Implementation of JAUS Architecture for Unmanned Ground Surveillance System

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Abstract

This paper presents the design issues and challenges in the implementation of JAUS architecture for unmanned ground surveillance system. The design goal was to control and obtain surveillance data from surveillance sensor suite mounted on the remote vehicle, remotely from the base vehicle and displaying this information on the base vehicle display. This approach provides the distinct advantages of using experimental JAUS messages along with available JAUS messages for controlling the surveillance sensors, mounted on unmanned vehicle.

Keywords: JAUS, Unmanned ground surveillance, Remote vehicle, Base vehicle and Experimental JAUS messages.

I INTRODUCTION

Efforts have been directed to develop and deploy unmanned ground surveillance system, comprising of ground surveillance radar and optical sensors. This paper discusses the design approach and benefit of JAUS architecture for unmanned ground surveillance system.

Unmanned systems reduce exposure of personnel to harmful environments, perform tasks not possible for humans, and provide cost effective solutions to repetitive tasks. Unmanned ground surveillance solution must be mission-suitable, scalable, flexible, maintainable, upgradeable, interoperable, and affordable. These requirements demand the engineered leveraging of commercial-off-the-shelf (COTS) components integrated with specialized hardware and software to deliver a scalable unmanned ground surveillance solution upon which user-driven situational awareness applications can be easily developed and added over time, through low-cost upgrades.

The Joint Architecture for Unmanned Systems (JAUS) is an upper level design for the interfaces within the domain of Unmanned Systems. It is a message passing framework that specifies data formats and methods of communication among computing entities of Unmanned Systems. For ground surveillance purpose the message classes like command, query, inform, report and event are not directly supported. Therefore, we opted to use experimental message creation by adhering to JAUS architecture. In this way, we were able to meet the level 2 JAUS compliance (Node Level). However, some of existing class of messages that were already part of the architecture is also being used. This approach provides the distinct advantages of using experimental JAUS messages along with available JAUS messages for controlling the surveillance sensors, mounted on unmanned vehicle.

This paper attempts to present an approach towards the use of JAUS messaging technology for unmanned ground surveillance system.

II UNMANNED GROUND SURVEILLANCE SUBSYSTEMS

Unmanned ground surveillance system consists of ground surveillance radar, optical sensors, remote vehicle, base vehicle and wireless network components.

1 Radar

The radar is meant to provide ground surface target detection and automatic tracking. This sensor provides real time positional information on all moving ground surface targets over any designated sector.

Information on multiple moving ground surface targets is maintained within the system in the Track While Scan (TWS) mode and target information can be displayed. Continuous Doppler tone and positional updates are provided for any designated target in the single target-tracking mode. Operator controls the operation of the radar using the display unit of base vehicle.

2 Optical sensors

Optical sensor consists of Thermal Imager (TI), CCD camera and Laser range finder (LRF).

TI Camera

Thermal Imager camera provides observation capabilities in full darkness as well as under harsh battlefield and degraded visibility conditions.

CCD Camera

The CCD camera is a high-resolution color camera. This camera operates automatically over a wide illumination range providing high quality images from full sunlight to twilight.

LRF

The Laser range finder (LRF) is used to obtain the range of targets. The LRF line of sight is integrated with the video from the CCD and the IR cameras, so that the LRF can be fired at targets seen through either the CCD or the IR cameras.

3 Base Vehicle

The base vehicle is a manually driven vehicle. It has an Operator Console Unit for navigation, Operator Console Unit for surveillance, surveillance controller and a Human Machine Interface for navigation, which is used by the navigation operator to remotely navigate the remote vehicle.

