Maritime Autonomous Surface Surveillance System (MASSS) - Development Details

MASSS – Overview

MASSS is designed to deliver a flexible, 24-hour, low visibility (including poor weather) maritime surveillance capability. The system architecture utilises newly developed, state-of-the-art electro-optical sensors and a novel surveillance radar, which combined with newly developed processing enables the automatic detection of objects, even in adverse weather conditions. The system architecture is oriented towards an open architecture-based system, maximizing the use of open source and open standard components, protocols and interfaces (both hardware and software) where practicable. This approach maximizes the interoperability, flexibility and durability of the resulting system, and facilitates future development. Another main architectural driver is low-level coupling between the various sub-systems and functions of the system. This modular approach should help ensure that future developments such as new functionalities or new sensors can be integrated with minimum effort.

The architecture distinguishes several system boundaries; overall MASSS includes the COTS autonomous maritime surface vehicle which will be procured from another organisation and house the MASSS sensors and computing, the TAU Ground Station which transmits and receives data to and from MASSS, and the TAU and PANTHEON OPERATING CENTREs where various data feeds and products are terminated. The development of MASSS spans multiple design teams within PROCULUS GROUP and several external commercial organisations.

MASSS is pre-programmed via the user terminal before mission launch. MASSS can be dynamically reconfigured during operation via the user terminal. MASSS controls the autonomous vehicle and the MASSS sensors during operation. MASSS can be remotely operated via the user terminal or operate autonomously if pre-programmed.

MASSS – COTS Autonomous Vehicle

MASSS makes use of an existing COTS autonomous vehicle which includes sensors, controllers and GPS for autonomous and remotely operating the vehicle along with a generator which provides power to the vehicle and its sub-systems. The vehicle also includes an Automatic Identification System (AIS) as a sub-system (not shown on architecture). The COTS autonomous vehicle is stated to perform at the sea state required by the TAU nation. The COTS autonomous vehicle is supplied with numerous operating modes including remotely piloted, auto piloted and autonomously piloted. PROCULUS GROUP has worked with the manufacturer of this vehicle before on several projects of various scales and for several different domains, achieving mixed results.

MASSS – Sensor Payload

MASSS includes newly developed sensors (electro-optic and radar) and a command and control sub-system. The command and control sub-system is responsible controlling the novel sensors and the direction of the surface vehicle, issuing commands to the controller on the vehicle. The command and control sub-system also gathers navigation telemetry data from the surface vehicle for use in processing data from the sensors. The command and control sub-system is also responsible for sending and receiving data to the TAU Ground Station via the communication sub-systems. PROCULUS GROUP has previous experience developing command and control systems and expects that the computational needs derived from the image and signal processing algorithms will mean a bespoke sub-system will need to be developed for this application.

PROCULUS GROUP has extensive expertise in electro-optic sensors and surveillance radars, having developed and manufactured these systems for years. Your organisation has developed their latest version of each of these following significant strategic research and development resources. A strategic aim of your organisation is to demonstrate the effectiveness of these new systems in order to generate future sales in order to recover the investment and generate a profit. The combination of the eletro-optic sensors and surveillance radar enable MASSS to provide automatic detection of surface vessels. There were significant hurdles in the development of this capability due to challenges from the operating environment e.g., detecting an object against sun glare, wakes, wave crests, cloud shadows and debris, etc, that can reduce the performance of the sensors and algorithms. This challenge is further compounded by variations in atmospheric conditions and lighting variations during the day and night. Finally, a range of objects are required to be detected meaning considerable research and development effort was invested in creating and labelling the datasets that enable object detection and recognition.

The electro-optic sensor is an advanced stabilised optronics equipment made up of various sensors, integrated into a tightly sealed container, to be installed on the mast of the surface vehicle. It includes a thermal imagery system (Forward Looking Infra-Red) which supports target detection and interrogation at long range and during night operations. It also includes a high definition colour camera for daylight operations. Both sensors are equipped with powerful zoom capability for observation at long distances. The overall system makes use of a stabilised platform which contributes to a sharp picture and accurate line-of-sight positioning, even during rough sea conditions. The system is also equipped with tracker for tracking surface and airborne targets. Finally, the system includes a laser rangefinder. All sub-systems feed their image and target data to the MASSS CPU before onward transmission. The electro-optic sensor sub-system is considered by your organisation to be TRL 7 (technology prototype demonstrated in an operational environment). The development effort also included the creation of novel functional chains, data processing and data compression techniques.

The surveillance sub-system is a rotating C band multifunction passive electronically scanned array radar developed to provide wide search coverage, low altitude and surface search and the tracking of multiple targets. The surveillance sub-system is also considered by your organisation to be TRL 7 (technology prototype demonstrated in an operational environment). The development effort also included the creation of novel functional chains and signal processing techniques.

MASS – Power supply

MASSS also includes its own power supply system comprising a generator that draws power from the maritime autonomous surface vehicle, backup batteries, and a power management board. The power management board is responsible for turning on and off sensors during operations and has a built-in failsafe system for ensuring a non-disruptive power supply to the primary systems even in the event of a generator failure.

MASSS - Communications

Data is sent from MASSS to the TAU Ground Station via satellite communications (SATCOM) and Very High Frequency (VHF) radios. The TAU Ground Station already exists and is in use for current maritime surveillance and search and rescue operations. Your organisation intends to team up with other organisations who have more experience in SATCOM and VHF to develop the required sub-systems within MASSS and within the Tau Ground Station and to ensure they meet security requirements. Your organisation has worked with several of these other organisations in the past with mixed results. Co-located at the TAU Ground Station is further data processing and recording, along with user terminals to allow remote operation and dynamic re-configuration by operators and maintainers. The data generated by MASSS will be provided to the PANTHEON Command, Control, Communications, Computers and Intelligence (C4I) system that already exists and to TAU's C4I system (not shown).