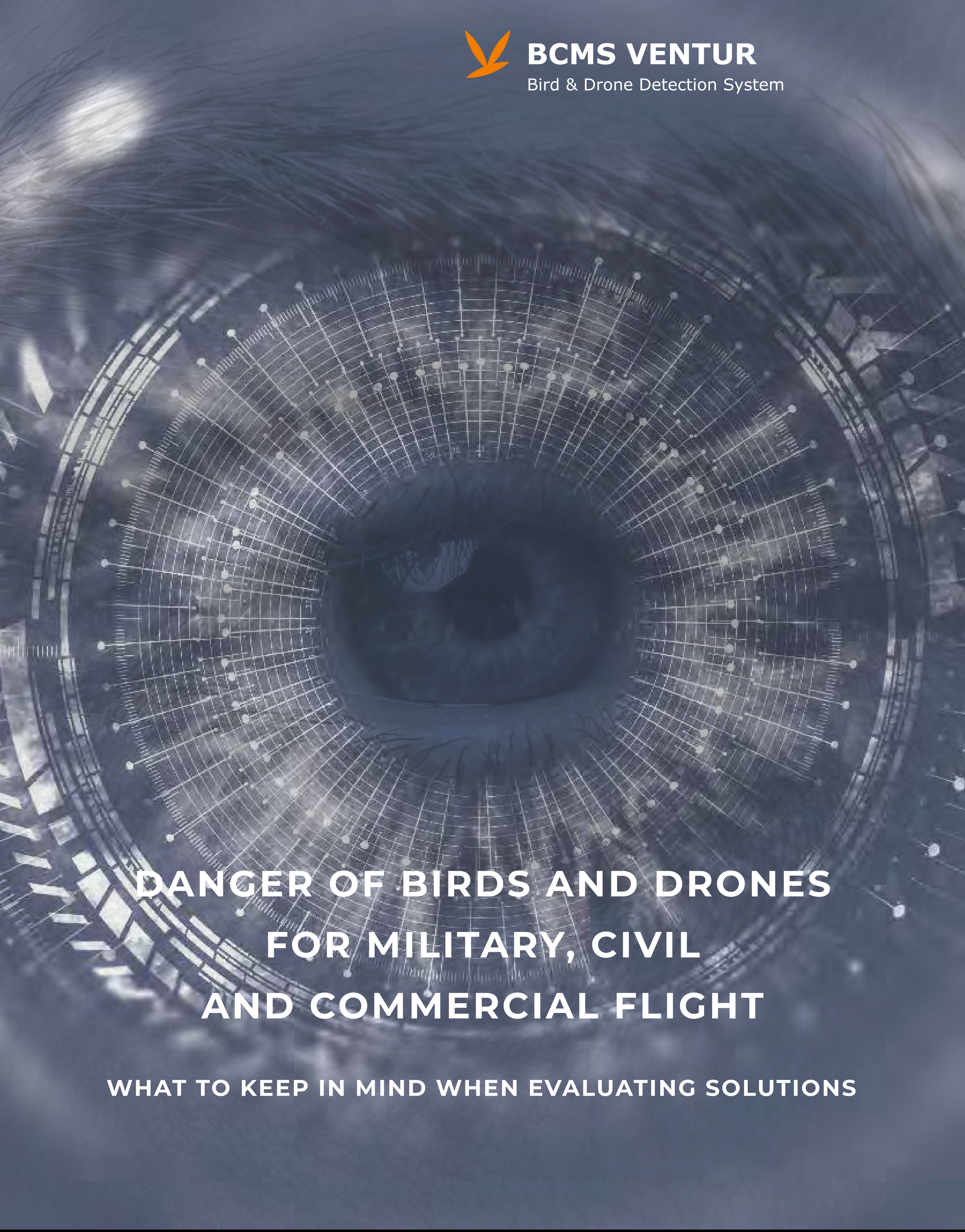
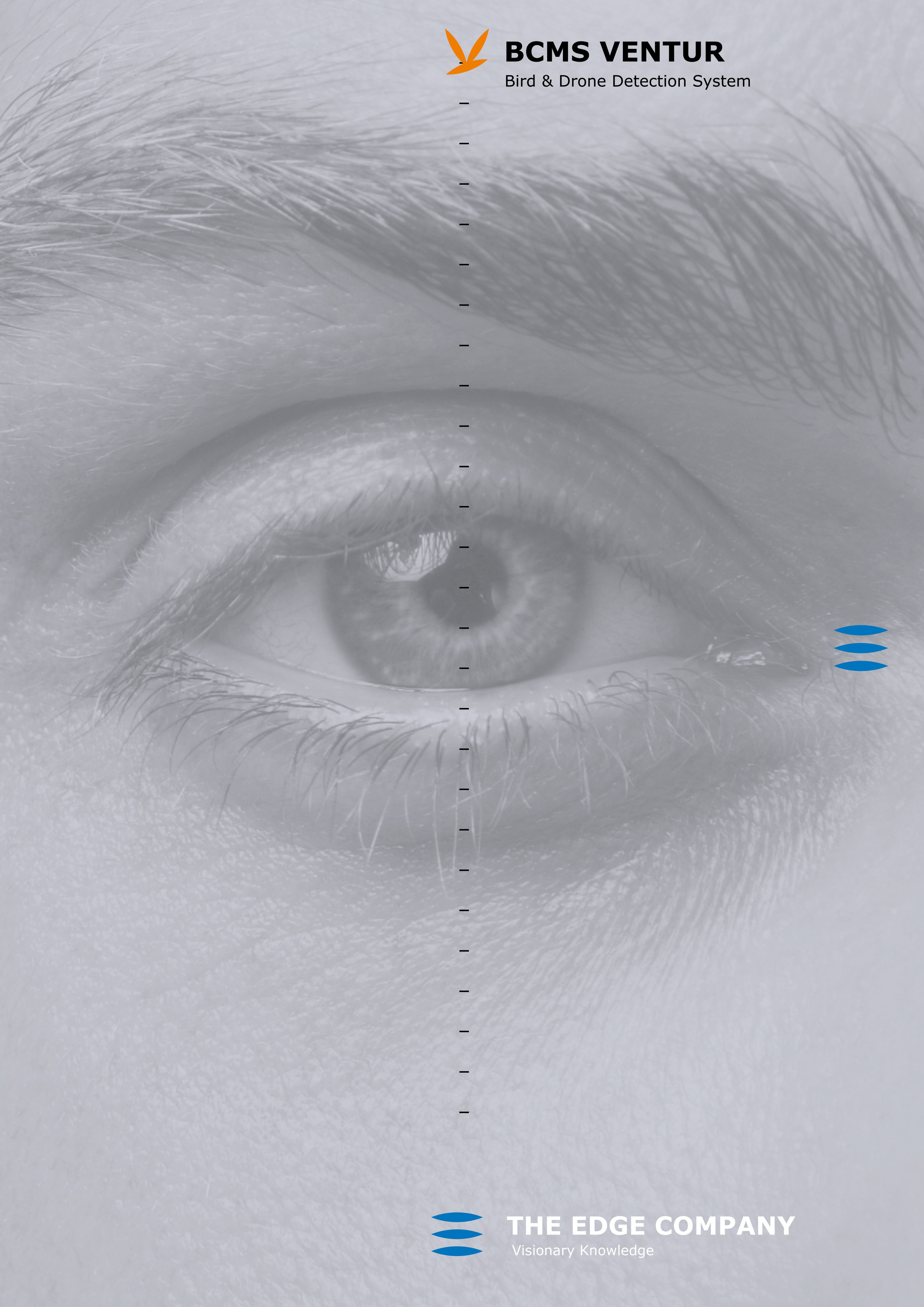
BCMS VENTUR
Bird & Drone Detection System



