Project thesis - Some Results

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1 Forces' impact on the Autonaut

I have tried to analyse all external forces affecting the Autnaut and these are the results that I have managed to get. The data is only gathered from Mausund (open waters).

1.1 Waves

When it comes to waves it seems like the frequency and size of the waves is what contributes the most to the speed of the AutoNaut.

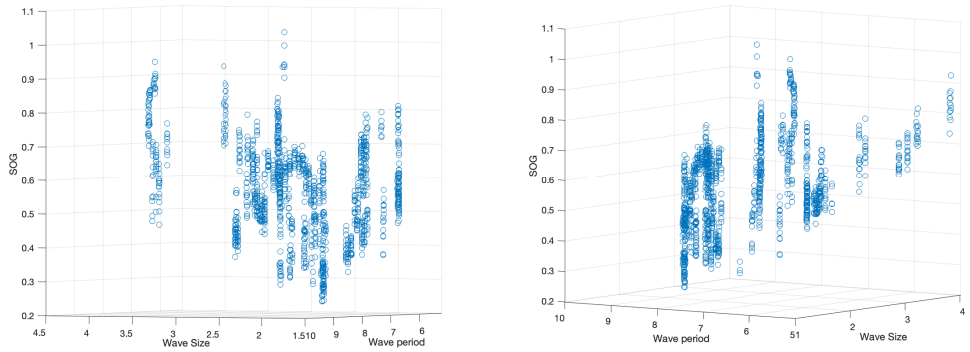

Figure 1: Lower period between waves and larger waves seem to yield higher speed over ground

When it comes to the direction of the wave relative to the vessel, it does not seem to have a significant impact. The relative wave direction is calculated as

$$\gamma_{wave} = \psi - \beta_{V_{wave}} - \pi \tag{1}$$

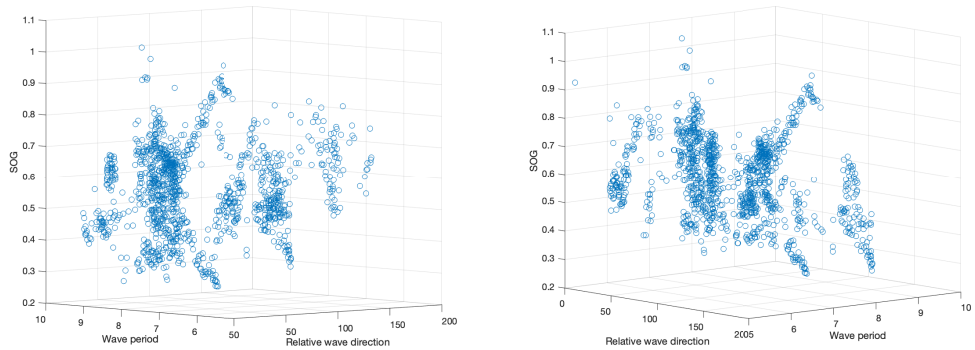

Figure 2: Relative direction to heading vs wave frequency

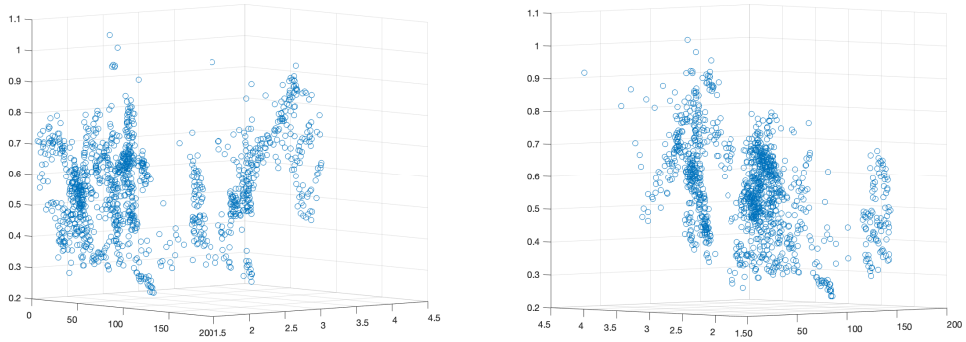

Figure 3: Relative direction to heading vs wave size

1.2 Wind

When it comes to wind it seems like with high wind-speed, there is some impact but does not have the same impact as waves. The relative wind direction is calculated as

$$\gamma_{wind} = \psi - \beta_{V_{wind}} - \pi \tag{2}$$

I cannot see a significant relationship in the following plots, only wind from the front is not desired.

