## Senior Design Project in Electrical & Computer Engineering

# Integrated Electronic Navigation Unit


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Sponsors: USCGA, FAA


## Project Background

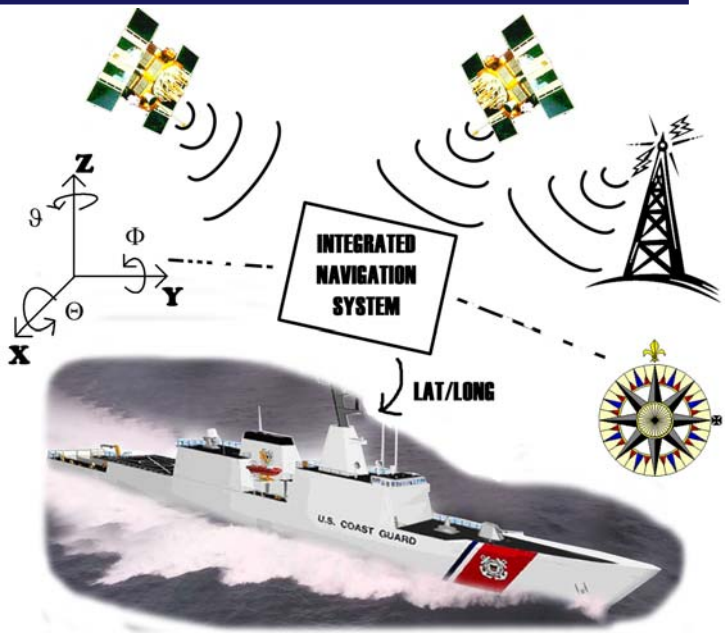
Currently the Coast Guard relies heavily on the satellite-based Global Positioning System (GPS) for navigating. However, GPS signals are vulnerable to:

- Jamming - The hiding of signals by inundating an area with stronger signals at the same frequency.
- Blocking - objects obstructing a line-of-sight to a satellite.
- Spoofing – The transmission of false signals.

GPS navigation should have a backup system to function if GPS vulnerabilities are exploited.
The goal of this project is to combine:

- GPS – Satellite based, 100W signals, line of sight
- LORAN-C – 4MW signals, repeatable, inaccurate
- IMU – unjammable, short term
- Compass – stable long term

into one unit such that each of individual system's strengths overlap creating a more robust system. The resulting navigation unit will output the best fix based on all available data. A system that uses redundant information from all available sources will be extremely reliable and will enhance the capabilities of Coast Guard assets.




## Project Work

The status of the project work at the end of last year was a complete block diagram, a simple dynamics algorithm and GPS signals implemented in MATLAB ®. This semester project work will continue with focusing on properly processing data from a Micro Electro-Mechanical System (MEMS) IMU made by Crossbow Technologies Inc and implementing a Kalman filter. The main goal will be developing a software algorithm to process data from GPS, LORAN-C, IMU, and a compass. The final integration of all systems into a Kalman filter will be the biggest challenge. I will build a prototype of the system to gather data on its reliability.

*The Crossbow Technologies MEMS IMU400CC.*
*Size: 3 x 3 x 3.2 inches. Cost: ~ $5000.00*

## Project Plan

A Kalman filter will be used to observe raw data from GPS, IMU, LORAN-C, and compass and compute a position, estimate errors in each system and predict future values. The Kalman filter is adaptive, by using those predicted values to disregard outlying data which could result in a poor fix. Each subsystem must be dissected in order to extract internal states that will be used as error models for the Kalman filter. This integrated system will still function with partial data from one system and combine it with partial data from another to obtain a position.

## Project Deliverables

- Dynamics algorithm – Needed to convert linear accelerations, angular rates and time into position
- Kalman filter – Implemented in software. Used to combine inputs from GPS, IMU, compass and Loran-C.
- Portable Prototype Navigation system
- Translations to C++ - System has been developed in MATLAB ® and will be translated to C++ for faster, independent operation.
- Test Plan – Will test for loss of and inaccurate data from each subsystem. To be conducted on USCGA tugboats