Drones for Active Sports Training & Monitoring

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Outline of the talk

What are drones?

- Drones
  - Autonomous **U**nmanned **A**erial **V**ehicle (UAV)
- Types of drone
  - Fixed wing: ArduPlane, Aeromapper
  - Rotary wing: Quadcopter, Helicopter
  - Hybrid: Vertical Takeoff Translational Vehicles
- Drones are classified based on weight, size, payload/range.
- Applications
  - Defense
  - Remote sensing/Aerial surveillance
  - Motion picture film making
  - Disaster relief
  - Logistics delivery
  - News

Autonomous quadcopter Video courtesy: Motherboard

Back

State-of-the-art in quadcopters

Surveillance Video courtesy: Travel Thailand

Commercially, UAV's claim their spot in surveillance and mapping

Mapping Video courtesy: Techno Systems

Quad at Cognitive Systems Group, SCE, NTU:

- Supported by Temasek Labs, NTU
- UAV carrying payload of 3.5 kg and endurance of 20 minutes. (500 meter height and 2.5 km range)
- Carry 1.5kg front hanging geo-localization sensor.
- Performs wave maneuver for 360° view.

Project Funded by Temasek Labs, NTU

Back

State-of-the-art in quadcopters

Advanced hover control

Video courtesy: ETH - IDSC

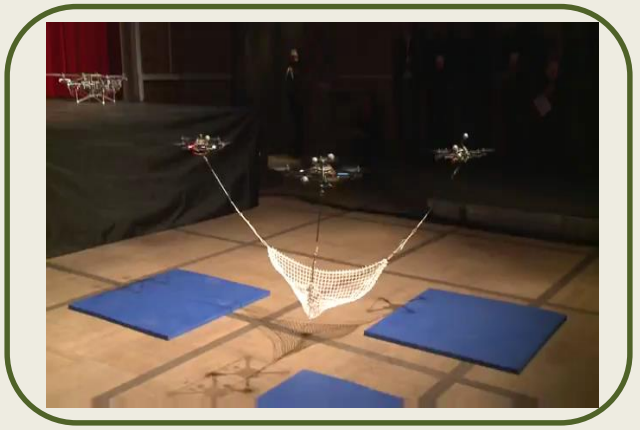
Current research focuses on indoor flying with synchronized control & obstacle avoidance.

Video courtesy: Upenn – GRASP Lab

Quad playing ping-pong

Video courtesy: ETH - IDSC

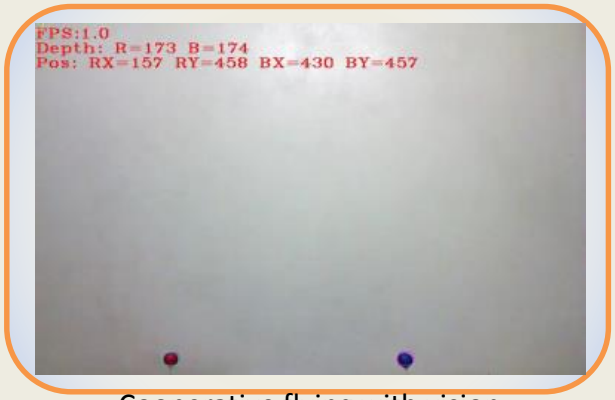
Vision based autonomous system capture UAV's states for efficient flight control system.



Coordinated game playing quad

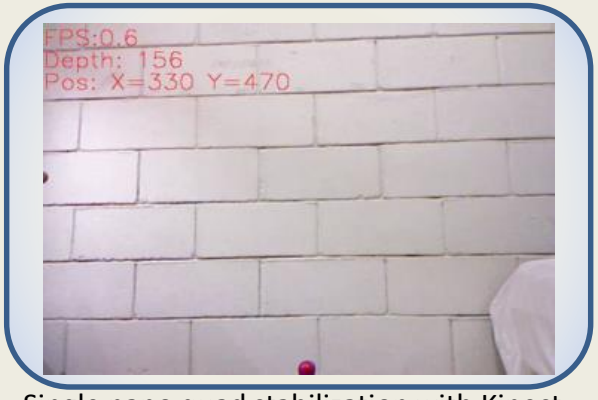
Video courtesy: ETH - IDSC

Recent advancements in quadcopter



Cooperative flying with vision

Video courtesy: Cognitive Systems Group, SCE, NTU

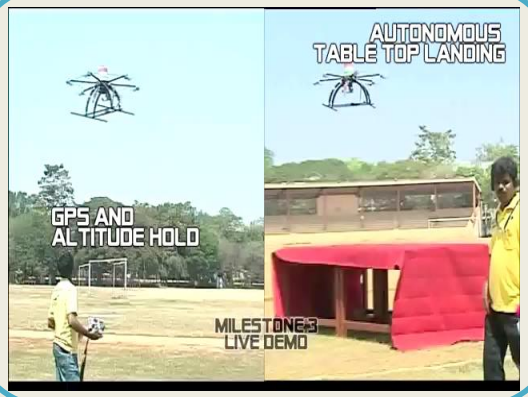


Single nano quad stabilization with Kinect

Video courtesy: Cognitive Systems Group, SCE, NTU

Natural gesture control for ease of flying

Video courtesy: Cognitive Systems Group, SCE, NTU



Dhaksha project

Video courtesy: MIT Anna University, Chennai, India

Mapping

Video courtesy: Techno Systems

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Some Commercial Applications

Courtesy: DHL

The future of logistics is in the hands of UAV.

