

Real-Time Vision Sensor for an Autonomous Hovering Micro Unmanned Aerial Vehicle

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DOI: 10.2514/1.40185

Vision algorithms were implemented on an field programmable gate array to provide additional information to supplement the insufficient data of a standard inertial measurement unit in order to create a previously unrealized completely onboard vision system for micro-unmanned aerial vehicles. The onboard vision system is composed of an field programmable gate array board, and a custom interface daughterboard which allow it to provide data regarding drifting movements of the micro-unmanned aerial vehicle not detected by inertial measurement units. The algorithms implemented for the vision system include a Harris feature detector, template matching feature correlator, similarity-constrained homography by random sample consensus, color segmentation, radial distortion correction, and an extended Kalman filter with a standard-deviation outlier rejection technique. This vision system was designed specifically for use as an onboard vision solution for determining movement of micro-unmanned aerial vehicles that have severe size, weight, and power limitations. Results show that the vision system is capable of real-time onboard image processing with sufficient accuracy to allow a micro-unmanned aerial vehicle to control itself without power or data tethers to a groundstation.

Nomenclature

G	autocorrelation matrix
H	image height, pixels
I	grayscale image intensity value
K	Kalman gain matrix
P	estimate covariance matrix
r	radius, pixels
S	innovation covariance matrix
T	state vector
U	innovation vector
W	image width, pixels
x	image column pixel index in image
y	image row pixel index in image
Z	sensor input vector

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