ULTRASONIC MODE IMAGING (UMI) TECHNOLOGY



Monitoring Navy Ships for Real-Time Hull Defect Growth

For Presentation to JTEG Tech Forum on NDI





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CMPWG'S VISION



- Develop an effective Structural Health Monitoring (SHM) system for US Navy ships
 - Based on Ultrasonic Mode Imaging (UMI) Technology
 - Monitor large area of hulls/structures for crack initiation and growth
- MSC UMI Pilot Project
 - Deploying UMI on a Ship for the first time ever
 - Created to usher in the future SHM system
- UMI Technology has the potential to significantly reduce Navy ship maintenance costs and operating risk



MSC UMI PILOT LOCATION









- Learn about the at-sea environment
 - Background noise and effects on analysis
 - Heat, cold, vibration, moisture and its effects on hardware
- Demonstrate UMI can detect hull cracks underway in an area of known concern
- Leverage MSC Pilot as a bridge to use in all Navy ships



PILOT PICTURES – STBD OUTBD SPACE





A system laptop, external hard drive, and Ethernet switch connected to two sensor arrays and associated data acquisition electronics









UNDERWAY RESULTS



- Hardware and software performing well in shipboard environment
 - Sensors working well with no issues
 - Electronics had minor problems which were easily corrected
- Can detect pencil lead breaks (crack signals) underway
- UMI system has overcome shipboard background noise
- Can differentiate hull bumps (from tug), rubbing, fretting, and actual crack indications

MSC Pilot Serving as Excellent Proving Ground for UMI Technology





THE TECHNOLOGY

ULTRASONIC MODE IMAGING

IMPROVING INSPECTIONS



ULTRASONIC MODE IMAGING



ULTRASONIC – The **IMAGING** – Using the frequency range the measurements from the **MODE** – Using the wave modes measurements are modes to image the flaw in the signal to measure the performed in source or the structure effects of the source and structure on the wave

propagation



UMI SYSTEM







PASSIVE FLAW GROWTH DETECTION



- Source is not controlled in passive monitoring
 - Orientation
 - Frequency content
- Modes excited by the source are contained in the signal cannot violate the laws of physics
- Analysis must be able to automatically identify the modes to be able to identify the source



WAVELET TRANSFORM – IMAGE ANALYSIS







ENHANCED SHM SYSTEM



- NASA SBIR Phase II Project
 - Developing innovative sensor designs
 - Developing advanced signal processing electronics
 - Using wavelet transform image analysis software
 - Developing Prototype UMI system for testing IN USNS NEWPORT
 - Will be installed in USNS NEWPORT in about March 2023
 - Will be tested for last 3 months of NASA SBIR project
 - After that, will be turned over to the crew for operation and use



WHY DOES ALL THIS MATTER? QUADRUPLE THE RANGE



PILOT

PROTOTYPE



We expect NASA Prototype to deliver 4 times the range of the Pilot System

10 Feet