Insect-inspired vision guidance systems for UAVs

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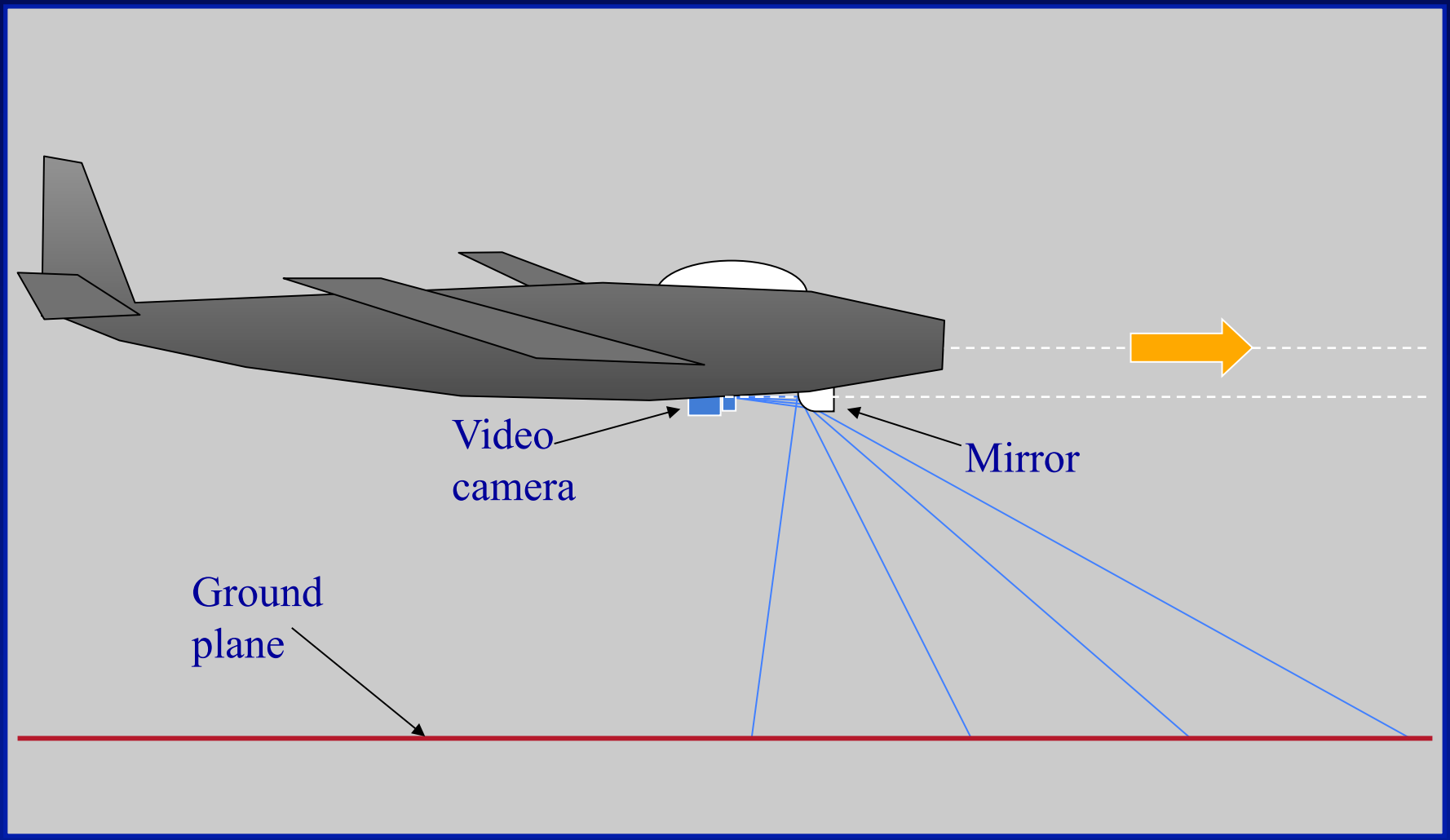
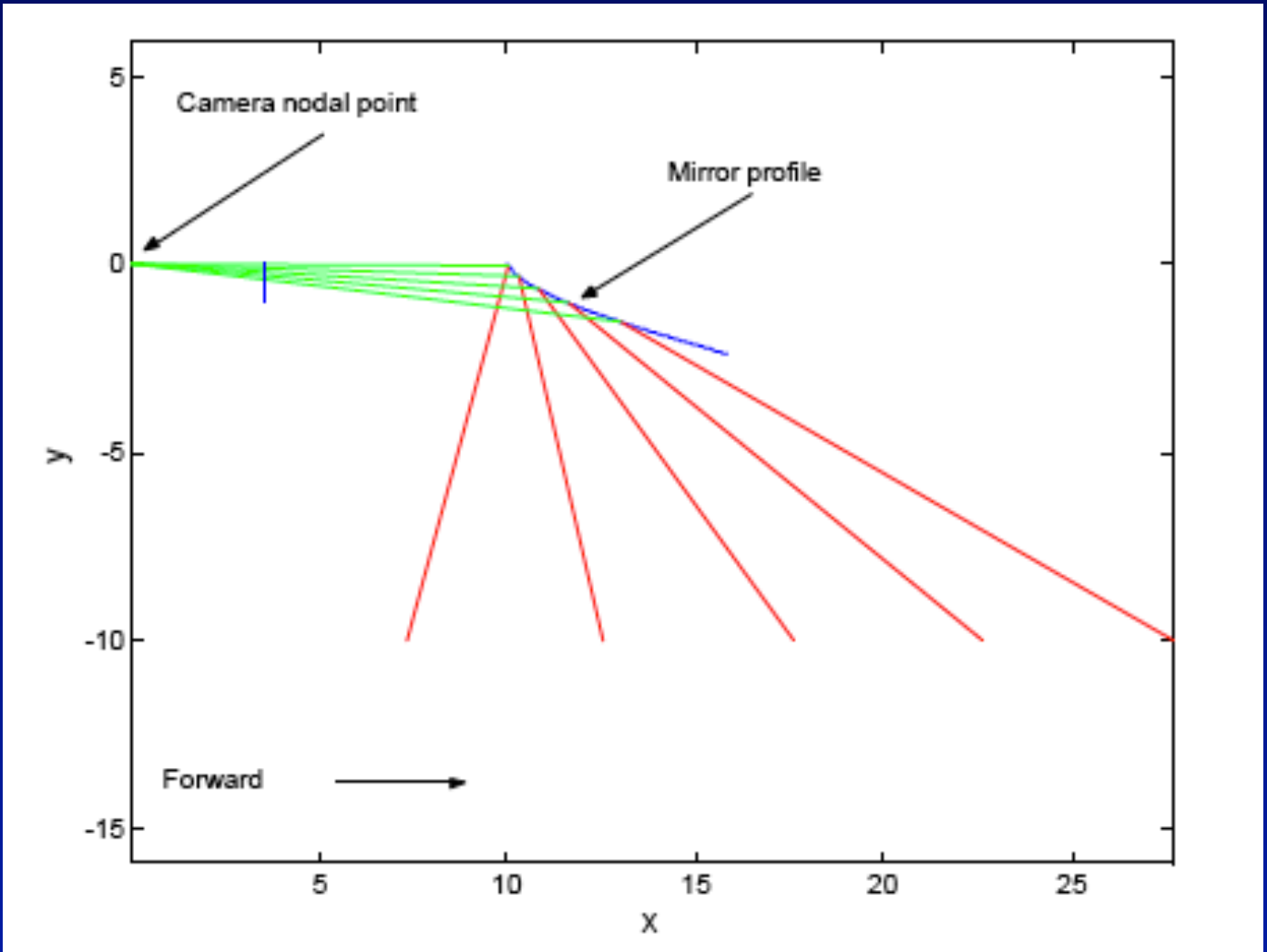
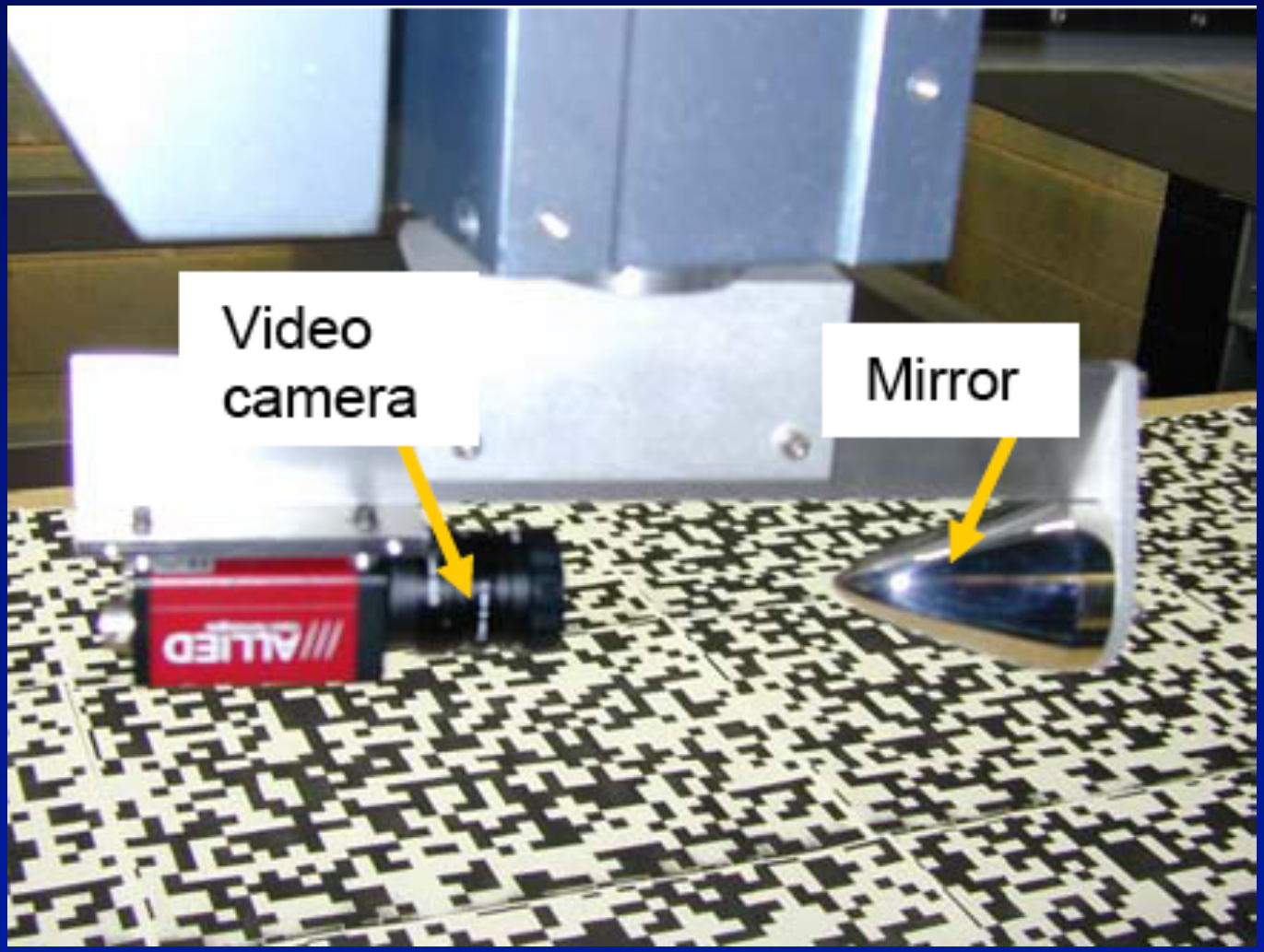


