STIC Note

Boat Crew Wearable Robotics

BACKGROUND/PROBLEM

Coast Guard boat operators are often required to conduct high-speed missions in rough seas that often result in subjecting the operators to high forces from wave impacts. Service members can suffer severe injuries from these impact forces or long-term exposure to these types of missions. USCG boat crews have enacted procedures and adopted equipment such as shock-absorbing seats to prevent these injuries. A wearable robotics system could be an additional method to protect USCG boat crews from injury. The Office of Boat Forces (CG-731) in conjunction with the Maritime Security Response Team (MSRT) requested that the STIC evaluate the Roam Robotics Forge System's effectiveness in reducing impact forces on their operators.

The Roam Robotics Forge System consists of two major components: a modular power pack and robotic knee system. The modular power pack consists of a small battery, air compressor and computer that provides artificial intelligence (AI) guided control. The power pack is worn as a backpack and can be seen on the operator in Figure 1. The robotic knee consists of a pneumatic actuator and brace to assist in power transfer while providing support to the user. The Forge System evaluated had two user modes. One mode provided constant supportive force and the second mode was predictive and assistive to the user's motion.

Figure 1. Roam Robotics Forge System undergoing evaluation by MSRT-E. (Source: USCG)

METHODS

The STIC worked with MSRT-East and Roam Robotics to identify a training mission to conduct an evaluation of the Forge System. For the evaluation, the STIC team employed three

Endaq S3 accelerometers to record the G-forces on the boat and its crew. One accelerometer was worn by an operator with the Forge System, a second operator wore the accelerometer without the system, and one was mounted on the boat. User feedback on the comfort and effectiveness of the system was gathered from the boat crew (in addition to the accelerometers).

EVALUATION

The STIC developed a test and evaluation plan for the system to include a non-attributable questionnaire to gather user feedback on the system. A Roam Robotics representative provided basic system familiarization for all participants before the evaluation. MSRT operators evaluated the Forge System while conducting high-speed boat maneuvers in the Chesapeake Bay. Before the evaluation, the system was weighed to ensure adequate buoyancy if an operator fell overboard. The accelerometers recorded all accelerations in all directions during the entire training event. After the evaluation, the STIC Team gathered comment cards from every crewmember that wore the system.

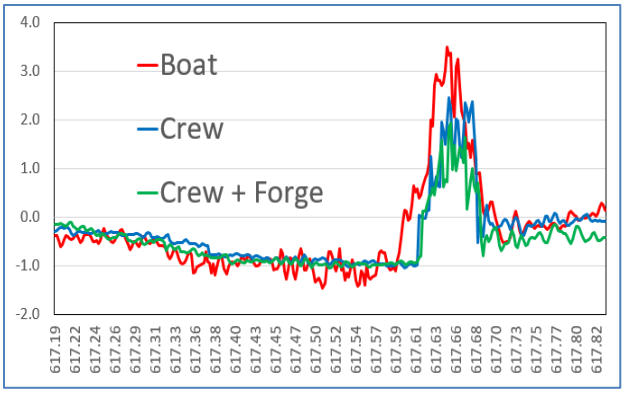

Figure 2. G-forces of operations with and without the Forge System. (Source: USCG)

CONCLUSIONS

The user feedback gathered during the evaluation was very positive. Most users indicated they could feel that the system was reducing the impact forces during the training exercise. No users reported any interference issues with existing gear worn by the operators. Analysis of the accelerometer data generally indicated a reduction in the G-force experienced by the operator wearing the Forge System. However, measurements were taken at different longitudinal locations on the boat which makes comparison less accurate. Other factors like how the different operators braced for impacts and the rigidity of the accelerometer attachment could also have had an effect on the data collection. The system evaluated was not intended for maritime use and Forge is working towards optimization for maritime applications.

FUTURE WORK

Roam Robotics continues to refine the Forge System for maritime applications in conjunction with other US military organizations. Current developments are focused on making the system more waterproof and neutrally buoyant. The STIC team will continue to monitor the development of this and other wearable robotics that could help prevent boat crew injury.

The Science and Technology Innovation Center (STIC) is a DHS S&T and USCG collaboration.