



Human Machine Interface for High-end Optronics Systems in Naval Platforms

Introduction

Optronics System is a combination of optical and electronics image capturing and processing technologies deployed on defence applications such as Naval ships, submarines, aircrafts, drones, and combat ground vehicles. Optronics systems greatly aid in intelligence gathering and real-time situational awareness by providing superior capabilities of ISTAR (intelligence, surveillance, target acquisition and reconnaissance).

This case study outlines Mistral's expertise in design and development of a next-gen HMI system with dual display operator console, touch input panel and powerful GPGPU sub-systems to process and control various functions of Optronics systems in Naval Platforms.

“ This case study showcases Mistral's expertise in design and development of a next-gen HMI system with dual display operator console and control various functions of Optronics systems in Naval Platforms. ”

The Customer

The customer is a leading research and development organisation in the field of optical and electro-optical instrumentation.

The Requirement

The customer approached Mistral to design and develop a Human Machine Interface (HMI) System including operator console hardware and embedded application software for HMI controls and interfacing of various Optronics sub-systems. The Human Machine Interface (HMI) system is a powerful multi-function image processing console that gathers data from multiple Optronics sub-systems in a Naval platform, process the data in real-time and provide crucial, actionable intelligence to the users for tactical decision-making. The operator console had to be of industrial grade and modular in design and consist of multiple displays, input devices and switches for various operations. The HMI electronics had to incorporate necessary hardware for interfacing with various sub-systems of Optronics System and other external systems.

Customer requirement can be summarised as,

- a) Development of Human Machine Interface unit
- b) Functional and performance testing of integrated system
- c) Development of embedded applications and interface with various electronics in HMI and optronic subsystems
- d) Support for simulating various test interfaces

One of the critical requirements was to constrain the overall dimension of the HMI, which had to be of a certain height and width as per the customer specification, because it needed to fit into a compact space.

Solution Provided

Mistral designed and developed a state-of-the-art HMI unit, conforming to customer requirements.

The Integrated HMI unit consists of,

- ▶ HMI console interfacing optronic sub-systems
- ▶ HMI electronics including the processing & display engines, video switching & recording
- ▶ Embedded application to interface various electronics supporting video capture, video switching, annotation & recording
- ▶ Application to communicate between various modules
- ▶ Application for testing interfaces
- ▶ Accessories such as video cables, interfacing cables and power cables for interconnecting different modules.

HMI Console

Mistral designed a modular, industrial grade ruggedized HMI console, which enables easy transportation. The modular structure of the console enables easy disassembly, re-assembly & installation. The enclosure of the HMI console is built using Aerospace grade Alloy HE 30 and powder-coated as per marine standard and equipped with shock and vibration protection. A rugged mechanical chassis is designed to house a 6U VPX Backplane with seven card slots for several modules. The chassis is also provided with an 800-Watt Dual redundant power supply module to power the modules. An additional power supply is incorporated to provide 12V DC output for switching on relays, powering various Optronics cameras and also to power the thermal management devices.



The HMI console is provided with two 21.5-inch LCD panels for displaying data from several Optronics sensors. These LCDs act as the primary displays to provide simultaneous display of images, text, and aid annotation over video images. The panels also display various sensor controls, operating modes & system status.

The HMI console is also provided with a 10.4" Colour TFT LCD touch control panel, a two-axis omni-directional joystick, track ball, keyboard, audio in & out, speakers, push-button switches for powering various connected devices,

IO panel consisting of MIL-grade connectors supporting video inputs, fans, anti-condensation heater, temperature sensors, headphone & a health monitoring unit. The 10.4" TFT panel along with keyboard, joystick, trackball, and other function keys allow the user to interact with the Optronics system. The 10.4" TFT panel also enables communication and control of LCD Displays.

The HMI console is built with a robust EMI rejection, and EMC performance to meet MIL-STD-461F standards. The HMI Cabinet is also designed to comply with Mil-STD-810F standards to meet harsh environmental conditions.

HMI Electronics

The HMI is built around a powerful Intel i7 SBC and Graphics card along with video switching & recording units and several VPX form-factor cards for Ethernet, Serial IO, 1553 XMC & PMC modules & a flash storage of 1TB capacity.

Key components of the HMI Electronics,

- ▶ Intel i7 SBC - 6U VPX Intel Core i7 SBC
- ▶ XMC GPGPU Graphics Card - Rugged NVIDIA Quadro Pascal GP107-based video processing mezzanine module
- ▶ Multi-channel Serial Card - Four Channel Gigabit Ethernet Interface from Tews
- ▶ Network Interface Card - 8 Channel RS232/RS422/RS485 programmable serial interface, HD50 connector
- ▶ MIL-STD-1553B Interface Card - Multi-Channel, Rugged XMC Card from DDC
- ▶ Video Recording unit - Dual Channel HD Video Recorder
- ▶ HD Video Switching unit - HD Video Distribution Unit
- ▶ VPX Carrier Card - Custom designed carrier card supporting both XMC & PMC form factors

Interfaces to communicate with Optronics System

The HMI system captures both digital (HD-SDI, SD-SDI) and analogue (Composite) video inputs from various Optronics sub-systems in the Naval platform. GigE is used within the system to ensure low latency data transfer between video switching and recording units. In addition, Mistral provided interfaces such as RS232, RS422, RS485 and MIL-1553B as required by the customer.

HMI Application

Mistral developed and integrated an embedded application program on RHEL platform using Qt framework in C++ for interfacing and controlling various Optronics sub-systems. The intuitive, user-friendly UI application supports video capture, recording, video switching & annotation. The application allows videos from multiple inputs and different formats and aids the user to easily switch among them in real-time.

How the system functions!

The HMI system has 12 video input channels that receive analog/digital data from several optronic sub-systems in the Naval platform. The video data is displayed in real-time on the HMI system. The UI enables a quad video display on one screen with a provision of input channel selection. The user can also annotate videos from any input channel and the annotated video can be recorded for future analysis and references. The system also provides a real-time recording and playback feature.

Challenges

Dimension and Weight of the System

Integration of multiple displays, VPX enclosure, and several electronics components within the given dimensions was a challenge. This was addressed by adopting a modular design approach, which allows easy disassembly of the system, transportation and reinstallation. The modular design also addressed the installation challenges that would have emerged due to the overall weight and size of the system. The system weighing 170KG, in its assembled form-factor, makes it tough to be transported through the narrow passages that lead to the compact command and control cabin in the Naval platform.

Defining Power Scheme

Defining a power scheme supporting redundancy, relay implementation & powering multiple electronics with single switch was a challenge. To address this, we implemented multiple PSUs controlled by a single switch relay. The modular design enabled accommodating multiple PSUs without impacting the overall size and weight of the system.

Wiring and Routing of Cables

Wiring and routing of many clusters of cables between multiple electronics inside the system has been another major challenge. Mistral custom designed rugged, modular C-section cable tunnels that run through the corners of the cabinet, making the design minimally cluttered and allowing easy insertion / removal of modules to/from the system. The modular tunnels are designed to ensure efficient connectivity between complex functional electronics and other system components.

Achievements

- ▶ The modular, pluggable design architecture of the HMI system enabled easy installation within an extremely compact cabin
- ▶ Designed and developed a VPX Carrier Card supporting both XMC & PMC form factors. This is a unique design as the configuration was not available from any COTS solution provider during the period.

Customer Benefits

- ▶ The modular design of the system enabled faster, easier and efficient installation
- ▶ The modular design also ensures easy maintenance, easy system upgrades, and efficient obsolescence management.



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