Chapter 1

Results

1.1 Investigation of the kinematics of the robot

This general expression is taken from the book "Modern robotics mecanics planning and control" by Kevin M Lynch, Frank C Park, page no 512, please refer this section for more details.

1.2 Three wheel omnidirectional robot

$$h_1(0)\mathcal{V}_b = \frac{1}{r_i}\left[\begin{array}{cc} 1 & \tan\gamma_i \end{array}\right]\left[\begin{array}{cc} \cos\beta_i & \sin\beta_i \\ -\sin\beta_i & \cos\beta_i \end{array}\right]\begin{bmatrix} -y_i & 1 & 0 \\ x_i & 0 & 1 \end{bmatrix}\mathcal{V}_b \tag{1.1}$$

$$\gamma_1 = 0, \beta_1 = 0$$

$$= \frac{1}{r_1}\left[\begin{array}{cc} 1 & 0 \end{array}\right]\left[\begin{array}{cc} \cos 0 & \sin 0 \\ -\sin 0 & \cos 0 \end{array}\right]\begin{bmatrix} -y_1 & 1 & 0 \\ x_1 & 0 & 1 \end{bmatrix}\mathcal{V}_b \tag{1.2}$$

$$= \frac{1}{r_1}\left[\begin{array}{cc} 1 & 0 \end{array}\right]\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}\begin{bmatrix} -y_1 & 1 & 0 \\ x_1 & 0 & 1 \end{bmatrix}\mathcal{V}_b \tag{1.3}$$

$$= \frac{1}{r_1}\begin{bmatrix} -y_1 & 1 & 0 \end{bmatrix}\mathcal{V}_b \tag{1.4}$$

$$r_i = r_1 = r_2 = r_3 = r \tag{1.5}$$

$$h_1(0)\mathcal{V}_b = \frac{1}{r}\begin{bmatrix} -y_1 & 1 & 0 \end{bmatrix}\mathcal{V}_b \tag{1.6}$$

Similarly for the second wheel

$$h_2(0)\mathcal{V}_b = \frac{1}{r}\begin{bmatrix} \frac{1}{2}y_2 - \frac{\sqrt{3}}{2}x_2 & \frac{-1}{2} & \frac{-\sqrt{3}}{2} \end{bmatrix}\mathcal{V}_b \tag{1.7}$$

Similarly for the third wheel

$$h_3(0)\mathcal{V}_b = \frac{1}{r}\begin{bmatrix}\frac{1}{2}y_3 + \frac{\sqrt{3}}{2}x_3 & \frac{-1}{2} & \frac{\sqrt{3}}{2}\end{bmatrix}\mathcal{V}_b \tag{1.8}$$

We know that

$$y_2 = y_3, x_2 = -x_3 \tag{1.9}$$

The final expression for the three wheel omnidirectional robot is

$$H(0)\mathcal{V}_b = \frac{1}{r}\begin{bmatrix} -y_1 & 1 & 0 \\ \frac{1}{2}y_2 - \frac{\sqrt{3}}{2}x_2 & \frac{-1}{2} & \frac{-\sqrt{3}}{2} \\ \frac{1}{2}y_3 + \frac{\sqrt{3}}{2}x_3 & \frac{-1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix}\begin{bmatrix}\omega_{bz} \\ \upsilon_{bx} \\ \upsilon_{by}\end{bmatrix} \tag{1.10}$$

To find $\begin{bmatrix}\omega_{bz} \\ \upsilon_{bx} \\ \upsilon_{by}\end{bmatrix}$

Lets insert the symbol for the above expression

$$\mathcal{A} = \begin{bmatrix} -y_1 & 1 & 0 \\ \frac{1}{2}y_2 - \frac{\sqrt{3}}{2}x_2 & \frac{-1}{2} & \frac{-\sqrt{3}}{2} \\ \frac{1}{2}y_3 + \frac{\sqrt{3}}{2}x_3 & \frac{-1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix} \tag{1.11}$$

Solving the above will lead to the following expression

$$\mathcal{A} = \begin{bmatrix} -d & 1 & 0 \\ -d & \frac{-1}{2} & \frac{-\sqrt{3}}{2} \\ -d & \frac{-1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix} \tag{1.12}$$

To find $\begin{bmatrix}\omega_{bz} \\ \upsilon_{bx} \\ \upsilon_{by}\end{bmatrix} = r\mathcal{A}^{-1}u$

ArUco marker detection

An ArUco marker is a square-shaped marker that has a wide black border and an inner binary matrix that determines its identifier as shown in FIG. ArUco markers are commonly used in computer vision applications such as robot navigation and augmented reality. The ArUco marker has a fixed dimensions which helps the program to estimate its position and orientation, in real-world frame.