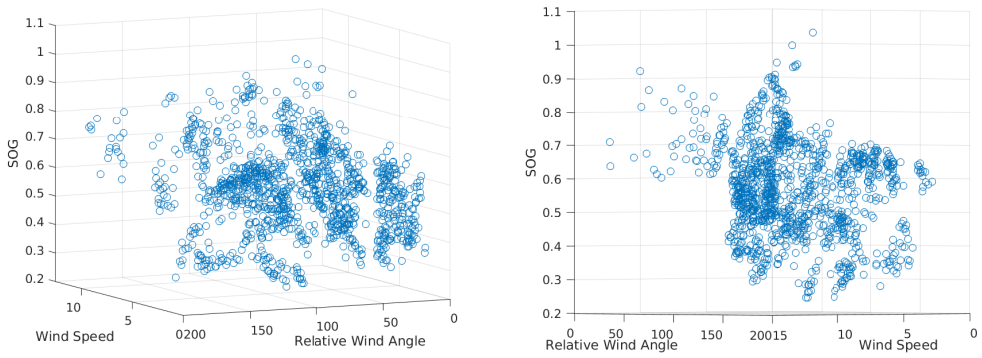

Figure 4: Relative wind direction to heading angle vs wind speed

When looking at the measured wind by the AutoNaut, it seems like the wind has more of an impact compared to the forecast data. From the figures below it seems that wind from the front contributes to less speed, while more wind from behind contributes to higher speed for the vessel.

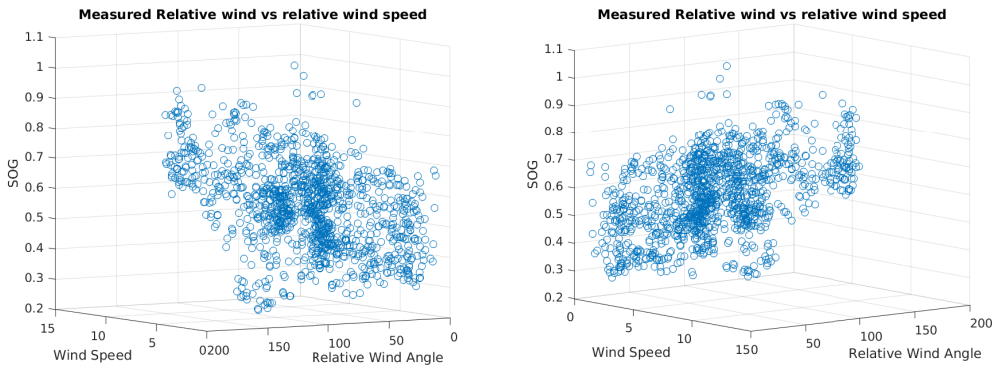

Figure 5: Measured relative wind direction vs measured wind speed

I also took a look at the forecast wind relative the course angle of the AutoNaut. The equation becomes

$$\gamma_{wind} = \chi - \beta_{V_{wind}} - \pi \tag{3}$$

The results form this is a bit more similar to the measured wind speeds and it seems that the closer to 180° the more speed.

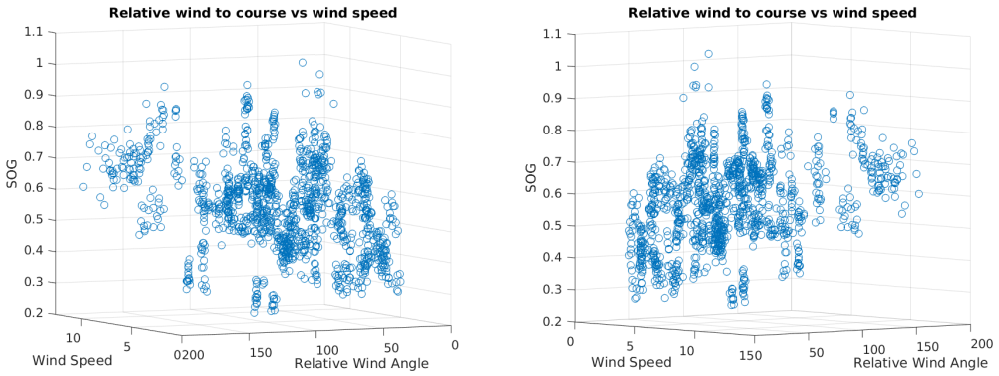

Figure 6: Relative wind direction to course angle vs wind speed

1.3 Current

I thought currents would have a large impact on the AutoNaut but from what I gathered the results seem to not have as big effect on the vessel as I thought. The current is downloaded on vector form with north and east directions. Then I find the direction the direction of the current is calculated as

$$\alpha_{V_{current}} = atan2(u_{east}, v_{north}) \tag{4}$$

And the angle between the current vector and vessel's heading is

$$\gamma_{V_{current}} = \psi - \alpha_{V_{current}} \tag{5}$$

and the speed of the current is found by taking the norm of the vector.