Illustration of vision system for visually guided terrain following and landing (not to scale). The vision system is shown on an enlarged scale relative to the aircraft in order to clarify its configuration.

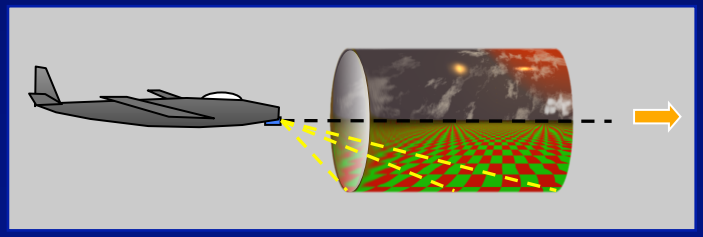
Design of terrrain-following mirror profile

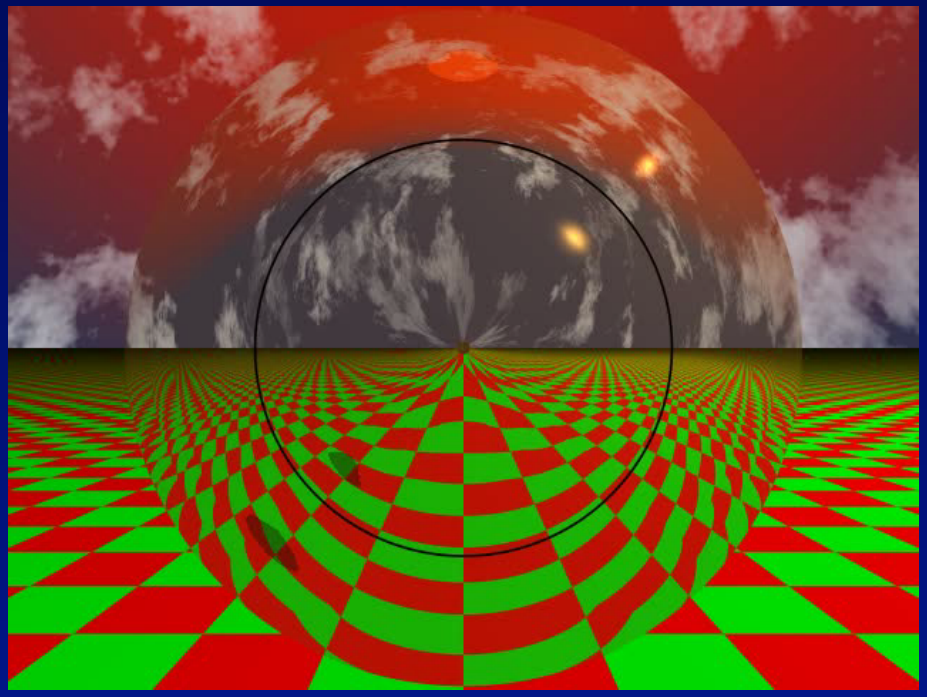



Video
camera
Mirror

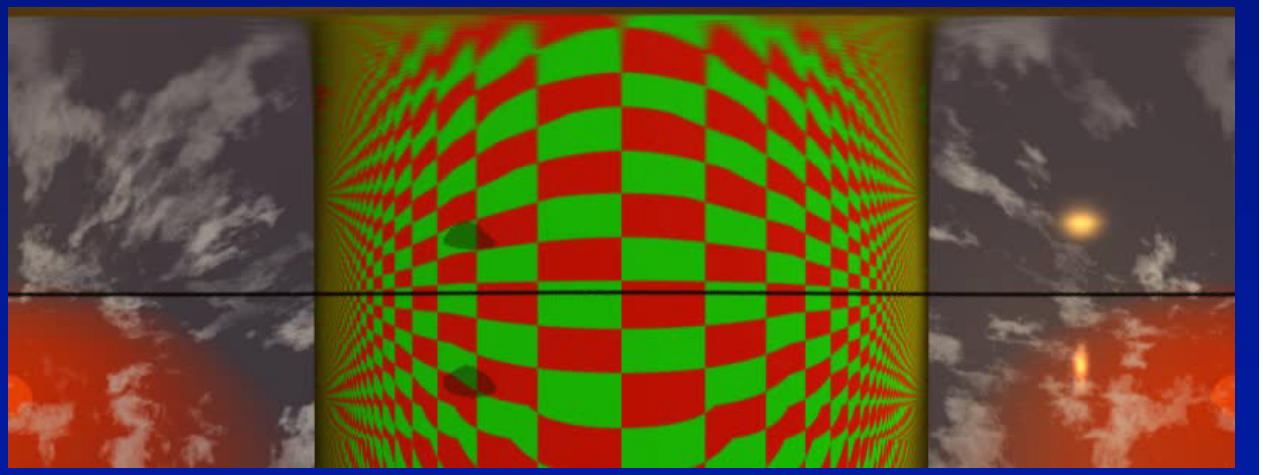
Imaging properties

- *Removes perspective distortion*
- *Scales down image motion*
- *Defines a "collision free" cylinder*



