
d = 2,000 cm

f = 15 mm

$$Image\ Size = f \times \frac{h\ or\ w}{d} \qquad (2)$$

$$Image\ Size = 15 \times \frac{5}{2{,}000}$$

$$Image\ Size = 0.0375\ mm$$

The image formed on the sensor will have an area given by this formula,

$$Area\ of\ image = image\ height \times image\ width$$

$$Area\ of\ image = 0.0375\ mm \times 0.0375\ mm$$

$$Area\ of\ image = \ 0.00140625\ mm^2$$

Area of the square sensor with length 14mm will be,

$$Area\ of\ sensor = \ Sensor\ width \times length$$

$$Area\ of\ sensor = 14\ mm\ \times\ 14\ mm$$

$$Area\ of\ sensor = 196\ mm^2$$

Minimum number of pixels occupied by the image of the object on image sensor will be,

$$Pixels\ occupied = Resolution \times \frac{Area\ of\ image}{Area\ of\ camera\ sensor} \qquad (3)$$

$$Pixels\ occupied = 9 \times 10^6 \times \frac{0.00140625}{196}$$

$$Pixels\ occupied = 64.57 \cong 65$$

Thus, the minimum pixels occupied will be 65.