Design of GNSS Aided Inertial Navigation System

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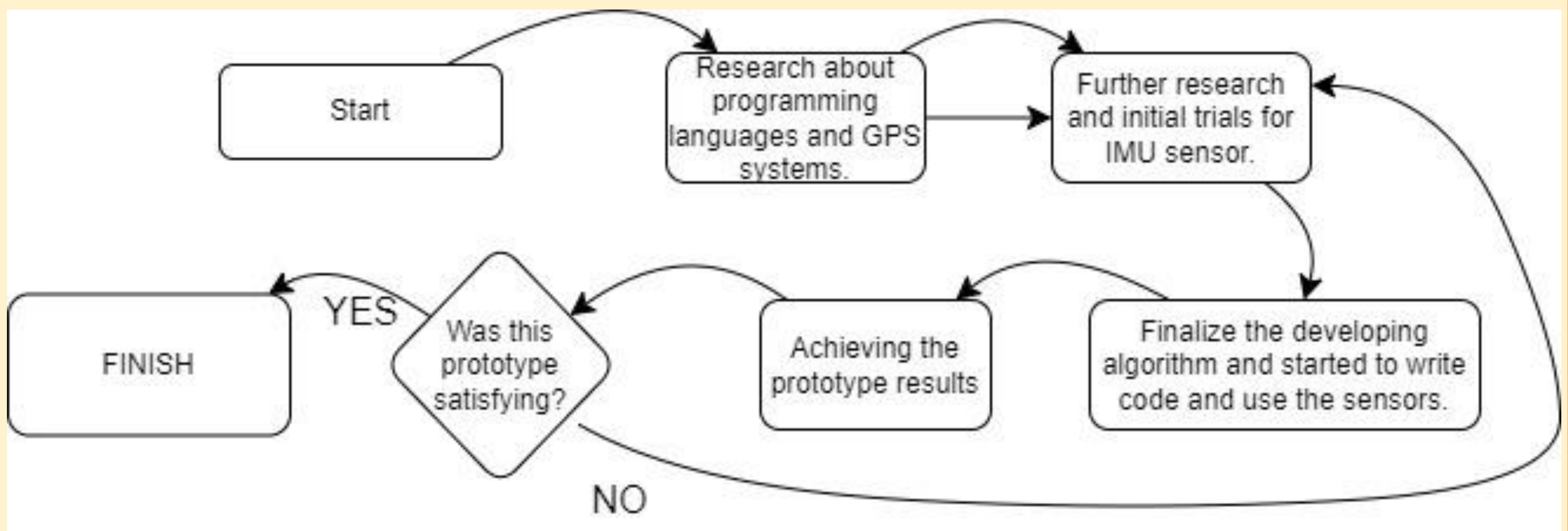
Introduction

- GNSS-aided INS provides accurate and timely location information.
- The project allows sea, land, and air vehicles to find their positions with low error.
- The unit consist of 3 main parts; a processor unit, an IMU sensor, and GPS receiver sensor.
- Processor unit finds the distance and bearing angle from IMU sensor and coordinates from GPS, use this data to find location by reducing error.

Design Process

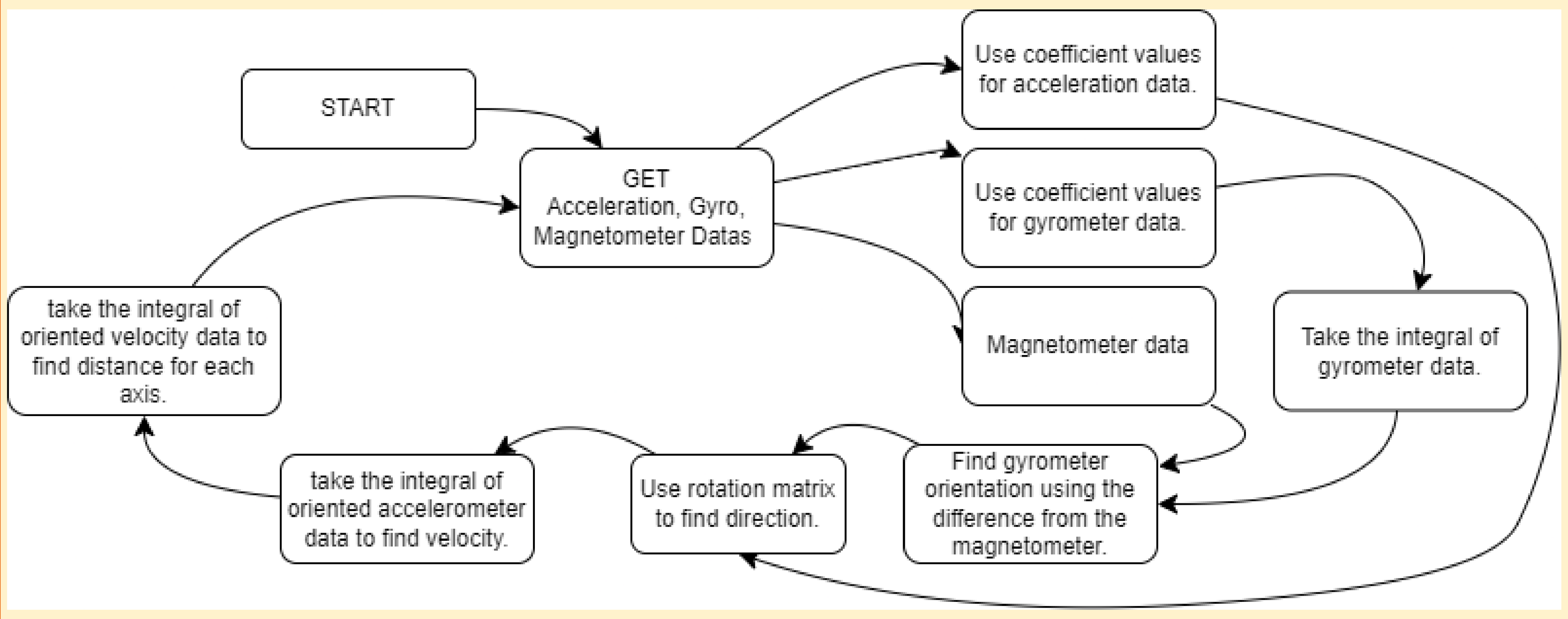
- Location finder designs are all about providing solutions to real-time problems.
- Since the selected products must be cost-efficient, the algorithm should work to maximize efficiency.



