

$$A=7, B=7, c=7$$

$$d_2=30, l_1=24, l_2=18$$

$$\theta_1 = 56, \theta_2 = 56, \theta_3 = 56$$

$$\theta_x = 180^\circ - 90^\circ - 56 = 34$$

$$d_3 = \sin 56 \times 24 = 19.89^\circ$$

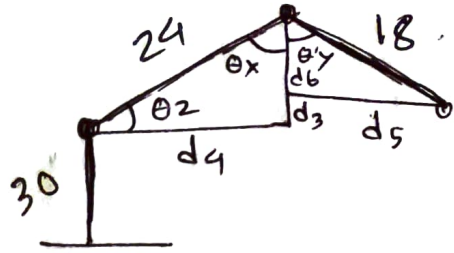
$$d_4 = \cos 56 \times 24 = 13.42^\circ$$

$$\theta_y = \theta_3 - \theta_x = 56 - 34 = 22^\circ$$

$$d_6 = \cos 22 \times 18 = 16.689^\circ$$

$$d_5 = \sin 22 \times 18 = 6.742$$

Question of Robotics

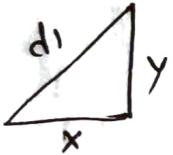


$$z = (d_2 + d_3) - d_6 = 30 + 19.89 - 16.689 = \boxed{33.207}$$

$$x = \cos 56 \times (d_4 + d_5) = \cos 56 \times (13.42 + 6.712) = \boxed{11.27}$$

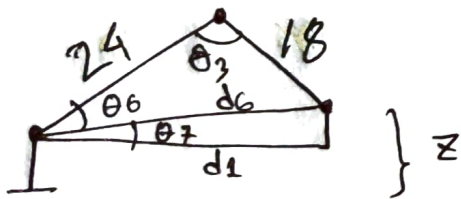
$$y = \sin 56 \times (13.42 + 6.712) = \boxed{16.71}$$

$$(x, y, z) = (7, 7, 7)$$



$$d_1 = \sqrt{7^2 + 7^2} = 9.899$$

$$\theta_1 = \cos^{-1}\left(\frac{7}{9.899}\right) = \boxed{45.002}$$



$$d_6 = \sqrt{d_1^2 + (z - 30)^2} = \sqrt{(9.899)^2 + (7 - 30)^2} = 25.039$$

$$\theta_7 = \cos^{-1}\left(\frac{9.899}{25.039}\right) = 66.712$$

$$\theta_3 = \cos^{-1}\left(\frac{24^2 + 18^2 - 25.039^2}{2 \times 24 \times 18}\right) = \boxed{71.577}$$

$$\theta_6 = \cos^{-1}\left(\frac{24^2 + 25.039^2 - 18^2}{2 \times 25.039 \times 24}\right) = 43.002$$

$$\theta_2 = \theta_6 + \theta_7 = 43.002 + 66.712 = \boxed{109.71}$$

Question - 05

a) Euclidean geometry is not optimal when it comes to explaining the phenomenon of images.

So we ~~can~~ can extend the euclidean space by adding points at infinity and imagine the parallel lines meeting at that point. This is why we need projective geometry.

Properties of vanishing point.

- i) it's where the set of parallel points meet or intersect.
- ii) In 2D image projection, these parallel lines meet at the point.
- iii) Vanishing point remain associate with the sets of parallel lines.

$$ID = \overset{1}{1} \overset{2}{8} \overset{3}{1} \overset{4}{0} \overset{5}{1} \overset{6}{4} \overset{7}{7} \overset{8}{7} \quad , \quad P=0, q=1, r=1$$

$$b) X = [2p \ 3q \ 4r]^T = [0 \ 3 \ 4]^T$$

Heterogeneous coordinate:

$$\begin{bmatrix} 0 \\ 3 \\ 4 \end{bmatrix} \rightarrow \begin{bmatrix} 0/4 \\ 3/4 \end{bmatrix} \rightarrow \begin{bmatrix} 0 \\ 0.75 \end{bmatrix}$$

$$c) m=1, n=1.$$

$$\therefore P = \begin{bmatrix} 10 & 0 & 4 \times 1 & 0 \\ 0 & 10 & 4 \times 1 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}$$

$$3D \text{ point} : [5 \ 6 \ 9 \ 1]^T$$

$$\text{we know, } X = PX$$

P = projection Matrix

X = Real world 3D point

X = image co-ordinate

$$\therefore \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 10 & 0 & 4 & 0 \\ 0 & 10 & 4 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \times \begin{bmatrix} 5 \\ 6 \\ 9 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} 10 \times 5 + 0 \times 6 + 4 \times 9 + 0 \times 1 \\ 0 \times 5 + 10 \times 6 + 4 \times 9 + 0 \times 1 \\ 0 \times 5 + 0 \times 6 + 1 \times 9 + 0 \times 1 \end{bmatrix}$$

$$= \begin{bmatrix} 86 \\ 96 \\ 9 \end{bmatrix}$$

$$\therefore [x \ y \ z]^T = [86 \ 96 \ 9]^T$$

Question - 6

An Unmanned Ground Vehicle (UGV) robot Elon Musk might need to solve this problem.

As Musk wants to pick and drop things, avoid obstacles automatically, move on uneven and sandy surfaces UGV robot will be suitable for this.

UGV robots can operate while in contact with the ground and even without human presence. It can be operated remotely.

UGV robot needs various kinds of sensors to observe the environment around it and also it will make its move or decision according to that automatically or it can be controlled manually by human.

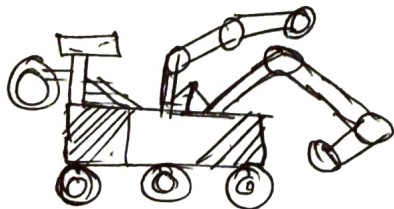
Some of the sensors it might need:

- 1) Acceleration sensor,
- 2) Ultrasonic sensor,
- 3) Radiation Detector,
- 4) Telephoto camera,
- 5) Compasses
- 6) GPS sensors
- 7) Gyroscopes.
- 8) Ultrasound range sensor
- 9) Cameras.
- 10) Robotic arms.

Features of the robot:

1. Using robotic arms. By using robotic arms it can carry things, examine and manipulate soil/rocks. Also use other instruments.
2. Use of wheels and legs for mobility.
3. For energy it will use battery.
4. For communication it will use antennas for speaking and listening.
5. Use of Laser for burn small holes in rock and soil.
6. Radiation detector for measuring radiation.
7. Mineral detector of water and minerals detection.
8. Color cameras for taking color images and 3D images.
9. Weather station for recording wind, air pressure, humidity, and UV radiation.

Details or rough sketch:



Question 2.

Goods of Robotics

1. Energy saving.
2. Accuracy.
3. Efficiency.
4. Adaptability in Dynamic environment.
5. Perfor dull, Dirty, difficult and dangerous job.

Question 2

Pneumatic

popular
less weight.
less powerful
Expensive.

Hydraulic

popular
weighted
very heavy
very Expensive

Electric

not popular
less weight
Extensive.
large.