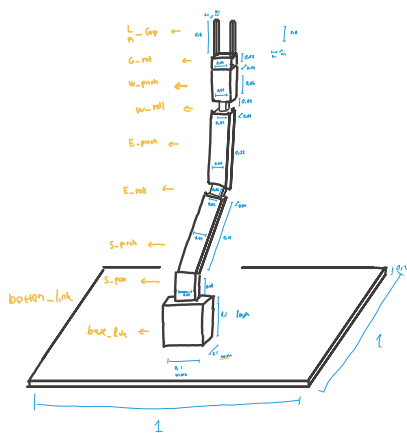


# Arm bot

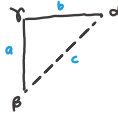


# Robot Motion 3 DOF

IMU Sensor  $\rightarrow x, y, z$  ↳ translate



$\Rightarrow$  pythagoras



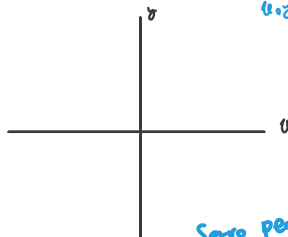
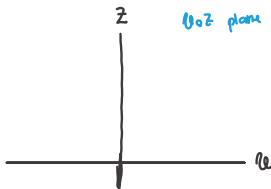
$$\cos \gamma = \frac{a^2 + b^2 - c^2}{2ab}$$

$$\cos \beta = \frac{a^2 + c^2 - b^2}{2ac}$$

$$\cos \alpha = \frac{c^2 + b^2 - a^2}{2bc}$$

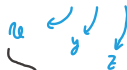
Concept  $\Delta \Rightarrow \alpha + \beta + \gamma = \pi \text{ rad} = 180^\circ$

IMU Sensor  $\rightarrow x, y, z$

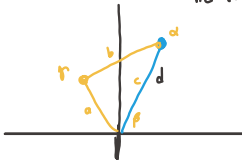


imu gerak, baca data (x,y,z)

↳ berupa titik



Jarak pusat ke titik



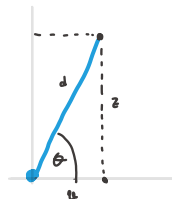
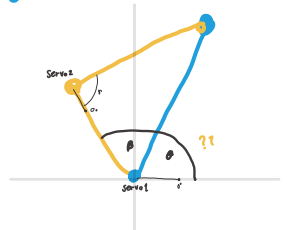
jarak robot  $d = c$

diperoleh

$$\left. \begin{matrix} a \\ b \\ c = d \end{matrix} \right\}$$

$$\begin{matrix} \text{servo 1} = \theta + \beta \\ \text{servo 2} = \gamma \end{matrix}$$

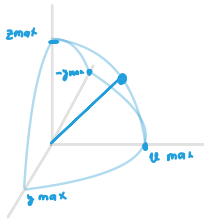
How to go to



$$\theta = \tan^{-1} \left( \frac{z}{x} \right)$$

# mat koordinat calculation

constraint



ball equation

$$(x-a)^2 + (y-b)^2 + (z-c)^2 = r^2$$

$a, b, c$  is center

final equation

$$x^2 + y^2 + z^2 = r^2$$

$r = a + b$  → first link → second link

## Servo 1 motion

$$\text{Servo1\_angle} = \theta + \beta$$

$$\theta = \tan^{-1}\left(\frac{z}{y}\right)$$

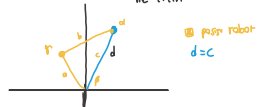
$$\beta = \cos^{-1}\left(\frac{a^2 + c^2 - b^2}{2ac}\right)$$

$$c = \sqrt{a^2 + z^2}$$

How IMU  
ke, y, z

1mu gerak, baca data B, y, z

by bantua titik  
ke  
y  
z  
jarak pusat  
ke titik



## Servo 2 motion

$$\text{Servo2\_angle} = \gamma$$

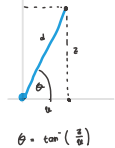
$$\gamma = \cos^{-1}\left(\frac{a^2 + b^2 - c^2}{2ab}\right)$$

diperoleh  
a  
b  
c = d



Servo1 :  $\theta + \beta$   
Servo2 :  $\gamma$

How to  
go  $\theta$



## Servo 3 motion

$$\text{Servo3\_angle} = \delta \text{ if}$$

Quadrant I

$$\delta = \tan^{-1}\left(\frac{y}{x}\right)$$

Quadrant II ( $90^\circ < \delta < 180^\circ$ )

$$\delta = \pi + \tan^{-1}\left(\frac{y}{x}\right)$$

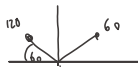
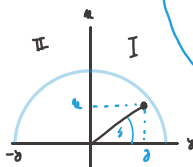
$$\text{Servo3\_angle} = \delta$$

Quadrant I

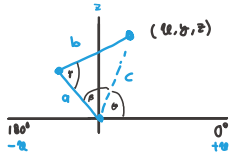
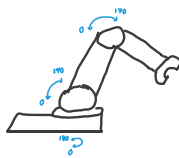
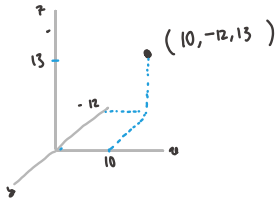
$$\delta = \tan^{-1}\left(\frac{y}{x}\right)$$

Quadrant II ( $90^\circ < \delta < 180^\circ$ )

$$\delta = \pi + \tan^{-1}\left(\frac{y}{x}\right)$$



# Test case



$$\theta = \tan^{-1}\left(\frac{z}{y}\right) = 52.1^\circ = 0.91 \text{ rad}$$

$$\cos \beta = \frac{a^2 + c^2 - b^2}{2ac}$$

$$\beta = \cos^{-1}(0.87) = 0.51 \text{ rad} \rightarrow \text{rad} = 29.25$$

$$\cos \gamma = \frac{a^2 + b^2 - c^2}{2ab}$$

$$\gamma = \cos^{-1}(-0.44) = 115.9^\circ = 2.01 \text{ rad}$$

$$\cos \alpha = \frac{b^2 + c^2 - a^2}{2bc} = 0.81$$

$$\alpha = \cos^{-1}(0.81) = 0.62 \text{ rad} = 35.9^\circ$$

constraint

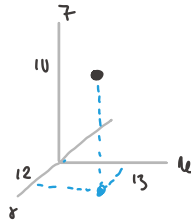
$$c \max a+b$$

$$c = \sqrt{a^2 + b^2 + z^2} < a+b$$

$$z > 0$$

$$a > 0$$

$$\text{known} \begin{cases} a = 13 \\ b = 11 \\ x = 10 \\ y = -12 \\ z = 13 \\ c = 20.32 \end{cases}$$



Wilayah kerja titik acuan

$$\begin{aligned} & a > 0 \\ & -\infty < y < \infty \\ & z > 0 \end{aligned}$$

