Navigation and Control of Unmanned Aerial Vehicles in GPS-Denied Environments

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Outline of This Talk...

- Introduction and motivations...
- Key issues in navigation and control of UAVs in GPS-denied environments
- Some Research highlights...
  - 2014 International Micro Aerial Vehicle Competition
  - Vision-guided rotorcraft vertical replenishments
  - UAV calligraphy
  - Unconventional UAV
  - Palm-size micro aerial vehicles
- Ongoing projects and acknowledgement...
Introduction...

NUS UAV Family
NUS NAV Team with a distinguished visitor, Dr Siva Banda, Chief Scientist of US Air Force Research Lab
Introduction...

Our aim to tackle missions in GPS-denied environments...

- Surveillance & patrolling
- Exploration & mapping
- Scout & reconnaissance
- Search & rescue
Key issues involved:
- Platform selection
- Sensors & sensing
- Control
- Data processing
- Collision avoidance
- Path planning
- SLAM
- Communications
- Power supply
- Software realization

Key issues in navigation & control in GPS-denied environments

Indoor & Outdoor Hybrid Platform

Q-LION
Achievement Highlights...

2014 International Micro Aerial Vehicles Competition

August 13, 2014. Delft, the Netherlands
We explore the development of fully functional miniature unmanned helicopter systems. Research on identification and control of highly nonlinear model of the chopper, control and formation of multiple UAVs is thoroughly investigated.

**Specifications**

- Dimension: $1.4 \times 0.2 \times 0.5$ m
- Bare weight: 4.8 kg
- Payload: 5 kg
- Flight endurance > 30 min
- Max speed > 20 m/s

**Raptor 90**
We have developed a real-time vision system for a UAV to transfer cargoes between two moving platforms for the Grand Prix. It requires a UAV to transfer four buckets one by one from one platform to the other. The UAV should also perform autonomous taking off, target searching, target following and landing. We had successfully completed the entire task, and were ranked first in the final round competition.
Achievement Highlights...

Fun stuff – UAV calligraphy

UAV calligraphy demonstration at Singapore Airshow 2014...
Achievement Highlights...

Unconventional aircraft – Hybrid platforms

An aircraft that is capable of vertical take-off and landing, hovering, cruise flight...
We aim to develop an ultra compact micro aerial vehicle (MAV), which is able to safely navigate through indoor environment and complete autonomously necessary flight missions. The MAV is tested in actual flights.

**Specifications**

- Largest dimension < 15 cm
- 40 grams including battery
- 8 minutes flight endurance
- VICON-based or vision-based fully autonomous
Ongoing Projects...

The UAE Drones for Good Award, Dubai, February 2015

A 1 Million Dollar UAV Competition
Ongoing Projects...

- GPS-less large-scale inside forest search
- GPS-less urban canyon flight and perching
- GPS-less landing on moving platforms
- Formation of 50 UAVs
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In memory of our deceased lions...

Acknowledgment...

Crashed on 25 March 2006 in Singapore

Crashed on 14 May 2012 in USA

we pained, we gained...
Thank You!

Welcome to visit our group website at

http://uav.ece.nus.edu.sg

for more information on our research activities and published resources...