Development of a Self-Sailing Sailboat

Introduction

With the constant pressure from disbelief of whether the climate change exists or not and at what rate our climate is changing, collecting sufficient data to prove the existence and rate of the climate change is of essence. Our oceans are an extremely important part when it comes to predicting the weather and climate change as they contain the fundamental processes behind this. Further understanding of these processes are extremely important but collecting reliable data behind it has been proven to be not only rather difficult but also very expensive, an autonomous sailboat can change this.

As we are facing the problems of exhausting our fish stock and affecting the ecosystems in our oceans it is in addition to the climate change extremely important to monitor these patterns of the fish in our oceans. For a long term stable fishing strategy, the understanding of how our fishing is affecting the fish stock is highly important and could easily be done with an autonomous sailboat.

Both of these areas of applications could be made with other data collecting tools and a common way to collect this data is through using research ships. However, these ships are not only very expensive but also in some cases dangerous. The usage of a research ship can cost $US 1 over 30 days while using a drone could reduce this cost to a small fraction of the research ship cost.

There are many areas of application that one could use an autonomous sailboat instead of a manned vessel. One could use it for surveillance, highly energy efficient transportation to mention a few in addition to data collection and monitoring.

The Art of Autonomous Sailing

Autonomous sailing is unlike any other discipline of unmanned vehicles. The main difference that makes autonomous sailboats such an interesting future tool is that they can be completely energy neutral and relocate themselves using the wind. This does not only present opportunities but also some complications. The wind is generally changing both its direction and intensity which makes it hard to determine how to sail, this is because of the fact that the boat can not sail in any direction with reference to the wind. The boat can not sail straight towards the wind, the boat speed is strongly depending on both wind intensity and what the wind direction appears to be on the boat.

The discipline of autonomous sailing contains many fields as the level of complexity of the sailing boat is high. There are advanced fluid dynamics acting on both the boat and the sails, as the wind and air acts on the sails it creates the propelling force making the boat go forward and in the water rudders are used to control the boat heading. Automatic control is used to control both heading through the rudders and sheets to control the angle of the sails. As the application has its main strength lying within the energy efficiency of the boat, one would therefore desirably moni-

tor the power consumption as carefully as possible. As the level of success for the autonomous sailboat increases, the importance of having a proper decision making algorithm underlying increase.

There are multiple functions that an autonomous sailboat could and should have. The boat should of course be able to steer and change its sail configurations without any external help. Another important function is to be able to perceive the wind conditions along with localizing itself and its orientation to ensure that the translation goal is achieved. Once these basic functions are properly working, installing tools for obstacle detection and proper energy harvesting is important goals.

The Autonomous Catamaran

The developed platform that was used during this project is a two-hulled catamaran sailboat, it has as of today two servos that control the rudders and sails, an IMU that perceives the orientation of the boat, a Bluetooth that communicates with a computer that sends the control inputs for the servos and an Arduino controlling the servos.

In addition to this an external camera is used to localize the boat using computer vision methods, this is performed using a computer that also sends the controls based on the boat position.

Path Planning

Once one can control the boat properly and it actually sails by itself, then it is important that the boat is controlled so that the time to reach the target position is minimized. Since the boat can not sail straight towards the wind it leads to the conclusion that this direction always remain undesired, even though the target might be in that same direction straight towards the wind. Determining the optimal path is therefore extremely important as the goal is to achieve both safe and fast transport.

One needs to take multiple factors into account and the path planning problem can be made infinitely complex. Some parameters that are important are obstacle avoidance, velocity made good consideration, loss of making any maneuvers as changing the heading slows the boat down and many more as currents, wind fields and waves.

Carl Strömbeck - Automatic Control - Lund University, Faculty of Engineering