



AresX™

Border Area Detection and Alarm System

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1 Overview

1.1 Background

Bangladesh shares a long border with neighboring countries, and in recent years, the situation has been unstable. Crimes, illegal immigration, and smuggling incidents frequently occur along the border, with thousands of refugees crossing into the country, creating significant economic pressure. To ensure the safety of citizens and protect national interests, it is necessary to deploy a reliable border protection system that can provide all-weather, comprehensive surveillance of individuals, vehicles, and drones near the border. This system aims to safeguard national interests and public security.

1.2 Solution

Given the various situations occurring along the border, such as unauthorized human crossings, vehicle intrusions, and drone violations, a more effective solution is required to rapidly and accurately detect intrusion targets and trigger alerts. This system utilizes active phased array technology and pulse-Doppler radar with a fully solid-state, fully coherent, 360-degree electronic scanning capability to detect targets within a specific distance and angle range. Once a target enters the designated alert zone, the system immediately activates an audible and visual alarm and automatically guides cameras to verify and capture images or video recordings of the intrusion for evidence collection. By installing the system at specific intervals along the border, full-scale detection and alarm coverage of the entire border area can be achieved.

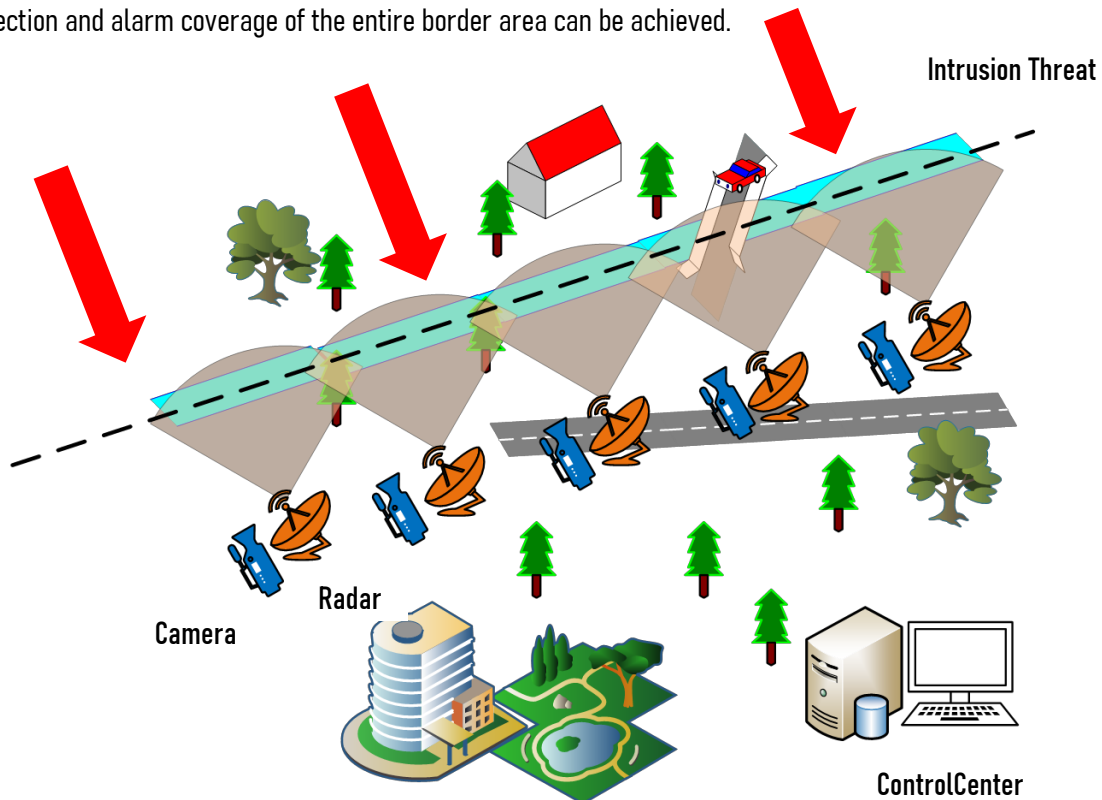


Figure 1 Regional Surveillance System Coverage Diagram

2 Function Specification

- 1) The system can effectively detect and track targets within the coverage area, including individuals walking at a low posture, standing, running at high speed, as well as vehicles and drones
- 2) Laser night vision equipment (optical cameras or infrared night vision imaging devices) can automatically capture images and record videos of targets under radar guidance
- 3) Laser night vision equipment (Optical camera or infrared night vision imaging devices) can track optical image of targets under radar guidance.
- 4) The system can define alert zones within the monitored area and trigger audible and visual alarms when a target enters the alert zone;
- 5) The system can define safe zones within the monitored area where targets entering will not trigger an alarm.
- 6) When an intrusion event triggers an alarm, the radar ensures no missed detections and minimal false alarms within the system's defense zone. It filters out disturbances caused by nearby vehicles, pedestrians, birds, falling leaves, electromagnetic interference, and strong winds to prevent false alarms.
- 7) When necessary, the system can deploy sound energy up to 166dB to disperse crowds in densely populated areas.

