Precise Landing for Unmanned Aerial Vehicles for a Pre-defined Target

Did you know...?
Currently, quadcopters are able to return to a pre-defined landing area which is set via Global Positioning Signal (GPS). However, GPS can be an inaccurate method for precise landing when used indoors. (Scientific American, 2008)

Objective:
To achieve autonomous landing capability using a computer vision programme that provides both landing target identification and position estimation.

Approach
- A vision-based approach was chosen for landing target recognition and pose estimation.
- Using visual markers on the landing target, an algorithm was developed to estimate the orientation and relative position of the landing target to the UAV.
- To capture the position and orientation, ArUco markers, which have fixed basis of references or fiducial markers, were used.

The Landing Algorithm was developed in two parts. The vision module will recognize the marker, after which the actuator will take over.

VISION MODULE includes:
- Thresholding gray-scale image into binary image
- Segmenting landing area out of the background
- Deflecting the corners in landing target
- Labeling the corners

ACTUATOR MODULE handles:
- Movement in horizontal position
- Orientation and direction of the drone
- Decreasing altitude while maintaining orientation and location until the surface has been reached

Results and Discussion
The algorithm was tested using 5 by 5, 6 by 6, and 12 by 12 markers which were rotated in 3 ways: Pan, tilt, and roll. Their detection times were recorded.

Roll Test:
- Range of angles for which the markers can be detected were the same for all 3 sizes (0° to 90°).
- Average time taken was higher for the 12 by 12 marker indicating a higher processing time.

Tilt (Pitch) Test:
- Algorithm was unable to detect any marker rotated > 81°.
- Time taken for 5 by 5 and 6 by 6 marker: < 35 μs, 12 by 12 marker: 40 to 45 μs.

Pan (Yaw) Test:
- Results similar to that of the Tilt Test.

Conclusion:
There is an inverse relationship between the size of the marker and the detection speed, that is, the larger the marker, the longer it would take to detect it. The orientation (roll, tilt and pan) of the ArUco marker also proved to affect the detection time.