Pharovision, LLC

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November 28, 2016

Interceptor Bird Detection System

White Paper

1 General

The Pharovision "INTERCEPTOR" bird detection system automatically detects individual birds and flocks of birds, day or night, using an infrared and electro-optical scanning payload, and advanced proprietary image-processing algorithms. The auto-detection system is also capable of manual user control, allowing for enhanced observation, target tracking, and study of specific targets on a real-time basis.

In contrast with RADAR-based systems, the "INTERCEPTOR" system produces visual imagery which enables positive identification of detected targets and determination of the altitude, behavior, individual numbers or group size, and contextual placement within the actual environment of target birds detected by the system.

In addition, the basic system is completely passive, causing no electromagnetic interference with other systems.

The system can be controlled from a remote station, far from the payload, using an Ethernet link. Link can also be accomplished through fiber optic cable or RF signal.

The system can optionally be integrated with a Long-range Laser Range Finder or RADAR system to yield additional range data if desired.

Pharovision's "INTERCEPTOR" bird detection system is based on hardware and algorithms that have been proven in operational use in both military and civilian applications, including both aerial and ground-based observations. The original hardware and algorithms were initially developed by the military more than 10 years ago to detect incoming gliders, rockets, and small aircraft coming over national borders from neighboring countries. Modified hardware and complementary software enhancements have allowed Pharovision to accurately auto-detect and identify birds in the region around an airfield to assist in the assessment of bird strike threats and to aid air traffic, in real-time, in avoiding potential conflicts with birds within a 3-4 nm radius of the airfield.

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2 System design

Pharovision's "INTERCEPTOR" bird detection system is based on militarized EO/IR system hardware and software. The system includes:

- 2-axis Gimbal with
  - MWIR Camera
  - Daylight CCD Camera
- Power Supply and Interface Box (IFB)
- Image processing computer
- Optional remote control station
- Optional Long-range Laser Range Finder
- Optional RADAR system

Figure 1: INTERCEPTOR System Payload. IR camera is located on the right-hand side of the system. CCD camera on the left-hand side. Long-range laser range finder is located on the top portion of the unit. All components are separately removable and customizable.

2.1 Potential Mounted Configurations

INTERCEPTOR can be mounted on an variety of structures, including but not limited to: ATC towers, portable trailer systems, standard airfield antenna arrays, hydraulic mobile masts, buildings, fences, or other relatively stable structures. A supplemental gyroscope can be added to the system to guarantee a stabilized image, even if the structure on which the system is mounted moves to a significant degree in the x-y directions. A second gyroscope can also be outfitted to stabilize the system if the mounted surface also shifts in the z direction.

Figure 2: Standard Air Traffic Countrol tower mount.

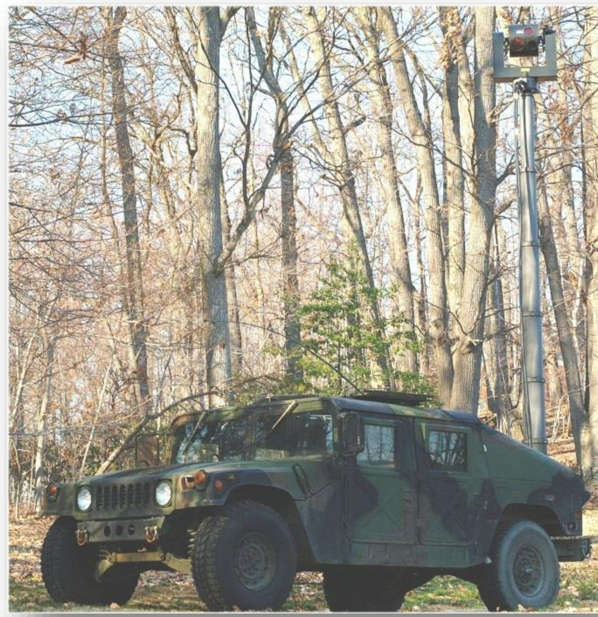

Figure 3: Vehicle mobile mast mount.

Figure 4: Airfield perimeter antenna mount.

Figure 5: Overview of antenna mount.

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Figure 6: Off airfield security tower mount.

Figure 7: Close-up of tower mount.

Figure 8: Building mount with integrated RF.

Figure 9: Close-up of system (IR payload only) with optional integrated RF system.

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The following block diagram shows the system configuration.

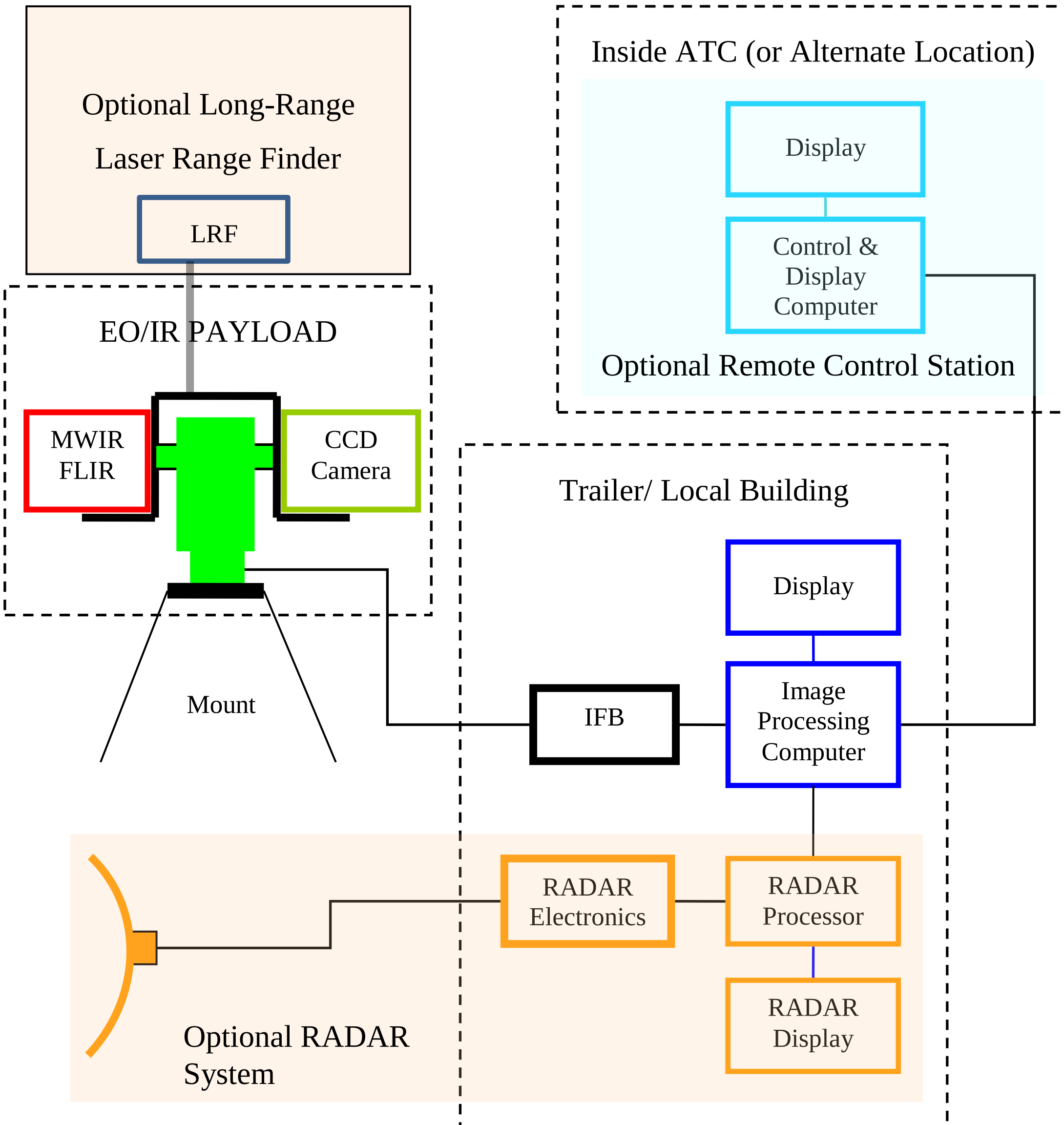

Figure 10: System block diagram.

