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Alaska Aluminum Fast Ferry gets NI-Based Hull Monitoring system

The Challenge: To develop a high-speed hull monitoring system that presents current hull and sea condition to crew while providing long term fatigue analysis information to marine engineers.

The Solution: LabVIEW and NI Data Acquisition hardware for hull sensor monitoring with OPC connectivity for ship instrumentation integration.

Overview

The *MV Fairweather*, the first of a fleet of new aluminum fast-catamaran ferries for the Alaska State Ferry system, needed verification of the safety and stability of its new hull design. Weir-Jones Engineering, based in Vancouver, Canada, asked LightWave Computing to help them develop a LabVIEW software application that would integrate the hull sensor monitoring and other instrumentation into an intuitive computer interface to display to personnel on the ship's bridge a picture of the ship and sea conditions.

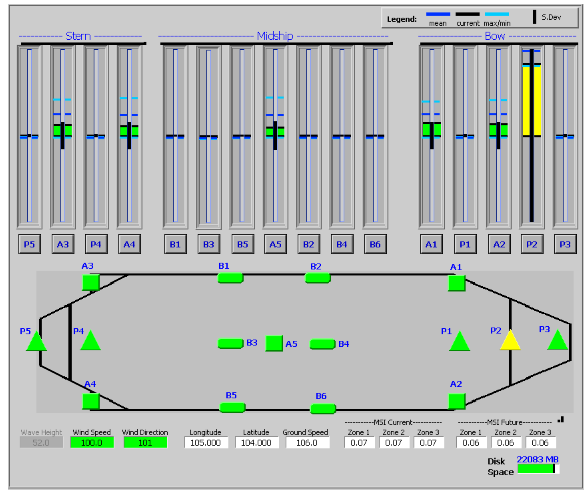
Hull Monitoring System

The hull monitor reads in a cluster of sensors at strategic points throughout the ships stress members:

- **Triaxial Accelerometers** quantify ship movement in the cabin and at various points about the vessel.
- **Pressure Transducers** measure hull slamming during high-sea conditions.
- **Bending Bars** measure the amount of hull flexing during a voyage.

The hull sensor data is streamed to disk in binary format from a 64 channel NI Data Acquisition card as soon as a signal detects that the ship is underway. Statistical information is calculated in real time and saved periodically to form daily, monthly and annual records of the hull performance.

All the hull sensors have two levels of alarm that alert the crew if a rogue wave impacts the ship's hull. There is also a sensor failure indicated on the display if any of the sensors become damaged. The user interface gives instant feedback of the alarm location, type and severity. Bar graphs also indicate average and standard deviation of a sensor signal while pop-up displays reveal details of the sensor location and statistics. Separate Alarm and Trend screens allow closer on-line inspection of the ship hull condition.



Hull Monitor Main User Interface

Motion Sickness Reporting

The triaxial accelerometer data is also used to generate real-time motion sickness index (MSI) information to help navigational crew quantify the probability of motion sickness affecting passengers on the vessel. The MSI index determines the percent probability of motion sickness instantaneously and two hours into the future at three separate locations on the vessel. This complex MSI algorithm was already developed by Weir-Jones Engineering in the C programming language. LabVIEW's ability to import the MSI DLL directly into LabVIEW avoided a time consuming and costly translation of code that was already well proven.

On-Line Fatigue Analysis

While the ship is underway, the bending bars and Accelerometers are also undergoing continuous Rainflow counting. Rainflow counting allows marine engineers to quantify the cumulative stresses in a section of the ship's hull by counting the number of bending or acceleration cycles along with the amplitudes of those cycles. The cycle amplitudes are separated into bins in a histogram chart and are available on the hull monitor's user interface for instant feedback.

Integrating Marine Instrumentation

Beside the hull monitor, the LabVIEW software was required to read multiple RS-485 based ship instruments that communicate using a standardized National Marine Electronics Association (NMEA) protocol. These included separate instruments delivering wind conditions, ship speed and GPS data. A ship Automatic Draught Indicator System (ADIS), developed by Weir-Jones Engineering, uses ultrasound to measure the distance to the water at different points in the vessel and then calculates wave height and available weight capacity on the ship. The LabVIEW software logs all of this information, then filters and passes it onto other ship monitoring and alarm systems using LabVIEW's built-in OPC functionality. LabVIEW's ability to easily collect and redistribute sensor data helped streamline the data flow to other bridge instrumentation.

Post- Analysis

Separate applications were developed to allow post-analysis of the accumulated data by regulatory authorities off-site. A raw file viewer allowed users to easily move through the data to determine the time and severity of various wave events at sea. A statistical file viewer allowed users to analyze daily, monthly and annual statistics data. A Rainflow file viewer allowed users to compare the Rainflow histograms between various ship sensors.

Conclusion

National Instruments hardware and software tools helped LightWAVE computing quickly deliver to Weir-Jones Engineering a sophisticated ship monitoring system that enabled marine engineers to validate the ship hull while giving the bridge personnel the information they need to ensure the traveling public's safety and comfort.

For more information on this project or if you would like an assessment of your Testing or Machine Automation requirements, please contact Rob Taylor at Light*Wave* Computing.

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