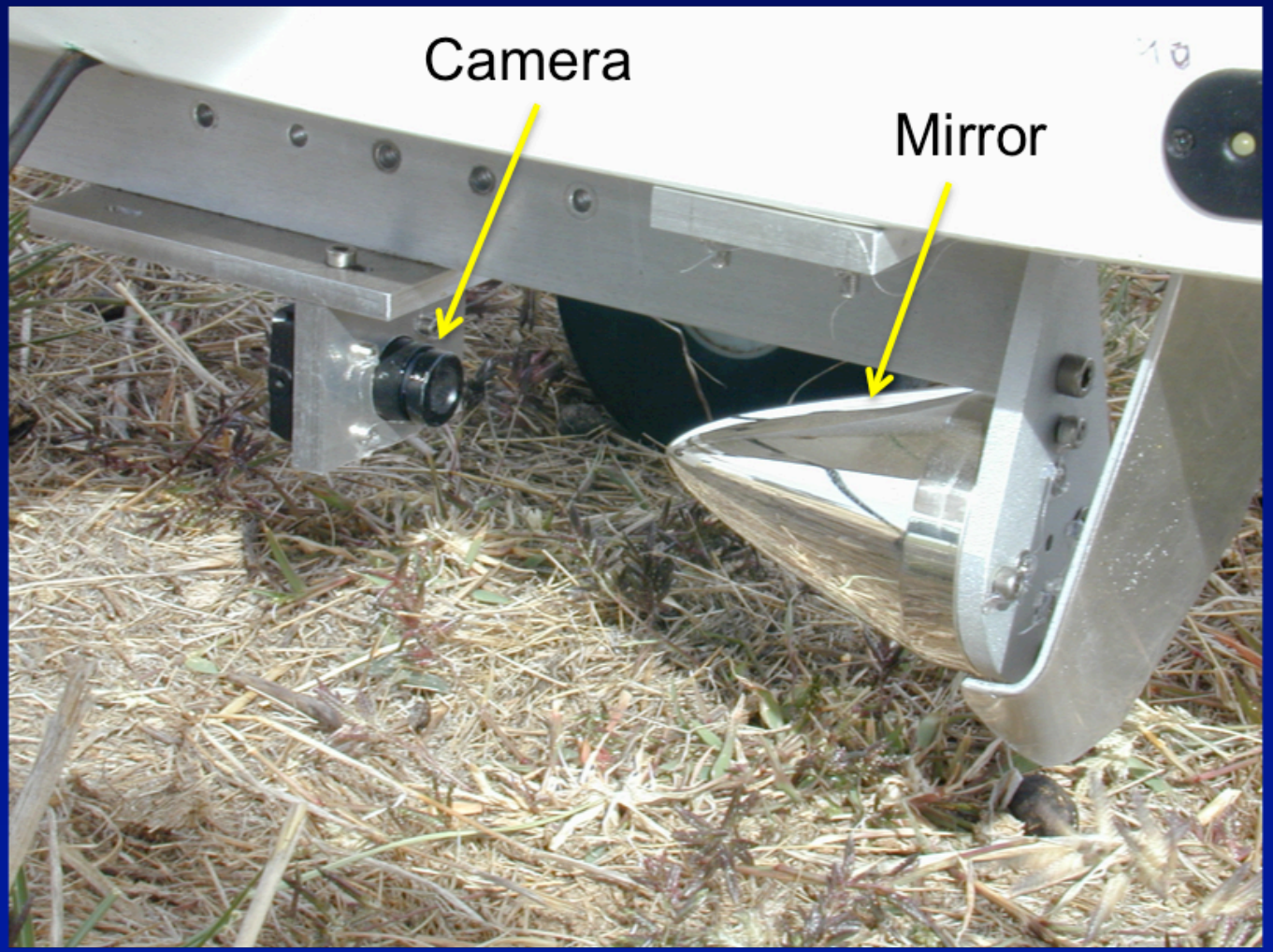


Centre of mirror →

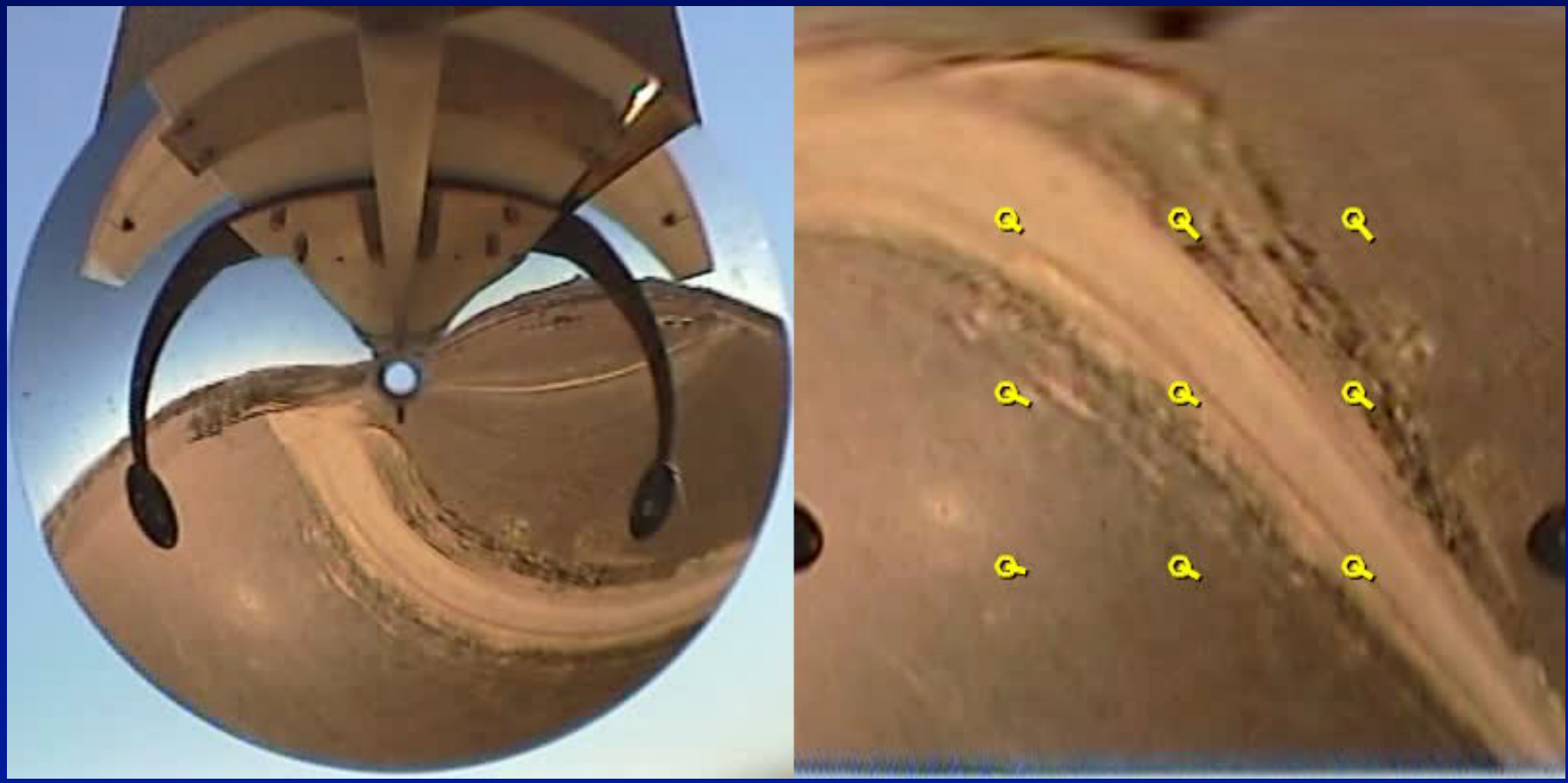


Digitally remapped version

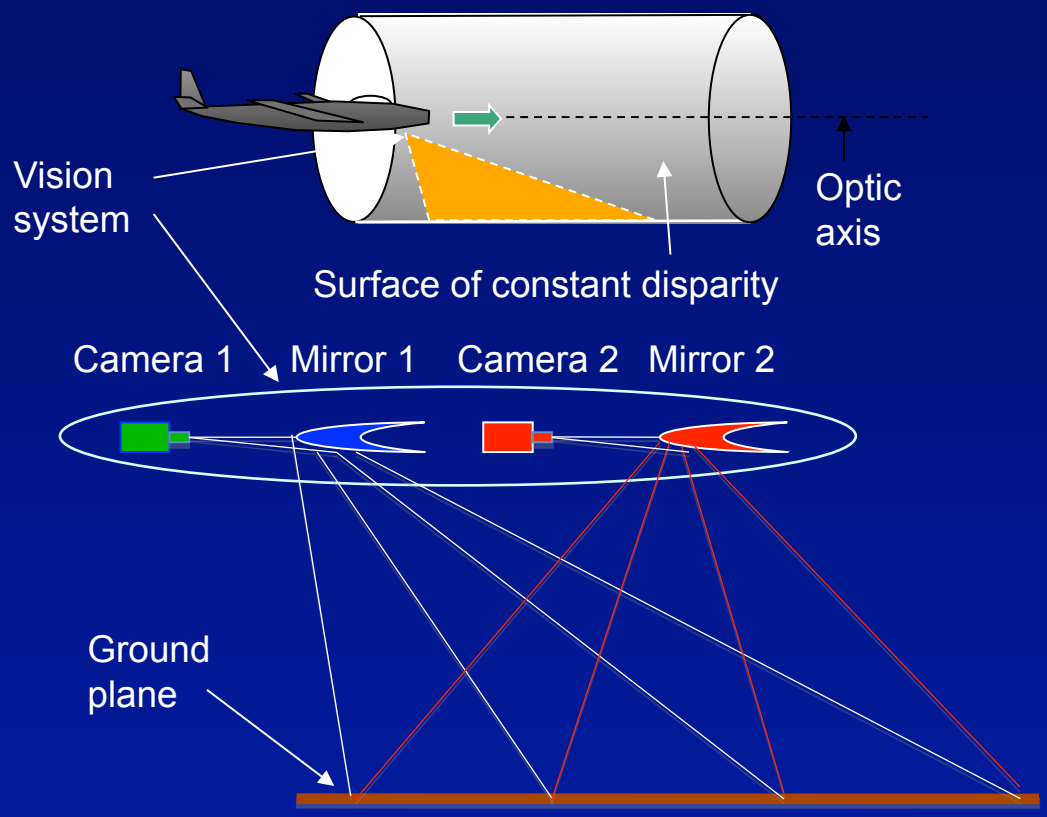
Work with Saul Thurrowgood and Dean Soccol