3 Principle of operation

3.1 Basic operation

INTERCEPTOR has two main modes of operation: Scanning mode and

Observation/tracking mode.

Scanning mode is used for automated bird detection. In this mode, the infrared and electro-optical scanning payload will continuously scan a pre-defined sector from side to side. Bird and animal detection will usually be accomplished using the payload’s mid-wave IR camera, although day camera CCD scanning is possible as well. The image processing computer analyzes the video and automatically detects birds and/or animals. A separate audio or visual alarm is sent when a large flock is detected.

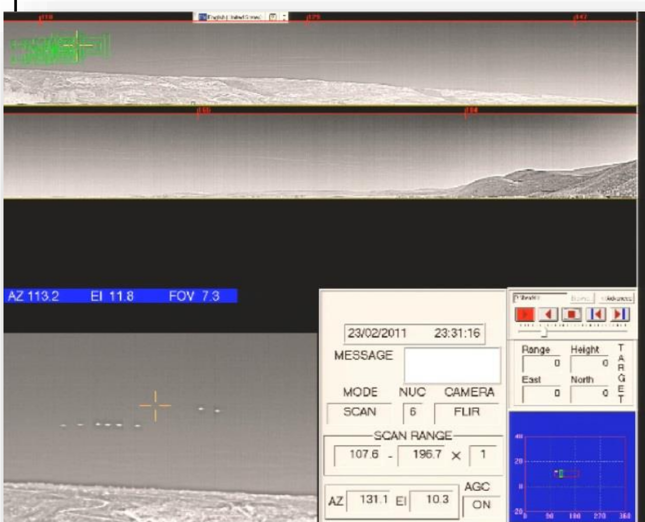

Figure 11: System video display output.

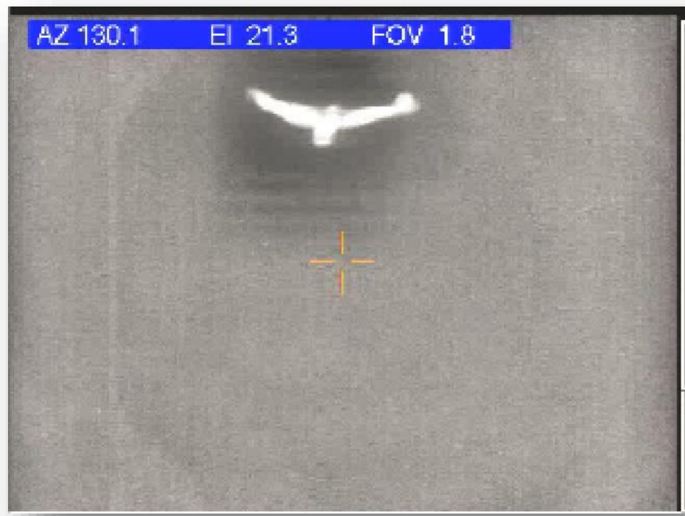

Figure 12: FLIR detector closeup of hawk at 15x zoom at a range of approximately 7 km.

In Observation mode the operator sees live video from either camera on the computer screen. The line of sight direction and various camera functions, such as zoom and focus, can be controlled using a joystick or a keyboard.

3.2 Automated Bird Detection

In the automated bird detection mode, INTERCEPTOR is placed in a continuous scan of a sector or number of sectors to detect birds, animals, or other moving objects in the environment. Scans can be accomplished in the air, on the ground, or a combination of the two. Currently INTERCEPTOR utilizes either an aerially-optimized computer algorithm to generate detections of birds in the sky or a ground-optimized algorithm to detect birds or other animals located on ground surfaces such as runways, grassy areas, or ditches on an airfield. At this time, the system does not run both algorithms simultaneously, though theoretically, specific sectors or areas of a scan could be identified by the user to utilize either optimized algorithm.

While scanning, a panoramic image of the entire scanned region(s) is built up in the computer's memory. This image is used to create two continuously updated displays:

- A downscaled panoramic image of the entire scanned sector(s) enabling quick orientation for the user.
- A full-scale image of a region of interest (ROI). This ROI display automatically steps through the same region from previous scans, creating in effect, a time-lapse clip of the ROI. This clip is very useful for identifying the type of target detected and the behavior and trajectory of the target.

3.3 Scanning Mode

When scanning in automated detection mode, the system follows through a series of predefined (user created) scan regions, looking for variability in thermal or optical images. The system can be used with either the infrared camera or the electro-optical video camera conducting the detections. Currently INTERCEPTOR is not capable of scanning and performing detections with the FLIR and CCD cameras simultaneously, though the detection cameras can be switched with the simple push of a button.

As the automated scan proceeds, detected birds are highlighted by a green box on the panoramic display. Each target is delineated with its own highlight box and as the scan proceeds, the visual highlights are updated to show the latest 3 scans on the panoramic display, removing highlighted boxes where birds are no longer detected. This allows a viewer to see the movement of a bird within the environment, at the same time not creating an overload of warnings with historical detections. Audible warnings or advisories can be associated with target detections or, as the system is currently configured, associated with a critical mass of target detections defined by the user. Though not implemented at this time, a bird threat level, or "Bird Watch Condition" can be configured to correlate with variable levels of bird detections. Once a pre-defined threshold of birds is reached, a visual and/or auditory warning could be announced, associated with Bird Watch Condition "Moderate" and "Severe" (or "Yellow" and "Red"). These levels could be modified by the user as conditions warrant or throughout changes in yearly migratory patterns. The levels could also be changed daily or hourly, with differing threat level advisories based on variable bird movements.

Display Components

The Region of Interest ("ROI") display is created from the full-scale scan resolution coming directly from the camera scans. The panoramic display is created by down-sampling and condensing the actual scan resolution in order

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to fit the output onto a single display unit. The ROI display is displayed from a fixed area around a central crosshair, manually controlled by the user through the use of a joystick on the panoramic display. As the user manipulates the crosshair through the joystick, the ROI display changes to match the area selected. Currently the system is configured to change the ROI display only with user input, though it could be altered to change automatically as further detections are received.

