OBJECTIVE: Develop a system to restore image degradation caused by a rolling shutter and correct for motion blur during fast periscope panning.

DESCRIPTION: Future submarine periscopes or future submarine off-board systems will employ Complementary Metal-oxide Semiconductor (CMOS)-based imaging systems operating at high resolution of 8 megapixel pixel density or greater, which pan across and image the scene. Some of these imaging systems will use rolling shutter-based imaging chips. Artifacts in rolling shutter imagery present challenges for many Navy maritime image-processing algorithms and severely affect Navy photogrammetry algorithms, which require highly accurate, geometrically correct measurements. In rolling shutter sensors, each row in the image is collected at a slightly different time, which results in scene distortion due to moving objects, platform motion, and panning. This makes single-frame image processing and multi-frame image registration difficult due to blur and pixel location errors. Approaches for mitigating rolling shutter effects include both video-processing algorithms and inertial measurement unit (IMU) data-processing algorithms. For image processing-based approaches to rolling shutter mitigation, the maritime environment presents a challenge due to the lack of consistent scene texture, as opposed to terrestrial imaging. For IMU-based approaches, raw IMU data may not be available, may have low fidelity, or may have time synchronization errors, which decrease the ability to accurately determine the camera’s attitude during image collection. The Navy seeks to address these challenges and improve intelligence, surveillance, and reconnaissance (ISR) capabilities to detect, track, 3D model, and geo-locate targets using on-board or off-board low-cost sensors in maritime environment. The approach will reduce motion blur and correct pixel geolocation.

To modernize key capabilities for advance naval operations from the perspective of sensing and navigation, the Navy must manage the operational environment and develop advance capabilities that exploit novel principles to bring new affordable capabilities to the warfighter. The technology identified in this SBIR topic will enable faster situational awareness; enhance enemy, friendly, and neutral ship detection and classification; and improve safety of ship navigation.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. Owned and Operated with no Foreign Influence as defined by DOD 5220.22-M, National Industrial Security Program Operating Manual, unless acceptable mitigating procedures can and have been be implemented and approved by the Defense Security Service (DSS). The selected contractor and/or subcontractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances, in order to perform on advanced phases of this contract as set forth by DSS and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material IAW DoD 5220.22-M during the advance phases of this contract.

PHASE I: Develop a concept for an algorithm to reduce motion blur and correct pixel geolocation in imaging data collected from a rolling shutter Complementary Metal-oxide Semiconductor (CMOS) camera systems as discussed in the Description. Demonstrate the
feasibility of the concept via analysis or data collected with cameras provided by the vendor. The Phase I option, if exercised, will include the initial capability description to build a prototype for Phase II. Develop a Phase II plan.

PHASE II: Develop and deliver a prototype algorithm for testing and evaluation. Ensure that the algorithm runs in real time and demonstrates motion blur reduction by showing improvements in edge sharpness, edge spread function, or other quantitative metrics. Test the algorithm with data provided by the Government at the developer’s facility and/or a government facility. Prepare a Phase II development plan to transition the technology for Navy and potential commercial use. It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL-USE APPLICATIONS: Support the Navy in transitioning the algorithm for Navy use through the Technology-Insertion / Advanced Processing Build (TI/APB) process into the submarine combat system (across multiple classes of submarines). Support the TI/APB process, which includes several steps of testing, both laboratory and at-sea, using Government-provided data sets.

REFERENCES:


KEYWORDS: Maritime Imaging; Periscope Imaging; Rolling Shutter; Image Enhancement; Complementary metal-oxide semiconductor; CMOS; Advanced Processing Build; Motion Blur