How to Make a Sea Rescue Drone Land on a Boat

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Imagine seeing a small orange drone flying above you on its way out to sea while you are taking a walk by the water. Just like in the case of an ambulance, you immediately know that there is an ongoing emergency nearby, but in this case it involves sea rescue. This could well be a real scenario in a not so distant future. But what happens at the end of the mission and how can the drone be retrieved after it has served its purpose? In this article, we explore a solution to this problem.

Every year, a large number of boat related incidents occur in lakes and along the coastlines of Sweden. The Swedish Sea Rescue Society (SSRS) is a large independent non-profit organization which assists in roughly 80 % of the Swedish sea rescue missions. When an incident is reported, the nearest of the 2300 volunteers are prepared to instantly let go of whatever they have at hand and get ready for departure with a boat in only 15 minutes. At a strategically located head quarter office on the coast in Långedrag, Gothenburg, the SSRS is working to incorporate autonomous technology to benefit their sea rescue missions. One application is to, directly after an incident is reported, autonomously deploy and navigate small airplanes to the site of incident and stream back video in order to prepare the rescue crew on what to expect upon arrival to the scene. At the end of a mission the drone would benefit from landing on one of the rescue boats in order to make use of the full battery capacity on tasks related to the mission. As it turns out, this landing sequence is quite a complicated task and has been the topic of our master's thesis.

Figure 1: Flying wing drone used by the SSRS.

First of all, a way of finding the relative position between the boat and airplane is needed. There are many different ways of achieving this and there are many research papers written on this topic. One way is to use two GPS receivers, one on the boat and one on the drone. By streaming the boat position to the drone, the relative position can be calculated and used as control input for the drone landing algorithm. When tested on real stationary GPS devices on the ground, the delay was low and the accuracy was within a few decimeters, which showed great potential.

Using the relative position information between the two vehicles, an attempt on doing an autonomous landing on one of the boats can be made. A likely landing scenario is for the boat to move towards the wind and letting the plane approach from the rear where a person or a net can catch the very light-weight plane (<1 kg). One way to make the plane fly towards the boat is to use what is known as a Model Predictive Controller (MPC). This is a optimization based control strategy that makes use of an internal mathematical model of the plane. The MPC makes it possible to predict and control where the plane will be, a short period of time into the future. By using this method, the plane can guided towards the boat in a robust way.

To test if this would be possible at all, a small GPS equipped RC car was programmed to navigate towards another GPS receiver. The car was able to always drive by within a 3 decimeter distance of the receiver repeatedly. With this kind of precision, this strategy qualifies as a good candidate to continue with tests on a real drone in the future.

Drones are one of many technologies that can be used in an effort to achieve a safer maritime environment. But before we are there, there are a number of hurdles to take on. Aside from further technical solutions and robustness in general, one of those hurdles is airspace regulations which currently does not allow drones to fly beyond visual line of sight of the operator. Hopefully, when the benefits of drones in sea rescue missions as well as the harmlessness of these devices become more apparent, there will be more progress in this area.