Explanations to the attached videos

Video 1 - Assessment of the computer vision methods

The first video shows the quadcopter in the simulator and the image stream from the bottom camera with the intermediate result from the computer vision methods marked on it. The result from the *ellipse* method is marked in blue and represent the center of the landing platform. The result from the *arrow* method is marked in red and represents the center of the landing platform (the big dot) and the detected orange arrowhead (the small dot). The result from the *corners* method is marked in yellow and represents the landing platform (the big dot) and the two inner corners used (the small dots) and a small arrow indicating the forward direction of the landing platform coordinate system.

The quadcopter is flown using the joystick and PID in set point mode. The quadcopter starting from a high place and down towards the landing platform. When the *arrow* method detects the arrowhead on the wrong side of the landing platform, it rotates to control the yaw to zero. It later rotates back when the correct arrowhead is detected. When the quadcopter is very close to the landing platform, the yaw set point is changed to just around -90 °. This clearly shows one of the limitation of the *corners* method, that the angle is estimated in the range (-90, 90]. In the worst case, this leads to the quadcopter spinning continually around the z-axis.

Video 2 - Automated landing in simulator

The second video shows the quadcopter in the simulator during an automated landing process. The experiment is described in section 5.1.7 "Landing using the PID controller and the automated landing planner" in the report. The central top window shows the set points, generated by the automated landing node, that the PID controller uses as reference. The bottom left window shows the x, y and z estimate from the computer vision method after one out of the three methods has been selected. The leftmost terminal window in the top right corner shows the output from the perception system nodes, where the current method in use is printed. The rightmost terminal window shows the state of the simple automated landing state machine.

The quadcopter is started in position (1.0, 2.0, 3.5) relative to the rotated landing platform coordinate system, where the x-axis of the quadcopter is parallel to the x-axis of the landing platform. A smooth trajectory is generated towards the landing platform, and when that is executed, the quadcopter lands. The only joystick operation in this video is pressing "Start" to initiate the automated planner.

Video 3 - DDPG landing in simulator

The third video shows the quadcopter in the simulator during a landing process using the external DDPG controller. The experiment is described in section 5.1.8 "Landing using external DDPG controller" in the report. The windows are the same as in the last video, with the exception of the rightmost terminal window, now containing the external DDPG node.

As in the last video the quadcopter is started in position (1.0, 2.0, 3.5) when the planning and control node is started. The DDPG controller first controls the quadcopter to a position directly above the landing platform. When it is sufficiently stable here, it also controls the yaw to zero and starts the descend. When sufficiently close to the landing platform, it lands. There are no joystick operations done in this video, from the DDPG node is started and until the quadcopter lands by itself.

Video 4 - Outdoor flight test

The fourth video shows the outdoor experiment, described in section 5.2 "Experiment with the physical quadcopter" in the report. It is put together of a screen capture of the computer (the background), a video captured by a mobile phone (to the lower right corner) and some plots generated after the experiment from the stored data. In the lower left corner of the screen capture, the processed image from the computer vision method is shown. It is the same video stream that is used in the first video. This shows quite clearly the difference in performance of the perception system between the simulator and the physical world.

The quality of the position estimate was not good enough to be used with the PID controller, so the quadcopter is flown with the joystick set to manual control and the PID turned off. The quadcopter is controlled to take off, fly about a bit and then land. There was only a small amount of wind present, however even some small wind gusts made it quite hard to land. This emphasizes how useful it will be to have robust autonomous landing capabilities on a quadcopter.