Azimuth markings are included on the scanned panorama sectors in order to enable overall environment and specific target orientation for a viewer. The standard INTERCEPTOR system displays the panoramic view on top of the other views on a single computer display unit to maximize user efficiency and minimize desk space, though this could be presented on a separate video display (or multiple displays) if the end user desires. An overlay of non-moving standardized structures such as antennas, buildings, or airfield tarmac surfaces can be placed on the panoramic image to aid in viewer orientation, though this must be specifically created and altered for each variable scan, as the field of view and perspective can be changed whenever desired. Preset standardized scans can be implemented with the addition of these structure overlays, where known structures are included as part of the pre-determined scans.

Included in the overall system display is a separate readout of multiple variables, including: date, time, camera in use, scan mode, elevation and azimuth range of the overall scan, as well as range, elevation, and azimuth of a specified target defined through user interaction. Also included is the amount of hard disk recording time remaining on the attached computer as well as controls for recording and playback of data, similar to push buttons of a VCR or PVR.

Data Collection

All raw camera feed data is recorded directly to hard disk and can be reviewed at any time through the use of proprietary software. The software recreates the generated display output, as if the user were viewing the display in real time. Raw data can be outputted to a separate computer or video file, though proprietary software must be installed on any separate computer system in order to accurately recreate the complete unit display.

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Detection reports and overall data analysis reports are automatically generated by the system, and since all video is time stamped, a user can review the recordings and examine the exact detections as viewed by the system. Current maximum playback rate is limited to twice the real-time playback speed. Data is also recorded in Excel database format, allowing for extensive risk analysis and overall historical bird movements and peak times for trend and risk modeling.

When a bird flock is detected in automated scan mode, the operator can first investigate the detection using the panoramic image and the ROI clip. Then, if desired, the operator can switch to Observation mode and zoom in for identification and further investigation.

In the basic system configuration, line of sight angles to detected flocks are known, giving accurate altitude positions of the birds (in AGL from the system). There is limited range data of specific targets without the inclusion of a long-range laser range finder, though the range can be estimated by the system through calculation of camera focal length and scan parameters. Range can also be estimated by the operator in Observation mode through the bird image size and known camera field of view, if the relative size of the bird is known.

Since every material above absolute zero (0^{o} degrees Kelvin) emits a thermal signature, the system is able to display all objects and surroundings, giving context and precise locations of detected birds. Not only are detected birds visually displayed but all environmental elements are displayed as well. To the system user, this means that birds can be viewed in

System Advantage

The extraordinary advantage of the INTERCEPTOR system is that all detections are displayed as true visual images of the targets themselves. An operator can easily assess the types, numbers, and locations (especially altitude) of detected targets without the need for extensive training or understanding of a complex representative system. Human visual systems easily and immediately understand visual imagery presented to them, particularly when they are included in the context of the surrounding environment. Unlike radar output, INTERCEPTOR's images are simply enhanced visuals and are not electronic signal returns translated onto a flat, two-dimensional model of the airport environment. An observer can actually see the individual birds present in the context of the surrounding environment and can view target behavior.

Normal human visual perception allows the observer to count the number of targets present in a scan and to assess the size of a flock or individual bird within a group. Radar returns present a user with displays consisting of dots that must be interpreted by the system (and then reinterpreted by the observer) in order to determine the size of the detected object. Without extensive training and careful inspection, an observer of radar returns is unable to distinguish between targets consisting of a single small bird and ones consisting of a flock of larger birds. Even the radar system itself is unable to consistently assess the target size, as the cross-sectional returns change with bird movement.

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the context of their environment, with trees, buildings, tarmac surfaces, other structures, and even aircraft, all visible notwithstanding the absolute darkness of night. Unlike night-vision systems, the infrared detector does not amplify ambient light, which often results in "overblown" areas of an image, caused by intensification of runway lights or other man-made light sources generally present on an airfield.

To date, Pharovision has found that automated detection is more effective and produces better overall detection results utilizing the infrared camera over the electro-optical camera, even in the heat of the day and in bright daylight. Though the CCD camera is also capable of automated detection, the infrared camera is better at capturing the subtle thermal differences of objects than the CCD camera is in detecting the minor variances of objects in the visual spectrum. Camera choice however remains completely in the end user's hands.

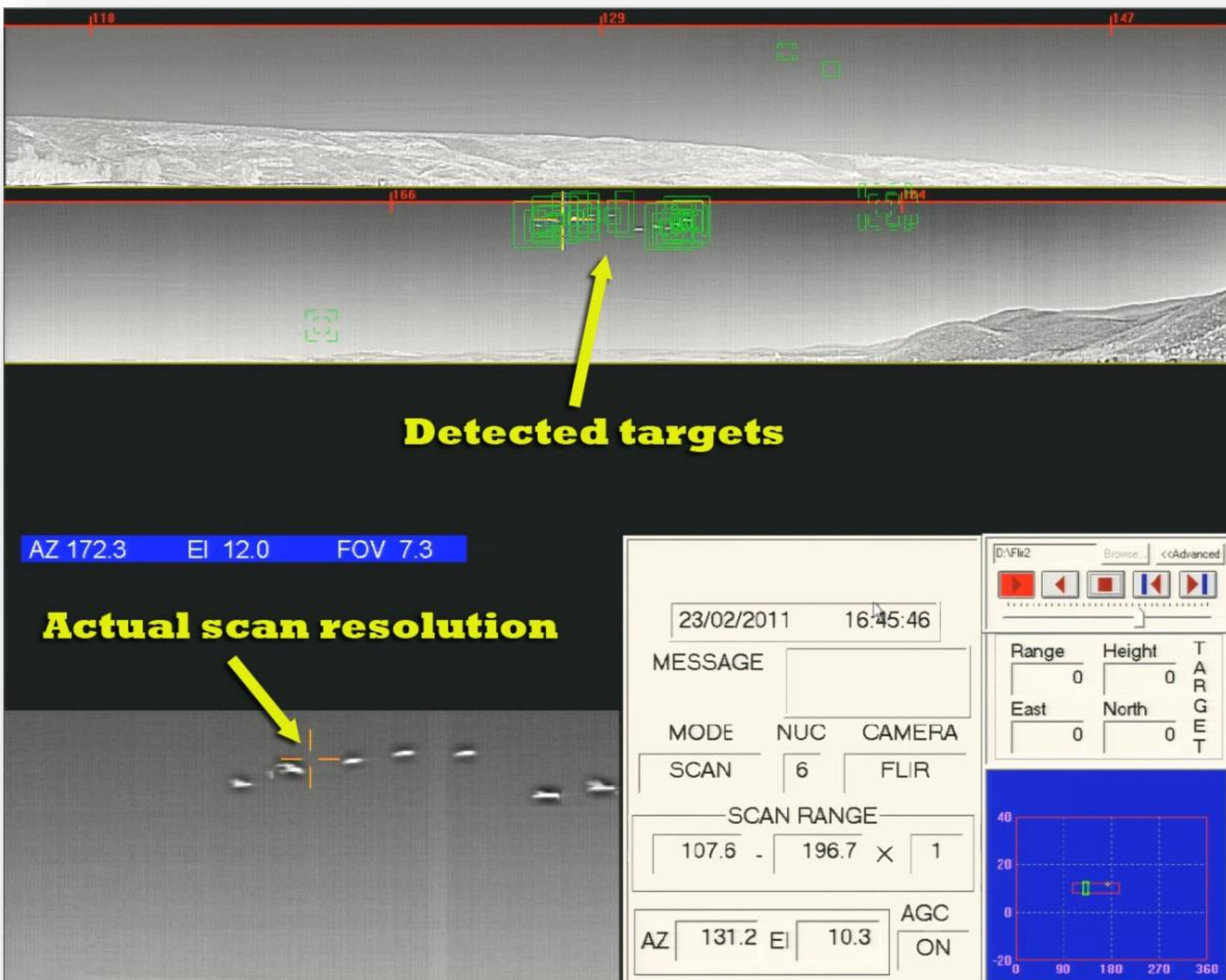

Figure 13: INTERCEPTOR infrared automated detection. Detected bird targets are outlined by green boxes in the panoramic display in the upper two strips. The real-time full scale resolution of the scan is shown in the lower left-hand corner. The extreme lower right-hand corner exhibits the overall region of the environment currently being scanned.

