Popular Scientific Summary

To achieve agile flight of quadcopters it is important to control the rotor speed of their motors and make sure that they reach their desired values. This can be done by meassuring the rotor speed and adapting the amount of current supplied to the motor thereafter. Measuring the rotor speed directly can be done in several ways and there are many sensors available for this task, for example optical encoders or hall sensors. For applications where these are not applicable, maybe because of restrictions on cost or weight, other approaches might be needed. In this thesis a different method was explored where the rotor speed is measured indirectly.

Instead of measuring the speed it is possible to measure the current being supplied to the motor and to use a simple linear model for the dynamics of a DC-motor, which describes the relation between rotation speed, voltage and current, to calculate the speed. This model used a certain number of parameters for which the values were unknown. To find the values of these parameters experiments were carried out were the rotor speed and current was measured for different voltage sequences. These data recordings was then used with so called linear regression, which is a method commonly used in statistics and for system identification, to find the values of the parameters. This method was proven to be feasible when the motor was supplied with a DC-source with variable amplitude.

The motors mounted on a quadcopter is however not supplied with a DC-source with variable amplitude but instead uses a fixed voltage source. The amount of current supplied to the motor is instead controlled by opening and closing a transistor so that the relation between the time it is open and the time it is closed is proportional to the desired current. When running the motor with this, so called pulse width modulation, it was discovered that the linear model prevoiusly used was not sufficient to describe the behaviour of the motor. It was also discovered that the current measuring became more difficult. The motors had very low inductance which means that the current changes very quickly giving us large amounts of noise. To handle this analog filters were used on the measurement signal as well as on the voltage supplied to the motor.

To capture this changed behaviour the motor model had to be expanded with a nonlinearity. The shape of this nonlinearity was found both by a trial and error

approach as well as a mathematical identification method. The later approach was deemed to give the best results while the trial and error method is simpler to implement on the actual hardware. Therefore it can be concluded that there are severall ways to achieve satisfactory rotor speed estimation by measuring the motor current and that it is a feasible approach for applications where an indirect measurement method is needed.