3 Performance Indicators

Table 1: Single-Station System Performance Indicators

Category	Name	Technical Indicators
System Response Time	Intrusion Alarm Time	$\leq 2s$
	Time for Optical System to Capture a Clear Image	$\leq 4s$
Single-Station Detection Capability	Horizontal Coverage Angle	$>90^\circ$
	Elevation Coverage Angle	4°
	Distance	Human (RCS=0.7m ²) 8km

	Vehicle (RCS=5m ²)	12km
System Processing Capability	Distance Resolution	Better than 12 meters
	Angular Resolution	Better than 1.8°
	Distance Accuracy	Better than 10m
	Angular Accuracy	Better than 0.2°
Environmental Adaptability	Lighting Protection	4000V
	Waterproof Rating	IP66
	Operating Temperature	-40°C~+70°C
	Continuous Operation	7 Day×24 hours
Other System Indicators	Power Supply	AC220V
	MTBF (Mean Time Between Failures)	10000 hours
	Data Interface	RJ45
	Installation Method	Roof-mounted Installation

4 Product Composition and Working Principle

4.1 Product Composition

The block diagram of the detection and alarm system is shown in Figure 2. The system consists of detection nodes and a central control station. Each detection node includes regional detection radar, an intelligent camera, and a communication gateway. All nodes are interconnected with the central control station via fiber optics.

The system comprises radar, cameras, and a high-intensity sound deterrence system, primarily designed for areas with high human activity. Upon detecting an emergency, the camera captures images and records video for forensic evidence, providing a basis for decision-making. When dispersal measures are needed, the high-intensity sound deterrence system is activated to effectively prevent crowd disturbances and emergency incidents, ensuring effective situation control. The system composition is shown in Figure 2

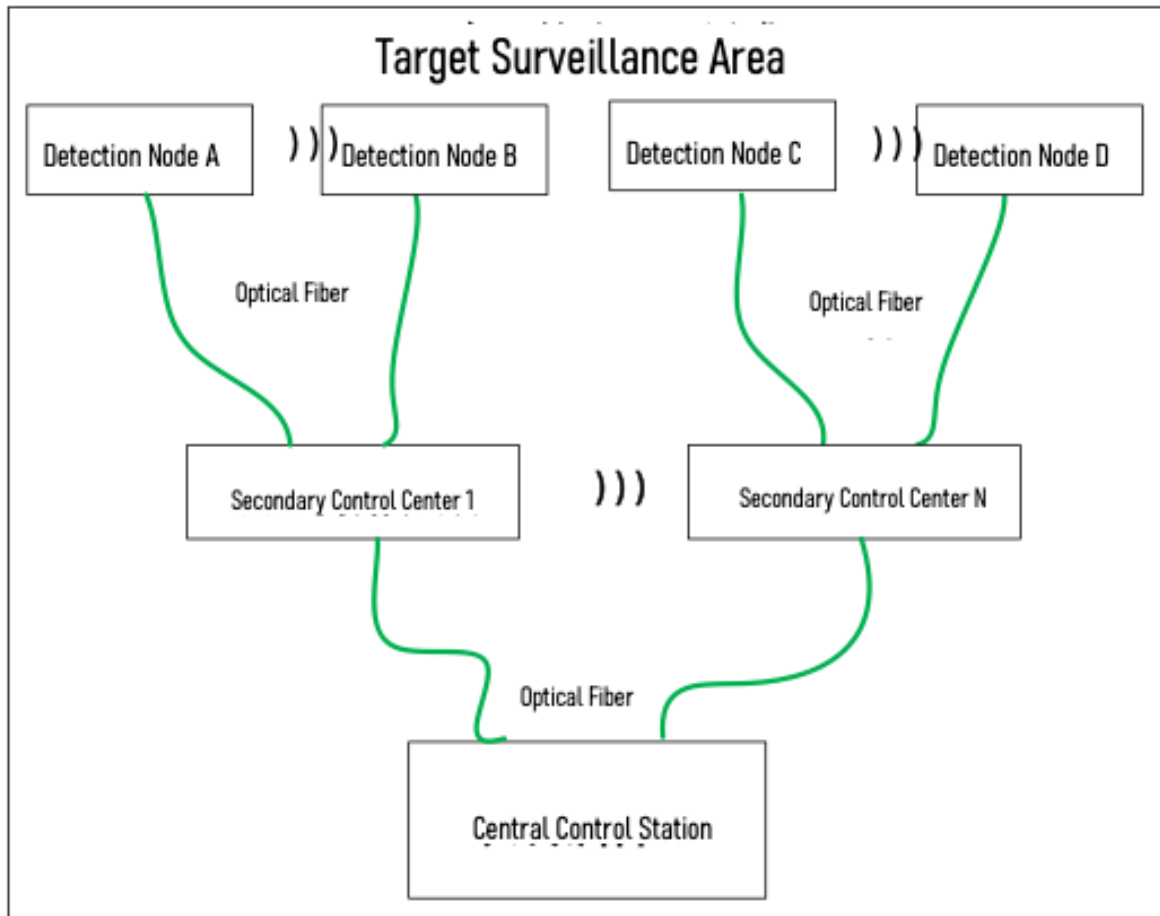


Figure 2 System Composition

The detection node consists of the SW-R6E radar, camera, and intelligent gateway. Its primary function is to detect and alert based on the predefined monitoring area and alarm strategy. The system enables optical auto-tracking, image capturing, and video recording of the target, while also reporting target information and site equipment status. Additionally, it integrates with the high-intensity sound deterrence system for coordinated action. The block diagram is shown in Figure 3.

