UAV Overcomes Position Challenges near the North Pole

Engineers on board the Alfred Wegener Institute's research icebreaker *Polarstern* have programmed an unmanned autonomous vehicle (UAV), allowing it to navigate despite the deviations produced by the Earth's magnetic field near the North Pole. The researchers recently celebrated the multicopter's first successful autonomous flight and landing on an ice floe.

According to Sascha Lehmenhecker, an engineer at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI, Germany), experienced that flying on high latitudes, autonomous navigation is a major challenge. Navigation systems normally use magnetic sensors. Near the poles, the lines of the Earth's magnetic field are nearly perpendicular to the ground, making precise navigation difficult. That is why commercial UAV control systems are not well suited for use in polar regions.

Ice Floe and Ship in Motion

Together with the PhD candidates Michael Strohmeier and Tobias Mikschl from the University of Würzburg, Germany, Lehmenhecker refined the control systems for multicopters – roughly half-metre-long devices, powered by multiple propellers, intended to land on ice floes and fly back to their 'mother ship' autonomously several hours later. The task: both the ice floe and the ship are in motion. The ship has to continue on its scheduled course to conduct other research, while wind, waves and currents cause the ice floe to drift. And it's precisely the direction and speed with which it drifts that the multicopter needs to determine.

The development team pursued two approaches to allow the multicopter's control system to compensate for the distortions in the positioning. In the first approach, the multicopter remains in constant contact with a receiving station, using the copter's GPS data to calculate the discrepancies. The second option is to use two onboard GPS receivers to calculate the actual change in the copter's position. Though this is a better method, it's also much more complex, and the researchers were starting to develop it.

The system passed its first test, conducted on an ice floe in the arctic Fram Strait (79° N parallel), with flying colours: the team and copter were left on a floe. Now clear of the magnetic interference produced by electric motors on board the *Polarstern*, the team manually flew the copter roughly three kilometres out, to the edge of visual range. They then activated the autonomous return programme – and the multicopter flew to the pre-set coordinates and safely landed on its own.

Connection to Under-ice Use

Sascha Lehmenhecker and his colleagues in the AWI Deep-Sea Research Group came up with the idea for this development in connection with the use of sensitive devices under the ice. One example is the Group's torpedo-shaped autonomous underwater vehicle (AUV) Paul, which explores the ocean beneath the sea ice. Conventionally, postion information was achieved by deploying ice trackers on floes with the help of a Zodiac boat or a helicopter – a difficult and time-consuming method. Further, the researchers generally try to avoid leaving the safety of the *Polarstern* wherever possible as water temperatures hovering around the freezing point, jagged ice floes drifting to and fro and polar bears, represent additional risks and should be kept to a minimum.

The Deep-Sea Research Group first used a multicopter developed by the AWI during a 2012 expedition. Flying by remote control, it landed on the ice and used GPS to determine its position, then transmitted the data back to the research ship, which was monitoring Paul's dive. In this way, the multicopter offered navigational support for the AUV. Once each dive was complete, the ship had to return fairly close to the multicopter's position: the pilot had to remotely guide the copter back to the ship, which was only possible in visual range. Extremely pleased by the successful test, which was conducted under the auspices of the Helmholtz Alliance 'Robotic Exploration of Extreme Environments' (ROBEX), Sascha Lehmenhecker recaps that this new development will expand the service radius of our copters from visual range to as much as ten kilometres.