Project Number: 16

Project Title: Ground Sensor Phase 2

Sponsor: US National Security Innovation Network and the USN, USMC

Project Description:

Marine Corps units need a way to efficiently sense an adversary's location or network signatures in a named area of interest using rapidly deployable sensors to provide timely and detailed information to aid a Commander's decision-making. This project will be a phase 2 project expanding and optimizing the functionality of the small ground sensor created by the 2020-2021 senior design capstone project "Team Argus".

Marines require a sophisticated understanding of where adversary forces are located within their battlespace. To keep pace with a quickly evolving battlespace, sensors would be most effective if they were networkable, lightweight, disposable, and integrated into a user-friendly, intuitive monitoring display. An adversary could be sensed in many different ways: foot movements give off a seismic-acoustic signature, vehicles emit a ferrous metal signature, body heat provides a thermal signature, and electronics produce a radio-frequency signature to name a few. A remote, unattended sensor's ability to alert a Marine to any of these signatures would provide useful battlefield data, focusing a team on suspected adversary locations.

The Phase 2 team will focus on optimizing the form factor, reliability, durability, weight, and performance. The work will include:

- Test and Evaluate the Prior Project Design
    - Evaluating the prior year's team device performance including conducting field testing.
    - Evaluate the prior year's requirements. Make the requirements more specific and realistic.
- Develop the Phase 2 design including new requirements. Simplify and optimize the design.

- Stretch goal: Develop a delivery method capable of being launched into position by team or sponsor chosen launcher. Due to the launching requirements, device must be able to withstand landing impact and right itself or work regardless of orientation.

Project Key Deliverables

- Test and Evaluation data/analysis of the existing design.
- Phase 2 design that meets the requirements. The team will deliver a rugged and weatherproof device that provides sensor functionality to meet the requirements.
- Test and Evaluation data/analysis of the Phase 2 design.
- All hardware, software and any testing equipment/apparatus.

System Requirements:

In addition to an updated version of the 2020-2021 project requirements, these will apply:

- Battery: The device will be battery powered, and the battery size and technology will be based on the communication technology (high or low power), the rate of interrogations, and the required battery life.
- Audio:
    - The device shall record audio in a one-hour memory.
    - The device shall accept a remote command to retrieve any audio segment provided it was recorded during the past hour.
    - The device shall have the hardware and firmware structure to perform audio processing, however, it will not provide sophisticated detection algorithms.
    - Small ground sensor capable of covertly monitoring remote areas in real-time with wireless user accessibility. Marines require a networkable, lightweight,disposable, and user-friendly device that is capable of

monitoring an evolving battlespace. These ground sensors shall be dispersed along key locations to detect possible adversaries by methods of acoustics, visuals, and motion. This device shall provide key information to the consumer to aid in their decision making.

- Seismic: The device shall include a low-power seismic sensor such as this one. Seismic activity shall be recorded in a one-hour memory and be retrievable via a remote command.

- Video: The device shall include a low-power video camera that stores video as either images or as video. Customer requirements and memory size will determine the exact specification. Video shall be retrievable via a remote command. As a stretch goal, the device shall stream live video and rotate the camera on command.

- Remote Command Interface: A command set must be identified so the unit can accept commands/queries and upload data. The command interface must be abstracted so that it can communicate over WiFi or over a land mobile communication link such as P25 or using a proprietary radio/modem. Alternatively, the user can provide one of their own data link radios.

Out of Scope work:

- The deliverable design/system will be limited to the remote stations which will communicate via Wi-Fi or longer distance land mobile backbones.
- The system does not include a centralized application. The system will not have advanced intelligence for detecting intrusion such as machine learning or recognition of specific signatures. However, with its sensor and communication technologies, as well as its ruggedness, will serve as an excellent development platform for graduate students or DOD personnel.
- The deliverable design/system will not include sophisticated algorithms for intrusion detection, though the firmware structure and protocol will include the

placeholders. It is anticipated that effective detection will include self-awareness, environment acclimation, and machine learning which is beyond the capability of the undergraduates.

This is a candidate for a joint ME/ECE project which means both ME and ECE students will be assigned and will work together for the duration of the project.