

Autonomous Navigation and Control of a Hexacopter in Indoor Environments

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A multicopter is a type of aircraft that has attracted a lot of attention for research in recent years due to their maneuverability, simple construction, flexibility and ability to take a payload. When flying autonomously outdoors the Global Positioning System (GPS) is usually the main source of information for position estimation, making navigation indoors a complex task since no GPS signal is available.



ArduCopter Hexa B

Multicopters are similar to traditional helicopters but with more than two rotors. The most common amount of rotors are 3 (tricopter), 4 (quadcopter), 6 (hexacopter) or 8 (octocopter), but any configuration is possible. More rotors give a higher maximum lifting capacity but are more expensive to build

and need a higher current output from the batteries. If the multicopter is carrying expensive equipment 6 or especially 8 rotors can be recommended since a crash can be avoided even if one motor fails during flight. Today their main commercial use is related to aerial photography, surveillance and remote sensing.

Vision

To be able to navigate indoors computer vision can be a solution and in a previous implementation a simple webcam was used to estimate the hexacopters motion by looking at the ground below. In this thesis it will be investigated if improved navigation can be achieved by using information from an Internal Measurement Unit (IMU). The IMU contains accelerometers and gyros to measure the hexacopters acceleration and angular rotation in three dimensions.

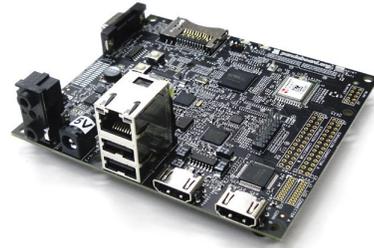
Sensor fusion

Sensor fusion is the combining of data from different sensors to receive better results than if the sensors would have been used individually. A dynamic model of the hexacopter will be used together with information from the web camera and the IMU to estimate the hexacopters position and velocity. The mathematical algorithm is known as a Kalman filter.

Simulink model

The development follows a model based approach in Matlab Simulink were the system

can be modeled by using different blocks in a graphical environment. To control the real hexacopter, the model runs on a software development platform called PandaBoard after automatic code generation into C-code. Position and altitude is controlled by sending setpoints from higher level controllers on the PandaBoard to an autopilot that communicates with the motors.



PandaBoard

Results

Tests show that the sensor fusion approach is able to provide increased stability and less drift, mainly by improved velocity estimates. The hexacopter can now hover for a minute without user interaction. The downside is that the hexacopter is still restricted to very slow movement for the computer vision algorithm to work properly and that delays in the system can cause problems in some situations.