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Computerized Maritime Navigation (C-MAN) for High End Capabilities and Challenging Environments

I. INTRODUCTION

Astronautics C.A. Ltd. (Astronautics) - Israel, a wholly owned subsidiary of Astronautics Corporation of America, is pleased to provide in this paper, technical information for its Computerized Maritime Navigation system (C-MAN) based on its affiliate's (Kearfott Corporation) Ring Laser Gyro (RLG) System.
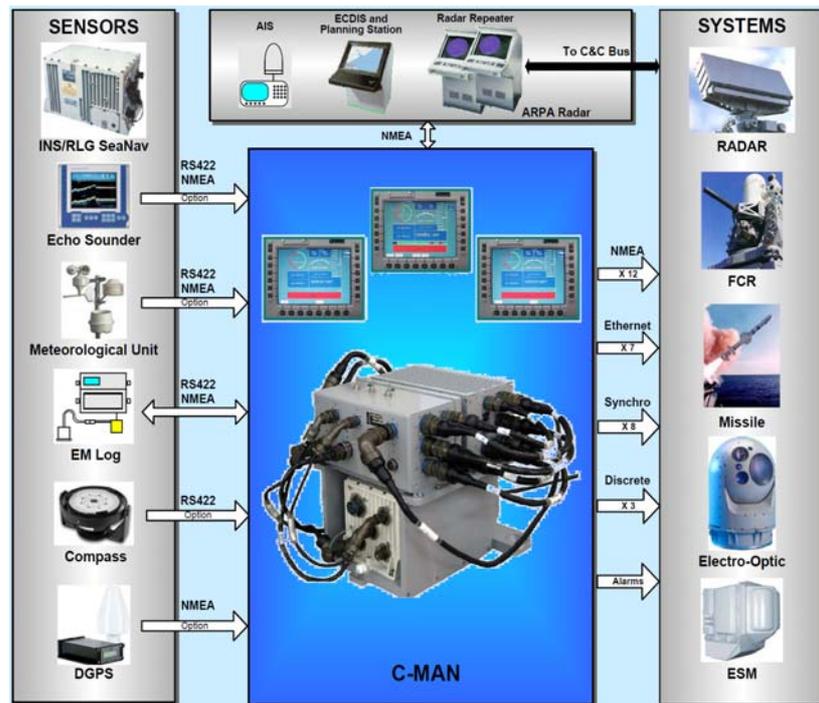
Over the past few years, there has been a growing need for navigation systems providing very high accuracies. It was developed due to the high accuracy requirement of combat systems and high accuracy position required from platforms with far distance sailing devoid of GPS. One such situation is underwater navigation.

Underwater navigation requires high end capabilities of INS. It should have high accuracy, update rate and stability. Above all, it should have autonomous capability.

Underwater navigation, especially for the submarine, requires independent navigation without any aids, which differs from above water surface navigation that can aid utilize GPS. With this requirement for high accuracy navigation, it becomes a challenge for companies to provide navigation systems. Astronautics with its C-MAN system meets this challenge.

II. COMPOSITION OF C-MAN SYSTEM

The C-MAN system is composed of the Inertial Navigation System, the Main Navigation Computer and the CDU. The C-MAN provides the ability to acquire process and distribute the full range of inertial and navigational information, using a modular and cost-effective configuration.

The C-MAN consists of a Monolithic Ring Laser Gyro INS Sensor - SEANAV with embedded GPS/DGPS receiver. The system is operated and controlled by Astronautics' Main Navigation Computer (MNC), and with the computerized Control & Display Unit (CDU) integrated with the navigation and other sensors and sub-systems package of the Vessel.

A. The Main Navigation Computer

The MNC is the "core" of the navigation system that collects data from all navigation sensors, calculating the information utilizing Astronautics' unique algorithms, and distributes the optimal navigation data to the vessel's users.

The MNC is modular and features unique distributed architecture with the following advantages:

- Easy addition or replacement of sensors. Easy and simple installation into new or retrofitted vessels.

- Excess capability for additional synchro or NMEA users.

- Powerful BIT for fast failure detection and repair (easy LRU/SRU replacement).

- Simulation Mode - Providing a dynamically simulated Navigation parameter by setting data values and selecting preprogrammed simulation scenarios instead of determining the values

- Calculation of navigation parameters using redundant sensor data (using dead rekoning when neccesery). On line

selection of the best instantaneously available sensor using Astronautics' proprietary algorithm.

- Minimal cable lines and connections which results in minimal space and weight, simple installation and increased reliability.

- Minimal Synchro and / or Digital error produced by calculation Latency which is compensated by special Astronautics' prediction proprietary algorithm.
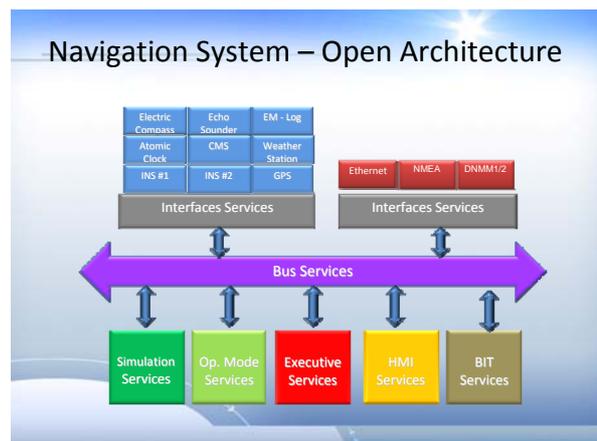
- Based on an Open Architecture (OA) concept that enables flexibility and scalability, and specified with modular design based on standards and COTS. The motivation is to reduce life cycle cost, from the development phase to deployment phase. The OA encompasses adoption of standards for SW development, selection of COTS and using data distribution standard. The obtained attributes of the C-MAN in general, and the MNC in particular, are modularity, flexibility,

interoperability, scalability and affordability.

- The C-MAN has broad input capabilities, enabling easy interfacing to a variety of sensors such as the INS, Logs Echo sounders, Metrological centers and more. The system also provides variety of data outputs such as Synchro, Ethernet, serial links / NMEA or others with a rate of 100Hz. The system calculates and distributes the best real time navigation data to the users, as mentioned above - using Astronautics proprietary algorithm.
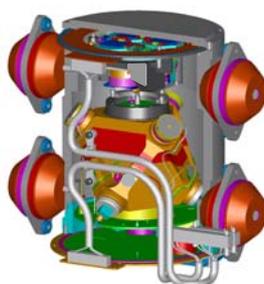
B. Inertial Navigation System (INS)

The Ring Laser Gyro (RLG) SEANAV offers high accuracy together with inherent durability, due to the unique monolithic design of the RLG sensor, resulting in improved reliability, at a reduced life cycle cost, compared to conventional Gyros.

Monolithic Block   RLG/INS

RLG / INS with GPS embedded

C. Control and Display Unit (CDU)

The CDU provides data entry, control and display for the MNC and INS.

The CDU is a 12" LCD display with an internal PC, Window base (Windows X Embedded XP).

The CDU provides a menu driven display & control functions as follows:

- INS mode selection including selection of Alignment modes.

- Manual data to the INS.

- INS Status and data display.

- Display of navigation data items computed and distributed by the MNC

- BIT status depth

III. TESTING AND RESULTS

The C-MAN performance is as follows:

C-MAN PERFORMANCE	
Position Accuracy	<1.0 nm TRMS 24 Hrs
Heading Accuracy (GPS aided)	1.2 arc min rms
Roll/Pitch Accuracy	0.9 arc min rms
Typical alignment time	15 minutes

Astronautics has proved practically while performing SAT in submarine high position accuracy in free inertial. Under this situation no inputs were introduced to the system. The free inertial was conducted by denying all aiding inputs i.e. GPS, speed log etc.

The 24 hr sails were executed most of the time at high seas (Sea state 3 - 5) with tough maneuverings which included changes of speed, depth and diversion angles, circles in a different diameter and at different speeds. The resulting accuracies were similar and repeatable in performances of better than half a mile after 24 hrs.

IV. CONCLUSION

The C-MAN fulfills the need for a high end capabilities navigation system with high accuracies and additionally encompasses a compact, lightweight, low-cost integrated system for a multitude of types of maritime navigation applications. The C-MAN has flexibility and modularity based on open architecture from a basic single sensor for small vessels, to a high-end extended full redundant system. The ancillary equipment supporting the C-MAN is mature and proven equipment, carefully selected following actual successful service in the maritime environment. The C-MAN is especially suited for new or retrofitted programs due to its high accuracies, easy installation and maintenance with modern and state of the art interfaces for a variety of sensors and users.