- Focused on optimizing algorithms for efficiency to maximize the performance of the location finder while minimizing computational resources.

Solution Methodology

- In order to convert device-referenced acceleration data to distance, the integral of the received data should be taken 2 times in the interval t. The shorter the duration t, greater the accuracy of the distance from the inertial sensor.



- The rotation matrix is used to convert Eart-referenced acceleration data into device-referenced acceleration data.

$$\text{Z-axis: } \begin{bmatrix} p'_x \\ p'_y \\ p'_z \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \bullet \begin{bmatrix} p_x \\ p_y \\ p_z \end{bmatrix}$$

$$\text{X-axis: } \begin{bmatrix} p'_x \\ p'_y \\ p'_z \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\theta & -\sin\theta \\ 0 & \sin\theta & \cos\theta \end{bmatrix} \bullet \begin{bmatrix} p_x \\ p_y \\ p_z \end{bmatrix}$$

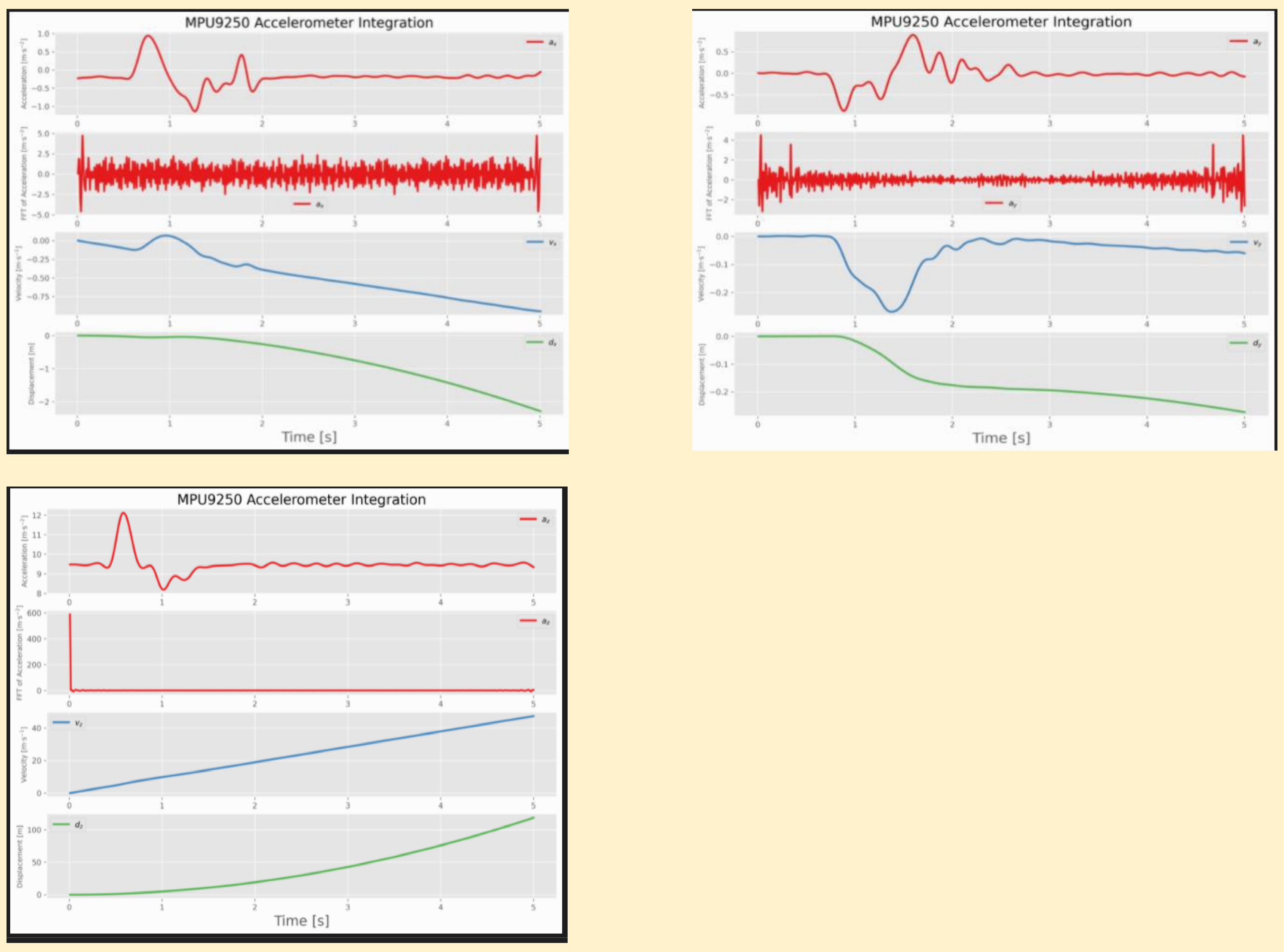
$$\text{Y-axis: } \begin{bmatrix} p'_x \\ p'_y \\ p'_z \end{bmatrix} = \begin{bmatrix} \cos\theta & 0 & \sin\theta \\ 0 & 1 & 0 \\ -\sin\theta & 0 & \cos\theta \end{bmatrix} \bullet \begin{bmatrix} p_x \\ p_y \\ p_z \end{bmatrix}$$