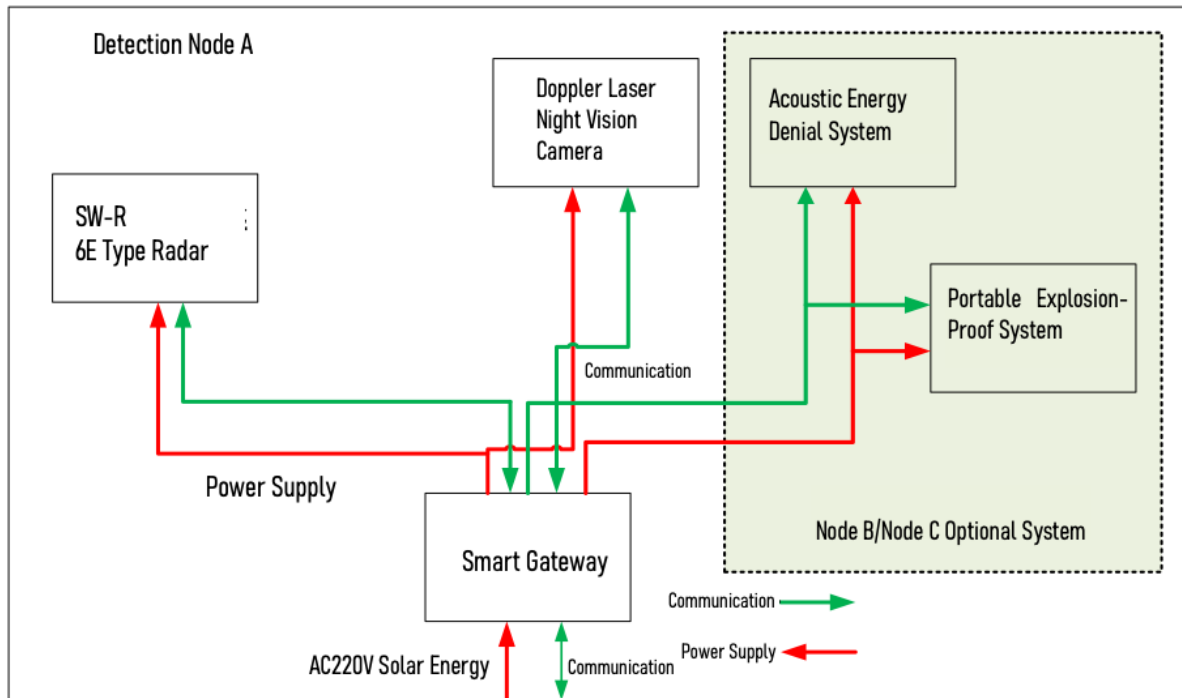


Figure 3 Detection Node



Figure 4: Detection Node Installation Diagram

When AC220V power supply is unavailable, the station operates on solar power. A high-capacity solar battery enables the system to function continuously for approximately 70 hours, ensuring normal operation even during three consecutive days without sunlight. The system uses polycrystalline silicon solar panels, which can fully charge the battery within a few hours. Additionally, different battery and solar panel configurations can be selected based on specific operational requirements.

The central control center consists of a server, control console, NVR video storage device, large display monitor, fiber optic switch, and UPS power supply. It displays the overall monitoring status. The system block diagram is shown in Figure 5.

