Combat Search and Rescue Location and Communication

2019-2020 Air Force Research Laboratory - University Design Challenge

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Objective

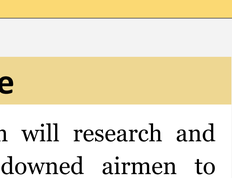
The UMD AFRL design team will research and develop a system allowing downed airmen to determine their position and assist in their communication with search and rescue personnel during a water rescue and recovery event. The system developed by the UMD design team will assist in locating the downed airmen and establishing and maintaining communication until rescue under potentially hostile conditions.

Constraints

- Capable of determining location and performing communication worldwide.
- Resistant to hostile jamming and spoofing.
- Functional in open water and barren environments.
- Minimize size while maintaining practicality.
- Budget: $25,000

Design Focus After Expert Input

Following input from Subject Matter Experts (SME) it was decided to focus on shortcomings of existing solutions such as the General Dynamics Mission Systems HOOK3 CSAR radio. Existing search and rescue radio systems primarily rely on satellite systems for both location and communication (GPS, satellite radio repeaters, etc). It was decided to address this shortcoming.


General Dynamics HOOK3 radio

Goal:
Eliminate Reliance on Satellite Systems
Primary Methods:
Shortwave Radio
Celestial Navigation

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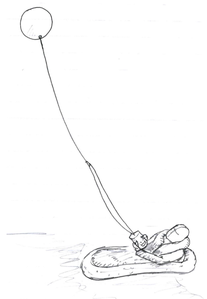
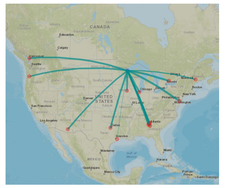
Design Components

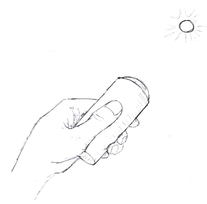

Concept of the shortwave radio antenna in use.

Shortwave Radio

- Viable for long range communication on low power but requires long antenna.
- A ~33 ft balloon hoisted antenna was prototyped.
- Modern Software Defined Radio (SDR) hardware means the entire radio package can be small.
- The antenna will be provided as a 'package' in a pilot's seat kit.

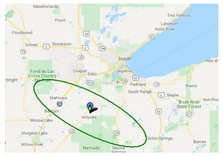

The shortwave antenna during testing.


Messages received over shortwave radio at 14.09 MHz during testing. Many came from 1000+ mi away.


Concept of the automatic celestial navigation device

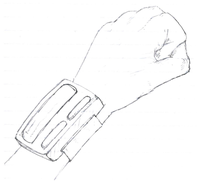
Celestial Navigation

- Technique to determine your global location proven by hundreds of years of use.
- Current process is highly manual and takes training and skill to perform.
- The process can be automated using modern hardware and computer vision.
- System being developed could be used in a standalone device or integrated into a larger device such as a SAR radio.


Test fix ~26 mi from sighting location at UMD.

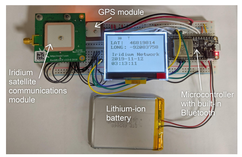

Celestial navigation development hardware


Hardware being developed for the handheld/integrated celestial navigation device. Uses a camera and computer vision to create an automated digital sextant.


Concept of the Satcom watch

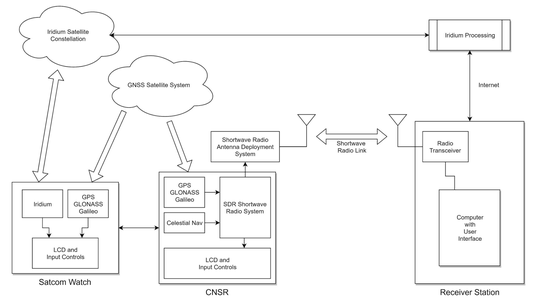
Satcom Watch

- Uses standard satellite technology, but offers better interface to using it.
- Wireless linking to larger 'parent' radios allows quick control and message display without needing to use the larger device.



Prototype of the Satcom watch.

Final System



System overview diagram for SAR radio system with redundant communication and location systems in the case of satellite communication jamming.

The final system is meant to augment existing search and rescue radio systems. In the case a standard GPS and Satcom radio loses capabilities due to jamming, the Celestial Navigation Shortwave Radio (CNSR) can be used. The Satcom watch would function as both a standalone satellite communicator and a better interface to both the CNSR and existing SAR radios.

The project phase 2 team (Spring 2020) will be responsible for integrating the design components developed by the phase 1 team (Fall 2019) to create the final CNSR and Satcom watch prototype.

Subject Matter Experts

Thank you to our consulting Subject Matter Experts:

- Lt. Col. Aaron Ruona
- Aircrewman First Class Kris Strand
- 2nd Lt Peter Galindez
- Prof. Tom Ferguson
- Matt Dunham