Abstract

SHARC Buoy

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Sea ice in the Antarctic Marginal Ice Zone (MIZ) plays a pivotal role in regulating heat and energy exchange between oceanic and atmospheric systems, which drive global climate. Current understanding of Southern Ocean sea ice dynamics is poor with temporal and spatial gaps in critical seasonal data-sets. The lack of in situ environmental and wave data from the MIZ in the Antarctic region drove the development of UCT's first generation of in situ ice-tethered measurement platform as part of a larger UCT and NRF SANAP project on realistic modelling of the Marginal Ice Zone in the changing Southern Ocean (MISO). This thesis focuses on the firmware development for the device and the design process taken to obtain key measurements for understanding sea ice dynamics and increasing sensing capabilities in the Southern Ocean.

The buoy was required to survive the Antarctic climate and contained a global positioning system, temperature sensor, digital barometer and inertial measurement unit to measure waves-in-ice. Power was supplied to the device by a power supply unit consisting of commercial-grade batteries in series with a temperature-resistant low dropout regulator, and a power sensor to monitor the module. A satellite modem transmitted data through the Iridium satellite network. Finally, Flash chips provided permanent data storage. Firmware and peripheral driver files were written in C for an STMicroelectronics STM32L4 Arm-based microcontroller. To optimise the firmware for low power consumption, inactive sensors were placed in power-saving mode and the processor was put to sleep during periods of no sampling activity.

The first device deployment took place during the SCALE winter expedition in July 2019. Two devices were deployed on ice floes to test their performance in remote conditions. However, due to mechanical and power errors, the devices failed shortly after deployment. A third device was placed on the deck of SA Aghulas II during the expidition and successfully survived for one week while continuously transmitting GPS coordinates and ambient temperature. The second generation featured subsequent improvements to the mechanical robustness and sensing capabilities of the device. However, due to the 2020 COVID-19 pandemic, subsequent Antarctic expeditions were cancelled resulting in the final platform evaluation taking place on land. The device demonstrates a proof of concept for a low-cost, ice-tethered autonomous sensing device. However, additional improvements are required to overcome severe bandwidth and power constraints.