Camera
Mirror

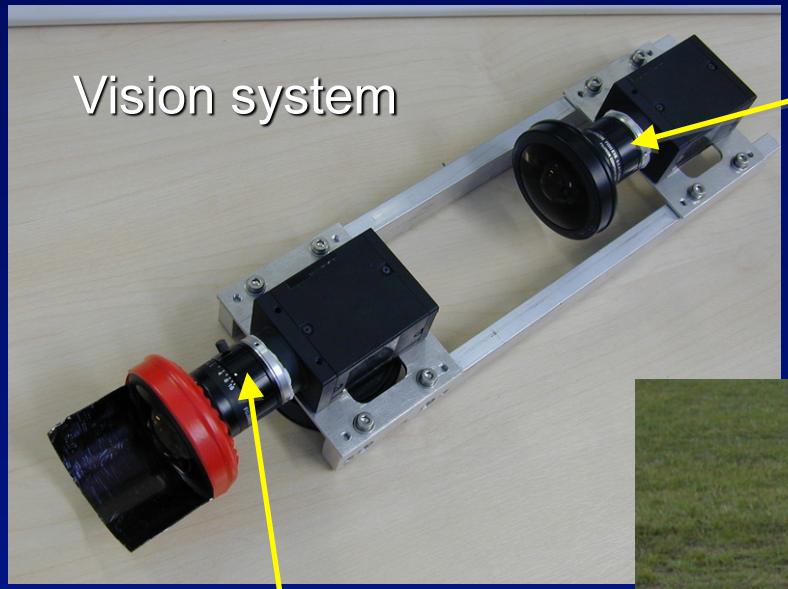
Flight test – terrain following mirror

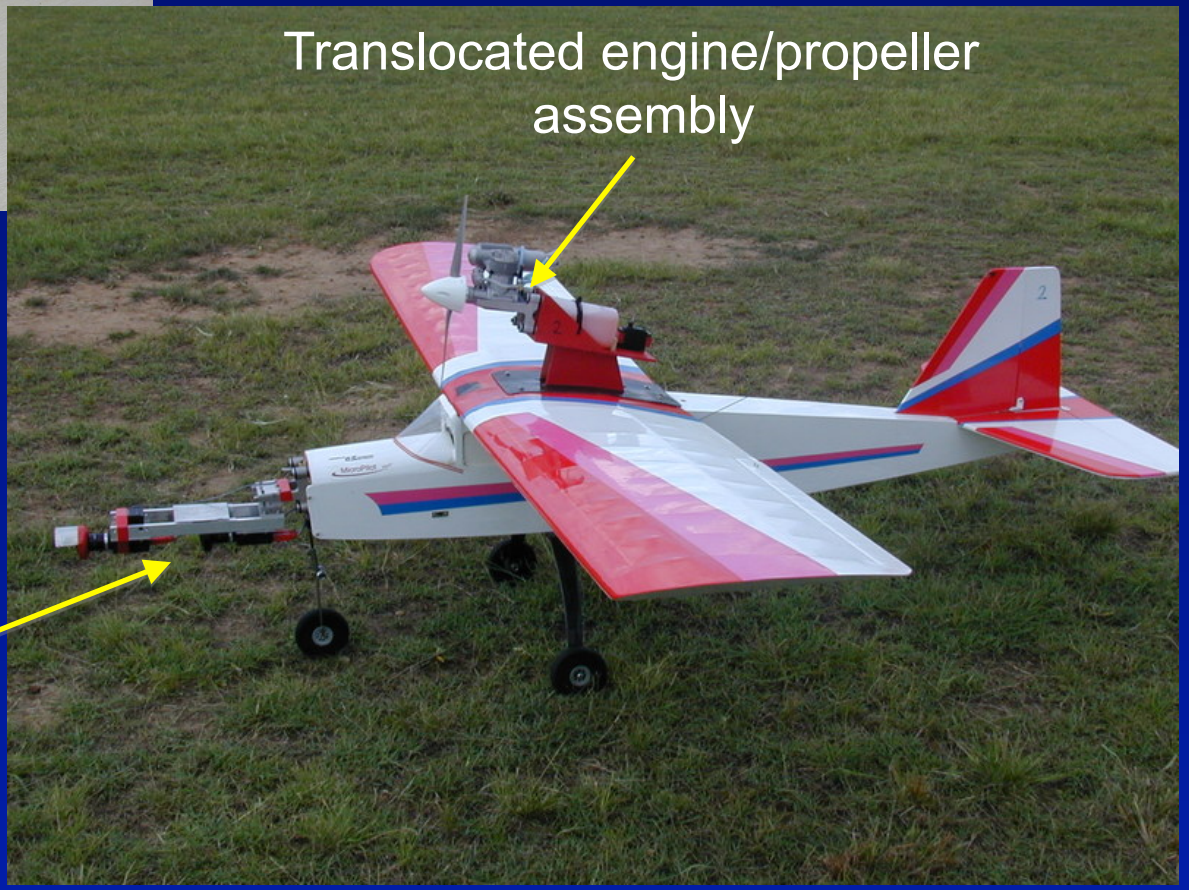


Collision-free cylinder



Moore, Thurrowgood, Bland, Soccol, Srinivasan (2009)


Vision system
Coaxial rear camera
Front camera

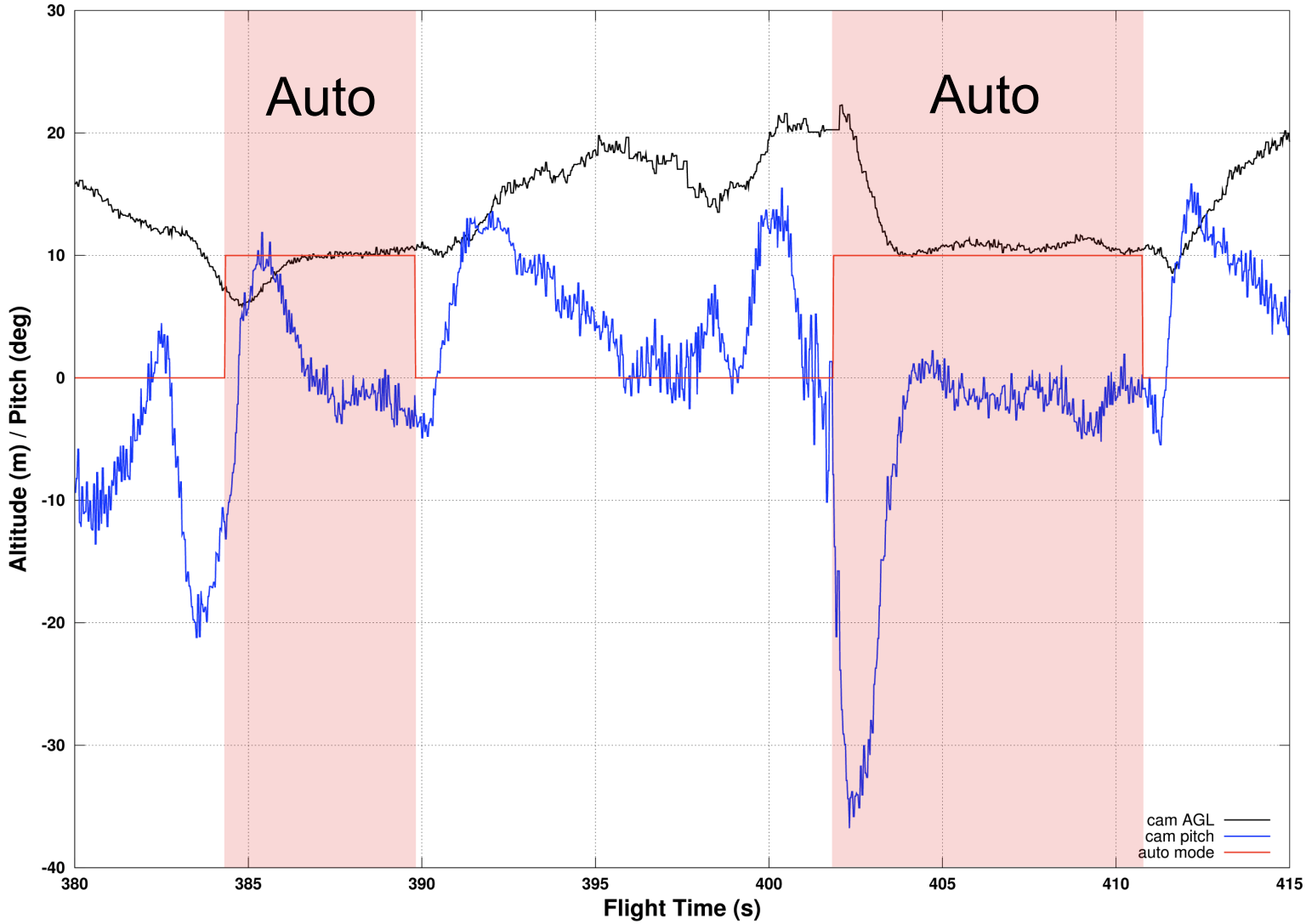

Translocated engine/propeller assembly
Vision system

Closed loop flight test

Field view

Front camera view

Moore, Thurrowgood, Bland, Soccol, Srinivasan (2009)

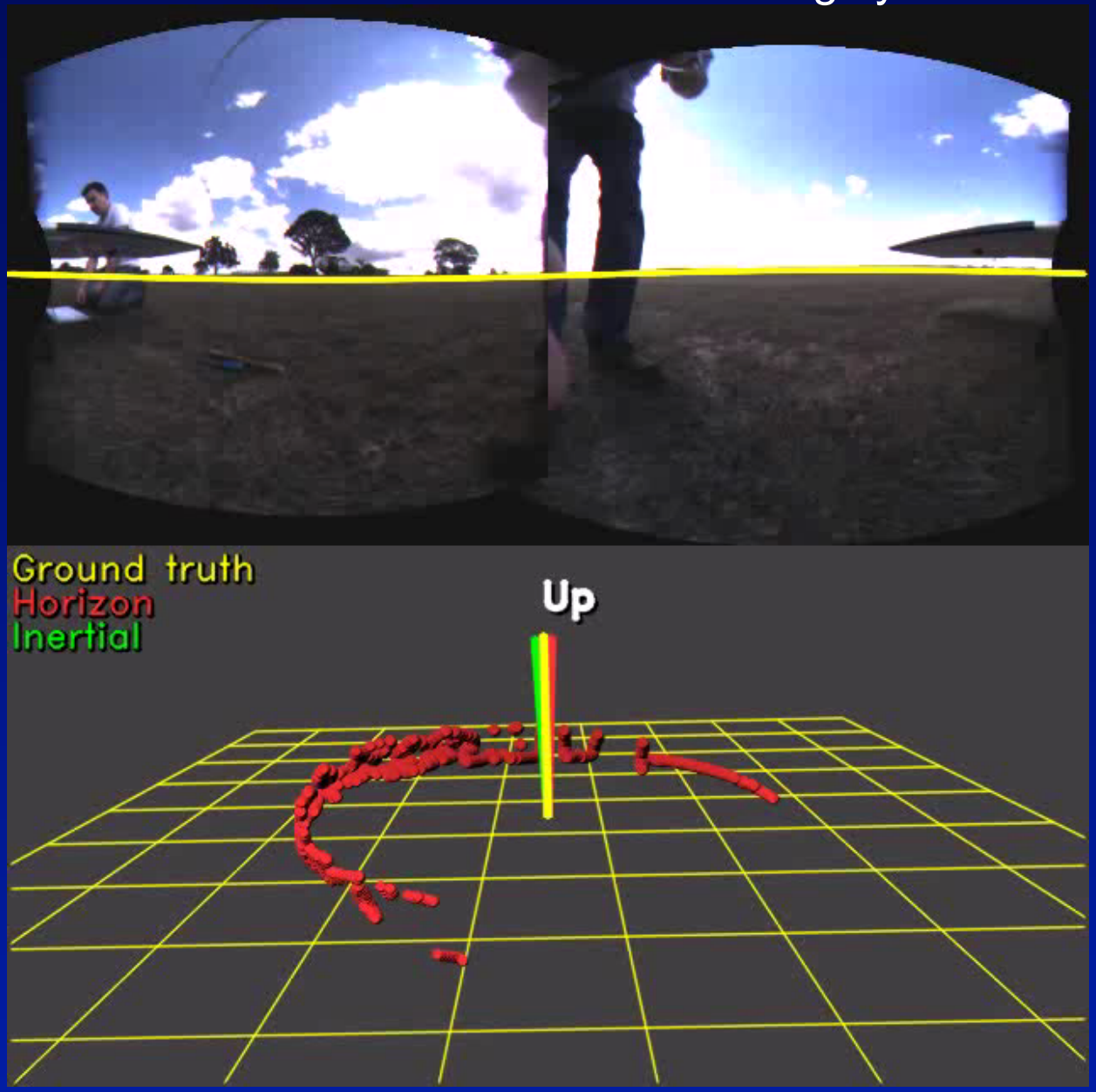

Auto
Auto
30
20
10
0
-10
-20
-30
-40
380
385
390
395
400
405
410
415
Altitude (m) / Pitch (deg)
Flight Time (s)
cam AGL
cam pitch
auto mode