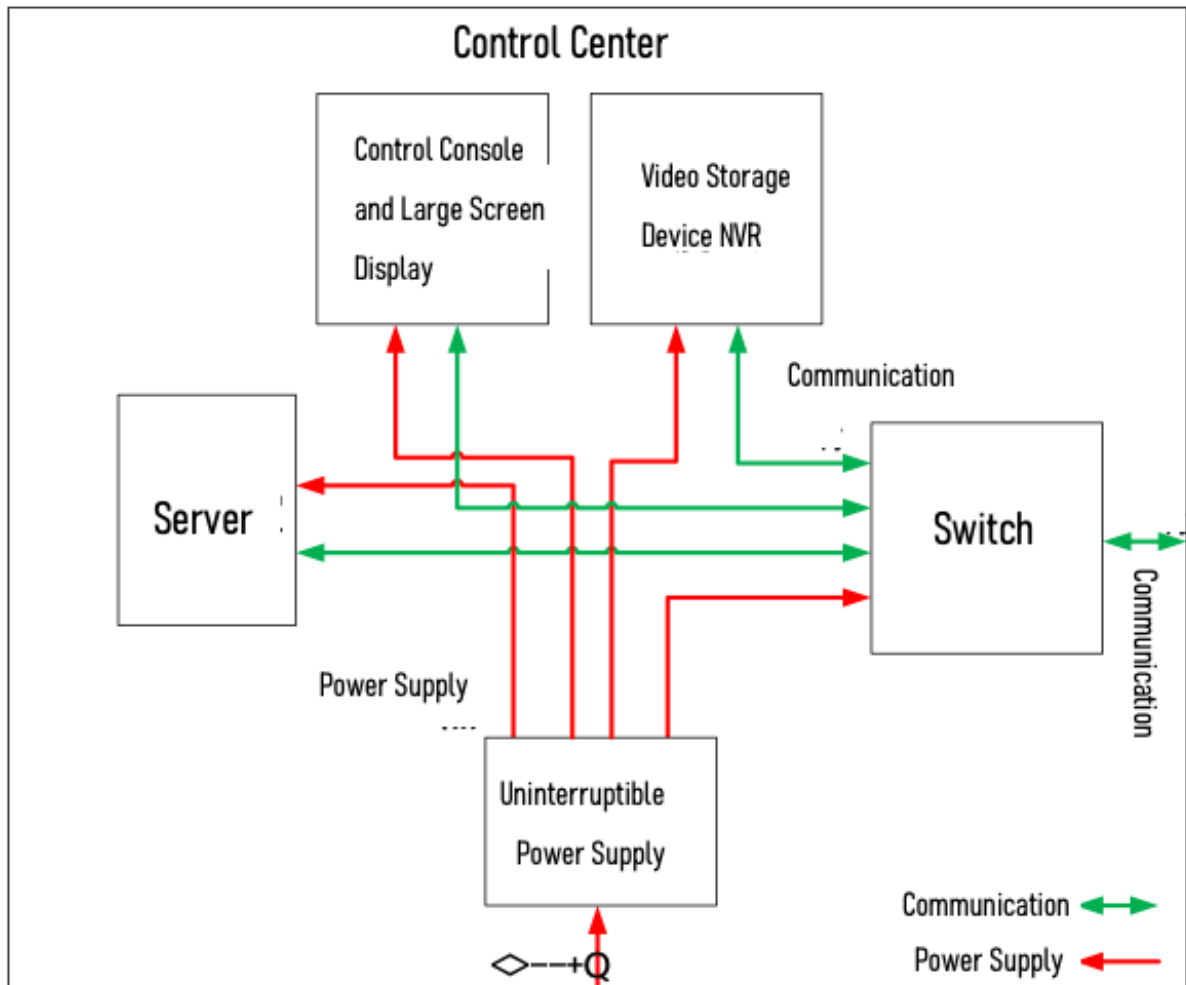


Figure 5: Central Control Center Block Diagram

4.2 Working Principle

First, the radar defines an alert zone within its coverage area. When a target is detected within this zone, the system triggers an audible and visual alarm and reports key target information—including latitude and longitude, speed, distance, trajectory, and target amplitude—to the central control center. The central control center analyzes this data and automatically directs one or more nearby cameras to the target. The cameras then adjust focus, continuously track the target optically, and capture images or record videos, which are stored for further analysis.

When the radar detects multiple targets, all target information is sent to the central control center, which prioritizes threats and intelligently assigns the closest camera(s) to capture images and videos for verification. Based on the threat level, appropriate response measures are taken.

Since multiple cameras work collaboratively, operators also have the option to manually select one or more cameras to track different targets. The radar guides the selected cameras, adjusting direction and focus,

enabling observation of target characteristics from different angles and distances. The system workflow diagram and data flow diagram are shown in Figures 6 and 7.

