Department of the Navy SBIR/STTR Transition Program

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Topic # N172-123

Wave Characterization from Improved Navy Lighterage System (INLS) Warping Tug Motions

Creare LLC

WHO

SYSCOM: NAVFAC

Sponsoring Program: Improved Navy Lighterage System (INLS)

Transition Target: INLS Warping Tug

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Other transition opportunities: The size of the market could grow to several hundred units if the system were to be used on Navy Causeway Ferries, Land Craft Utilities, Land Craft Air Cushion, and Army landing craft. The system can be commercialized by ship builders and is also suitable for foreign military sales.

US Navy Photo

Notes: The Warping Tug is the backbone of the Improved Navy Lighterage System. The flat bottom hull structure provides a very stable platform to work around ship to shore vessels and the causeways connecting them to shore. The vessel is rated to safely operate up to sea state 3.

WHAT

Operational Need and Improvement: The Improved Navy Lighterage System (INLS) has expanded Naval capabilities. The INLS enables cargo transfer in areas of operation where access to port facilities is limited or contested and is the backbone of logistic support for humanitarian assistance and disaster response missions. However, the INLS is only designed to be operated at Sea State 3 or below. Sea state determination, while critical to safe operation of the INLS, is currently made subjectively by Navy personnel—a process that is very difficult and highly dependent on the experience of the individual making the determination. To address this issue, Creare is developing a Sea State Predictor to enable automated, highly reliable determination of sea state.

Specifications Required: The system must be capable of determining the local wave environment in near real-time, including significant wave height, the associated period, and the predominant wave direction. The ideal system would calculate these parameters using only the recorded motions from the INLS warping tug and would not require the deployment or use of other ancillary wave measuring equipment. The system must be compatible with the existing warping tug interfaces, and require as little modification to existing infrastructure as practicable. Wave characteristics must be displayed and recorded locally on a graphical user interface.

Technology Developed: Creare's Sea State Predictor (SSP) determines sea state from motions of the INLS warping tug. The system relies on commercial hardware components combined with a custom software code to measure the motion of the tug when mounted in the pilothouse. These inputs are then processed using a numerical model of vessel geometry and wave response to determine sea state, significant wave height, and wave period.The SSP leverages the warping tug itself as a "wave gauge." A major benefit of this approach is that the entire system is contained in a small box on the bridge of the warping tug. The system includes an Inertial Measurement Unit (IMU) containing accelerometers and gyroscopes that measure all six degrees of freedom of the motion of the tug. Analytical models are used to account for the fact that the warping tug's motions will not follow the water surface exactly. For example, small wind chop may not cause any vertical motion of the tug, while larger swells whose period correspond to the inherent resonance of the tug may result in larger than expected heaving motions. This response is captured in a numerical model of how the tug responds to incident waves. A family of models is used to capture the nonlinear behavior of the tug in different wave conditions.

WHEN

Contract Number: N68335-19-C-0579 **Ending on:** September 24, 2020

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Characterization of scale model in wave tank	Low	Accurate modeling of vessel motion	2	July 2019
Validation of IMU for the application	Low	IMU deemed appropriate	3	August 2019
Validation of noise filters and measuring vessel dynamic response	Med	Signal strength meets targets	4	March 2020
Prototype SSP developed	Med	Navy accepts design	4	November 2020
Prototype testing and evaluation	Med	Performance validated against gold standards	5	February 2021

HOW

Projected Business Model: Manufacturing and Distribution Plan. In 2010 Creare created a sister firm (Edare) for the purpose of transitioning our research efforts into commercial products. Edare has its own in-house fabrication, assembly, and engineering capabilities in a 20,000 sq. ft. facility located in Lebanon, NH. Edare has transitioned another system developed by the Creare project team into a full commercial product. This system is an optical measurement tool used to measure fastener flushness with respect to the skin of the F-35 aircraft. The underlying technology was developed at Creare and then transitioned to Edare who finalized the mechanical design to assist in manufacturability. Edare is currently building systems for sale to the commercial market, training the customer on use of the system, and providing field support for previously sold systems. Creare will use the same approach to manufacture, sell, and sustain Sea State Prediction Systems.

Company Objectives: Fully qualify prototype pre-production units, then build, provide, and sustain SSPs for the Navy.

Potential Commercial Applications: Creare's SSP innovation is designed for the Improved Navy Lighterage System but is adaptable to vessels with a variety of hull forms where increased capability of anticipating and reducing vessel response is needed. Specifically, SSP measurements and algorithms could integrate with PEO Ships' Environmental Ship Motion Forecasting (ESMF). Like ESMF, Creare's SSP is a tool that forecasts wave motion and ship motion response. Our SSP could integrate with, or replace elements of ESMF, to extend the operational environment for various missions by predicting time periods or ship headings where cargo movement may be conducted despite sea states normally considered beyond safe operating limits.

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