The Ocelli

Visual horizon sensing

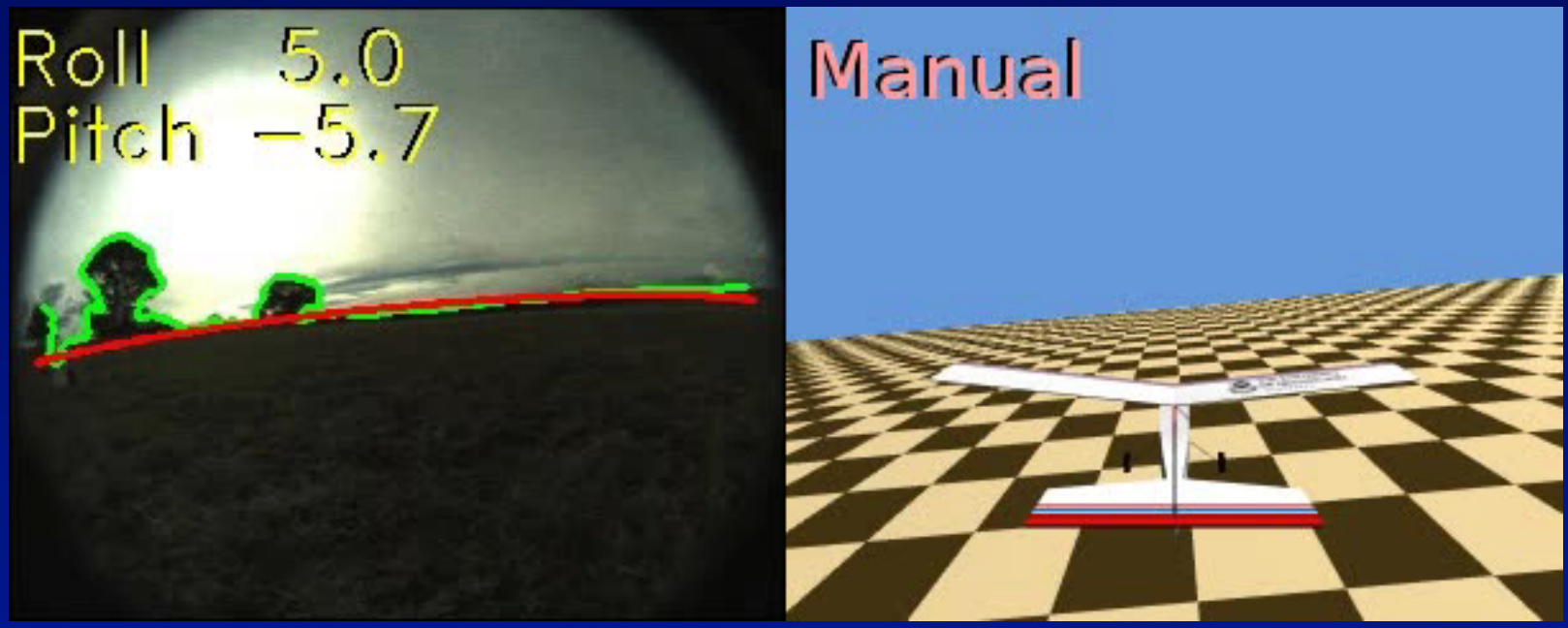
Image from Goodman (2000)

Test of horizon-based attitude sensing system



Thurrowgood, Soccol, Moore, Bland, Srinivasan (2010)

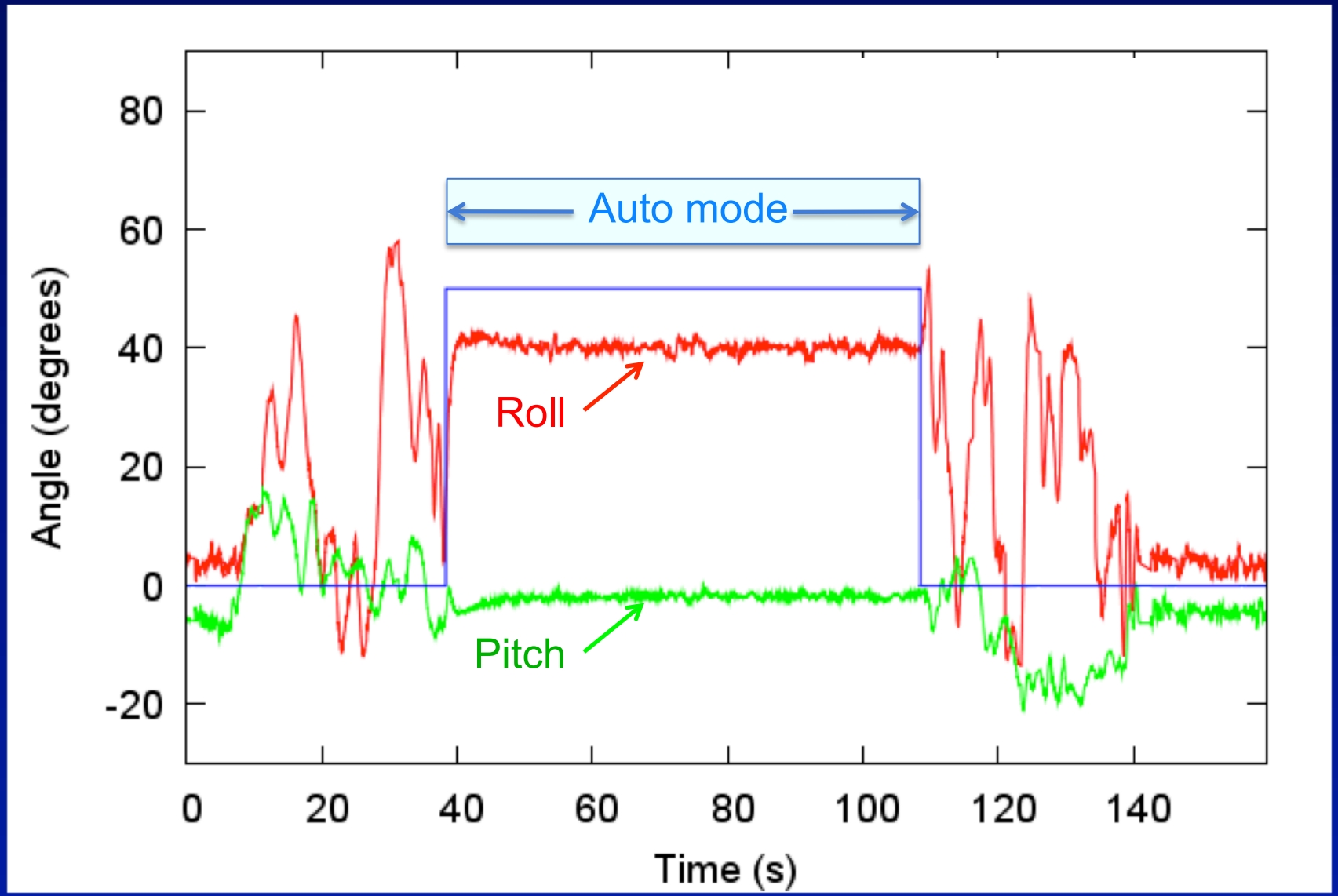
Flight test: Horizon-based closed-loop control of roll and pitch