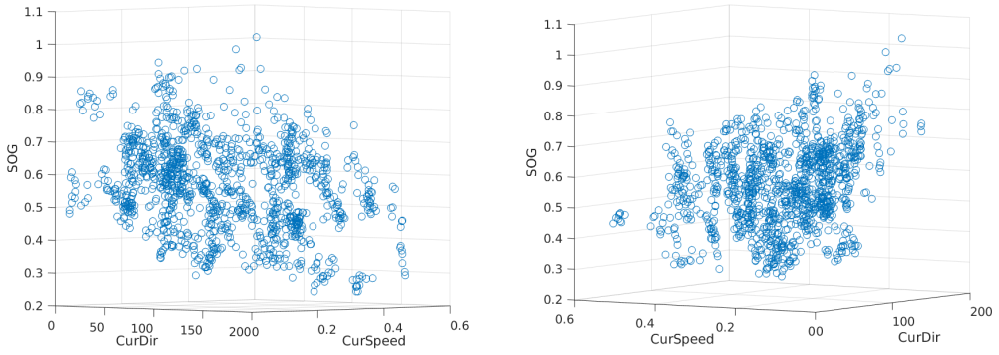

Figure 7: Angle between heading and current vector vs current speed

It seems like the speed of the current has more effect than the direction. From what I gathered high speed from the front contributes to lower speeds for the vessel, while low current speed in general yields the higher speed for the AutoNaut, even higher than higher current speeds in the same direction. I also looked at the current relative to course angle but it yielded a very similar plot.

1.4 Conclusion

So as a conclusion from what I gathered it seems like the wave frequency and size is the most significant. The combination of large, frequent waves, with large wind speed from behind and low current speed is the desired environment in open water. When extracting speeds only from the most preferred environment we get

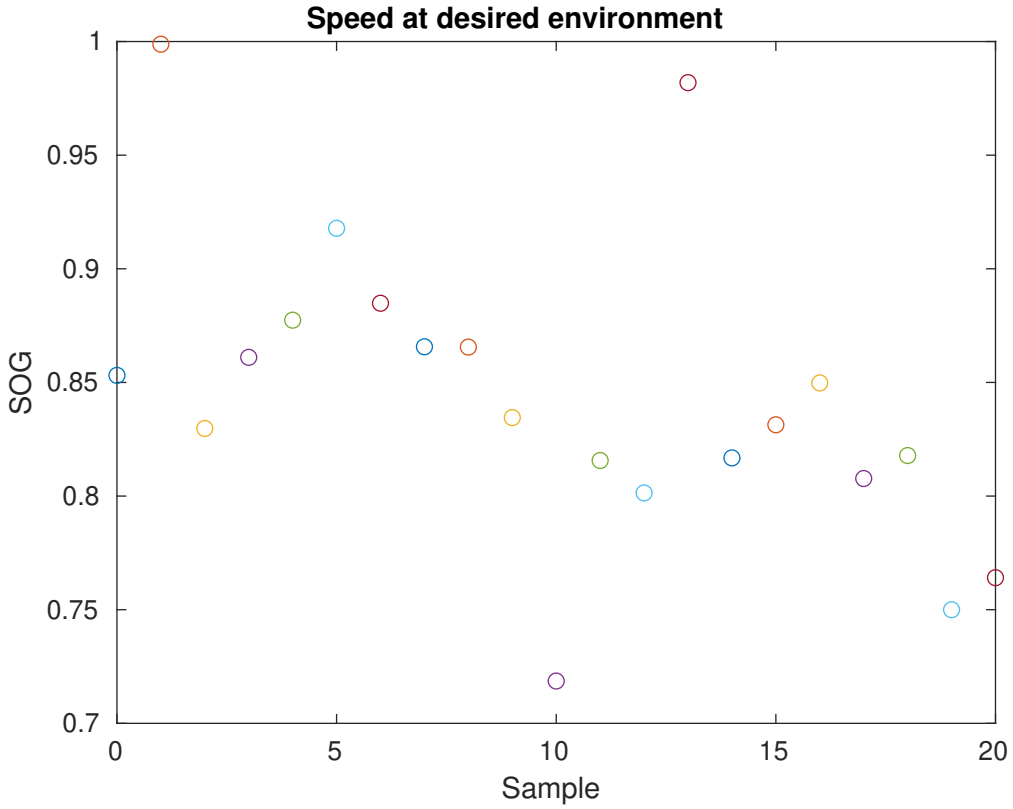

Figure 8: Samples of Speed at desired environment

We do not have many samples at the best environment but the speed is at high levels in all samples.