INS UATR Program

User Acceptance Test Report Tool

ELECOMP Capstone Design Project 2021-2022

Sponsoring Company:

iXblue Defense Systems Inc.
27 Wellington Rd
Lincoln, RI 02865
https://www.ixblue.com/

Company Overview:

iXblue Defense Systems Inc. (iXDS) is a division of iXblue SAS, a French technology company specializing in inertial navigation systems (INS), photonics, acoustic positioning and communication, seabed mapping, drones, and several other areas. As a global leader in navigation and positioning technology, iXblue brings multidisciplinary expertise and solutions to the forefront of industrial practice. Located in St. Germain, France, the inertial navigation division develops and manufactures a wide variety of equipment used in offshore, defense, and scientific operations focused on iXblue's cornerstone FOG technology. The INS is comprised of Fiber Optic Gyroscopes, Accelerometers, and processors to synergize inputs from the internal and external sensors using iXblue's proprietary navigation algorithm. iXDS, located in Lincoln Rhode Island, has a large presence in the Autonomous Underwater Vehicle (AUV) market providing both Inertial Navigation Systems (INS), and acoustic positioning systems, such as the GAPS and acoustic transponders.

Technical Director:

Daniel Nugent (Virginia Tech '16)
Support Engineer

Project Motivation:

Phins C3

Inertial navigation is a growing field with numerous parties interested in developing autonomous capabilities, of which INS is a key component. The iXblue INS is based on the Fiber Optic Gyroscope (FOG) technology which calculates rotation by measuring phase shifts between counterpropagating light waves, a principle known as the Sagnac Effect. The INS includes one FOG per axis (X, Y, Z) as well as three accelerometers on these axes to create the IMU of the INS. Paired with processing intelligence to correctly interpret internal and external sensor data combined with an advanced Kalman filter, the INS achieves high accuracy attitude and position data.

With high performance equipment such as the INS, occasional functionality tests are performed to ensure the unit is still functioning properly. This usually occurs between missions, before installation to a new vehicle, or after potential damage to the unit. The purpose of the User Acceptance Test Report (UATR) is to ensure each INS is within specifications and performing properly. The test is performed in stable, static conditions but currently requires significant user interaction. Currently iXblue's UATR is a non-automated procedure which involves a certain degree of human interaction. This introduces room for error in the execution of the procedure, resulting in false unit failures that could be avoided through automation. The goal of creating a user friendly UATR tool is to improve the ease of competing the procedure and eliminate customer errors in performing the test.

Anticipated Best Outcome:

The project will culminate in the delivery of a software prototype UATR tool. Adequate documentation of all software such that the project can be expanded upon or drawn from in the future should be created and updated throughout the project. Successful software will be able to correctly differentiate between units working properly and not working properly. The following deliverables will be developed through the course of the project:

- A user guide for the tool
- Software design document
- Software documentation detailing the operation of the prototype software
- A final report covering all results, test data, project progress, and suggested next steps
- Source code
- Non regression tests

Project Details:

The UATR is a procedure performed to evaluate the well-being of an INS. The UATR procedure should be used if an anomaly or malfunction has been detected on the unit (i.e. instability of heading, roll or pitch, or error messages in the web interface) or for periodic calibration check. The procedure tests the short-term and long-term drift of the INS position, attitude (heading, roll, and pitch), and FOG/ accelerometer biases. Each system type has criteria that must be met to certify the unit as within specification and ready for field operations.

Team Breakdown

The team will be directed by iXDS personnel, specifically Support Engineer Daniel Nugent. All team members will be involved in the initial prototype requirements definitions, architecture description, and test development. Guidance on product technical matters will also be provided from iXblue personnel.

- **Systems engineering** tasks will be split between CPE students
- **Software design** tasks will be handled by CPE students
- **Testing** tasks will be handled based on functionality being tested

Systems Engineering Tasks

- Software Functional requirements documentation
- Defining software architecture and functionality, inputs and outputs
- Thorough software documentation
- Define required system tests

Software Design Tasks:

- Develop the control software and include functions to:
  - Send individual commands to each INS unit
  - Decode repeater data messages
  - Intuitive graphical user interface
  - Create plots of the attitude/ positioning data
  - Determine "health" of an INS
  - Email/ alert when steps are competed for the test

Testing Tasks:

(Testing tasks are focused around simulated and live testing)

- Software functionality with simulated/ recorded data
- Software functionality with live data
- Email notification functionality
- Non regression test procedure

Prototype In-Lab Testing:

- Performance qualification
- Data recording for performance analysis

Final Project Report:

- Comprehensive report detailing project
- Details on what and how goals were accomplished
- Immediate next step recommendations for prototype

Composition of Team:

2 Computer Engineers

Skills Required:

Computer Engineering Skills Required:

- Proficiency with or willingness to learn Python coding language
- Interfacing with sensors
- Desktop/Web Application Development
- Database Design and Data Storage
- Computer Networking

Anticipated Best Outcome's Impact on Company's Business, and Economic Impact

The system described in this proposal has potential to improve customer autonomy as well as demonstrate the iXblue FOG technology's longevity to customers. The UATR tool will alleviate downtime from shipping units to iXblue facilities for checks by aiding the customers in testing the unit independently.

Broader Implications of the Best Outcome on the Company's Industry:

Broader implications of a well-designed UATR tool include increased customer confidence in the iXblue brand and iXblue products.