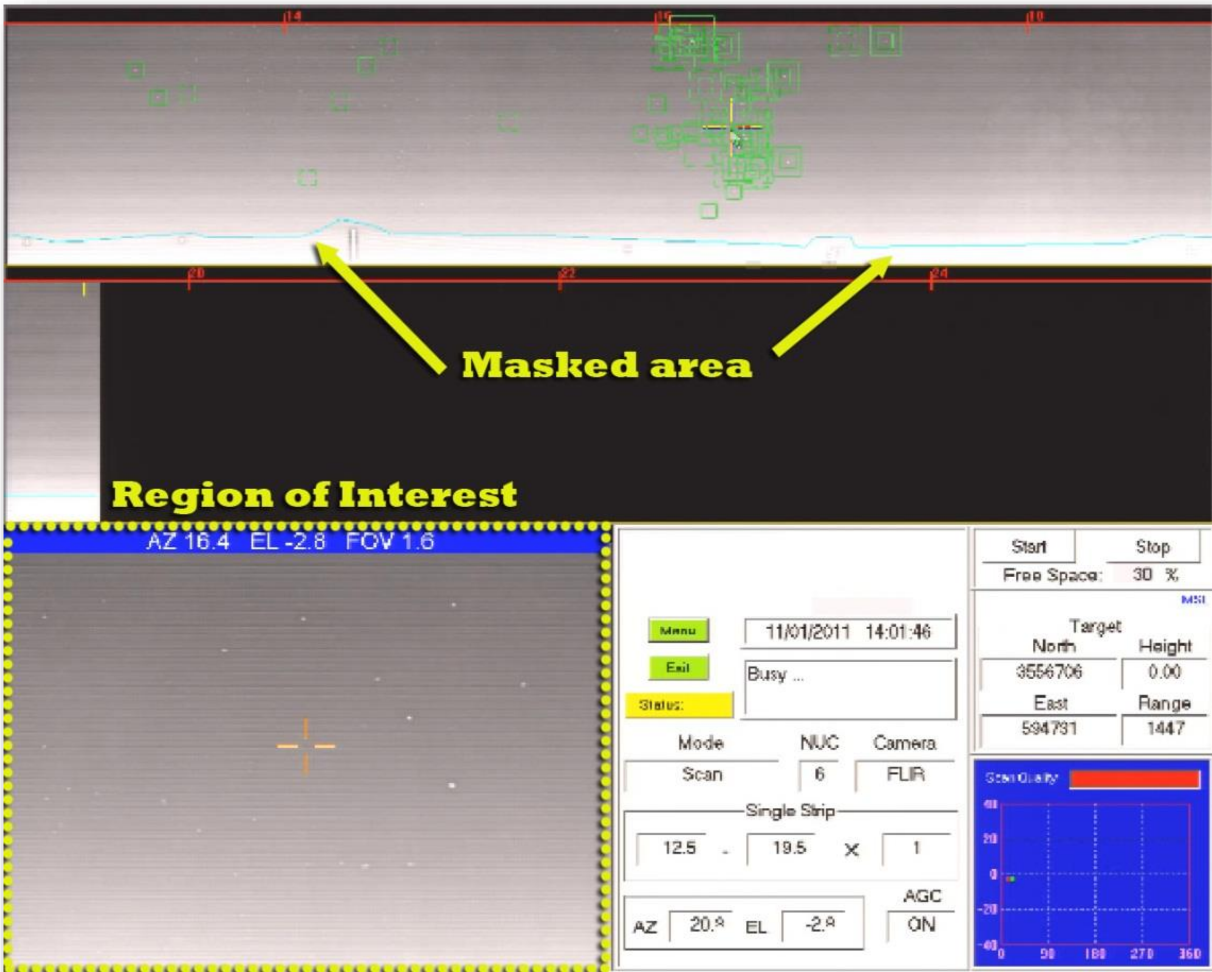

Figure 14: INTERCEPTOR infrared automated detection. A masked area can be created in the panoramic display in order to avoid potential false alarms with known problem areas that may include extraneous moving targets. The lower left-hand corner displays the "Region of Interest".

3.4 Observation and Target Tracking Mode

In addition to the automated detection and scanning mode, INTERCEPTOR can be utilized to either track individuals or groups of targets or operated for close-up inspection of specific locations or targets. At the user's discretion, automated scan mode can be interrupted at any time and manual viewing can be initiated. Once observation or target tracking is completed, automated scanning and detection can be instantly resumed through the computer interface.

In target tracking mode, the user identifies a desired bird or group of birds through manipulation of the crosshairs on the panoramic display, "marking" the target by the simple click of a button. At this point, the system automatically takes control of the camera payload and tracks the target as it moves through the environment. Without any further input from the user, the system adjusts camera focus and follows the target(s) through adjustment of azimuth and elevation. Target tracking continues until the user reverts to full control of the system or reinitiates automated scanning mode.

If desired, the user can manually zoom the camera into the subject, while the system continues to automatically track the detected targets, maintaining the target bird(s) as close to the center of the viewing region as possible (depending on the speed of the birds and distance away from the system). Tracked targets can be switched instantly through joystick input by the user, as the crosshairs are moved to another group of birds on the panoramic display.

The user can also manually control the system's cameras, zooming in on a specific location or desired target. Pan and tilt of the system is accomplished through manipulation of a joystick, moving the stick forward and backwards to initiate camera tilt and side to side to initiate pans. The system is controlled identically to a standard first-person video game, and camera viewing changes can be seen on the panoramic display in a larger context (via movement of the crosshairs). Camera zoom is accomplished through the joystick "trigger" and all three variables – pan, tilt, and zoom – can be manipulated simultaneously.

Camera zoom is accomplished to the maximum focal length of the installed lens. The standard INTERCEPTOR system is capable of approximately 15 times zoom for the infrared camera and slightly less for the CCD video camera. Since each camera is customizable, lenses with greater power can easily replace the standard system cameras as an upgrade, resulting in a higher overall system power and consequential cost.

Observation mode and target tracking can be accomplished with either camera system, though as in the automated scan mode, Pharovision has found that the infrared camera produces better overall results. At night, the infrared system is obviously the only available component. However, INTERCEPTOR's electro-optical camera does allow the user to see the actual colorations and markings of an observed bird, allowing for greater identification of the target species during daytime investigations.

Runway Scanning

One of the tremendous benefits of Interceptor is its ability to not only scan the airspace around an airfield but to also scan the runways (and taxiways) themselves. The system is capable of detecting birds on or near tarmac surfaces in automated detection mode. However, it also allows the user to manually view the runway surface (e.g. before each departure or arrival), to ensure that the runway environment is free of birds or other obstructions.

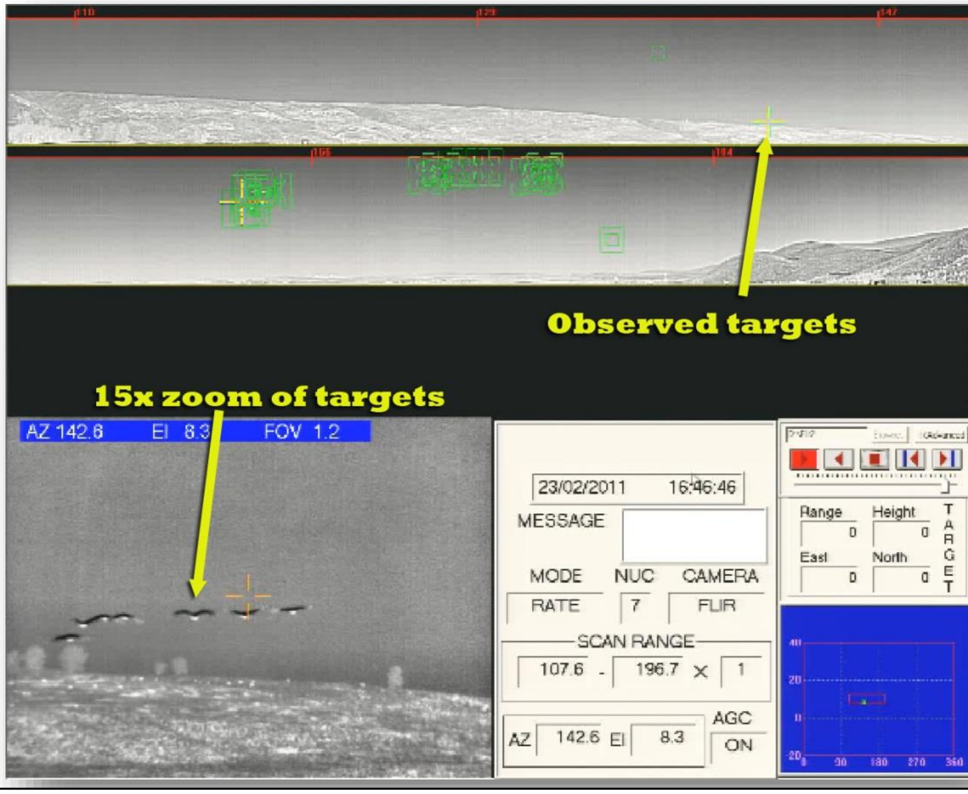

Figure 15: INTERCEPTOR infrared observation mode. Bird targets being observed are denoted on the panoramic display by the crosshairs, which corresponds to the zoomed area of the ROI display in the lower left-hand corner. Bird numbers, location, behavior, and species identification are easily discernable even at a distance of 6 km.

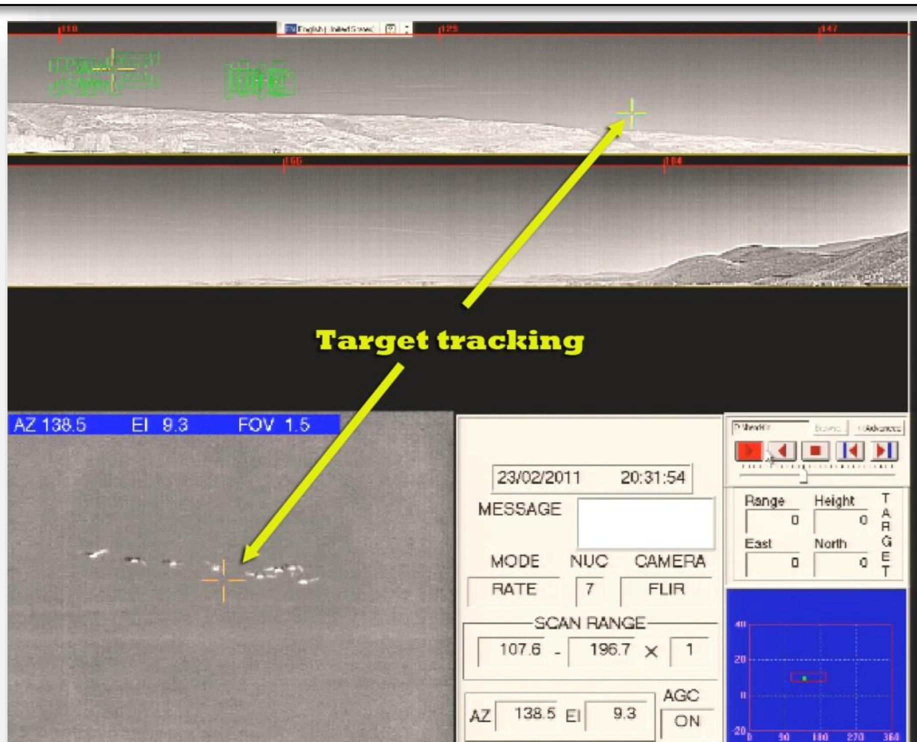

Figure 16: INTERCEPTOR infrared tracking system. Once a target group of birds is marked by the user in the panaoramic display, the system automatically tracks the birds as they move through the environment. Zoom capabilities are simultaneously operational while in tracking mode.

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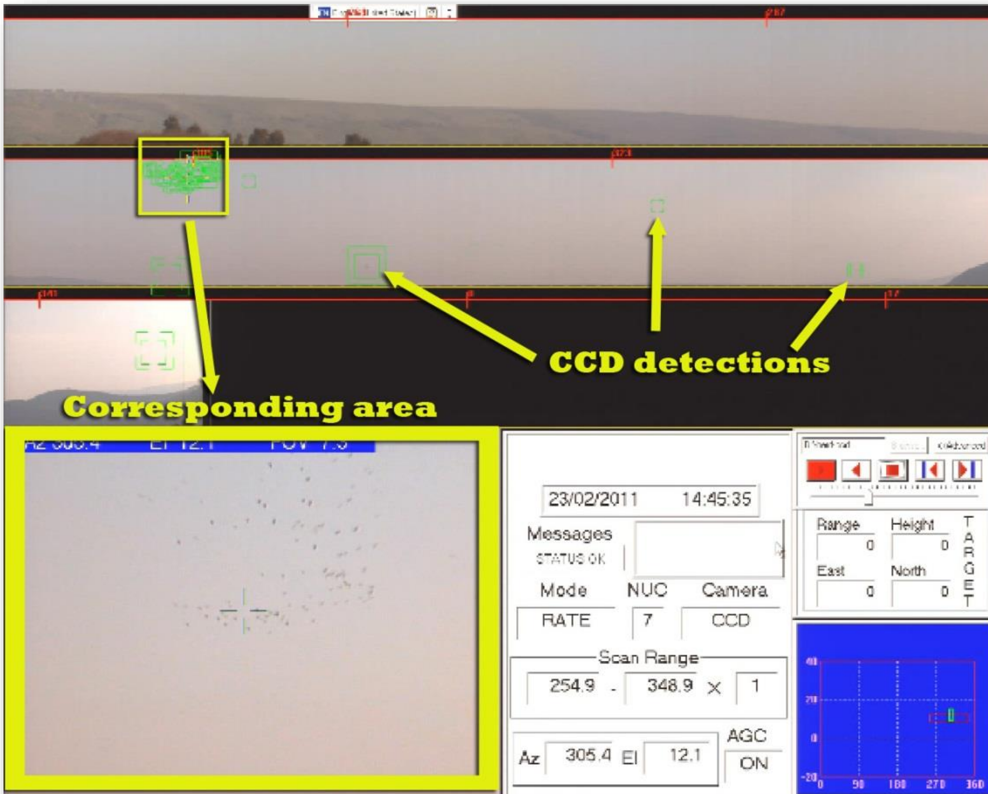

Figure 17: INTERCEPTOR CCD automated detection. Bird targets being detected are outlined by green squares on the panoramic display. The area of interest of a detected flock denoted by the yellow square corresponds to the zoomed area of the ROI display in the lower left-hand corner.

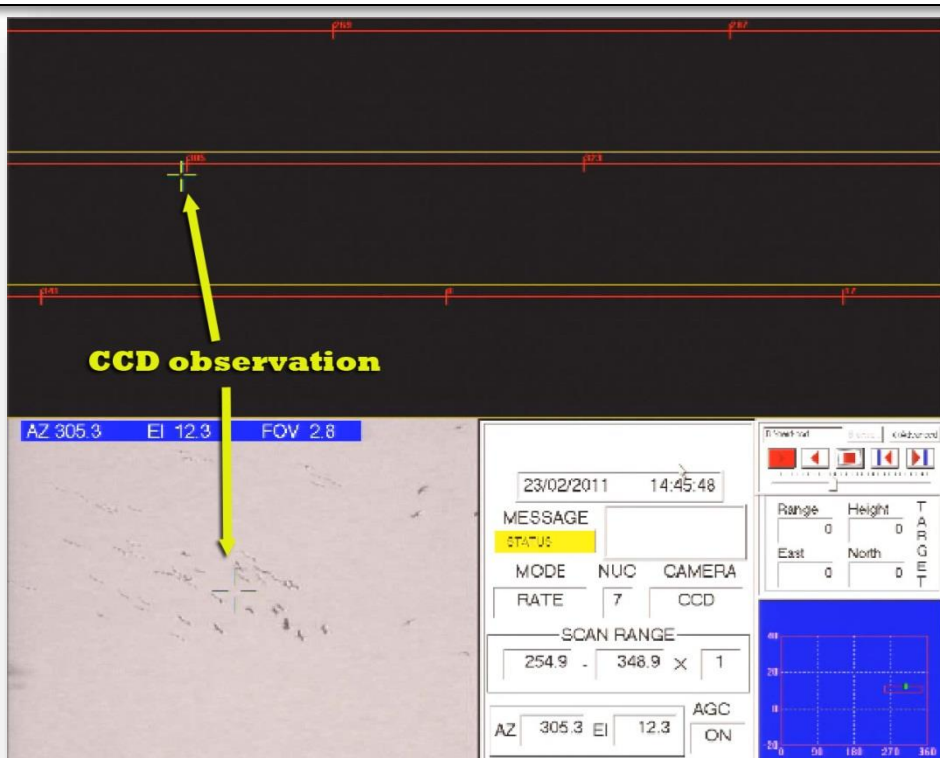

Figure 18: INTERCEPTOR CCD observation mode. The location of the bird targets is noted on the panoramic display by the crosshairs. The ROI display in the lower left-hand corner shows the birds at normal, non-zoomed focal length resolution.

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3.5 Advanced Operation

INTERCEPTOR can also be utilized in a number of other modes, as well as utilized for several different purposes. The system can be utilized to scan for and identify birds and/or mammals on ground surfaces, including runways and taxiways, as well as along fence lines, open areas of an airfield, or on ground structures such as buildings or antennas. INTERCEPTOR can be set to automatically scan ground areas for targets, though the bird/animal must exhibit some movement in order for the system to detect the position changes. Non-moving targets detections must rely on human observation through the system display.

The system can also be placed in manual mode and the airfield or runways can be scanned by the user to observe potential birds or other animals on the ground. With the system, an individual in the control tower or other location can easily observe a single small bird on a runway surface or hiding in the grass, even at extreme distances.

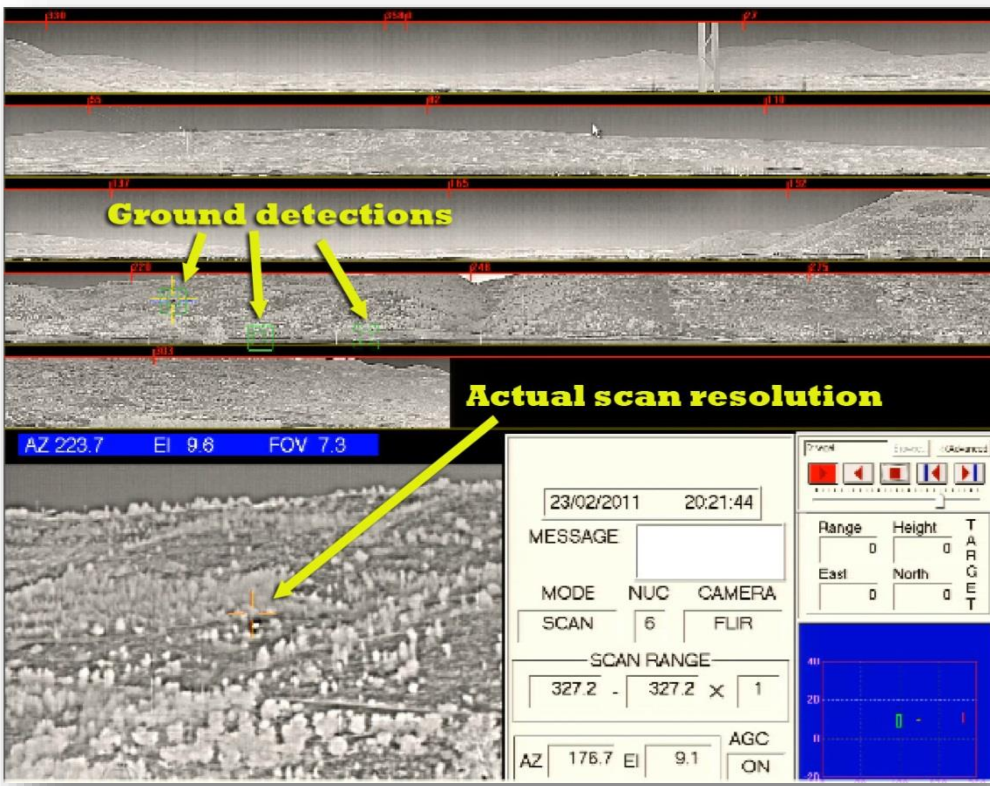

Figure 19: INTERCEPTOR can also be utilized in automated scan mode to automatically detect birds and other animals on the ground. In this case, several small mammals are detected moving through scrubland on a distant ridge.

While INTERCEPTOR is specifically designed to detect birds and other animals in the airfield environment, it can also be utilized for other purposes, such as security scans, enhanced visualization of the airfield and aircraft during nighttime operations, FOD detection, or powerful image sensors. The system can even serve dual purposes. If, for example, flight operations at a particular airport cease at 11 pm each night, the system can be placed in a security scan mode to detect potential intruders along the airfield perimeter fence line and then returned to bird detection the following day when flight operations recommence.