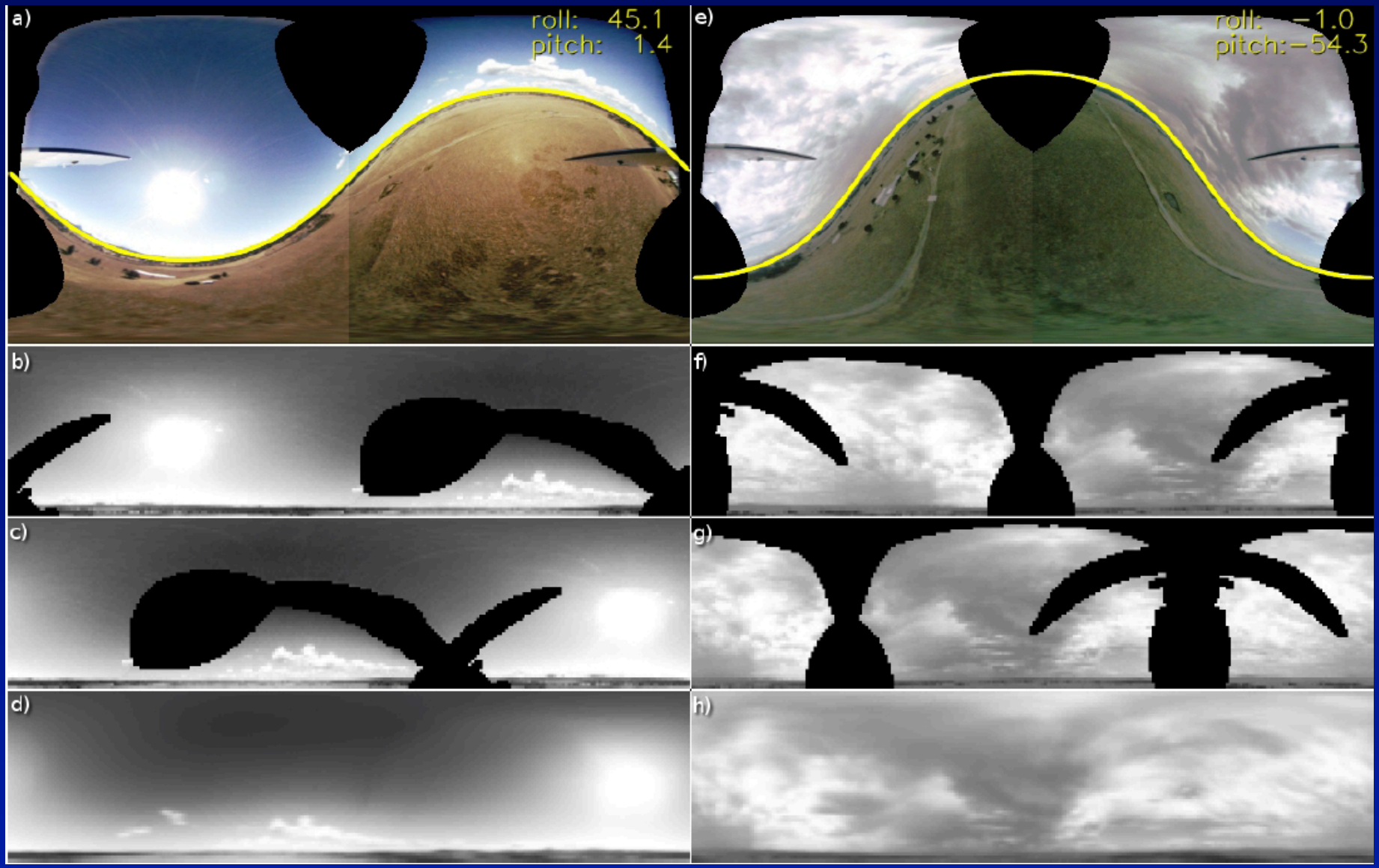
'Manual' : Human pilot controls attitude
'Automatic' : Horizon-sensing autopilot regulates attitude
(Roll: +40.0 deg; Pitch: -2.0 deg)

Thurrowgood, Soccol, Moore, Bland, Srinivasan (2009)

Results: Closed-loop horizon-based control of roll and pitch



Sky-based estimation and control of heading direction



Moore, Thurrowgood, Soccol, Bland, Srinivasan (2011)

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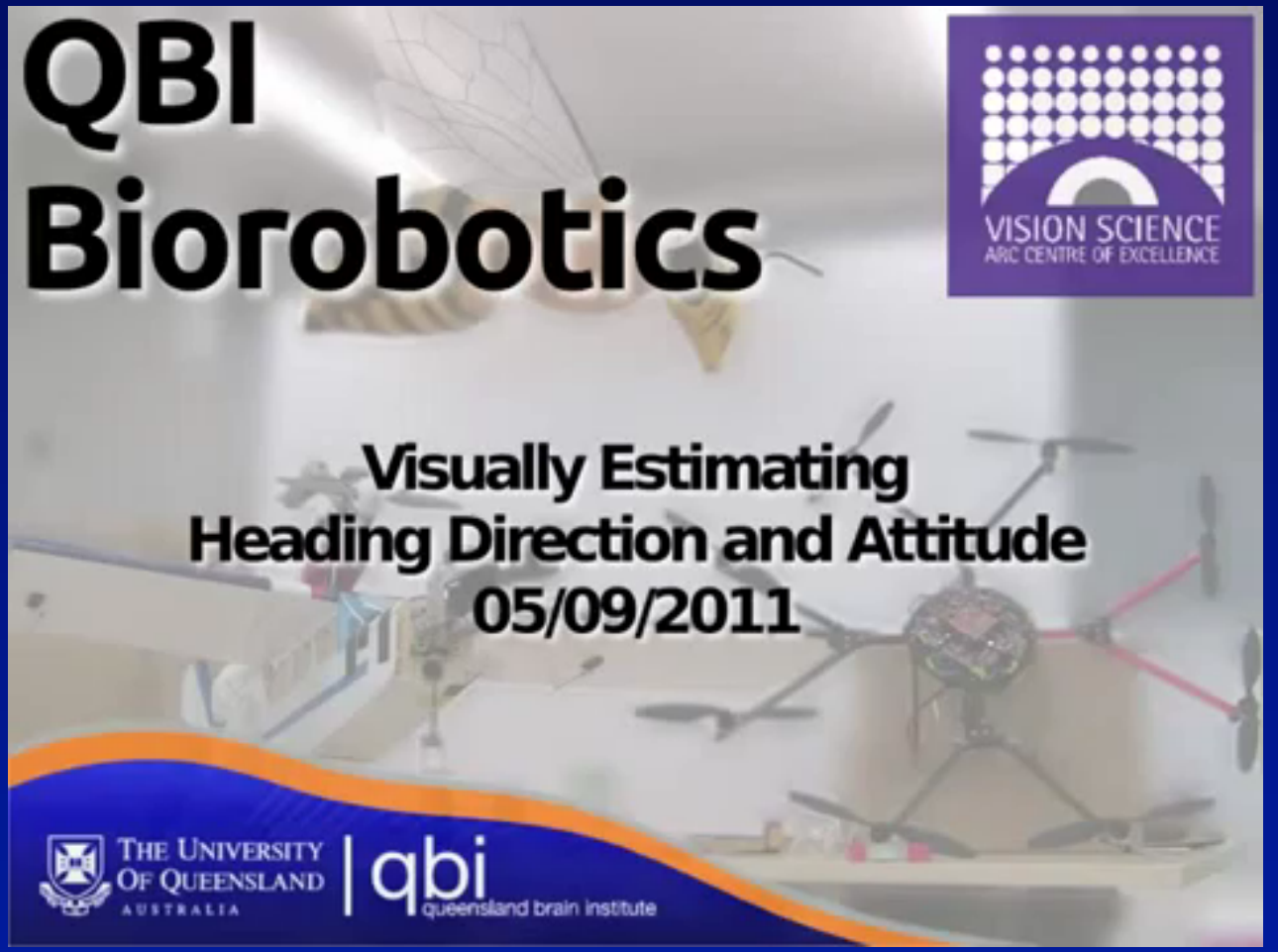


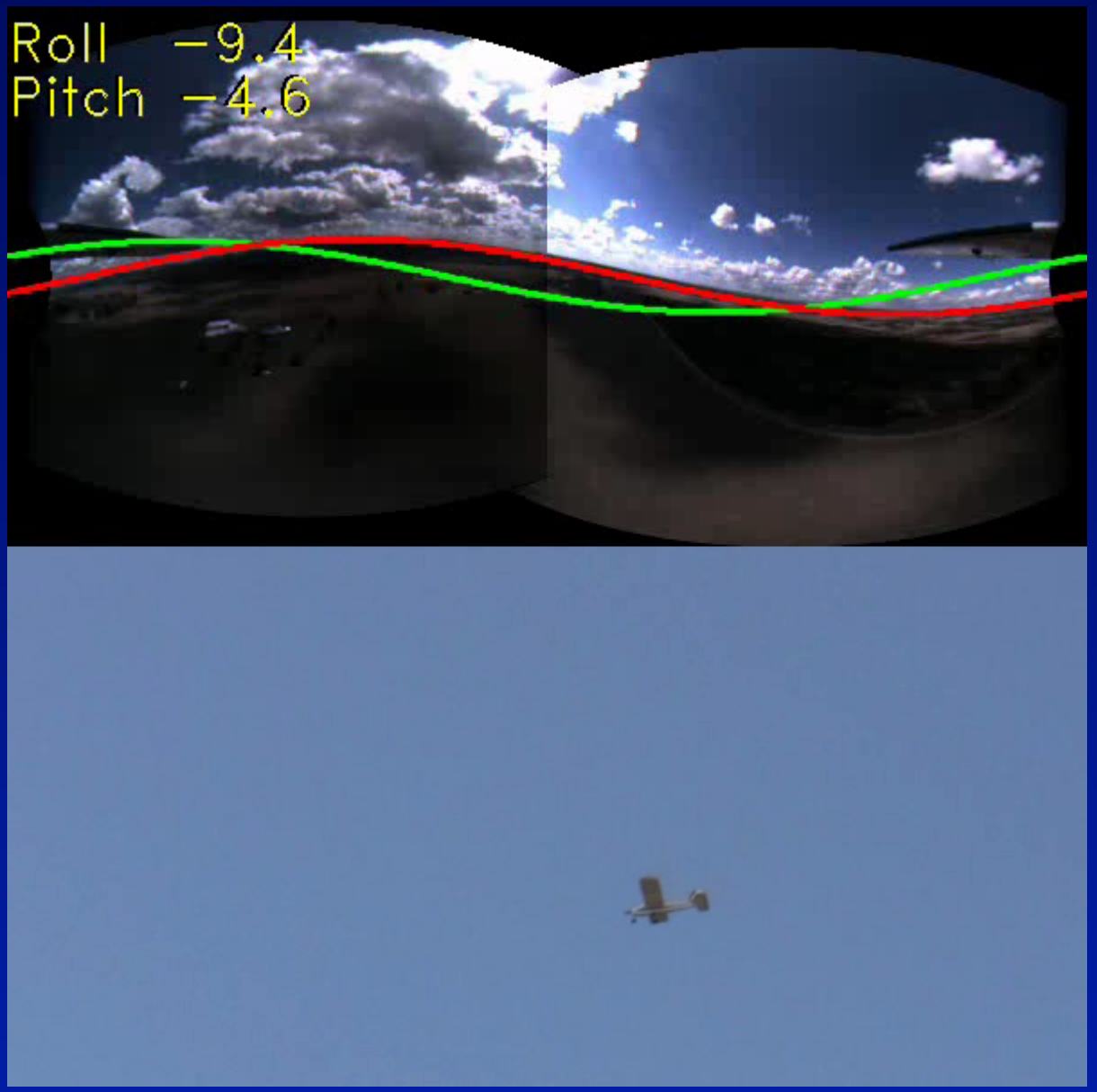
Moore, Thurrowgood, Soccol, Bland, Srinivasan (2011)