DANGER OF BIRDS AND DRONES FOR MILITARY, CIVIL AND COMMERCIAL FLIGHT

WHAT TO KEEP IN MIND WHEN EVALUATING SOLUTIONS

THE EDGE COMPANY
Visionary Knowledge



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GENERAL SUMMARY

WILDLIFE STRIKES, THE IMPACT BETWEEN AN AIRCRAFT AND ONE OR MORE WILD ANIMALS - MAINLY BIRDS (THE SO-CALLED "BIRD-STRIKE") - ARE CONSTANTLY INCREASING WORLDWIDE, WITH CONSEQUENT COSTS IN TERMS OF HUMAN LIVES AND MATERIAL DAMAGE TO AIRCRAFTS.

In the United States, the number of wildlife strikes has risen from 1,847 in 1990 to 13,795 in 2015 and in Italy from 348 in 2002 to 1,313 in 2016. This increase is due to several factors, including greater attention to the analysis performed, accuracy in reporting events, the significant increase in air traffic and undoubtedly the increase in some bird populations. It is easy to see, therefore, how the phenomenon of wildlife strikes has a strong impact on civil and military aviation all over the world.
The International Bird Strike Committee (IBSC) (now the World Birdstrike Association) was established in 1966 to deal with the problems associated with wildlife strikes, and is composed of a group of professionals with the task of sharing experiences to improve air safety by understanding and reducing the risk of bird impact with aircrafts.
In Italy, the Bird Strike Committee Italy (BSCI), founded in 1987, which depends on ENAC, has the task of: Preparing and monitoring the implementation of legislation on the subject; collecting, processing and sending statistics to ICAO; supporting internal ENAC bodies and airport operators; carrying out training courses, targeted visits and awareness-raising actions; involving local authorities and maintaining international relations.
The common key to national and international
regulations dealing with the wildlife strike problem is the recommendation to airport operators to adopt measures to minimize the probability of collision between wildlife and aircraft through: reporting systems; groups of experts and operational units; prevention and control plans (developed on the basis of studies and research in and around the airports).
Monitoring, therefore, is undoubtedly the best tool for the prevention of wildlife strikes, but how effective/efficient is the monitoring in airports now?

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WHAT IS THE DANGER WITH BIRDS IN AIRPORTS?

Most impacts between aircraft and wildlife occur at airports and in their immediate vicinity. Approximately 80% of impacts occur below 300ft altitude during take-off and landing. The risk of impact, during a landing or take-off phase, is linked to several contingent factors: type of bird present in the airport, the intensity of the activity, the number of individuals, the direction, the position and in general to factors typical of the airport under consideration: geographical location, proximity to foraging areas for birds or sources of attraction such as landfills and cultivated fields, the presence of wetlands, the fact of being positionedalong particular migration routes for certain bird species, the anagement of airport sediments and much more.
All these factors contribute to the determination of the degree of risk of impact at a given airport. Very often, airport areas represent a resting or foraging area for different species of birds, the meadows surrounding the runways provide plenty of food to species such as the Magpie, the Starling, the Crow and other species that moving from one area of the airport to another constitute a continuous danger to aircrafts during takeoff or landing. The same can be said of Pigeons and Swallows, which use buildings and hangars as nesting areas and consequently end up flying over the runways hundreds of times a day. The airport area is also often used as a resting place by migratory or wintering species such as Starlings and Lapwings which, for example, in some periods of the year frequent Fiumicino airport with several thousand individuals. We can conclude that the presence of landfills, wetlands and areas where there is high availability of water, food and suitable sites to shelter, reproduce, aggregate and rest, in and around an airport, are a formidable attraction for wildlife, especially birds. For all these reasons, an effective risk management and mitigation plan must include a reliable and constant monitoring system capable of providing detailed and timely information on the habits of the birds that frequent the airport area.

WHAT TYPE OF BIRD IS A DANGER TO AIRCRAFTS?

Not all bird species are equally dangerous, both in terms of the probability of causing a bird strike and the extent of the damage they can cause to the aircraft. Obviously, bigger species such as the Mediterranean herring gull or the common seagull can cause considerable damage compared to smaller species such as sparrows or swallows, but the tendency of a species to fly in large flocks is also a factor of danger. If we think of flocks of thousands of starlings, we can consider them as bullets that can cause

more damage than a single seagull. The average data collected at Italian airports tells us that the most dangerous species in terms of number of impacts with aircraft are: kestrels, swallows and swifts, pigeons and seagulls - rather common species that frequent the airport areas assiduously or, as in the case of swallows and swifts, in late spring - but whose high concentrations due to the ephemeral presence of food in this period, make them particularly dangerous for air traffic. Sunrise and sunset are the times of the day when birds are most active, and also the times when more bird strikes occur; while June and July are the months of the year when the risk of bird strikes is greatest, given the presence of large numbers of inexperienced birds who have just left the nests. Each airport, however, represents a different case, depending on the geographical position in which it is located and the birdlife that frequents it. The distribution of bird species in Italy, as well as in the rest of the world, is not homogeneous, but differs according to environmental conditions, the morphology of the territory, and also locally based on the distribution of trophic resources and refuge areas, and obviously it is also influenced by migrations. All this makes each airport a unique system that requires a coordinated approach of monitoring and management systems and tools to mitigate the risk of bird strikes as much as possible.

SPECIES	SWIFT SWALLOW	KESTREL	HERRING GULL	PIDGEON	UNKNOW SP.
WEIGHT	56/25 GR	0,150-0,300KG	0,7-1,5KG	0,5KG	?
WINGSPAN	48/35 CM	60-75CM	120-140CM	75CM	?
NO. OF IMPACTS IN 2017	185	160	76	51	35
% ON THE TOTAL	23.93%	20.70%	9.83%	6.60%	4.53%

Number of impacts by species in 2017 (Enac 2017 Annual Report)

RISK REDUCTION STRATEGIES

The main strategy on which the action of mitigation of the risk of bird-strikes in airports is based has its cornerstone in the daily monitoring of birds. The model presented in Circular APT-01B is the result of a survey carried out in order to obtain as much information as possible with minimum effort and maximum accuracy. The monitoring is supported by the various deterrent systems and the ecological environmental management plan of the airport in order to minimize the sources of attraction for birds and make the airport a hostile place for bird presence. In order to obtain reliable information, the forms must be filled in every time a runway inspection is carried out (at least 4 times a day), using a new form for each inspection, in order to have a complete picture of the situation. The annual cycle of data collected in this way is enough to provide a more than optimal picture of the bird situation at the airport.

