PROJECT SUMMARY

Overview:

This project aims to broaden participation in future subsea works via a human-robot sensory transfer approach that substantially lowers the barrier of underwater robot teleoperation and cultivates an inclusive subsea workforce and industry. Subsea industry provides a historical opportunity for new economic growth and scientific discoveries. Subsea activities heavily rely on underwater robots e.g., remote operating vehicles (ROV). ROV operation remains a highly specialized work that requires years of training and licenses. This project proposes a new underwater human-robot interaction (HRI) based on sensory augmentation and virtual telepresence to simplify ROV-based offshore inspection, and thus attracts workforces from other industries to enter a subsea career. Thrust 1 will create a mixed reality (MR) sensory simulator to convert ROV sensor data into human-perceivable sensations. ROV sensing and data infrastructure will be optimized to meet the need for subsea. To further reduce the transferred data amount for fast visualization, reduced-order hydrodynamic modeling will be examined. Thrust 2 will assess improvement in operation accuracy, training efficiency, and operator's confidence for ROV using the proposed HRI via field tests and simulation experiments. It will also evaluate if it increases the willingness of workers from other domains to start a career in subsea industry, and adult learning performance. Thrust 3 will examine the HRI viability in terms of transforming workforces for scaling up the future subsea industry. It also involves activities to certify the proposed HRI to promote industry adoption. This project features a strong partnership with industry, through American Bureau of Shipping, the world's largest classification organization for maritime industry. The outcomes will set a stepstone for human deep-sea exploration and inspire workforce transformation for other industries that have experienced adversarial impacts from automation.

Intellectual Merit:

This project will reconceptualize future subsea industry by advancing knowledge of underwater HRI in under-explored subsea workplaces, illuminating socioeconomic features and adult-learning needs of workforce transformation to subsea industry, and establishing academia-industry-government partnerships for improving performance, safety, and societal outcomes of subsea works. Novel human-robot sensory transfer methods are proposed for reliability against conditions unique to subsea. These methods will support fast and accurate reconstruction of subsea workplaces. MR will be used to generate human-perceivable simulation of remote subsea workplaces in real time based on feedback from a novel robotic sensing and data transmission system. Motion capture will be created for easier navigation of ROVs. This research will establish new knowledge on motivational and educational determinants of introducing "idiot-proof" collaborative ROVs to augment transformative workforce for future subsea robot operations, through extensive participation from industrial partners. The assessment will integrate techniques from psychometric and behavioral sciences as well as engineering and human factors. The work will also pioneer the development of a new subsea job framework for integration of ROVs into a participatory delivery of core subsea services in the future. The economic benefits of robotic adoption will be estimated based on demand projection and elasticity estimation. This research will transform the frontiers of human-technology partnership in the context of the future subsea industry, reposition workforce threatened by automation in other domains, enhance future workers' safety and well-being, and improve subsea operation performance, thus enhancing the long-term sustainable ocean exploration.

Broader Impacts:

This project will establish a Subsea Generation Initiative (SGI) consortium with industry partners to disseminate knowledge and promote interests in subsea industry. SGI will create training materials for future ROV collaboration and reduce personnel onboard time. This project empowers women workers and allows aged or injured workers to continue, thus reducing skills gaps. Findings can provide insights on continuous human adapting to HRI. Moreover, education requirements for robot applications can generate recommendations for future workforce training with robotic augmentations. The MR models developed in the project will be transferred to subsea service providers and clients to enhance immersive training. The project involves advancements in Robotics, AI, HRI, and MR in promoting STEM teaching.