Using a UAS for environmental monitoring of the marine environment

[Abstract]

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ABSTRACT:

Environmental monitoring generates data allowing decisions to be made regarding the potential impacts human activities may have on the natural environment. Environmental monitoring can be achieved in-situ, using human operators to collect samples/data, automated sampling equipment which can be left on site to collect samples/data over time; or by the use of aerial systems, such as satellites and aircraft, for remote sensing. The latter group is often quicker than surface based assessment and allows much larger areas to be monitored but often at higher cost and higher safety risk. A rapidly developing area in environmental monitoring utilises Unmanned Aerial Systems (UAS), which are versatile, customisable, readily available, safer and are often seen as cost effective solution.

Previous research by the authors into using a UAS for environmental monitoring of the marine environment has been concerned with the acquisition of underwater acoustics [1]. Under real world conditions where the UAS is on the surface of the water and is logging the response from the attached acoustic system, the UAS is free to move with the ocean waves and current. During this time, the flight controllers’ on-board sensors are still producing data. The data includes acceleration, angular velocity, heading and pressure from the inertial measurement unit (IMU), alongside the latitude, longitude, time and speed over the ground from the global positioning system (GPS). This data, for our application, can be used to determine when wave height exceeds safe heights to carry on with an acoustic survey, due to an increased chance of capsizing. It is also important for the UAS to take-off from the crest of a wave, to avoid the UAS propellers contacting the waves face or rear during take off and causing it to capsize. Additionally it the data can also stop the UAS capsizing when on a breaking wave by starting up motors on one side to keep it going beyond an angle of 45°. Beyond the scope of this research, a UAS based system could be used after an earthquake to detect if a tsunami is present and for short term environmental monitoring of the marine environment.

Current marine sensor systems, such as wave buoys and weather station buoys already use sensors seen in UAS for measuring significant wave height, wave direction, wave energy spectra [2], [3]. Wave buoy systems are used for high resolution data on small spatial scales, and are moored in order to keep them close to their original deployment position. Deployment of these devices requires the use of large ocean vessels to transport them to site, and tow boats for positioning. These devices are made for long term environmental monitoring, as they are slow and expensive to deploy and retrieve.
An alternative to wave buoys is wave radar. This device uses high frequency radio waves for detection, and can measure significant wave height, current and wind speed. Wave currents, wave heights and wave direction can be detected up to 200 km away from the shoreline [4], [5], and large spatial areas can be covered in a small time frame. This coverage comes at the expense of resolution; resolutions of 2 km are common, depending on the spatial range required. These systems require receive and transmit antennas on a coastline, requiring transport and setup at site. The receivers and transmitters are vulnerable to vandalism and tampering due to their set up location.

The use of a UAS for the short term monitoring of the ocean, would provide in-situ, high resolution data, while being able to rapidly deploy numerous times at multiple locations. The UAS also has the ability to self-deploy and self-retrieve, reducing transport and deployment costs significantly compared currently methods. The system is highly reconfigurable, and with the addition of sensors such as air speed, temperature and salinity sensors, further information about the local environment the UAS is in can be obtained. A waterproof detachable data acquisition prototype system using a National Instruments MyRIO has been developed. The system attaches to a waterproof UAV known as the Splashdrone, which can be autonomously remotely flown to station, where on board sensors can gather data from an open source flight controller platform, known as the Pixhawk 2.0, which the MyRIO logs. The UAS can be deployed until its battery power runs low or it has completed a time dependent mission. The current state of research for using a UAS for environmental monitoring of the marine environment will be presented. This will include details of hardware and software used for the data acquisition system, as well as the current evaluation of system performance.

References:


