Unmanned Areal Vehicles – UAV, Drones Detection, Tracking, Control

Prof. Dr.-Ing. Dr. h.c. Dr.-Ing. E.h. mult. Werner Wiesbeck
Content of the Presentation

- Application of UAVs and Drones
- Security - problems and tasks
- Approaches for UAV detection and localization
  - Radar detection and tracking
  - transponder localization
  - optical localization
  - audio UAV recognition
  - state of the art systems
  - UAV/Drone control
Definition for UAVs and Drones (FAA)

A UAV is a powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or nonlethal payload.

When used, UAVs should generally perform missions characterized by the three Ds: dull, dirty, and dangerous.
Commercial Applications of UAVs, Drones ....

- Utilities
- Communications
- Construction
- Mining
- Oil & Gas
- Insurance
- Architecture
- Transportation
- Government
- Agriculture

Control of Mining by UAVs
UAV Traffic Management (UTM)
Military Applications of UAVs, Drones ....

Typical Applications:
- reconnaissance
- weapon control
- weapon carrier

Military UAVs are usually equipped with sensors for the detection of surveillance, and often with Electronic CounterMeasure equipment (ECM)
Private Applications of UAVs, Drones ....

- hobby or recreation
- taking photos for personal use
- surveillance of private areas
- surveillance of public areas
- flying at local model aircraft club
- use for farming and forest
- ......
UAV 3D Photography
Dangerous Abuse of Drones and UAVs

**Spionage**
- private areas
- industrial installations
- public institutions
- governmental institutions
- military installations

**Smuggling**
- prisons
- borders
- industry

**Terror acts**
- governmental institutions
- critical infrastructure (f.e. atomic)
- dense populated areas
- people assemblies, events

**Violation of Privacy**
Typical News to UAVs and Drones

09.05.2015  Versand-Drohnen orten Empfänger via Smartphone
03.05.2015  Wenn Drogen vom Himmel fallen
02.05.2015  Graffiti-Drohne sprüht über riesiges Calvin Klein-Plakat
23.04.2015  Japan: Radioaktive Drohne landet auf Regierungsgebäude
21.04.2015  Spezial-Drohnen saugen Wasser für Umweltanalysen auf
15.04.2015  Chinesische Drohnenfirma soll zehn Milliarden wert sein
14.04.2015  Drohne gefährdet Cessna im Landeanflug

+ cases where drones entered governmental institutions:

  Washington, Paris and Berlin

We realize, in the wrong hands, drones can be dangerous.
Uncontrolled Photography Private, Public, Military
Threat by Ammunition, Chemicals ….
Football Stadium, Threat by Ammunition, Chemicals

Allianz Arena
Munich
Swarm UAVs: Silent Threat Multiplier
UAV / Drone Detection, Tracking, Control
Detector Systems and Functions

Audio Detection → Noise of the rotors
GPS Detection → Position link
Radio Frequency Detection → Communication link
Video Detection → Visibility
Thermal Detection
Radar Detection → Increased temperature

Scattering and reflection
UAV (Drone) Localization Task

Detection of UAV presence:

- is a UAV flying in an endangered area?
- is a UAV approaching an endangered area?
- does the UAV carry a dangerous load?

How is the UAV controlled:

- by a radio link?
  - up-link only?
  - up-link and down-link?
- by Laser/optical?
- autonomous by GPS coding?
- by mobile phone?
Detection of the Drone Communication Link

Remote UAV control:
- Frequency: 2.45 GHz, or arbitrary frequencies?
- Range: up to several hundred meters
- Almost spherical radiation

- Spectrum surveillance
- Direction Finder
- Transmitter, receiver location
Sensor System for UAV Link Detection

Direction Finder 1

Direction Finder 2

Direction Finder 3

Localization

Direction finder base station
Monitoring Stations for UAV Communication Control

Allianz Arena
Munich
UAV / Drone Detection and Tracking by Radar
MIMO Radar Network Concept