Application Areas

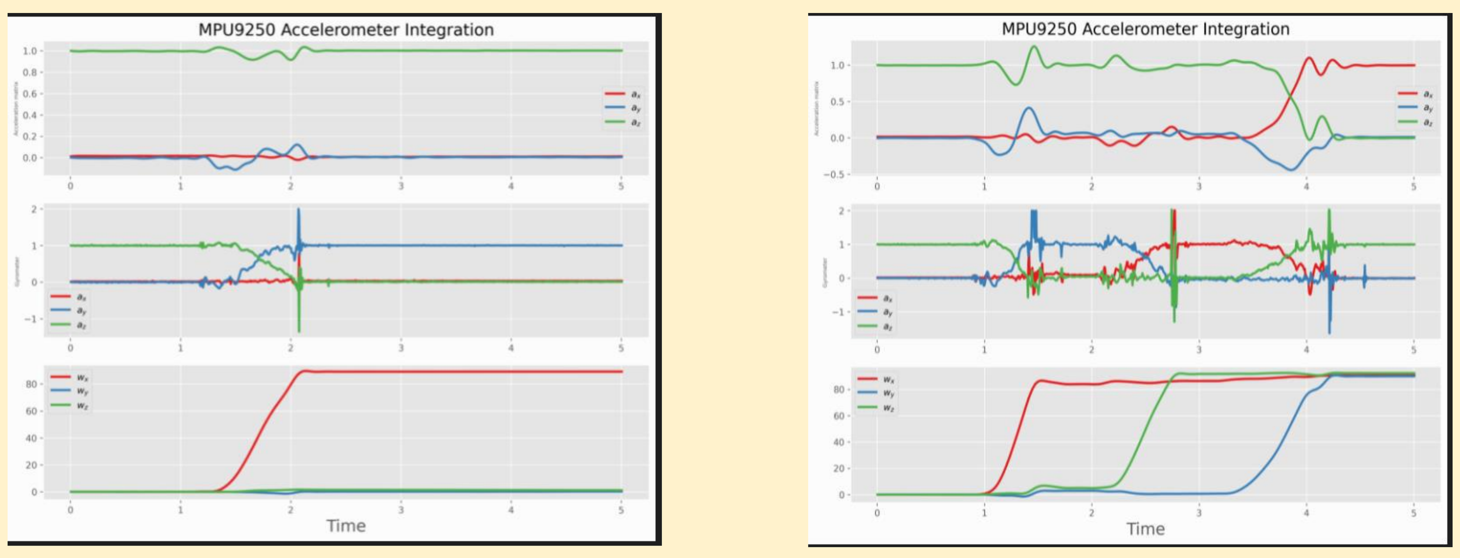
- GNSS systems are used in ground, air and land vehicles.
- The systems are used in military applications, cargo ships, submarines, automobiles, transport fleets, airplanes, helicopters.

Results and Discussion

- The images below show graphs related to acquiring accelaration data, applying rotation matrix and filtering



- The images below show 90° rotation in the roll, pitch, yaw axes.



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