Sentry – An Unmanned Swimmer Intercept System

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LONG-TERM GOALS

The primary goal of this program is to develop and deploy an Unmanned Swimmer Intercept and Verification (USIV) system for terminal swimmer detection and targeting. This system will provide the US Navy and port security organizations with the ability to detect, track, and assess unauthorized swimmers using autonomous and semi-autonomous operation. The system uses field-proven components integrated into a system that will locate and confirm the classification of a target detected as a potential swimmer by an early warning system. It will provide high quality imagery that commanders can rely upon to take action against surface and underwater threats. A system overview is presented in Figure 1.
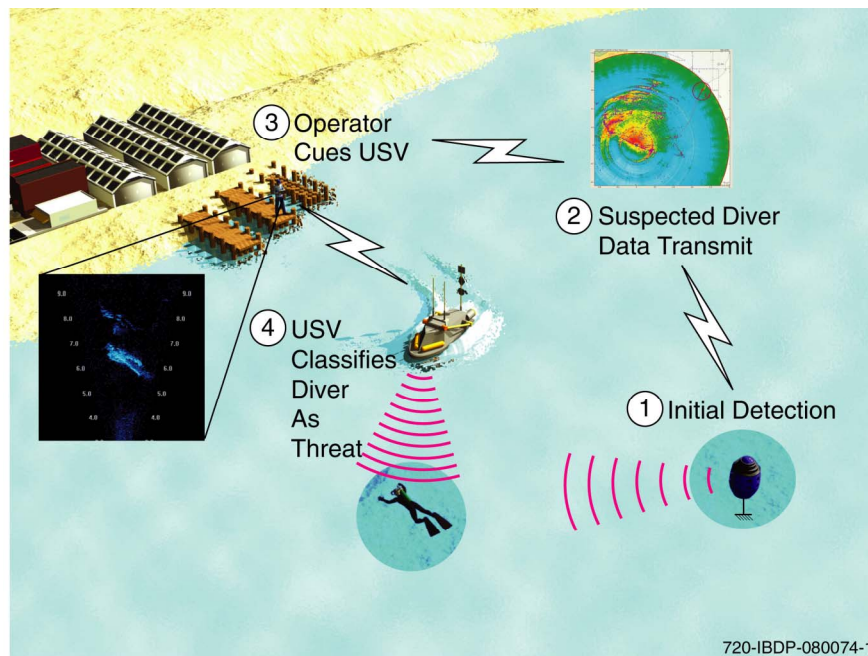

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Figure 1. The Sentry system provides operators and commanders
with the ability to rapidly respond to, identify, and track potential threats.

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14. ABSTRACT
The primary goal of this program is to develop and deploy an Unmanned Swimmer Intercept and Verification (USIV) system for terminal swimmer detection and targeting. This system will provide the US Navy and port security organizations with the ability to detect, track, and assess unauthorized swimmers using autonomous and semi-autonomous operation. The system uses field-proven components integrated into a system that will locate and confirm the classification of a target detected as a potential swimmer by an early warning system. It will provide high quality imagery that commanders can rely upon to take action against surface and underwater threats.

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After an early warning detector such as a Swimmer Detection System (SDS) signals a potential threat, the USIV is dispatched to the target location, deploys underwater imaging equipment, intercepts the threat, and gives the USIV operator and commanders the images required to take further action or not.

This system meets a key current US Navy need while also having application to port security agencies.

OBJECTIVES

Key technical objectives of this program include: 1) the integration of a mission versatile unmanned platform with a mission specific sensor suite utilizing a robust, modular system architecture; 2) assessment of the system concept of operations in a benign and then an up tempo environment; and 3) development and integration of algorithms to autonomously search for and track targets.

APPROACH

Our technical approach integrates the Sentry USV, the Foster-Miller Common Control Unit (CCU), and a DIDSON high resolution imaging sonar and a low light underwater video camera. Additionally, we will develop algorithms for autonomous and semi-autonomous searching and tracking of swimmers.

Sentry Unmanned Surface Vehicle

Our system is based on the Sentry (USV). The Sentry USV (Figure 2) was developed for the delivery of a range of mission-specific payloads. Using a fast, maneuverable jet-ski chassis, it is well suited for operations in a harbor environment. It has no propellers that may be fouled, is self-righting and small, and is easily maneuvered, even at low speeds. The ability to rapidly task and autonomously deploy the Sentry means it can swiftly investigate unidentified targets above and below the water.

The Sentry core platform's suite of standard sensors to support USV operations include a daylight above-water camera system, a QinetiQ Q20 high sensitivity GPS module, and a digital video transmission system. A key asset of the Sentry USV is the Command Control and Mission Management (CCMM) system that provides high-level, goal-driven mission programming for the USV missions.

Figure 2. The Sentry USV is an ideal platform for in harbor use. Adding underwater imaging sensors makes the platform a versatile swimmer intercept and verification system.

Modifications to be made to the Sentry for this program include a remotely operated sensor deployment mechanism, enhanced communications system, and additional mission behaviors designed to allow autonomous and semi-autonomous searching and tracking of swimmers.

Operator Control Unit

A key feature of this system is the operator control unit (OCU). The OCU is used by the operator to task and control the vehicle as well as to view and assess target images. It must be easy and intuitive to use, and reliable and robust under extended operation in marine environments. The software must be reliable, and the graphical user interface (GUI) must give the operator a clear picture of the operational environment - above water and submerged - as well as the vehicle's internal state.