Example 1 Loop

Extreme maneuver accomplished autonomously by controlling the position of the horizon in the I-Eye vision system

Visual horizon

Inertial horizon



Thurrowgood, Soccol, Moore, Bland, Srinivasan (2011)

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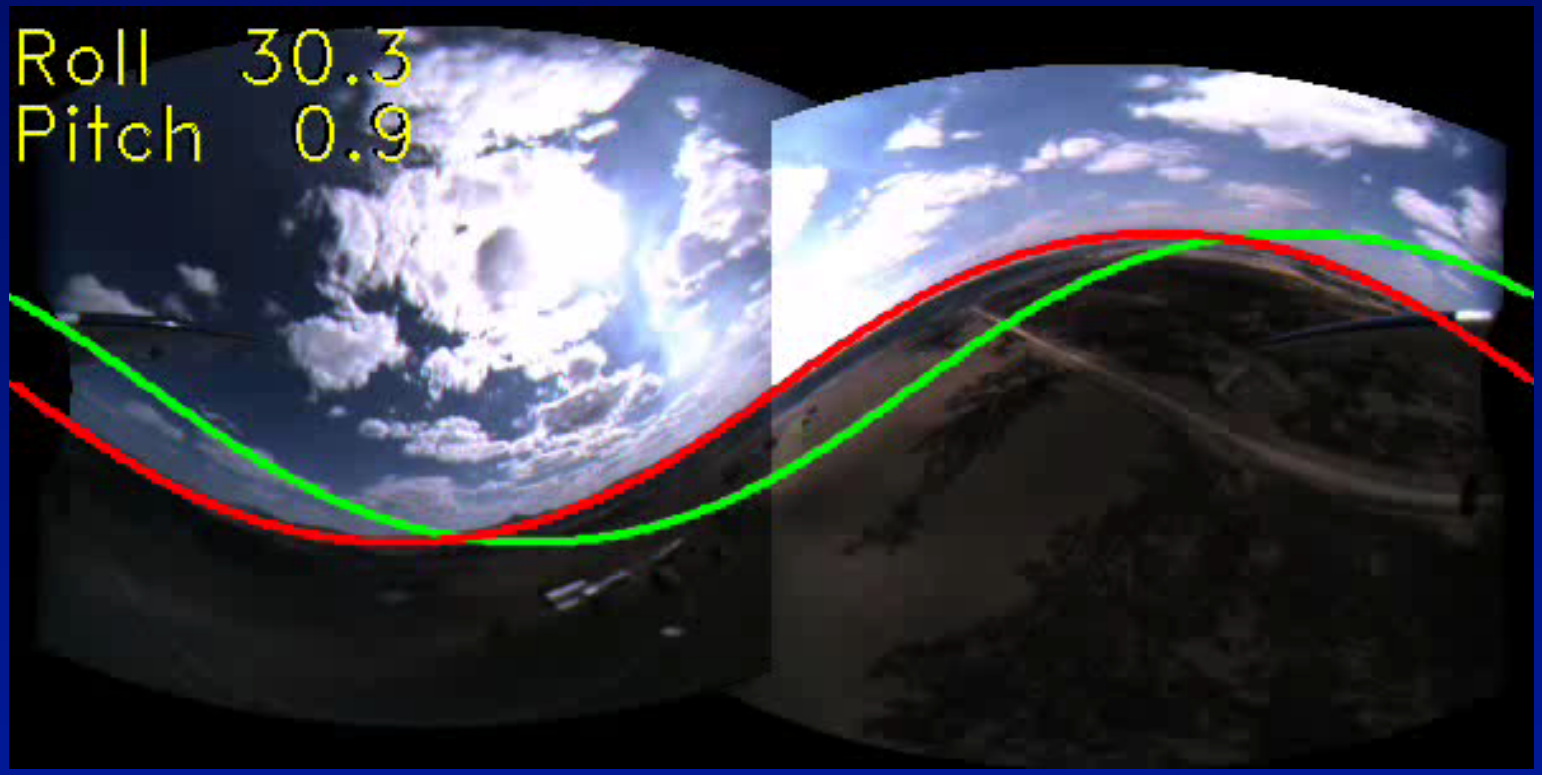
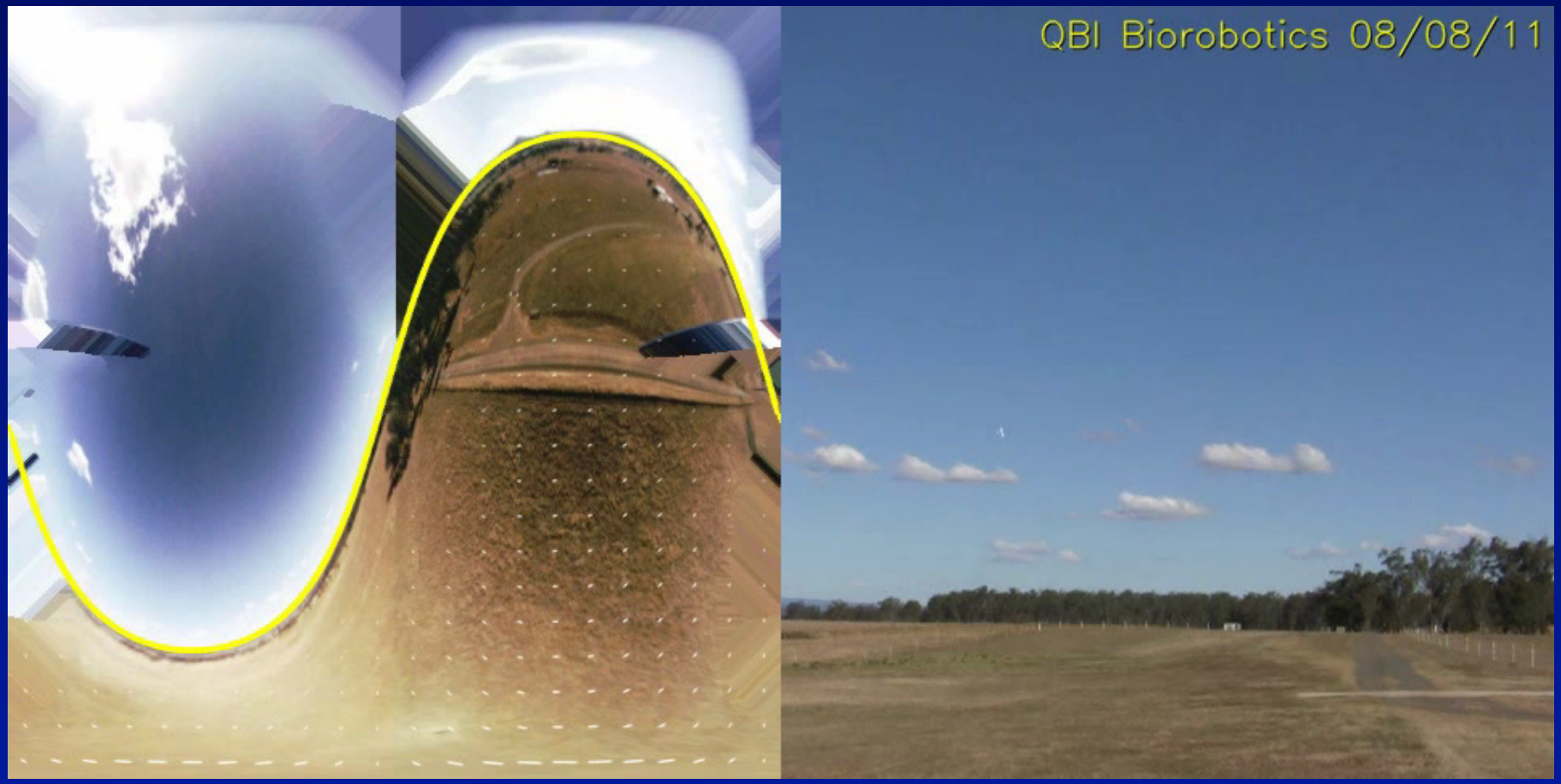


Example 2 -- Immelmann maneuver

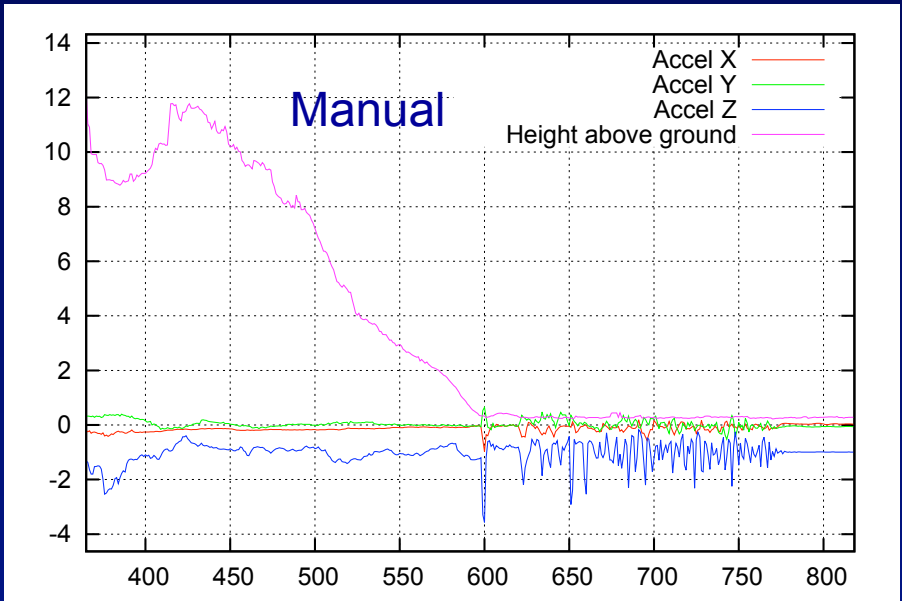
Thurrowgood, Soccol, Moore, Bland, Srinivasan (2011)