However, the critical points of this strategy are many and varied:

- Accuracy in data collection (species recognition, counting, position)
- Non-continuous data collection during 24h
- Inability of BCUs to monitor the entire airport grounds at the same time These are just some of the weaknesses of the monitoring system currently used in airports around the world. If we could count on asystem able to simultaneously monitor the entire airport area, from dawn to dusk, able to recognize, classify, count and identify the position of the bird species present and perhaps provide an estimate of the instantaneous risk for each movement based on the detected species, the number of individuals, the direction, this would allow us to:
- have the airport area under constant control
- take effective action in the event of an alarm based on the actual risk
- use deterrence systems more efficiently (distress-call) knowing the target species before the intervention
- optimize the work of the BCUs
- collect accurate and consistent data on birds for the annual report In the various phases of the process of mitigating the risk of wildlife strikes, the monitoring phase is certainly the weakest - and consequently the one with the greatest possibility of being improved and thus of providing a step forward that could mean a drastic reduction in the impacts between aircrafts and wildlife.

The focal point: if I do not know exactly what is happening at the airport I cannot intervene immediately and efficiently, so I cannot do effective prevention. If instead of doing 4, 8, 20 monitoring sessions a day, we could have the entire area of the airport monitored from dawn to dusk, second by second - it is easy to see how this can affect the ability to control and prevent risk.

ECONOMIC IMPACT ON CIVIL AND MILITARY AVIATION

The civil aviation of the United States alone spends almost a billion dollars a year on wildlife strikes, while in Italy it is estimated a cost of 40 million euros/ year, between repairs and delays in flights. Since 1988, more than 255 people have been killed in the world because of wildlife strikes, and at least 380 military aircrafts and 88 civilian aircrafts have been destroyed. The focal point is imple: if you do not know exactly what happens at the airport, it is not possible to intervene immediately and efficiently, and therefore it is not possible to effectively prevent the risk of impact between the aircraft and the fauna.

FLIGHT PHASE	NO. OF IMPACTS	%
LANDING ROLL	69	23.47%
LANDING	35	11.90%
TAKE OFF RUN	63	21.43%
APPROACH	59	20.07%
TAKE OFF	31	10.54%
CLIMB	22	12 4.08%
DESCENT	12	7.48%
TAXI	3	1.02%

No. of impacts in the various flight phases - year 2017 (Enac 2017 annual report)

WHAT HAPPENS WHEN A BIRDAND A PLANE COLLIDE?

The consequences of the impact between an aircraft and one or more birds basically depend on parameters such as: the type and extent of the impact area; the hysical and mechanical properties of the impact area and the strength of the impact.
The force exerted by the bird during the collision depends on the physical characteristics of the animal (therefore on its species), the number of animals involved, the impact trajectories and the speed.
An impact at low speeds with a small bird is likely to cause minor damage both from a mechanical and structural point of view and from the point of view of passenger safety, while a collision at high speed with birds of considerable size such as seagulls or crows can generate significant safety risks.
As kinetic energy increases, damage to structures, be they wings or nacelles or windshields or engines, can become very serious. Obviously the most serious damages that may occur are those to the engines: birds that end up in the engines can rapidly compromise their operation damaging the turbines, and therefore the safety of the crew.

EQUIPMENT AND COUNTERMEASURES TO AVOID WILDLIFE STRIKES?

As previously mentioned, the first and indispensable tool to prevent wildlife strikes is airport monitoring - only by knowing what happens I can know how and when to intervene. The tools available today to intervene in the prevention of wildlife strikes are many and with varying effectiveness:
Removal by noise tools

1. PROPANE GAS GUNS:
devices that generate high intensity explosions and can be fixed-cycle, variable or randomized.

2. DISTRESS CALL AND ELECTRONIC SYSTEMS:
equipment that emits warnings for certain bird species, capable, if carefully used, of effectively removing one or more species from the desired area. Usually placed on vehicles able to quickly reach the area to be cleared.

3. FIRECRACKERS AND OTHER PYROTECHNIC DEVICES:
different types of projectiles are available on the market, they can be fired from various types of weapons and are configured in such a way as to obtain strong and weak explosions, obtain

fumes of various smells and colors, obtain flashing lights, etc.

4. ULTRASOUNDS AND INFRASOUNDS:
they belong to the category of least effective means of removal, since most birds receive sound frequencies in the same way as human beings.

FALCONRY

The use of hawks to keep birds away from airports is a tried and tested practice. The innate fear in many bird species, which pushes them to flee at the sight of the silhouette of a falcon flying is the basis of this practice, used in some airports - including Italian airports. However, the excessive costs of this system and some logistical problems for its development in the airport have slowed down its diffusion over the years.

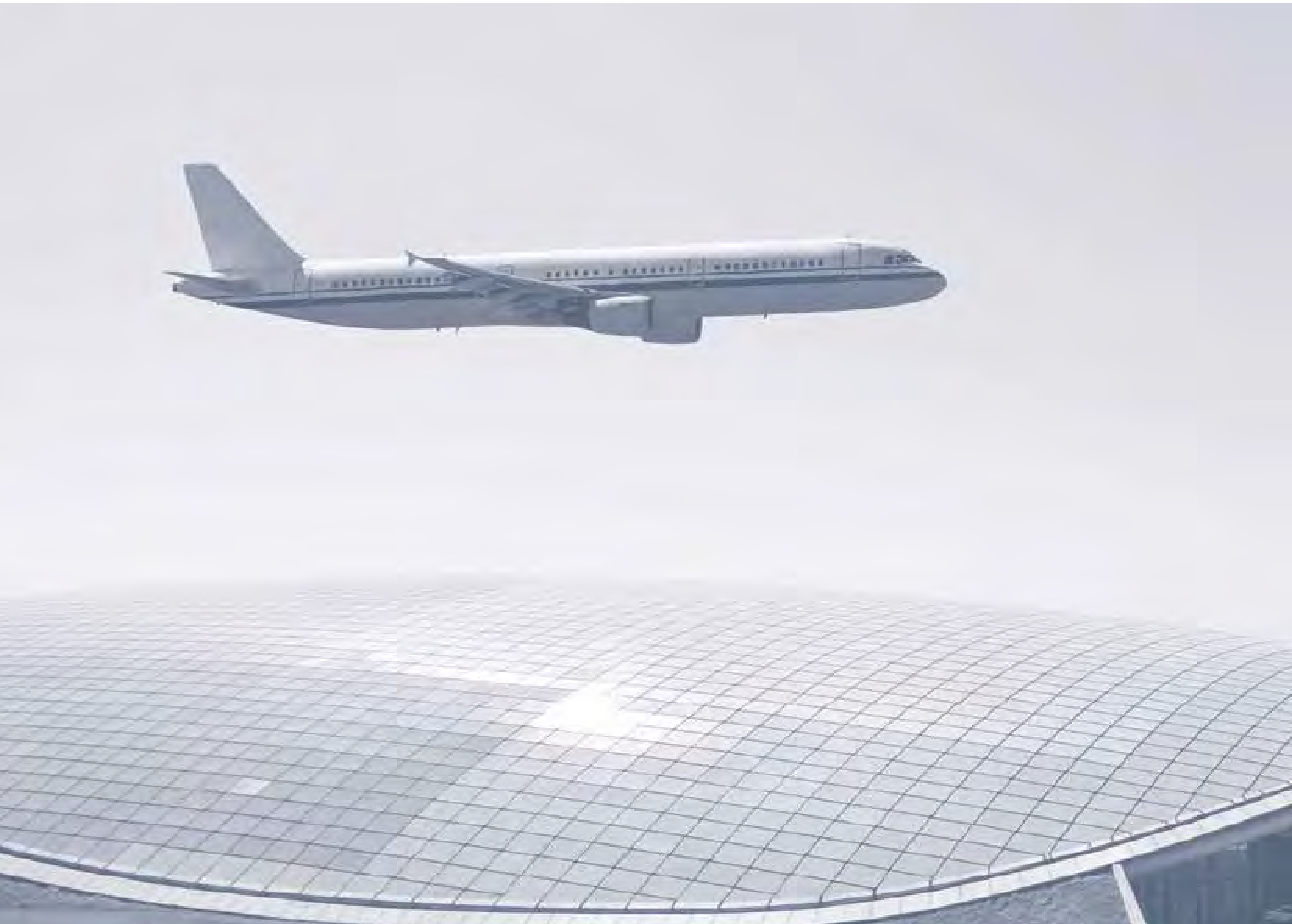
1. only some species of birds are sensitive to the presence of hawks - seagulls, for example, are difficult to remove
2. with some species, such as herons, it is almost ineffective; crows even drive out hawks by doing the so-called "mobbing".
3. all hawk species cannot work in adverse weather conditions (heavy rain, wind, fog) and with temperatures above 35°.
4. only small aerodromes are suited to the use of hawks
5. it is necessary to hire highly professional falconers
6. the operations must be carried out daily throughout the year, it is therefore essential to use more than one falcon, with additional costs
7. the first tangible results can be seen after a minimum period of 6 months In consideration of all the above, we can say that the use of distress-calls (calls for alarm of a certain species) has proved over the years to be the most effective system for the removal of birds at airports. If used well they do not generate habituation, and in association with a continuous and constant monitoring of the airport are the best tool for the prevention of bird strikes. This system should be associated with an appropriate policy of ecological and environmental management of the airport, established on the basis of accurate and detailed naturalistic research.

FINAL CONCLUSION

Civil and military airports, even all airfields, should inherently guarantee the take-off and landing phases with systems for preventing impacts with flying objects, which may be birds or, as is increasingly the case, drones. **The B.C.M.S.© VENTUR system is the "system of the systems"**, as it is capable of effectively recognizing and classifying bird species and calculating their trajectory, but also of immediately orchestrating the actions required to remove species from the area to be kept safe. In fact, it is possible to integrate the system with the others already present and to interface in an immediate way.

The B.C.M.S.© VENTUR system allows you to:

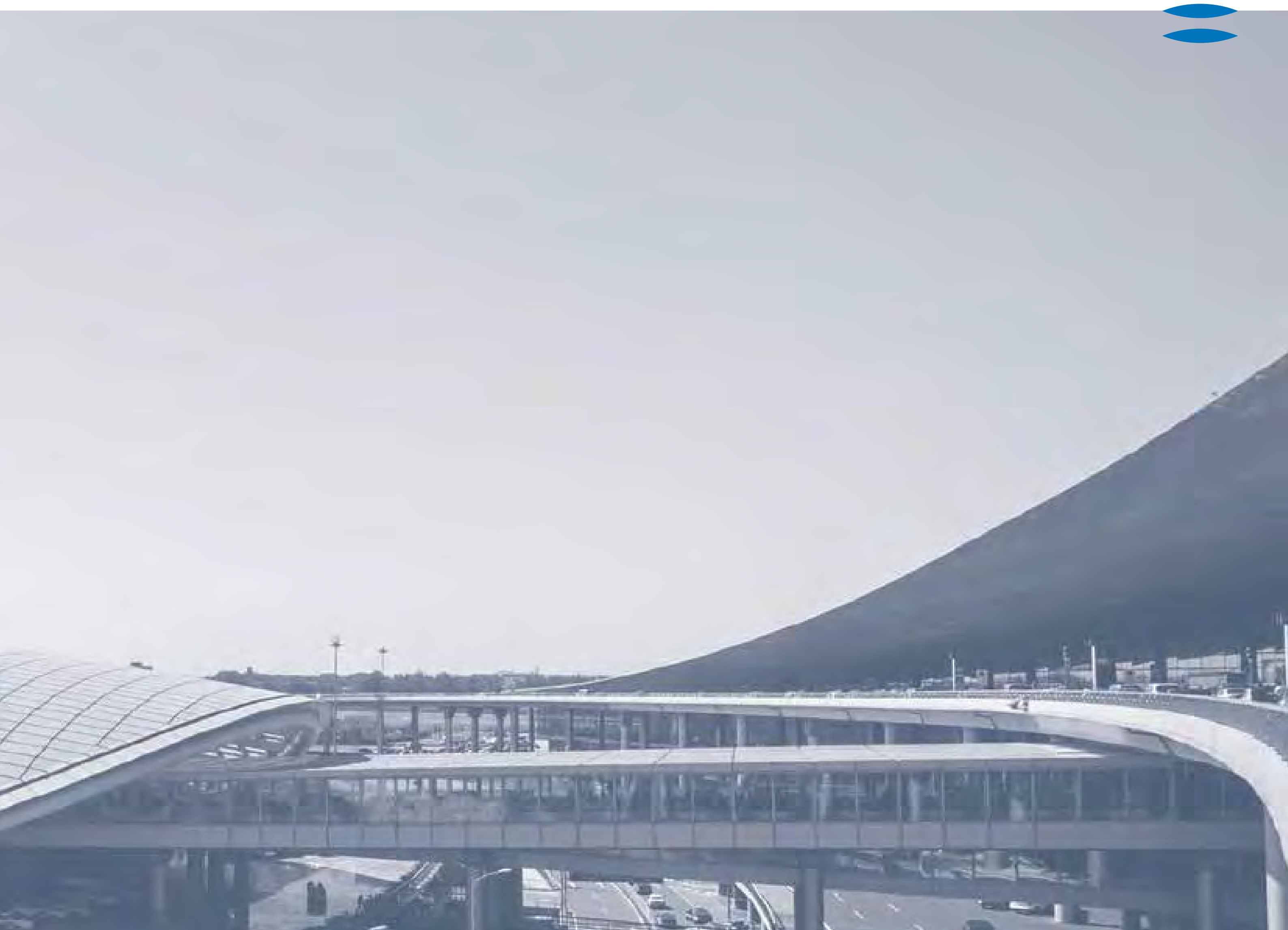
- Have a low-cost alternative to traditional radar or micro-doppler systems
- Have an intuitive system with a quick



learning curve. No expensive course to teach new employees how to use it

- No permit issues for electromagnetic wave emissions
- Provide immediate and visual support for the detection of fauna and birdlife that could cause problems to the normal flight activities of the area concerned
- Prevent costly downtime if the system is used to protect power generation fields with wind turbines Unlike radar and micro-doppler systems, VENTUR can classify the species with an accuracy of more than 95%, in order to guarantee the activation of the most suitable deterrent system.

