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

$$\begin{pmatrix} 1 & 3 \end{pmatrix} \mathbf{x} = 7. \qquad (1.0.1)$$

2 SOLUTION

Let, given vector

$$\mathbf{P} = \begin{pmatrix} 3 \\ 8 \end{pmatrix} \qquad (2.0.1)$$

Let, image point be **R**. Let vector,

$$\mathbf{n} = \begin{pmatrix} 1 \\ 3 \end{pmatrix} \qquad (2.0.2)$$

Let m be the directional vector along the line, $\begin{pmatrix} 1 & 3 \end{pmatrix} \mathbf{x} = 7$. Hence m is,

$$\mathbf{m} = \begin{pmatrix} 3 \\ -1 \end{pmatrix} \qquad (2.0.3)$$

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

$$2\mathbf{Q} = \mathbf{P} + \mathbf{R} \qquad (2.0.4)$$

Where, **Q** is the point on the line, $\begin{pmatrix} 1 & 3 \end{pmatrix} \mathbf{x} = 7$. Hence the reflection vector **R** is given as,

$$\left(\frac{\mathbf{R}}{2} \right) = \left(\frac{\mathbf{m}\mathbf{m}^T - \mathbf{n}\mathbf{n}^T}{\mathbf{m}^T\mathbf{m} + \mathbf{n}^T\mathbf{n}} \right) \mathbf{P} + c \left(\frac{\mathbf{n}}{\|\mathbf{n}\|^2} \right) \qquad (2.0.5)$$

$$\|\mathbf{n}\| = \sqrt{1^2 + 3^2} = \sqrt{10} \qquad (2.0.6)$$
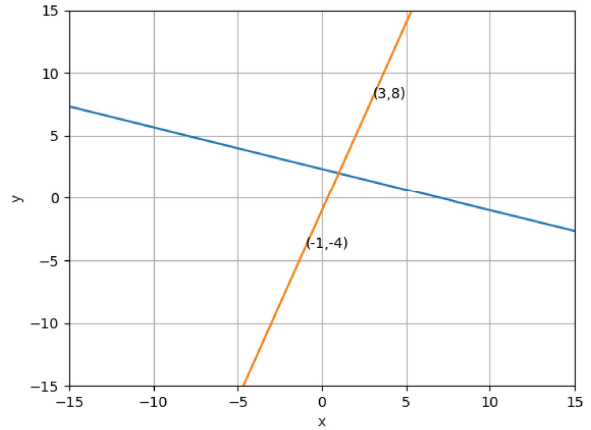

Fig. 0: Image of a point in 2D line

Substituting these values in equation (2.0.5) we get,

$$\mathbf{R} = \begin{pmatrix} -1 \\ -4 \end{pmatrix} \qquad (2.0.7)$$

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