DHL on the left and Google on the right delivering parcels

Courtesy: Google, Telegraph

Amazon delivering pizzas.

Pizza delivery

Video courtesy: Amazon

Back

Drones in active sports: Unexplored Opportunities?

araton video
cling
wing
otball
dminton

derstand issues
lp in training
ual monitoring

Video courtesy: Cybernawk Innovations and 3DRobotics

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Drones in active sports: Challenges

- Needs an expert to fly
  - Assembling and handling the UAV needs proper training.
  - Flying is a multi-fold problem.
    - Hand-eye co-ordination is the key.
    - Maneuvering the UAV coupled with handling the ground station need expertise.
  - Requirement: Able to fly with limited knowledge.

- Intelligent flight control system
  - Custom driven Maneuvers from application perspective for autonomous flying
  - Cooperative control for effective monitoring
  - Requirement: Seamless monitoring to control framework

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Drones in active sports: Challenges

- Tracking a person/vehicle
  - Tracking the dynamics in the sports activities need special skills.
  - Attention to details of a player is important.
    - In cycling, tracking the dynamics of the cyclist will help improve the sport as a whole.
    - Detecting the speed during the turn of a rower in a rowing event is important.
  - Requirement: Dedicated vision system for a given sport

- CURRENT MAJOR LIMITATION
  - Off the shelf quads does not solve any of the above problems

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OUR AIM:

PROVIDE A NATURAL GESTURE INTERFACE FOR MULTI-DRONE CONTROL.

PROVIDE A STABLE AND AUTONOMOUS CONTROL SCHEME FOR DRONES.

PROVIDE END-TO-END SOLUTION TO MONITOR A GIVEN SPORTING EVENT.

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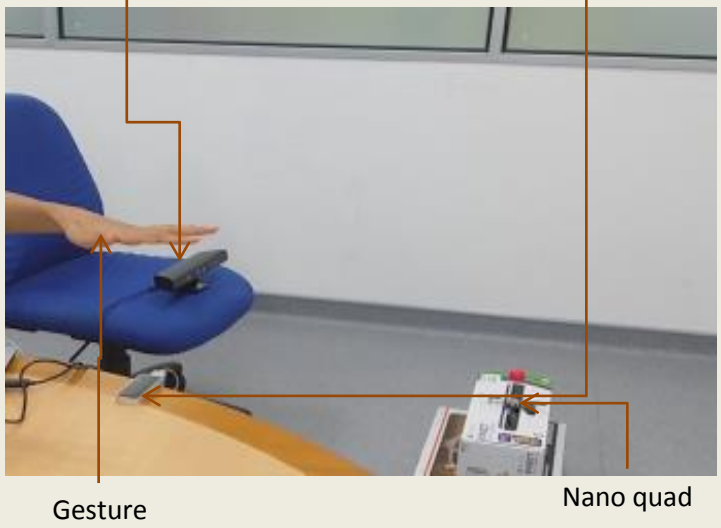
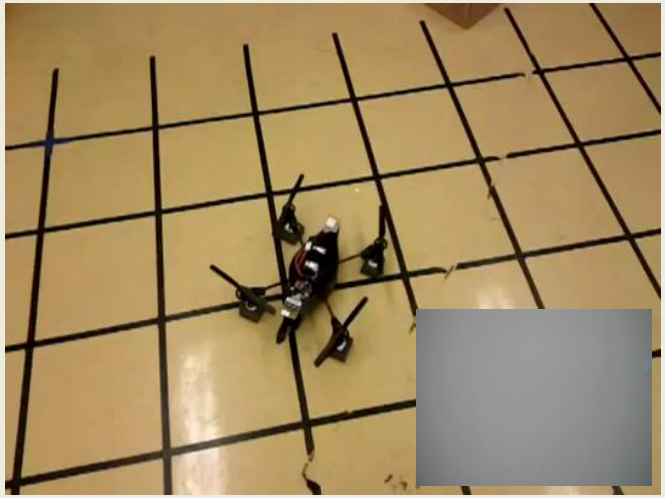
Natural gestures for flying

- Achieved by hand gestures and body movements.
- Leap motion™ captures the hand gestures using the IR and sends the command back to the controller.
- Kinect™ is used to capture the body movement and gestures.
- A customized glove can be used to capture the natural hand gestures.





- Natural hand gesture is used to control the drone.
- Different signatures used for different control mechanism.
  - Here, “take-off” is mapped to hand-unfold
  - “Yaw” is mapped to the left/right movement of palm.
  - Holding the palm wide open is mapped to “hover”.
  - Finally, hand-fold is mapped to “land”.

Gesture Interface for natural flying

Video/Assessment System

Transmit live video

Flight Computer

Live Video Feed

User gesture transmitted to UAV

Water Sports Field

User controls UAV camera based on video

Natural Gesture Platform

Will the user/trainer/coach need to control the UAV and the camera?

Stable & autonomous flight control

Video/Assessment System

Trainer/coach

Natural Gesture Platform

Custom trajectory for accurate monitoring

Flight stability augmentation system

Intelligent control system

Stabilizer

Trajectory calculator

Flight computer

No need for UAV control!!
Just control camera

Future Directions






- Monitoring
  - Sensor data and the feedback from the controls must be self-regulated and monitored intelligently.
- Intelligent control system
  - Gesture interaction to command for UAV
  - Gesture to multi-UAV control
  - Fully autonomous system
- Sports activities
  - Building customized drones for sports activities.
    - Possible trajectories based on the sports.
    - Possible gesture to video sensor command.

Team members

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THANK YOU ☺

Q & A

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