Practice of Low Altitude Aircrafts Counter System in China

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1. Introduction of SNERDI

2. Current Status of Airborne Threat

3. Solution of Aircraft Counter System

4. Problem & Discussion

Introduction of SNERDI

- Plant General Design
- Core Design
- System and Equipment Design
- Electric and I&C Design
- Safety Analysis
- Building Layout
- CI Design
- ……

Introduction of SNERDI

Experience in Physical Protection

- Physical protection of QinShan-III CANDU-6 HWR.
- Upgrade of physical protection for QinShan-I.
- Physical protection of AP1000 project for Sanmen and Haiyang.
- Physical protection State Nuclear Power PWR Demonstration Project.
- Detailed Design of COE(Centre of Excellence) in Beijing.

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Definition of Low Altitude Aircrafts

Key characteristics:

- Low altitude: under 500m
- Low speed: under 100km/h
- Small size: RCS<1m^2

“低慢小”

Drones: multi rotor /fixed-wing,

Light helicopter,

Balloon, Airship

Powered parachute, Gliding parachute

Types of Low Altitude Aircrafts

Electromagnetic Cooperative

- Standard commercialized UAVs
- Using standard channel for flying control or image transmitting

Non-Electromagnetic Cooperative

- No distinguishable RF characteristics
- Using unknown channel for flying control or image transmitting





Chinese Regulations on Restricted Area

Provisional Regulation on Flying Unmanned Aerial Aircrafts (2018)

Airport

10km from the center line of runway

20km from the ends of runway

Populated Area

Station, portal, hospital,

international conference and summit, etc.

Sensitive Area

Government, military base, communication facility, power plant, dangerous goods storage, etc. (100m from the boundary)

Difficulty with Low Altitude Aircrafts Counter

Easy to access:

- Almost all the parts are available online (hardware and software) .
- Cheap, easy to carry, simple to operate.

Hard to detect:

- Small size, small RCS, Doppler effect is not significant.
- Easy to hide in the environment.
- Similar characteristic with birds, vehicles, small ships.

Hard to counter:

- High mobility and hard to predict.
- Flyer could be far away from the site.

Summary

- Aircrafts other than drones should be taken into consideration.
- Standard UAVs are easy to stop by setting a restricted area.
- Non-Electromagnetic cooperative aircraft is the most dangerous type of threat.
- Regulation supports counter of UAV in NPP, but is not clear on how to deal with illegal aircrafts.

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Detection of Low Altitude Aircrafts

	Advantage	Disadvantage
Optical Imaging	Low cost Mature technology No radiation	Susceptible to weather Limited detection range Poor performance during night
Thermal Imaging	Suitable for all weather No radiation	Most UAVs have no distinguishable thermal characteristics. More limited detection range
Acoustic Detection	Low cost No radiation	Very limited detection range Poor identification ability
RF Detection	Low cost No radiation Mature technology	Cannot provide accurate position Only useful to aircrafts with electromagnetic characteristics
Radar	Provide accurate positioning Detect all types of aircraft	High cost Cannot tell the difference between aircrafts, birds, vehicles Electromagnetic radiation
Magnetic Detection	No radiation	Most UAVs don't use a lot of metal material. Limited detection range

Counter of Low Altitude Aircrafts

	Advantage	Disadvantage
Kinetic weapon	Low cost	Lethal weapon Poor effectiveness
Directional Energy weapon	High Efficiency	Lethal weapon High cost
RF interference	Low cost High Efficiency Do not destroy the aircrafts	Only effective on electromagnetic cooperative aircraft. Can cause interference to normal communication signal. Can cause interference to GPS signal. Electromagnetic radiation

Current Solution

Radar

“雷光电”

First detection
Position of aircraft

Optical
Imaging

RF Interference

Identify the target

RF Detection

Cover the blind zone of radar
Assistant to identify the target

Equipment Introduction

Optical Imaging

Identify ability: clear to identify a target with size of 350x350 at 2km
(for visibility>10km)
maximum focus length 775mm

Tracking ability: Horizontal angular velocity: 0.1~30°/s
Pitch angular velocity: 0.1~10°/s

RF Detection

Range: 5km Accuracy: 3°

Working frequency: 300MHz~6GHz

RF Interference

Range: 5km Power:<100W

Working frequency： 1500MHz-1650MHz, 2400-2483MHz, 5775MHz-5850MHz

Equipment Introduction

Radar

Three coordinates: distance, direction, altitude

Range: 2~5km in radius for RCS=0.01m^2

Pitch angle: 40° , from -10° to 50°

Working Band: S band(2-4GHz)/ C band(4-8GHz)

Accuracy: <10m/<0.5° /<0.5°

Power: <500W

Horizontal Scanning Mode: electronic scanning/mechanical scanning?

OR

Summary

- The combination of radar, optical imaging, RF detection and RF interference is a solution widely accepted in the industry.
- The total cost is relatively expensive if using phased array radar.
- It performs well for detecting commercialized drones.
- Experiments show the system could be ineffective against more experienced flyer with malicious intentions.

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Problem & Discussion

1. What is the design basis threat?

Flyer	Common Civilians	Criminal or Activists	Terrorists	State Actor
Aircraft	Standard product Fly based on regulations	Little modification Possibly bypass the restricted zone Using standard communication channel	Modified or self assembled Possibly fixed-wing aircraft Non-Electromagnetic cooperative	Fixed-wing Drones cluster
Action	Taking Photos	Recon Propaganda	Transfer contrabands, weapons	Attack critical infrastructure	Attack Safety-related components
Detection Measure	Flying data	RF detection	Radar		
Counter Measure	Restriction zone	RF interference	Physical destruction		

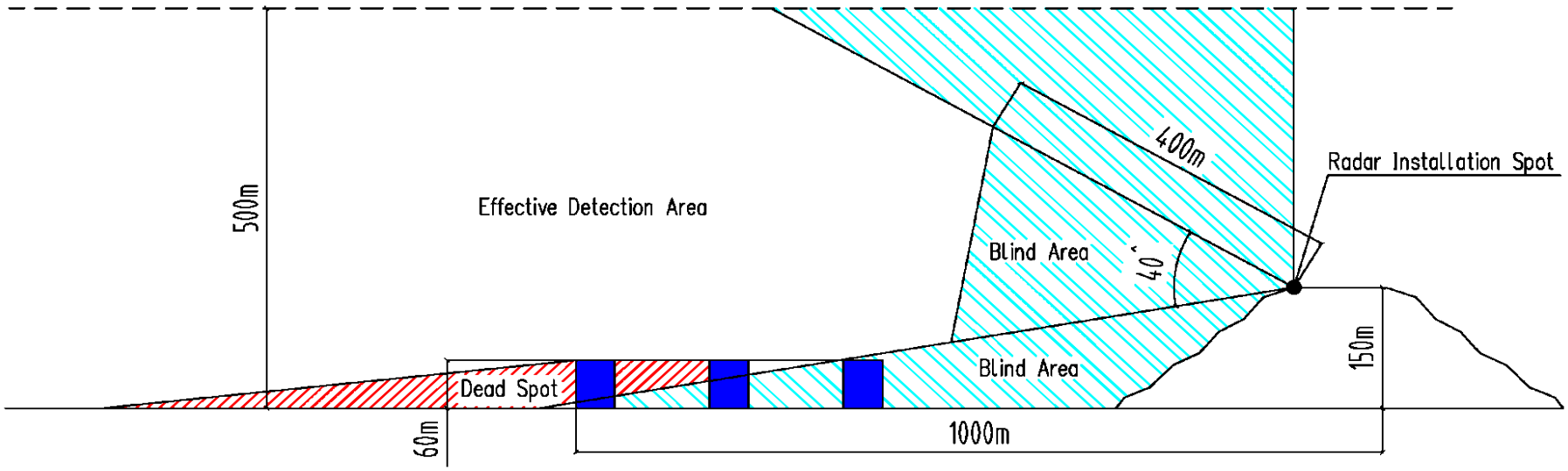
Problem & Discussion

2. What should be the protected target?

Very large blind area and dead spot.

Protection area might be within the blind area.

Shall we defend aircrafts flying really low?

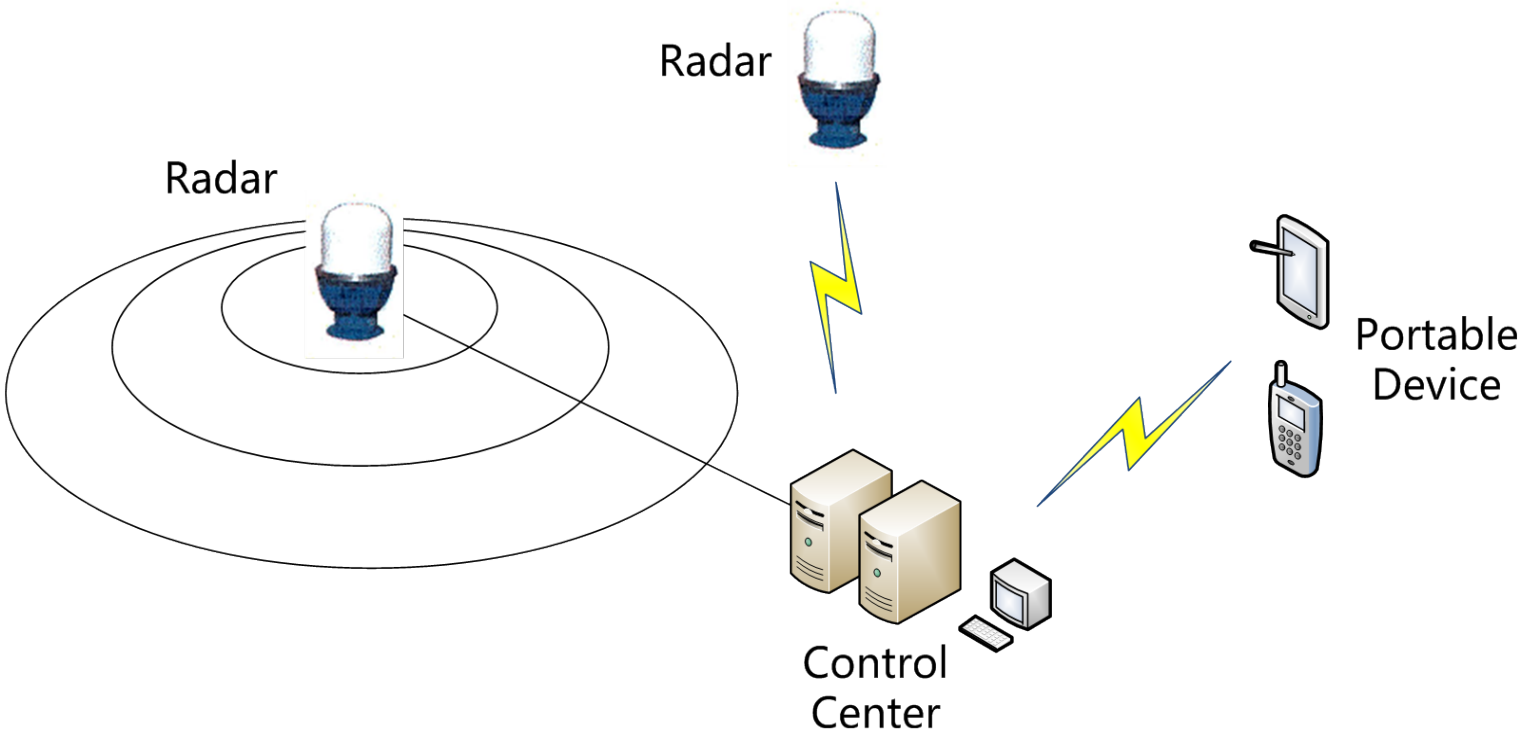


Problem & Discussion

3. Is it possible to use wireless communication?

Communication between detection equipment if they installed in mountain.

Communication among response force.



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