3.6 Aerial View Mapping

The aerial mapping application is used to operate one or more (up to three) electro-optic (EO) systems. The aerial mapping computer is connected to each system computer via an Ethernet connection to transmit commands and receive data and images. The aerial mapping application is however generally installed on Interceptor’s system computer and serve as the user interface application of the video processing application.

It is also possible to connect a number of aerial mapping computers to multiple systems. This allows one aerial mapping user to control the systems and the other to view. The systems supported by the aerial mapping applications can be either observation systems or scanning systems which provides automatic detection in a wide panoramic view. Each system may include day and night cameras with zoom lenses and might have a Laser Range Finder (LRF) and a laser pointer.

In systems that contain a LRF, target range can be measured using an eye safe LRF and the target location is calculated and displayed. Having DTM files enables the aerial mapping program to provide the range to a target and the target position even without firing the LRF but with slightly reduced accuracy. The laser pointer can designate the target if required. The aerial mapping program includes the complete functionality of the electro-optic systems as well as additional features such as GIS computations and display, allowing the user to maximize the systems' capabilities.

The aerial mapping display shows the range of each scan, as well as any hidden areas that may be obscured due to higher elevations and line of sight loss. Each detected target is marked with an “X” on the aerial mapping display, allowing a user to immediately determine the location of a target with respect to geographical inform Targets are displayed for a user-defined number of scans, before being removed from the display.

System control can also be enabled from the aerial mapping display itself while in observation mode. If a user clicks on a location on the aerial mapping display, the system will automatically pan and zoom to that precise location in

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the field. Multiple pre-defined locations can be marked on the aerial map and the system can maneuver between each point either manually or through a series of defined set locations, performed as a macro operation. The aerial mapping display is also a modular display component of the system and as such, can be shown independently on its own monitor or as part of other system displays.

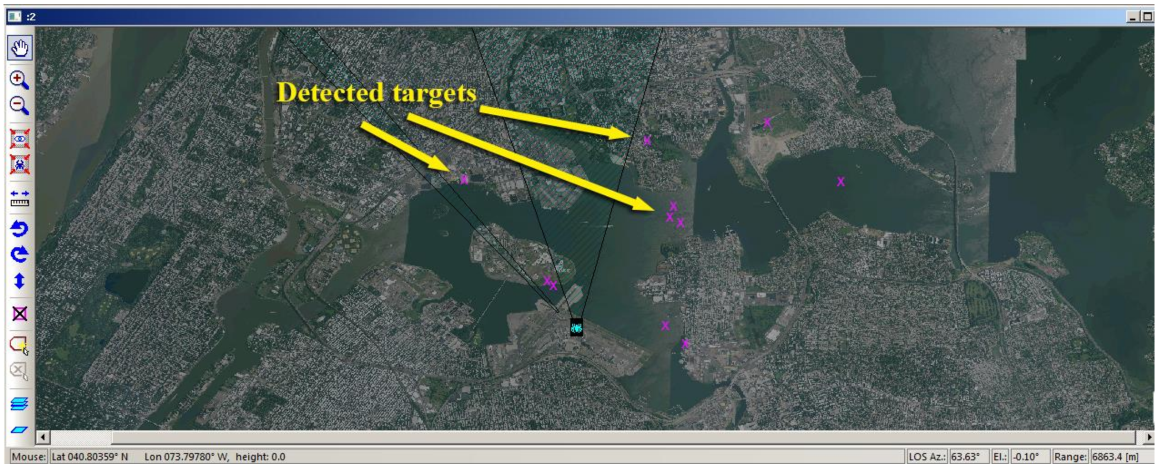

Figure 20: INTERCEPTOR' aerial mapping display shows detected targets on a geographically accurate map of the area. Pink "x"s mark the location of detected targets. Black lines show the defined extent of each scan area. Cross-hatched areas show ground locations that may be out of the system's line of sight, depending on the elevation of a potential target.

3.7 Performance Capabilities

With the standard system configuration, INTERCEPTOR is capable of automatically detecting a single Standard Avian Target ("SAT"), with a mass of .5 kg, at a range of 2.5 km while in FLIR automated scanning mode, day or night with a 95% level of confidence. At 2.5 km, the system is capable of detecting targets on a single scan up to an altitude of 2,200 ft, dependent on camera focal length and scan parameters. The system is capable of detecting a 2 SAT object at a range of 6 km while in FLIR automated scanning mode, day or night with a 90% level of confidence. The system is also capable of automatically detecting the same targets in daytime conditions with the electro-optical payload while in CCD automated scanning mode. At 6 km, the system is capable of detecting targets on a stacked double scan up to an altitude of 5,000 ft, dependent on camera focal length and scan parameters. Overall system performance is degraded by heavy precipitation.

Individual targets can also be automatically tracked by the system at these same ranges. INTERCEPTOR is capable of differentiating 2 SAT objects at a range of 2 km when separated by 10 meters in both range and azimuth. It is

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unknown at this time how many targets the system is capable of simultaneously tracking, though theoretically, there is no limitation to the number of targets other than what is possible to display on the panoramic portion of the monitor.

In automated scanning mode, INTERCEPTOR is capable of inspection of an infinite variety of areas located around the airfield environment, including runway/taxiway surfaces and ground areas. The user-defined scanning regions allow an airport to establish and modify at will the location and size of the system surveillance area. These areas can include departure and arrival corridors for multiple runways, as well as other potential areas of frequent bird activity. Scan frequency and update rate are entirely dependent upon the user-defined regions to be scanned.

In target tracking mode, INTERCEPTOR is capable of tracking an individual bird or a group of birds in real time, with no time delay between successive updates of the target's position. The system provides the user with instantaneous views of the tracked target, until the system is taken out of target tracking mode or the bird moves out of the line of sight. Even birds moving from the air to the ground and back to the air are capable of being tracked in real-time with the system. Ground clutter provides no obstacle to system performance – in fact, ground objects, structures, and the physical environment enhance the overall system function by providing important contextual information to the end user.

In observation mode, INTERCEPTOR is capable of detecting a single SAT object at a range of more than 6 km, when zoomed in on the target at the maximum camera focal length (the FLIR payload in day or night conditions; the CCD payload in daylight conditions).

3.8 Remote control

The image processing computer also has the capability to transmit images and information via Ethernet to a remote operating station. The remote station then has complete control over the system, enabling all functions available from the local image-processing computer. The same displays are also available including live imagery, panoramic images and time-lapsed clips. Real-time display, with limited system control, can be accomplished over the Internet with the appropriate setup, including the establishment of a static IP address.

3.9 RADAR option

If a RADAR system is integrated with the image processing computer, it should be possible to correlate data from both systems, to obtain additional target ranging data. This has not yet been implemented in the system and is not necessary at this time.

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4 System parameters

4.1 Camera parameters

The EO/IR system has an open architecture and enables different configurations. The basic system camera configuration includes:

- A MWIR camera (FLIR)
  - 640 × 512 pixel detector, with 15 micron pitch
  - 2.2° - 27° continuous optical zoom lens
  - NTSC standard video in Observation mode
- A daylight camera
  - 1/3" color detector
  - 0.9° - 13° continuous optical zoom lens
  - NTSC standard video

Optional configurations include fixed field of view or wider zoom range and different detectors for the FLIR, and different daylight camera detectors and lenses.