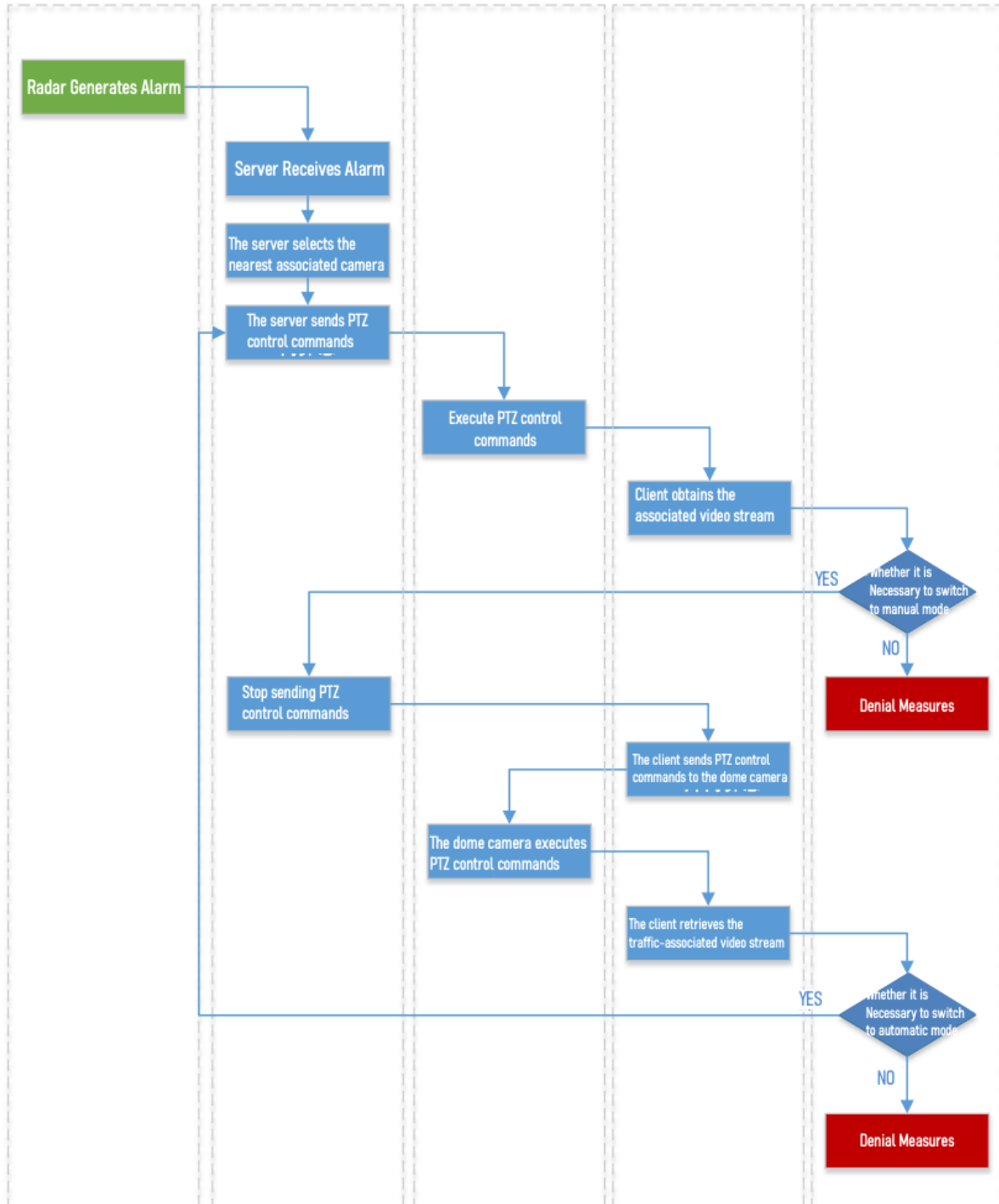


Figure 6 Radar and Electro-Optical Linkage Workflow Diagram

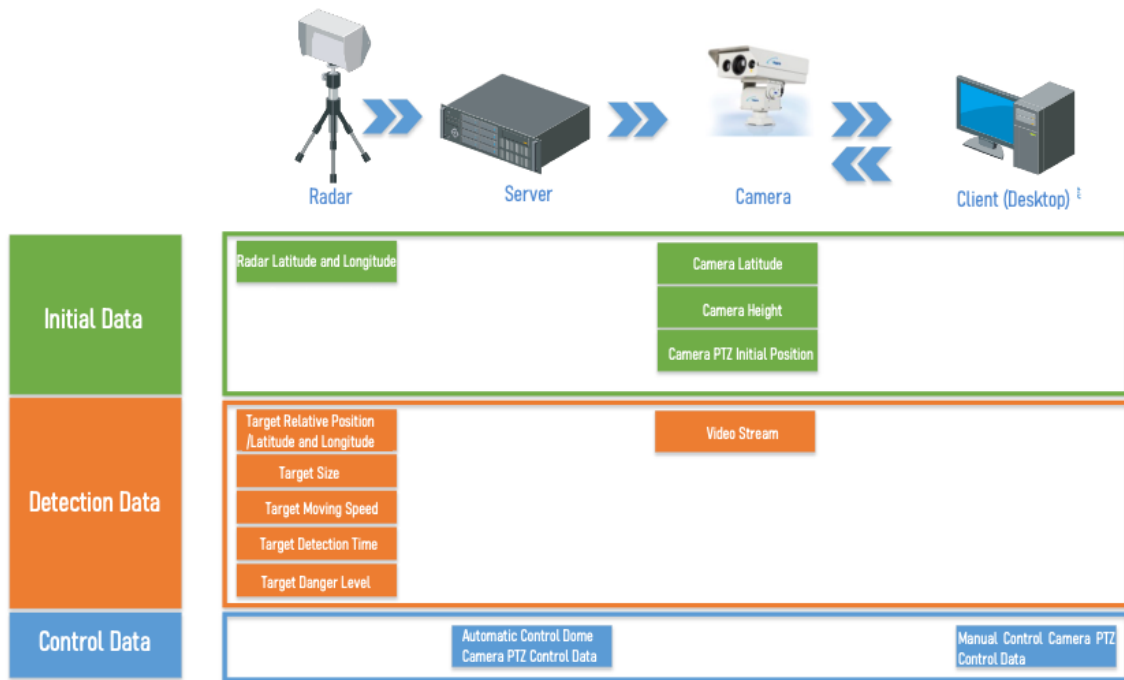


Figure7: Data Flow Diagram

5 System Design Solution

5.1 Design Principles

Equipment deployment should be based on the defined detection and alarm zones, ensuring full coverage of all areas within the border management scope to enable rapid detection and alarm functionality.

5.2 System Solution Design

5.2.1 System Construction

This system provides focused detection and alarm coverage for designated areas. The main defense targets include rivers, trees, roads, residential buildings, etc. Considering these characteristics, the radar and laser night-vision cameras are installed on iron towers, with the radar positioned lower than the laser night-vision cameras.

The radar of a single detection node effectively covers a distance of 6 km. To ensure no blind spots within the monitored area, adjacent detection nodes are deployed with a 1 km overlapping coverage zone. The coverage of detection nodes is illustrated in Figure 8