The B.C.M.S.© VENTUR system is ecological, does not emit electromagnetic pollution, and is friendly to wildlife and birds because it is able to reach the ultimate goal without having to resort to bloody deterrent means.



BCMS VENTUR

Bird & Drone Detection System

SMART AI SOLUTION

FOR AVIATION SAFETY & SECURITY

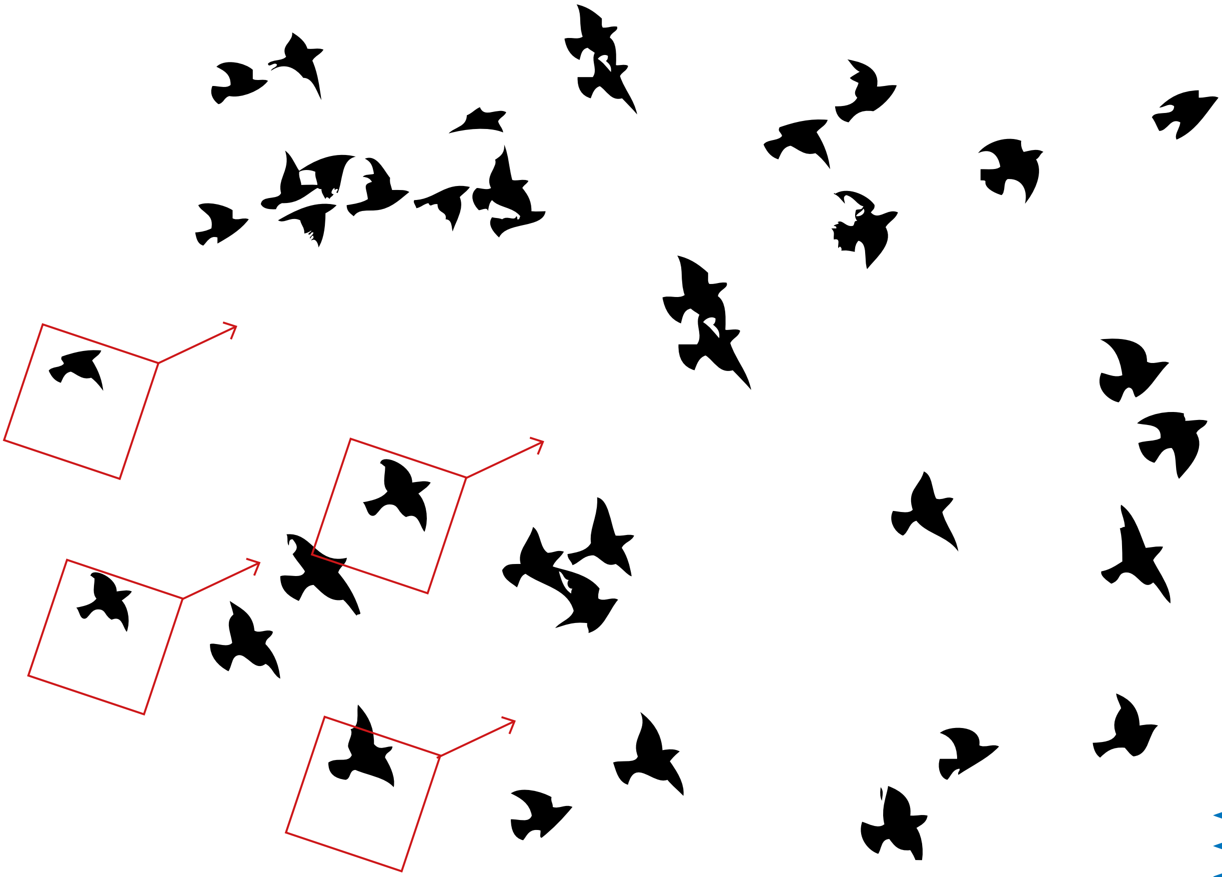
1 BIRDSTRIKE EVERY 15 MINUTES

EVERY AIRCRAFT, AT ANY AIRPORT IN THE WORLD EVERY DAY RUNS THE RISK OF COLLISION WITH BIRDS, ESPECIALLY IN THE PHASE OF TAKE-OFF AND LANDING, OFTEN WITH SERIOUS CONSEQUENCES.

IN ITALY WE SPEND **40 MILLION EUROS** PER YEAR ON REPAIRS AND FLIGHT DELAYS. SINCE 1988, MORE THAN 255 PERSONE HAVE BEEN KILLED WORLDWIDE DUE TO IMPACTS WITH WILDLIFE AND AT LEAST **380 AIRCRAFT** MILITARY AND 88 CIVILIAN **AIRCRAFT** HAVE BEEN DESTROYED

All systems used to date at airports to mitigate the risk of birdstrike and drone intrusion (in most recent years), are based on monitoring through personnel and/or radar systems, which activate deterrent systems and hazard management procedures as they are detected. Current monitoring methods, however, are not sufficient to ensure effective management and acceptable flight safety level. All this translates into an average increase in birdstrikes worldwide of about 500% over the past 20 years, 1 every 15 minutes.

BCMS
VENTUR
Bird & Drone
Detection System



BCMS® VENTUR IS THE WORLD'S FIRST SYSTEM USING ARTIFICIAL INTELLIGENCE TO IDENTIFY, TRACK, COUNT AND CLASSIFY SPECIES OF BIRDS AND THE PRESENCE OF DRONES, IN REAL TIME.

BCMS® VENTUR IS THE MOST APPROPRIATE SOLUTION FOR THE SAFETY OF VEHICLES AND PEOPLE AT AIRPORTS, VOLOPORTS AND SPACEPORTS.

TO MONITOR OBJECTS IN THE AREA OF INTEREST AS WELL AS TO DETECT AND CLASSIFY FLYING AND GROUND OBSTACLES, NON-COOPERATIVE AIRSPACE PARTICIPANTS IN THE AIRSPACE WITHIN THE SITE VICINITY AND ALONG DEFINED FLIGHT ROUTES TO INCREASE THE SAFETY FOR THE OPERATION OF FLYING MISSIONS IN CONGESTED AREAS.

BCMS® VENTUR IS AN INTEGRATED AND DISTRIBUTED SYSTEM. IT IS BASED ON STATE-OF-THE-ART PROPRIETARY TECHNOLOGY THAT REVEALS THE RISK OF BIRDSTRIKE IN REAL TIME, INCREASES SAFETY, RESPECTS THE ECOSYSTEM AND DECREASES MONITORING COSTS.

All systems currently used in airports to mitigate birdstrike risk and invasion of drones, are based on monitoring. Monitoring is carried out through staff and / or radar detection systems, which consequently activate the deterrence systems and procedures hazard management. Current monitoring methods in the airport field, however, are not currently sufficient to ensure effective management.
The staff are not given the necessary information or, the before mentioned staff is numerically insufficient to guarantee continuous and efficient monitoring of the entire airport area.
Furthermore, the danger management is compromised by the delay from its sighting and communication to management bodies and the activation of deterrent systems. All of this translates into an average increase in birdstrike worldwide about 500% in the past 20 years, 1 every 15 minutes.

B.C.M.S.© VENTUR is a system that uses UHD cameras distributed on the site installation with proprietary artificial intelligence algorithms for the detection of birds and drones at or near the airport, wind farm, power plant, city.
Other objects such as planes or different obstacles can be detected and reported. It boasts unmatched performance to improve installation safety, travelers and operators.

It is a green system. The use of passive sensors (cameras) does not pollute the environment with electromagnetism, and does not require any authorization for installation because it does not interfere with other equipment.

The B.C.M.S.© VENTUR system was developed together with the University of Verona, Department of IT, and eVS S.r.l., manager the engineering.

Italsicurezza S.r.l. is our responsible partner coordination of system integrators globally.

Below, the main functions of the B.C.M.S.© VENTUR:

- **AUTOMATIC DETECTION OF BIRDS AND DRONES**
  - **- location of objects**
  - **- classification of the species**
  - **- counting of objects**
- **GENERATION OF ALARM SIGNALS**
- **RECORDING OF EVENTS**
- **AUTOMATIC PRODUCTION OF DAILY, WEEKLY, MONTHLY REPORTS**
- **AUTOMATIC CONTROL OF SYSTEMS DETERRENT (OPTIONAL)**

SYSTEM ARCHITECTURE

BCMS® VENTUR IS LIKE THE BLACK BOX AT AIRPORTS. THANKS TO HARDWARE COMPONENTS AND THE IMAGES COLLECTED BY THE SENSORS, IT OFFERS A CLEAR PICTURE OF THE SITUATION.

THE REAL HEART OF THE SYSTEM BEATS IN THE ARTIFICIAL INTELLIGENCE ALGORITHMS THAT REALIZE THE REAL MAGIC OF BCMS® VENTUR, MAKING IT UNIQUE FOR THE SECURITY OF CIVIL AND MILITARY AIRPORTS, AIRFIELDS AND SPACEPORTS

SENSOR (TELECAMERA)

By strategically positioning one or more cameras, BCMS VENTUR guarantees the continuous monitoring of the area of interest with a radius of more than 2 km of distance.

DATA CENTER

Operations center which supervises the operation of the system in order to improve over time the performance by continues system training.

VIDEO MANAGER

Records the video streams captured from the cameras labeling them with the as events allowing access to the user.

DATA MANAGER

It groups and organizes detected events within a database making them available by remote client via web API.

VIDEO ANALYTICS PROCESSOR

Control the cameras and analyze video streams to detect, classify and locate birds in the scene using algorithms of computer vision and machine learning.

SITUATION AWARENESS MODULE

Compatible with all operating operating systems, allows to see in real time species, number and concentration of birds/drones and quadrant in which they are located.

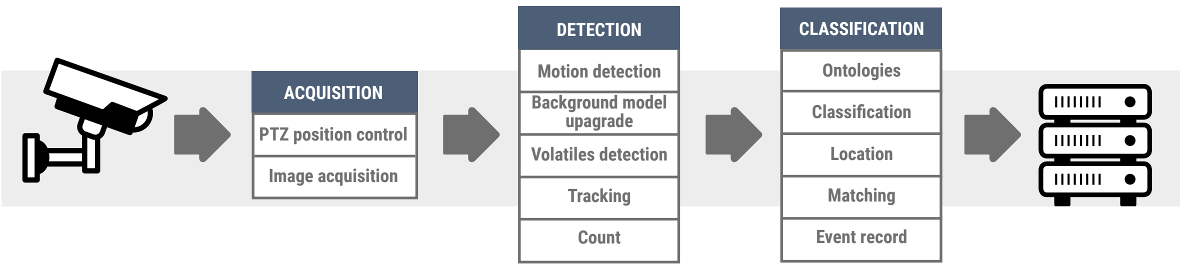
Apple iOS

android

Lenovo e Nvidia per **Artificial Intelligence** and **Augmented Reality** soluzion partner, and **Bosch Security System**

SYSTEM WORKFLOW

Shows a flowchart that describes how the data is processed and analyzed from the acquisition of the images to the registration of the events. Each operation corresponds to algorithms for selecting, specializing and implementing on the chosen technological platform.



PHASE DESCRIPTION

- **Motion detection:** we identify the parts of the image to put in focus (close-up) detecting all moving objects against the background
- **Background update:** you need to keep a solid background model to update for each frame; it is taken into account that the background can change for various reasons, like the movement of clouds and sudden changes in lighting
- **Bird detection:** moving objects detected on the first pass are classified as "volatile" and "non volatile" based on some particular characteristics automatically learned from the model.
- **Tracking:** prolonged observation of the same bird allows you to extract dynamic characteristics, such as flight path, and discard false positives (the tracking will only last 5-10 sec)
- **Counting:** prolonged observation also allows to count the number of birds present
- **Application ontologies:** knowledge based on birdlife information and on the territory allows to include a phase of reasoning useful for increase the accuracy of the classification of the species
- **Classification of species:** objects recognized as birds are classified according to their species (defined for each installation based on the place, the time of year, etc.). An additional class will contain all the specimens for which it was not possible assign a species with sufficient confidence, both because their species is not among those under analysis or because it was not possible to understand clearly which species it belongs to
- **Position:** the coordinates of the obstacle are indicated on the coordinates on the map. From a single image it is possible to provide only a rough indication of where the bird is, based on the size and speed of flight; if multiple simultaneous images are available of the same object from different cameras, it is possible to triangulate and estimate the position more accurately.
- **Matching with previous surveys:** within certain limits the system will be in able to understand if two volatile sighting events generated by two different single cameras actually correspond to the same group of birds.
- **Registration of the event:** the information relating to the event detected must be managed in an adequate manner, you need to create a data packet to send to the central server and written in the database.

HARDWARE ARCHITECTURE

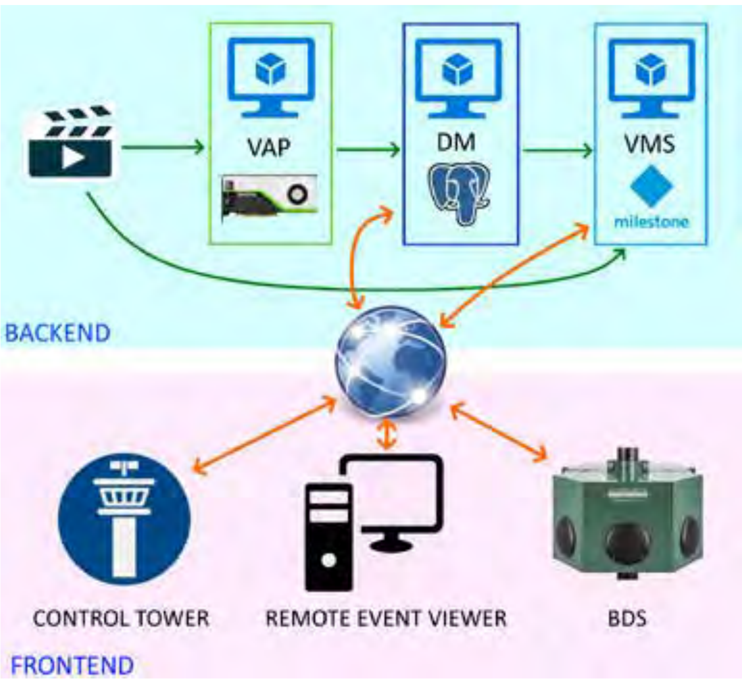
4K PTZ Bosch IP Cameras

Network infrastructure (copper/optic fiber/ radio links), 114Mbps per camera required

Server Lenovo SR650 server con 2 Nvidia Quadro RTX 4000 hosting multiple virtuals machines

Nvidia Quadro RTX 4000 cards process data gathered from 4 cameras and/or video management system. MOVING TO NEW CARDS

THE SYSTEM



Video Analytics Processor (VAP): analyzes videostreams of up to 4 cameras for bird detection

Data Manager (DM): Stores detected events to database

Video Management System (VMS): records video segments documenting bird detections

Currently VAP, DM and VMS are virtual machines running on a Lenovo SR650 Server

Multiple agents can access the system through a secure connections (REST API)

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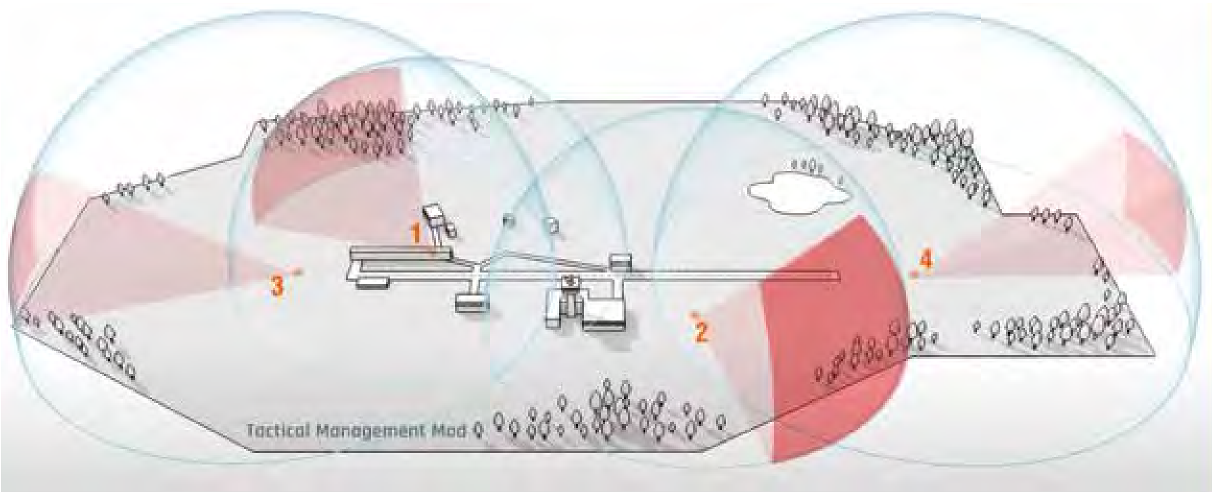
Bird & Drone Detection System

SPACE MONITORING

The area monitoring is done with high performance BOSCH cameras capable of monitoring the scene at 360 degrees.
The camera will be moved according to a sequence of predefined positions that will continue to repeat cyclically in an automatic way. The camera will remain a few seconds, it will move to the next position performing a 360° control, acquiring a certain number of frames and then it will perform the next movement.



SCANNING ROOM
In a monitoring unit, the camera can perform three types of movement, as shown in Figure 4. Pan is the rotation of the camera around to an axis that passes through the optical center and is orthogonal to the ground. The camera panes to monitor the scene 360 degrees. The inclination is the rotation around an axis that passes through the center optical and parallel to the ground. The camera will tilt to monitor the presence of birds at different heights.
Zoom is a movement of the lens that allows you to change the width the field of view of the camera. This movement allows you to change the focal length and therefore the level of detail (pixels / meter) that the camera is able to solve. The greater the focal length and therefore the level of detail, the sharper the angle of vision. Changing the zoom requires a focus adjustment On fire.

BOSCH MIC IP Ultra 7100 BOSCH MIC IP Fusion 9000

BOSCH
Invented for life

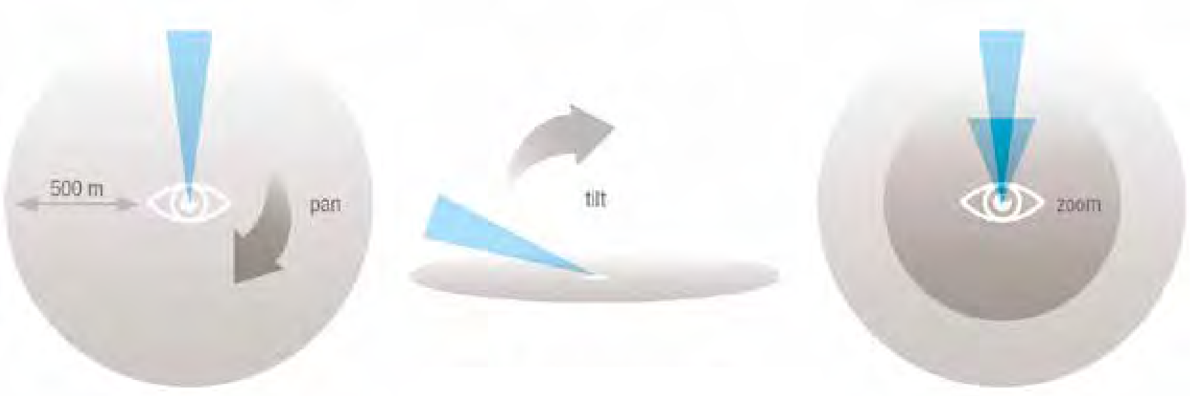


Fig.4 Types of movements

The camera will be moved according to a sequence of predefined positions (presets) which will continue to repeat cyclically. The steps of movement they are automatic or the camera moves, it remains a few seconds in the position acquiring a certain number of frames and then executes the next move. The optimal sequence of presets must be evaluated during the project, taking account of the observation space defined in the requirements, as well as movements of the other monitoring units present in the same basic module.

SENSOR POSITIONING

The positioning of the sensors will be customized in relation to specificities of the airport and the reference environment.

COORDINATE SYSTEM FOR LOCALIZATION

The location where a bird has been located will be expressed in a system joint reference to the airport. The two XY coordinates will indicate the position of the dial on a grid as shown in Figure 5.

Fig.5 coordinate system

MINIMUM OPERATING REQUIREMENTS

WORK SPACE

• The monitored area will be divided into quadrants (zones), 100 x 100 meters each; quadrants could be customized accordingly with end user requirements

• The monitored area is divided into critical. Sub-critical and other sectors. The critical sector represents an area that cover the runway and the approach path _500 mts wide, 250 mt from the centerline and long enough to cover the distance at which the aircraft will transit to/from the 300' height_

• The sensors will monitor the designated area using a preset scan pattern;

• Any sensitive area may be obscured.