4.2 Scan parameters

The scan parameters are flexible and controlled by the operator during a simple process of scan setup. The FLIR zoom lens can be used to set the coverage in elevation, and the coverage in azimuth can be set in small steps

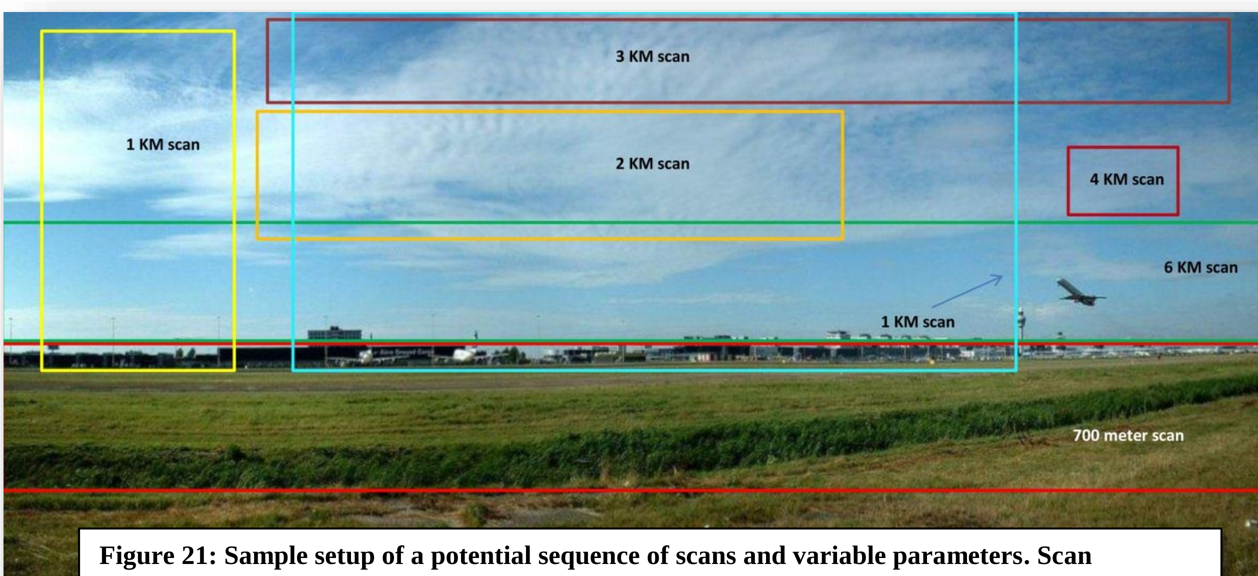

Figure 21: Sample setup of a potential sequence of scans and variable parameters. Scan distances, locations, sizes, and field of view can all be varied and custom managed by the user or pre-programmed as defined series of scans.

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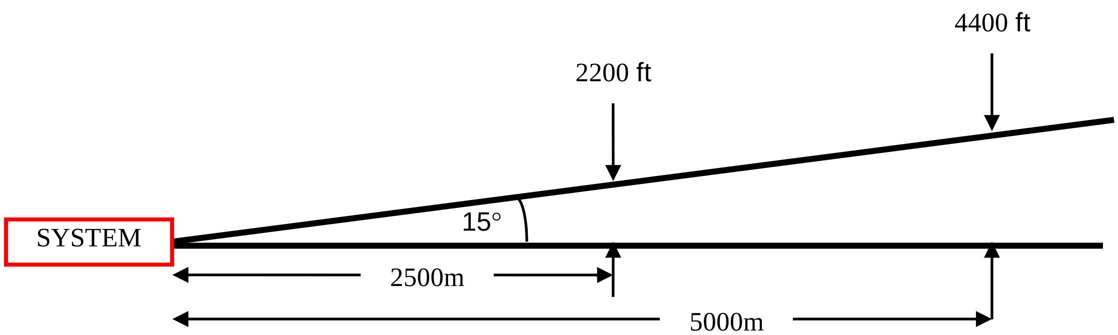
from approximately 20° up to 360°.

Scanning can be defined for a single horizontal sector or for a number of consecutively scanned sectors. Each of these sectors can have different coverage in azimuth or elevation, range and focal length. User-defined scan regions can be set on an *ad hoc* basis or can be preprogrammed into the system. The system will scan up to ten defined regions that are created by the end user. These scan regions can be utilized to scan various sectors of the environment, including runway areas, departure and arrival corridors, or any other areas of interest. Scan regions can be stacked on top of one another in order to cover additional elevations or overlapped for varying range/elevation combinations. Once the scan regions are established by the user, the system automatically configures the most efficient scanning process and order, minimizing system slew time. The scanning regions can be changed at any time by the user and established scanning patterns can be preprogrammed into the system and implemented when desired.

The rate at which a sector is scanned is equivalent to about 1.5 times the vertical coverage per second. If the coverage in elevation is set to 15°, the scan rate will be approximately 22.5°/s. This enables covering a full 360° in 16 seconds. Maximum system slew rate is currently 60°/ second.

The following diagram shows the height of the scanned region at different ranges for 15° coverage in elevation.



The system can also be set up to mask out problem areas that may cause frequent false alarms of targets other than birds or animals. For example, a perimeter road can be masked out to avoid alerting the user of detections of vehicles and personnel moving along the road.

4.3 Detection ranges

The detection range of the system ultimately depends on the camera's angular resolution, focal length and the type of bird being detected. Automated detection ranges of about 2.5 km are established for birds with a 640 pixel detector FLIR covering 15° in elevation (400µrad/pixel resolution). A range of 6-7 km is established when scanning with a field of view covering 7.5° in elevation. It is then possible to scan two strips one above the other in order to cover the same 15° (with a corresponding doubling of scan elevation). Two scans with a field of view of 7.5° will take approximately four times as long as one scan with a field of view of 15°.

5 Summary

Pharovision's "INTERCEPTOR" bird detection system is a passive, electro-optical system giving automated day and night long-range bird detection and observation/investigation capabilities. Aerially-optimized algorithms allow the system to detect birds in flight at great distances. Ground-optimized algorithms can also be utilized for detection of birds or other animals on ground surfaces or hidden in vegetation in the airfield environment. The system allows for actual real-time warnings with the automated detection.

Automated tracking mode allows the user to track specified targets across the environment.

Flexible configuration and zoom lenses enable optimization of the system to each location. Areas with excessive false alarm potential can be masked from automated detections.

Proprietary image-processing algorithms yield automated bird detections within ranges of 6-8 kilometers. Observation of birds can far exceed this range through the utilization of the system's zoom capability. All images are recorded directly to hard disk and can be reviewed at a later date as recorded in real time.

Full control of the system can be ported to a remote station. The user has the ability to take full control over the system to scan the airfield, observe aircraft movements, zoom in on specific birds, or track identified targets.

Custom scanning regions can be established on-the-fly and can be modified and manipulated at the discretion of the user. System can also be used to scan 360° at customizable focal lengths.

The system ultimately allows the user to determine the altitude, range, number, behavior, and even type of targets detected.

System Video

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