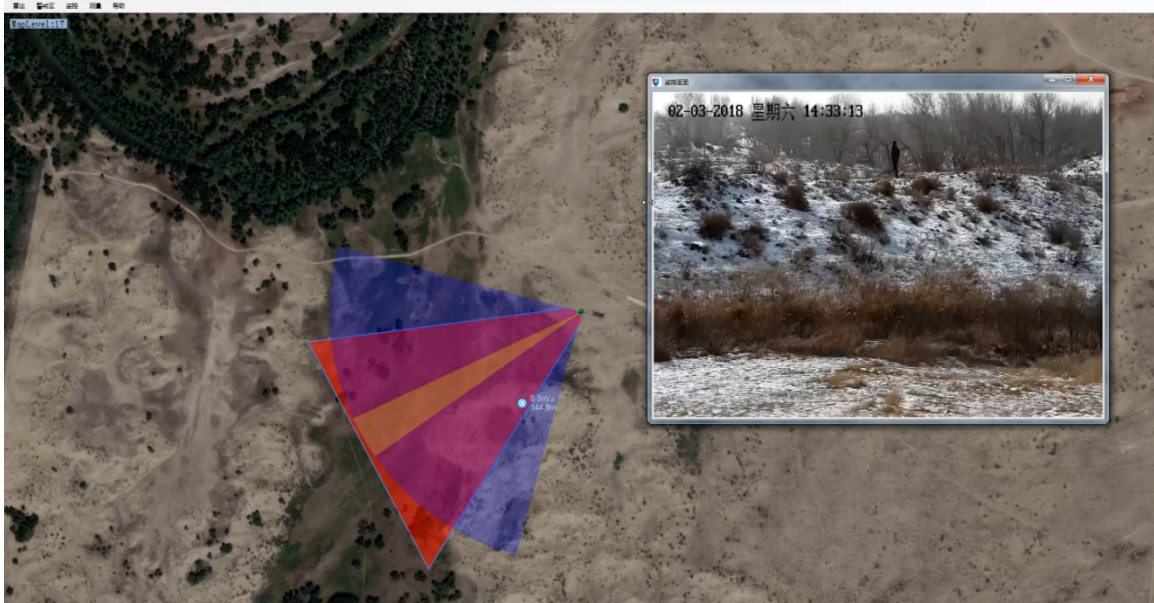


Figure 8 Detection Node Scenario Diagram

5.2.2 System Composition

See Table 2 for the detailed system composition.

Table 2: System Composition Table

No.	Equipment Name		Main Functions	Quantity	Remark
1	Detection Node	Short-range Surveillance Radar	Detect and track targets	Determined by actual requirements	One node per 5km on average
		Laser Night Vision Camera	Confirm targets, capture photos and videos		
		Intelligent Gateway	Integrated power supply and interface distribution		
2	Central Control Center		2 nd level control center, handles reported alarms and displays terminals		To be determined
3	Optical Fiber Communication Network		-		
4	Infrastructure and auxiliary system such as civil engineering, data transmission, power supply, and lightning protection		Arrange according to actual site conditions	/	

5.2.3 System Workflow

· During system installation, differential GPS is used to precisely determine the location and true north orientation of each detection site, and initial camera focal lengths are calibrated accordingly.

- Complete the parameter configuration for radars and cameras.
- Define alarm zones and safety zones.
- Activate radar and camera systems to start operational monitoring.
- Radar beams are electronically directed toward the detection area, rapidly scanning it. Detected target information is sent to the intelligent gateway, which then guides cameras to capture real-time images and videos of the target, simultaneously sending the target data back to the central control center.
- After the cameras complete angle alignment and automatic focusing, intelligent image-recognition algorithms are used to identify individuals and targets, triggering the NVR for video recording and storage. The system then evaluates whether to report the information to the primary control center.

The detailed node workflow is illustrated in Figure 9

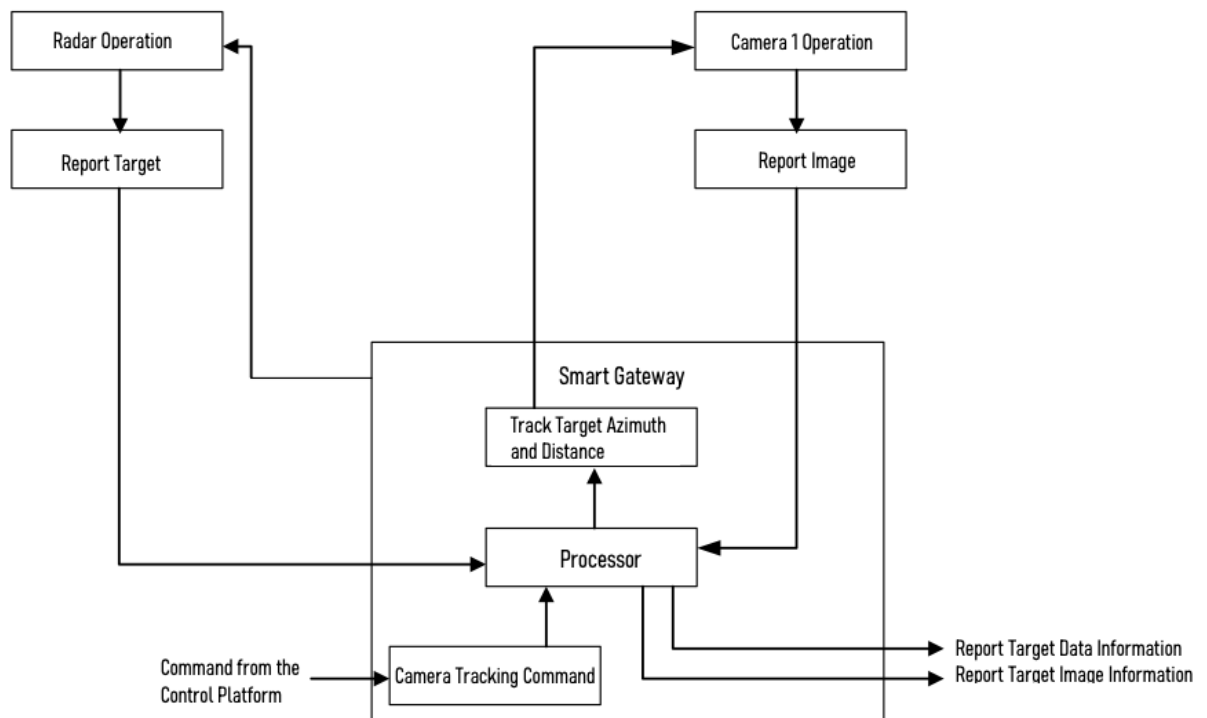


Figure 9 Single node workflow

5.3 Subsystem Composition

5.3.1 HSW-R6E Radar

The HSW-R6E Battlefield Surveillance Radar is capable of detecting targets over long distances and wide areas, including pedestrians, military units, vehicles, ships, and low-altitude aircraft. It accurately measures

their distance, direction, and speed, continuously tracks target trajectories, and automatically identifies the target type and triggers alarms.



