

The exploration of the presumably life harboring subsurface ocean of Europa will provide scientists with extensive new knowledge in the search for extraterrestrial life. A highly miniaturized payload is required to penetrate a narrow passage through the thick ice crust covering Europa's surface. Underwater wireless communications may be the most viable means of communication for such exploratory missions, accounting for size and weight restrictions. This presents a challenge to achieve satisfactory data rates and a range that permits autonomous underwater vehicles (AUVs) to communicate within their region of operation, as well as with a surface lander or orbiter. This work presents thorough prototype experimentation on an underwater communication system established between several nodes using RF signals.

During an eight-week internship experience at NASA's Ames Research Center in September-October 2014, our team developed a Europa exploration mission concept, built representative hardware, and carried out tests to assess the feasibility of key aspects of the concept. Experiments demonstrating the viability of RF communication underwater comprised inspecting the effect of depth and horizontal distance on signal strength as well as the optimum positioning of antennas. To test the system's performance, two submersibles were designed and built. A commercially available remotely operated vehicle (ROV) was also modified and used as a main communication node. The two submersibles were wirelessly connected and accommodated sensors capable of characterizing water properties and equipped with 2.4 GHz, 1 mW transceivers to communicate the measured data. The communication procedure is that the main communication node requests the collected data from the two submersibles when in range and receives it instantly through RF. This work models what may take place during an actual mission to Europa. The developed mission concept involved a hybrid communication system consisting of acoustic and RF signals to enhance the capability of the nodes to communicate over greater distances. The AUVs will need to avoid obstacles and maneuver around to collect data based on predefined algorithms. Thus, they will be provided with two positioning systems; the inertial navigation system, backed with an acoustic positioning system to mitigate drift. The AUVs divide the ocean into planes and explore along circular paths increasing in diameter with depth. Moreover, they make use of miniaturized sensors to map the surrounding environment. In this paper, the ROV and the submersibles are described, along with sections explaining the mechanism of communication and the testing procedures conducted to yield results.