Matrix Theory Assignment 1

Ankur Aditya: EE20RESCH11010

***Abstract*—This document contains the procedure to get image of a point in a line.**

Download the python code from the below link. Go through the README file in the repository.

https://github.com/ankuraditya13/EE5609–Assignment–1

1 Problem

Find the image of the point $\begin{pmatrix}3\\8\end{pmatrix}$ with respect to the line

$$\begin{pmatrix}1 & 3\end{pmatrix}\mathbf{x} = 7 \tag{1.0.1}$$

2 Solution

For this problem, I am considering the general case. Let the Equation of line be ax + by = c and let the coordinates of,

P(given point) = $\begin{pmatrix}x1\\y1\end{pmatrix}$

Q(point on mirror) = $\begin{pmatrix}x2\\y2\end{pmatrix}$

R(image point) = $\begin{pmatrix}x3\\y3\end{pmatrix}$

Let vector **n** = $\begin{pmatrix}a\\b\end{pmatrix}$

Let m be the directional vector along the line, ax + by = c.

Hence, m = $\begin{pmatrix}b\\-a\end{pmatrix}$

By property in Figure 0, the line PR bisects the mirror equation perpendicularly. Hence,

$$2\mathbf{Q} = \mathbf{P} + \mathbf{R} \tag{2.0.1}$$

Hence the reflection vector **R** is given as,

$$\frac{\mathbf{R}}{2} = \frac{\mathbf{m}\mathbf{m}^T - \mathbf{n}\mathbf{n}^T}{\mathbf{m}^T\mathbf{m} + \mathbf{n}^T\mathbf{n}}\mathbf{P} + c\frac{\mathbf{n}}{\|\mathbf{n}\|^2} \tag{2.0.2}$$

Hence, substituting the values of x1 = 3, y1 = 8, a = 1, b = 3 and c = 7 we get,

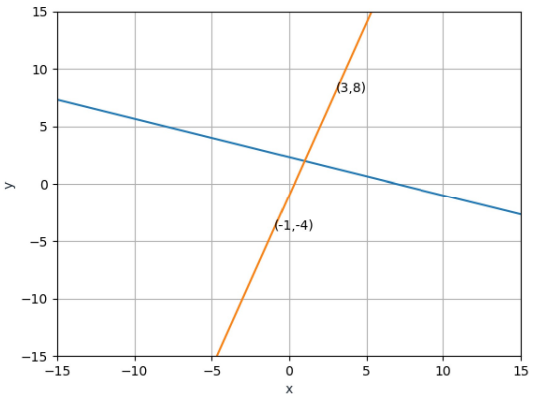

Fig. 0: Image of a point in 2D line

P(given point) = $\begin{pmatrix}3\\8\end{pmatrix}$

m (direction vector) = $\begin{pmatrix}3\\-1\end{pmatrix}$

n = $\begin{pmatrix}1\\3\end{pmatrix}$

Norm, $|||\mathbf{n}||| = \sqrt[2]{a^2 + b^2}$

Substituting these values in equation (2.0.2) we get,

$$\mathbf{R} = \begin{pmatrix}-1\\-4\end{pmatrix} \tag{2.0.3}$$

Hence, it is the required answer for image of **P** in line $\begin{pmatrix}1 & 3\end{pmatrix}$ **x** =7.