Figure 10: HSW-R6E Radar Product Photo



Figure 11 HSW-R250C Radar Actual Measurement Diagram

Table 1 Radar Specification

Parameter	Specification
Detection Range	Personnel: 8 km Vehicle: 12 km
Scanning Mode	Full Electronic Scanning
Azimuth Scanning Speed	10°/s ~ 50°/s
Scanning Angle	90°
Distance Accuracy	Better than 10 m
Azimuth Accuracy	Better than 0.2°
Azimuth Resolution	Approx. 1.8°
Distance Resolution	Better than 12 m
System Interface	Ethernet, RS-485
MTBF	100,000 hours
Weight	35 kg
Operating Temperature	-40°C to +70°C
Storage Temperature	-55°C to +85°C
Environmental Humidity	≤95%
Weather Conditions	All-weather applicable
Corrosion Resistance	Salt spray resistant
Protection Level	IP66

5.3.2 Laser Night-Vision Camera

The HTN-V5000HD Long-Range Multispectral Thermal Imaging Laser Night Vision Surveillance Camera from Hermesys uses a high-performance, low-illumination day/night HD camera equipped with a long-range HD lens and laser-assisted illumination. Combined with a thermal imaging system that is unaffected by fog, haze, or other harsh weather conditions, it utilizes a scientific approach to deliver 24-hour, all-weather surveillance capability.

In daytime conditions, both visible light and thermal imaging can achieve coverage of 5–8 km. At night, thermal imaging provides wide-area target detection and identification, while the laser illumination enables detailed observation. The thermal imaging detection range reaches up to 9 km, with laser illumination effective up to 3 km.



Figure 4 Product Image of the Camera

Table 2 Technical Specifications of Laser Night Vision Camera

Monitoring Distance

Category	Type	Specification
Visible Light	Daytime Monitoring Distance	8-10 km
Laser Night Vision	Night Monitoring Distance	3 km
Thermal Imaging	Detection Distance	Target (2.5m×2.5m): Recognition distance 3km, Identification 1.7km, Discovery 9km Target (1.7m×0.5m): Recognition 1.2km, Identification 1km, Discovery 3km

Laser Light Source

Category	Specification
Laser Power	20W
Illumination Angle	0.5°22° (Adjustable from 1°45°)
Laser Wavelength	810nm (940/980nm optional)

HD Camera Module

Item	Specification
Resolution	1920×1080
Sensor	2 Megapixels, 1/1.8" Progressive Scan CMOS
Minimum Illumination (Color)	0.002Lux @(F1.2, AGC ON)
Minimum Illumination (B/W)	0.0002Lux @(F1.2, AGC ON)

HD Lens

Item	Specification
Sensor Size	1/2"
Lens Pixel	2 Megapixels
Aperture	F3.5~720
Focal Length	f=12.5~775mm
Magnification	62X

Thermal Imaging Module

Item	Specification
Detector Type	Uncooled focal plane array
Resolution	640×480
Pixel Pitch	30~150mm/F1.0
Optical Zoom	5X (continuous zoom)
Field of View	19°×15°~5°×4°
Detector Pixel Pitch	25μm
Frame Rate	25Hz
Response Band	7.5~13μm
Temperature Sensitivity	50mK (@F1.0, 300K)

Pan-Tilt Unit

Item	Specification
Maximum Load	50KG
Horizontal Rotation	360°
Vertical Rotation	-45°~+45°
Horizontal Rotation Speed	0.01~25°/s
Vertical Rotation Speed	0.01~15°/s
Positioning Accuracy	≤0.01°
Preset Positions	256

General Parameters

Item	Specification
Protection Level	IP66
Operating Temperature	-40°C~+60°C
Power Supply	AC24V±10% / DC24V±10%
Total Power	120W
Total Weight	60KG

5.3.3 Acoustic Deterrent System

The Acoustic Deterrent Broadcast Subsystem possesses very powerful acoustic radiation capabilities, clearly transmitting audio information over distances of several kilometers. It exerts strong psychological deterrence, imposing psychological pressure on adversaries. The system has precise directional capabilities, allowing the targeting of a specific angle to emit unbearably irritating sound waves, while remaining comfortable at other angles. This enables high-fidelity, highly directional sound transmission, restricting the sound waves to designated areas. The system is structured through a combination of three deployment modes: fixed installation in critical protected areas, mobile deployment in unmanned areas, and individual protective equipment for personnel.

In critical protected areas along borderlines, typically 2-3 fixed acoustic deterrent broadcast devices (including rotating platforms) are deployed within a 1 km radius. Guards stationed at posts can observe at any time through infrared night-vision devices at the control center. Upon detecting suspicious individuals or groups, vehicles, or boats, the system activates powerful acoustic broadcasts, alarms, and strong lighting to warn and repel them.

For unmanned border areas, acoustic deterrent broadcast devices can be mounted on patrol vehicles. Patrol personnel can monitor these areas using onboard infrared night-vision equipment. Upon detecting suspicious activities, personnel can activate strong lighting and acoustic broadcasts to alert and repel suspicious

individuals, groups, vehicles, or boats. Additionally, portable acoustic deterrent broadcast devices can be temporarily deployed in suspicious border regions to conduct immediate strong acoustic and lighting warnings and expulsions.

During patrol operations along the borderline, personnel can utilize individual portable acoustic deterrent broadcast systems and dazzling acoustic shields to broadcast warnings and repel suspicious individuals effectively.