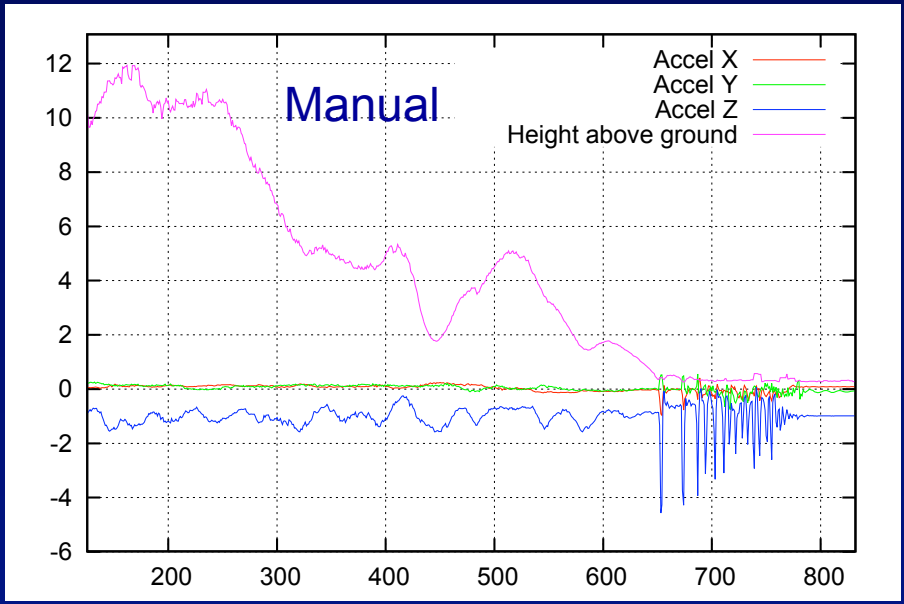
Automatic landing

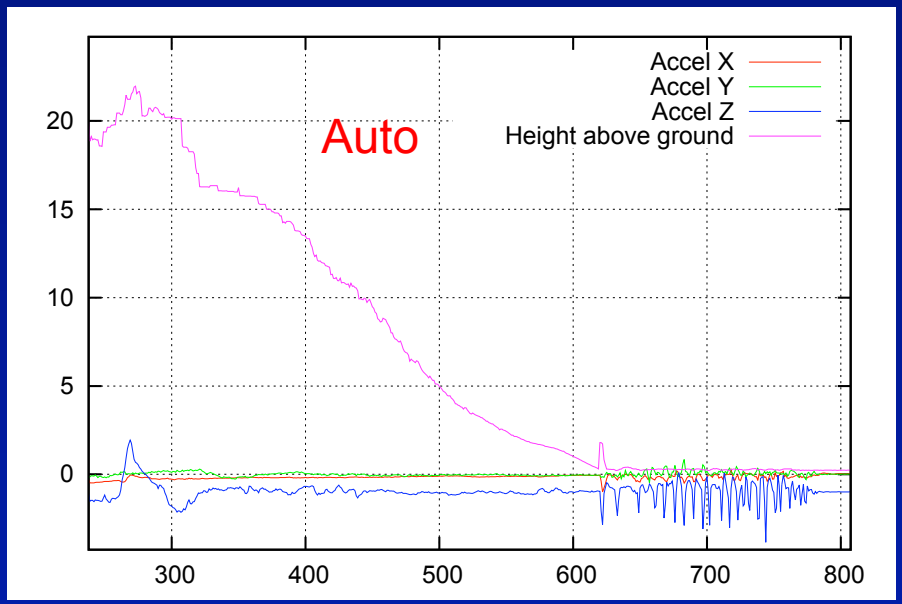


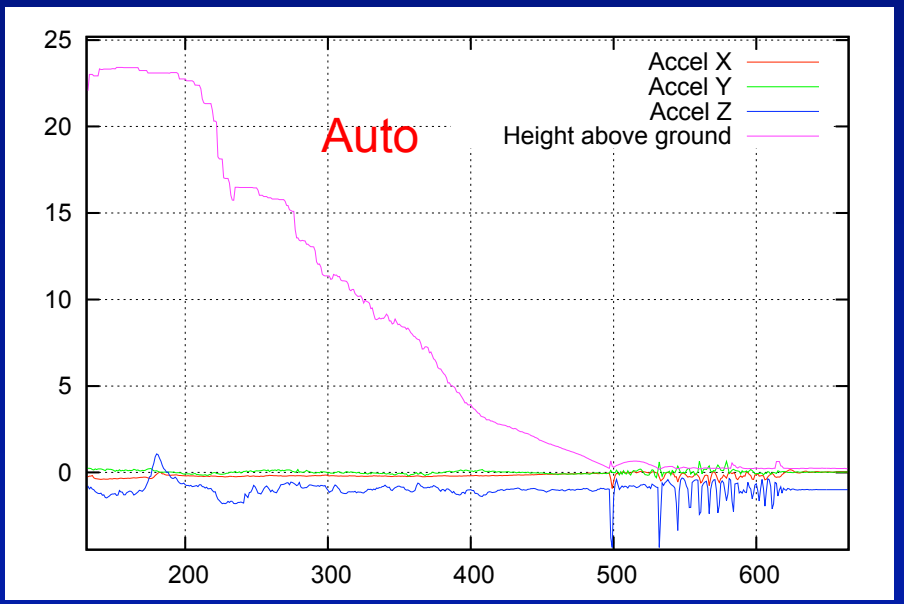
S. Thurrowgood, R.J.D. Moore,
D. Soccol, D. Bland and M.V. Srinivasan (in progress)

Automatic versus best manual landings: comparison

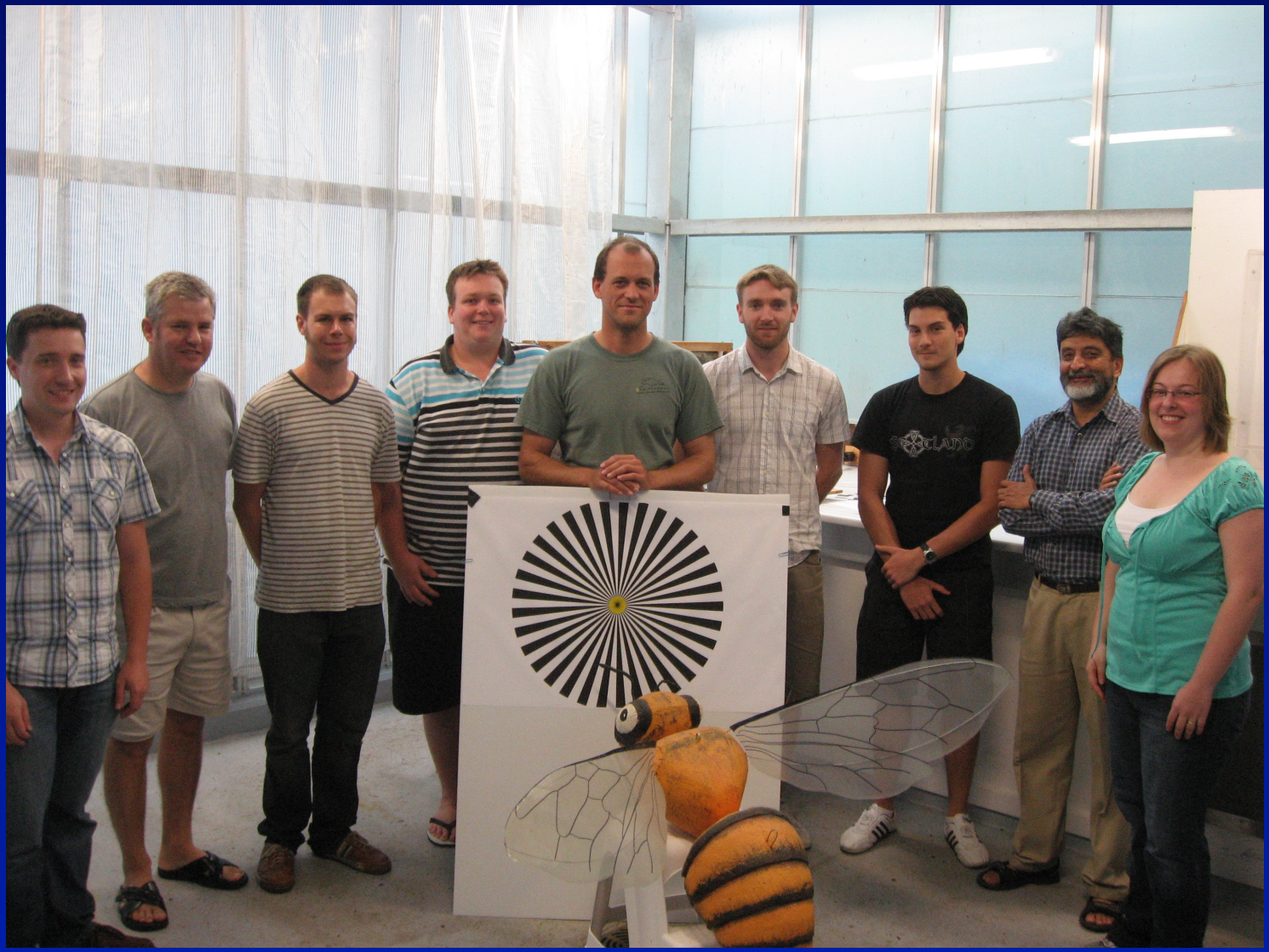








Sam Baker, Daniel Bland, Natalie Bland, Nikolai Liebsch,
Richard Moore, Gavin Taylor, Saul Thurrowgood, Dean Soccol



Thank you