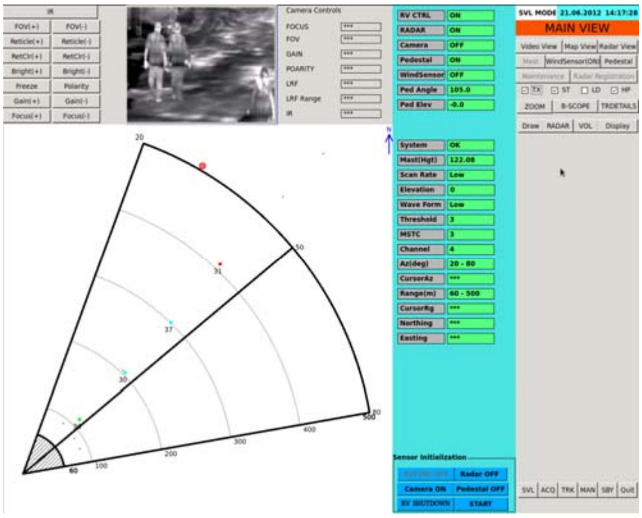

Fig1: Typical Radar and video display on the surveillance OCU

4 Remote Vehicle

The remote vehicle surveillance system is responsible for acquiring surveillance data through the surveillance sensor suite and for transmitting this data to the base vehicle, after suitable processing. The surveillance sensor suite consists of radar, CCD, IR and an eye safe LRF

5 Wireless Network

Communication between base to the remote vehicle is through three RF links - a video link, a command/data link and an emergency link. The video link is for transferring video data, cmd/data link is for the transfer of commands and emergency link is a standby link for the cmd/data link.

III JAUS FRAMEWORK

The Joint Architecture for Unmanned Systems (JAUS) is a messaging architecture enabling communication with and control of unmanned systems.

The Surveillance System is divided into following sub systems w.r.t JAUS Framework:

- Remote Vehicle Surveillance Sub system
- Base Vehicle Surveillance Sub System

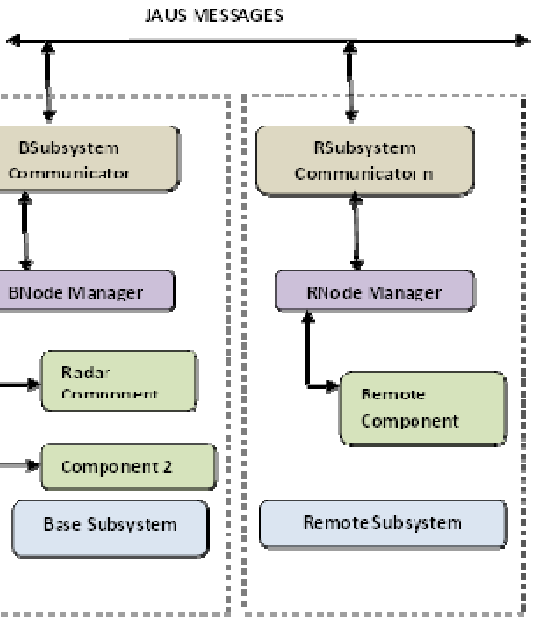

Fig2: Interconnection between Surveillance Subsystems

Remote Vehicle Surveillance sub system consists of:

Communicator - Responsible for sending and receiving messages between sub systems.
Node Manager – Responsible for communication between Communicator and different Components.
Sensor Suite component – Responsible for monitoring and controlling different sensors.

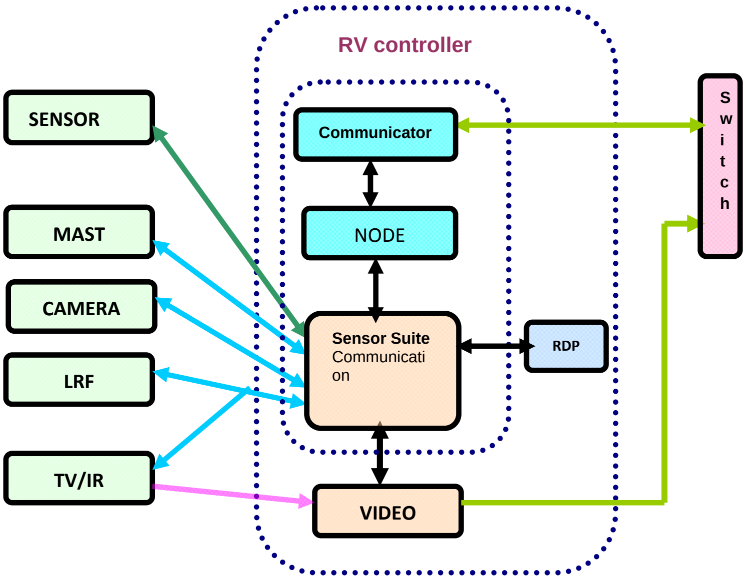

Fig3: RV Surveillance Subsystem Architecture

Base Vehicle Surveillance sub system consists of:

Communicator - Responsible for sending and receiving messages between sub systems.
Node Manager – Responsible for communication between Communicator and different Components.
Radar Component – Responsible for displaying Radar data information sent by RV Surveillance Controller
Config Component – Responsible for configuration of all the sensors.

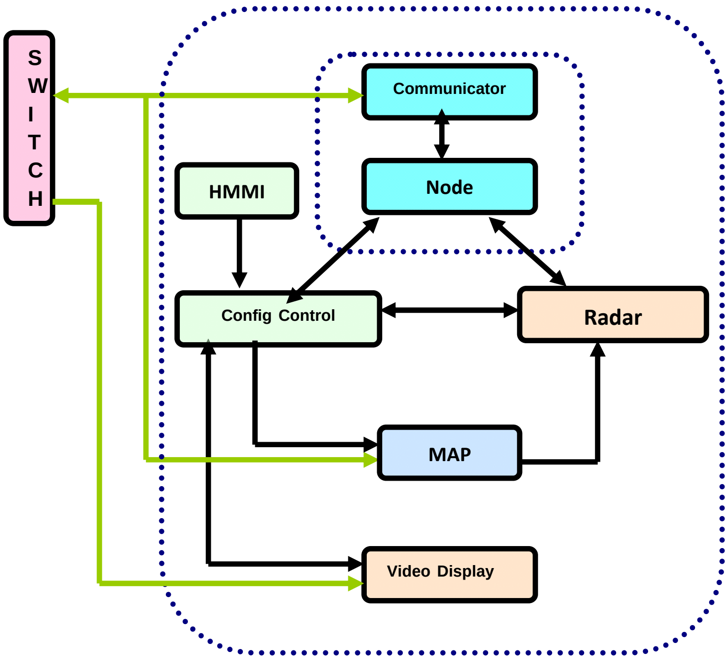

Fig4: BV Surveillance Subsystem Architecture

The experimental messages created for Surveillance Subsystem purpose are as follows:

- Surveillance Controller switching ON/OFF messages
- Sensor configuration messages
- Mode of operation messages
- Target Information messages
- Sensor ON/OFF messages (Radar, Mast, Camera, Pedestal etc.)
- Sensor control messages (Radar, Mast, Camera and Pedestal etc.)

The above types of messages were tested for its level two compliances. The setup includes Surveillance subsystem, Navigation subsystem and Teleoperation subsystem.

Advantages

- Interoperability on other platforms - Mission Isolation
- Supports configurable payloads - Computer Hardware Independence
- Remote Subsystem was developed on different platform and language. Base Subsystem application was developed on different platform and languages.
- Any unmanned subsystems can be added into the main system at any point of time.
- Failure of any component/subsystem will not halt the system.
- Auto discovery feature enables the user to identify subsystems/components availability.
- Mandating message priority
- Determining service connection availability of other subsystems.
- Identification of original data and retransmitted data.

IV VALIDATION

Unmanned ground surveillance system has been tested in real time with the different subsystems. The figure 5 describes the details of system tree where it includes different subsystem, communicators and different components. Whenever any subsystem with or without components added/deleted to the systems, the system tree automatically will be updated.

Fig5: System tree details

V. CONCLUSION

The JAUS framework is used to integrate radar, EO sensors and various other sensors to realize the unmanned ground surveillance system. Because of its modular approach, unmanned ground surveillance system is highly scalable.

It has been shown that unmanned ground surveillance system can be upgraded with relative ease with modification in software and hardware to improve system performance.

It will also be a good platform to experiment on various unmanned ground surveillance applications by appropriately configuring the system.

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