- Each node is a fully functional MIMO radar – can estimate 3D+velocity
- Each node can communicate with each other (OFDM signals)
- Self-calibration network – positions, synchronization (time & frequency) done via communication/radar
- To simplify network, all commands come from the Master node
True Trajectory of 3 Targets by Radar

IHE 24 GHz MIMO Radar
UAV / Drone Optical Detection and Tracking
UAV / Drone Acoustical Detection and Tracking
Commercial Systems for UAV / Drone Detection and Tracking
Multi-Sensor Surveillance: Dedrone DroneTracker

- Multi-Sensor, stand-alone
- Wireless LAN (-B/-G/-N)
- Sensor range 100 m
- Size 420 x 420 x 120 mm³
- Data registration

Dedrone GmbH
Otto-Hahn-Straße 31
D-34253 Kassel-Lohfelden
T: +49 (0)561-579847-50
info@dedrone.de
Secure Hemisphere: Dedrone Drone Tracker

http://www.dedrone.com/de
Secure Hemisphere: Dedrone Drone Tracker

http://www.dedrone.com/de
Sensor Surveillance: dronehunter

No detailed information available

- Radar Sensor
- range up to 500m
- weather independent
- alarm
- scalable

Fink Secure Communication GmbH
Simonsgasse 28
D-96489 Niederfüllbach
info@dronehunter.de
Comparison of Drone Detector Systems (05.2015)

<table>
<thead>
<tr>
<th>Detector Feature</th>
<th>Drone Detector</th>
<th>Drone Shield (USA)</th>
<th>Orelia aka Drone Detector (France)</th>
<th>Dedrone (Germany)</th>
<th>CellAntenna (USA)</th>
<th>Domestic Drone Countermeasures (USA)</th>
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</thead>
<tbody>
<tr>
<td>Audio Detection</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Radio Frequency Detection</td>
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<td>Video Detection</td>
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<td>✓</td>
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<tr>
<td>Thermal Detection</td>
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<tr>
<td>Radar Detection</td>
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http://www.dronedetector.com/compare-drone-detector/
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<tbody>
<tr>
<td>Detect Flying Drones</td>
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<td>✔️</td>
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<td>Detect Ground-based Drones</td>
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<tr>
<td>Detect Waterbased Drones</td>
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<tr>
<td>Detection Strength</td>
<td>Strong (Multi Layer)</td>
<td>Weak (Single Layer)</td>
<td>Weak (Single Layer)</td>
<td>Weak (Double Layer)</td>
<td>Medium (Single Layer)</td>
<td>Medium (Single Layer)</td>
</tr>
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UAV/Drone Risk Reduction
Registration of UAVs and Drones

The registration of all produced and operated UAVs and Drones in databases is required:

- manufacturer
- type
- specifications
- owner/user
- License ID
- localization

All UAVs and Drones have to transmit continuously their identity when flying.

All UAV and Drone operators must have a license;
they have to certify their qualification to operate a drone.

In case of problems for public security all UAVs and Drones must be identifiable via the database.
Security Measures for UAV/Drone Control

- Identify the UAV or Drone
- Determine UAV task: commercial, hobby, terrorist
- UAV communication link interference
- GPS interference
- Take over UAV control
- Prevent dangerous actions
Take over Control

Required Information:
- frequency
- modulation
- Code

Take over control with excess power

GPS Spoofing:
GPS spoofing takes advantage of the fact that the civilian GPS signals are unencrypted and unauthenticated

Take over control with false GPS (∼1000$)
Destroy the UAV

This is not a good idea, because the threat may become reality.

- High precision shooting
- Collision by a controlled UAV
- Anti-radiation missiles (ARMs)
Summary
Unmanned Areal Vehicles – UAV, Drones
Detection, Tracking, Control
Scenario Summary

UAVs may become a major threat for private, public and office areas.

- What to do?
  - Prepare a law regulating the Drone registration, use and applications
  - Take over UAV/Drone control
  - Surveillance and control of endangered areas
  - Track away dangerous UAVs and Drones