The core of the OCU is the Common Control Unit (CCU) from QNA/TSG/FMI (see Figure 4.) Designed for use in rugged conditions, the CCU is ideal for use in boat- and shore-based environments. The CCU comprises a ruggedized computer, day/night glare-resistant touch screen display, a variety of manual controls, interconnection ports, reliable RF communications, and a splashproof enclosure. The ergonomic controls are designed for use with cold weather clothing.

With the existing software installed, the CCU will allow the user to plan missions, monitor and control missions in progress, and review and analyze sensor and vehicle data after the mission is completed. All OCU applications are self-contained, fully functional without access to external network or computer resources. The operator can transfer mission data from the OCU to external storage including

DVD, USB storage devices, and network storage devices. The open architecture allows third parties to develop new software for the OCU. The OCU's 200 GB of storage allows for at least 50 missions worth of data.
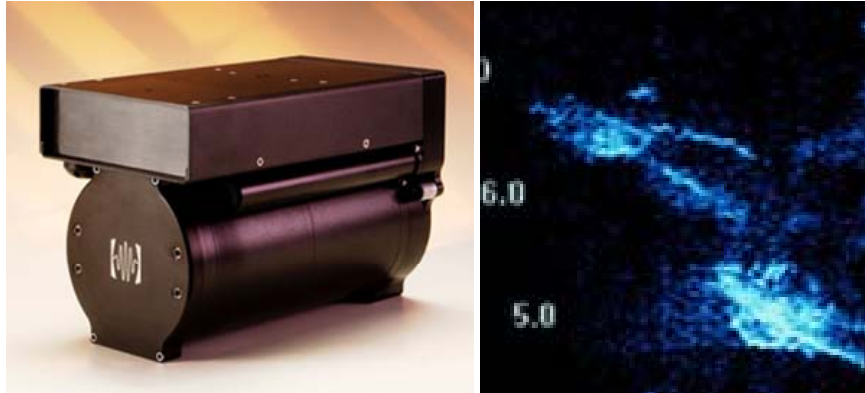

Figure 3. DIDSON high definition sonar (left) and image of two divers (right)

Figure 4. Designed for use in rugged environments, the Common Control Unit is ideal for use in boat- and shore-based environments.

As part of this program, the Sentry vehicle control software and DIDSON application software will be integrated onto the CCU. A new communications interface will be developed to provide a robust wireless link between the OCU and the Sentry vehicle. In addition, a JAUS interface will be developed for both the OCU and Sentry, providing an open interface to both components.

DIDSON Sonar

We will integrate the DIDSON high resolution imaging sonar (Figure 3) from Sound Metrics onto the Sentry platform to provide high quality sonar images of divers in the water. This integration includes the ability to tele-operate the sonar from shore. We will also add the ability to store the sonar on deck

during high speed transit to a suspected diver location and to deploy the sonar into the water for search and tracking operations all on operator command.

The DIDSON sonar provides near video-quality images for inspection and identification of objects underwater and is a surrogate for optical systems in turbid water.

The limited range and resolution of the sonar, as well as the form-factor of the COTS device, present the main technical challenges to integration. We have designed and are constructing a mechanical mount and electrical interface designed for optimal sonar performance. This effort will include significant bench testing (with hardware in the loop), followed by field testing the sonar and its software through deployment from manned boats at speeds that the system will use to track swimmers.

Searching and Tracking Algorithms

We will develop algorithms to transit to suspected swimmer locations, search and identify targets, and track the targets. These algorithms will leverage the capabilities of the Sentry USV, the CCU, and the imaging data from the DIDSON sonar. The goal is to remove low level tasking from the system operator allowing them to focus on higher level situation assessment and response. The algorithms include area searches and image based target tracking.

Key individuals for this program include: Jim Murray, PMP, program manager for QNA/TSG; Rob Knochenhauer, lead engineer for QNA/TSG; Neil Paul, program manager for QinetiQ, Ltd.; and Steve Ray, lead engineer for QinetiQ, Ltd. and developer of the Sentry vehicle.

WORK COMPLETED

Work completed to date includes the development of a draft overall system requirements specification as well as requirements and design specifications for the mounting assembly for the DIDSON sonar and underwater video camera. Procurement and assembly of the sensor suite is nearing completion. The base Sentry vehicle platform has been purchased and design modifications are in progress.

RESULTS

Expected results of this program include delivery of the Sentry system including Sentry vehicle, OCU, and software to the US Navy in FY10. Verification of sensor suite operation is scheduled for early FY09. Integration testing of the sonar and vehicle is scheduled for FY09. Full system integration and demonstration is scheduled for FY10.

IMPACT/APPLICATIONS

In addition to providing the capability to remotely intercept, identify, and track swimmers, the Sentry system will demonstrate a new capability for harbor and shore operations. The ability to remove personnel from the dangerous area around potential threats is a key benefit of this systems and can be applied to other situations. The remotely operated Senty has the potential for additional modular sensor suites for covert and overt surveillance of shore and harbor locations. It also has the potential for use as a weapons platform and for delivering small teams quickly and covertly.

RELATED PROJECTS

This program is related to the Low Cost Swimmer Detection (LCSD) program and the Blocker program. The LCSD program is developing low cost fixed sensors capable of detecting swimmers based in part on previous work by QinetiQ on the Cerberus SDS (Figure 5). This system could be integrated with the Sentry system to provide initial detection of threats and updated threat position as the Sentry transits to and searches for the swimmer.

Figure 5. The Cerberus fixed position swimmer detection system

The Blocker program will utilize the Sentry USV in intercepting and halting noncompliant vessels.