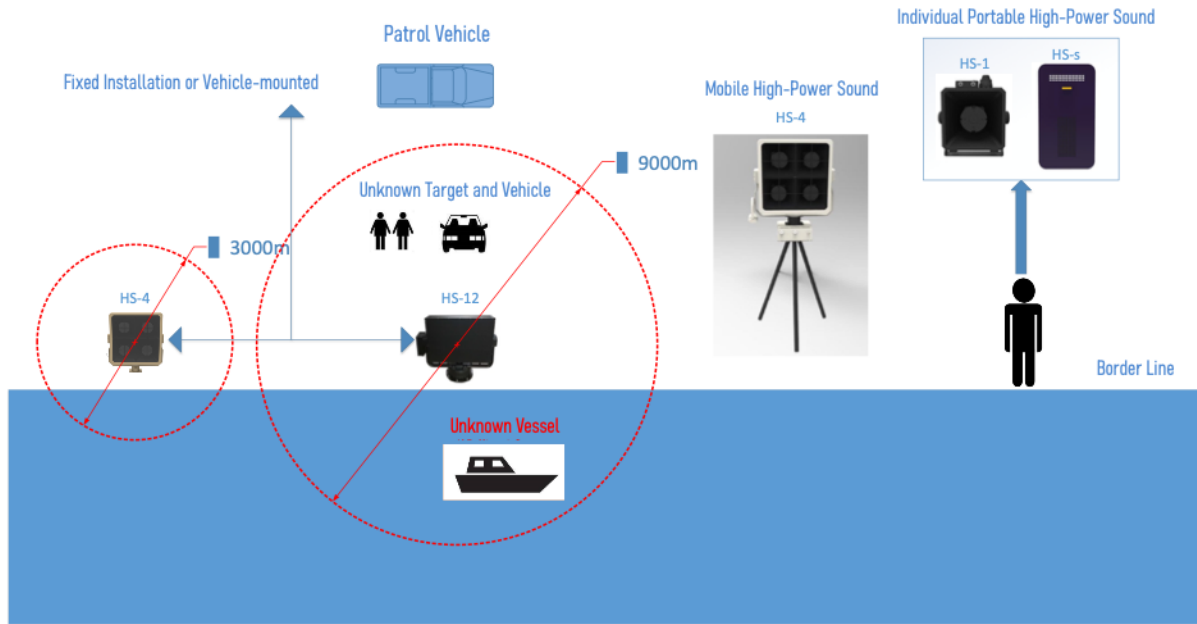
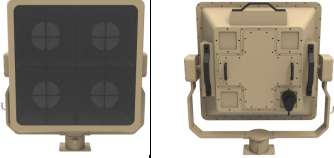




Figure13 Acoustic Deterrent Broadcast Subsystem

Acoustic Deterrent Broadcast Subsystem

Performance specifications for various types of acoustic deterrent broadcast devices, including fixed (with rotating platform), mobile, portable units, and dazzling acoustic shields are as follows:

Acoustic Deterrent Broadcast System- Product Illustration		Model	Max Sound Pressure@1m (max)	Deterrent Distance(≥ 12 0dB)	Effective Broadcast Distance (≥ 90 dB)	Communication Distance (≥ 80 dB)	Carrying Method
Front View	Rear View						
		HS-1	140dB	10m	316m	1000m	Portable

	HS-4	154dB	50m	1585m	5000m	Mobile
	HS-12	163dB	141m	4467m	14125m	Fixed
	HS-S	130dB	3m	100m	316m	Shield
<p>Daytime dazzling distance: $\geq 400\text{m}$ (visibility: 10km);</p> <p>Daytime deterrent distance: 800m~1200m (visibility: 10km);</p> <p>Nighttime dazzling distance: $\geq 800\text{m}$ (visibility: 10km);</p> <p>Nighttime deterrent distance: 1600m~2400m (visibility: 10km);</p>						

High-Intensity Searchlight

Operating Temperature	-45°C-+65°C
Input Voltage	12VDC
Maximum Range	1500m
Beam Width	1°(focused) to 40° (wide-angle)
Beam Intensity	75W, 45W, 35W (Three levels)
Working Duration	90min (High Intensity) -180min (Low Intensity)
Maximum Luminous Intensity	10000000 Candela (Min.deviation-10%, No max deviation)
Protection Level	IP65
Weight	$\leq 2.5\text{Kg}$

5.3.4 Intelligent Gateway

The Intelligent Gateway utilizes a custom display and control host RG4001XK, integrating components such as a computer, power converter, laser night-vision converter, and network switch. It provides power supply to radar and cameras, controls radar operations, processes radar data, and supports functions such as online rebooting. The gateway dimensions (length × width × height) are approximately 220mm × 180mm × 140mm, as shown in the figure below.

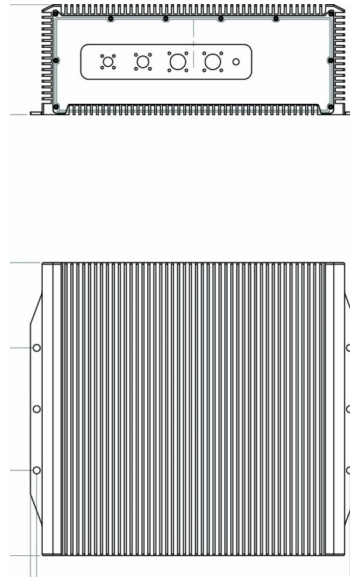


Figure17: Schematic Diagram of Intelligent Gateway Appearance