MONITORING

• The system detects all birds on the ground and in flight. up to 300 feet height. To be detected, birds on the ground must be in motion and in the sensor's visual field;

• The System classify the species for which has been trained to. Other species will be added as the system collect further data thanks to the artificial intelligence learning system _continuous improvement_;

• It is possible to modify the set of species to be classified also according to the season;

• The type of species to be classified will be determined in accordance with the specific needs and the geographical location of the airport;

• The number of birds will be expressed according to the following format (example: 1, 2, 6, 30, etc.);

• The area where the obstacle is detected will have the same identification code as the reference map;

• The simultaneous detection of different species in the same area will give rise to different events;

• The simultaneous detection of obstacles in different areas will give rise to different events.

USER INTERFACE

• Each generated alarm includes the location of the detection, the number of obstacles and the species;

• The operator can select and review a recorded video sequence from each of the cameras. This includes all events that generated an alarm;

• The operator can select and take control of each camera. In this case, video analysis will be disabled;

• In case of a false alarm, the operator can enter the event as a false alarm in the system. The system will learn on its own;

• The system generates alarms on operating status based on conditions weather conditions (e.g. low visibility) or malfunctions.

PERFORMANCES

OPERATING CONDITIONS AND TIME COVERAGE

• The system works all year round;

• Bright conditions. The system works from sunrise to sunset;
Note 1. *The use of IR illuminator provide the system with night capability*
Note 2. *The implementation of a multi-sensor camera is planned. The multi-sensor camera will allow the system to cover the entire operating spectrum.*

• The optimal performances are guaranteed with good visibility;

• In adverse weather conditions, performance could be degraded;

• Operating temperatures -20 °, + 50 °. Relative humidity between 10 and 100%

• A low grass cutting regime it is desiderable.

OUTPUT

• Automatic recording of events on the database indexed with time and day;

• Automatic recording of video streams;

• Event database back up;

• Extraction of recorded videos.

From real life operations:
- Acquisition distance with a 4K sensor up to 1 Km.
- Identification and tracking rate > 93%%
- Accuracy of classification of bird's species> 90%
- Localization error with single chamber <80 Mt
- Error detecting target speed <20Km/h

The level of performance expressed refers to the acquisition of birds with a wingspan of 100 cm (seagull) detected on a contrasting background (example: sky or mountains) not against direct sunlight; Maximum performance is achieved after a 12 month (four seasons) training period. This will make it possible to include migratory birds in the database, not only sedentary ones.

AUTOMATIC CONTROL OF DISSUASION SYSTEMS _Add On_

• The B.C.M.S.© VENTUR can control the automatic activation of the dispersal systems. THE EDGE COMPANY supports the use of distress call devices;

• The B.C.M.S.© VENTUR controls the deactivation of the deterrent device, normally when the presence of the bird is no longer detected or with time control;

• Activation and outcome of the intervention _ Es Bird no longer present_ are recorded as an event.

OPTIMIZATION OF PROCESSES

B.C.M.S.© VENTUR was designed according to the I.N.A. (Integrated Networked Architecture) to minimize the operator's workload and increase efficiency.
Monitor and control an area of 10 square km continuously. It is modular and can cover larger areas. After implementation bird control unit patrols will no longer be necessary. The personnel in charge may intervene only when necessary, following a system alarm. In addition, thanks to its integrated functionality, the dispersion system can be automatically controlled and the operator can simply monitor performance and results.
It allows to redesign and optimize the processes pertaining to the tactical and strategic management of the problem.
The system returns detailed reports and objectives which, among other things, allow to improve the management of the airport habitat.
On average, the implementation of the B.C.M.S.© VENTUR system reduces management costs by up to 40%

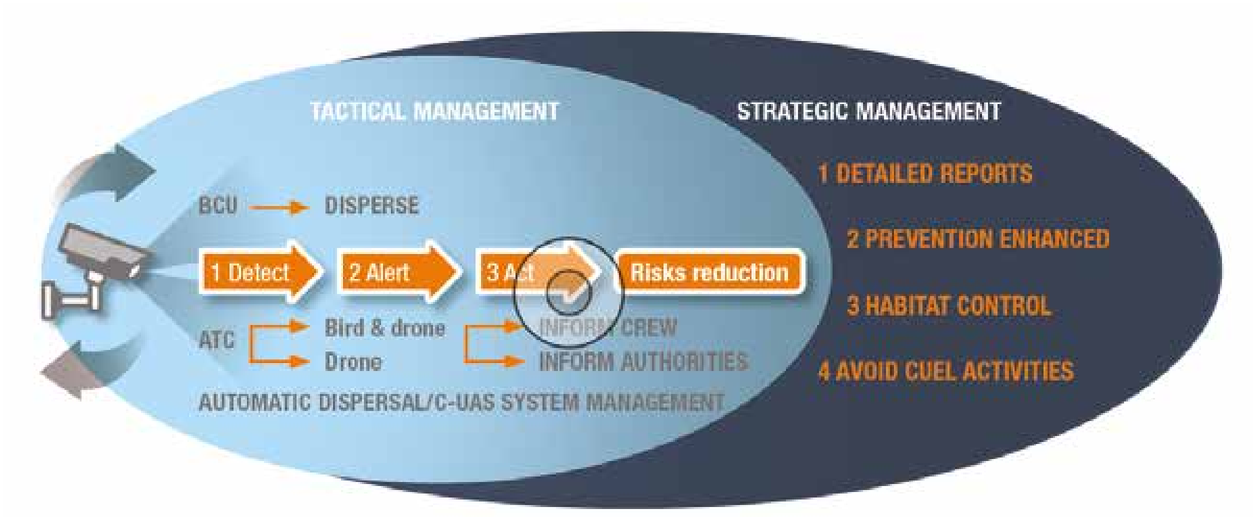


Fig. 6 B.C.M.S.© VENTUR operational processes and results

MINIMUM INSTALLATION REQUIREMENTS

Video stream: multicast to NRV e VAP

#Monitoring units	#vap	#Data flow Monitoring units	Video stream to display	GigaBit Ethernet	Optic Fiber
4	1	228Mb/s	57Mb/s<=2 devices		
8	2	456Mb/s	57Mb/s<=2 devices		
12	3	684Mb/s	57Mb/s<=2 devices		
14	4	798Mb/s	57Mb/s<=2 devices		

TASK

Increase flight safety levels by improving management processes.
Designed according to the INA (Integrated Networked Architecture) approach, the system allows operators to reduce their workload. Automatically, it analyzes and processes low and medium level data, returning operators to readily usable information.

- Birdstrike prevention
- Management and reduction of drone intrusion risk
- Drastic reduction of intervention times in the tactical phase

MONITORING

The purpose of the B.C.M.S.© VENTUR system is to obtain information relating to the concentration of birds in a certain space.
This information is recorded and sent to a database.

These recordings correspond to the "detection" events and will contain the following information:

• progressive identification code
• airport code
• code of the camera that made the sighting
• date / time of sighting
• initial position of the sighting
• confidence in the position
• number of birds in the same species (by intervals)
• confidence in the number
• species (class)
• confidence in the species

DETERRENCE

automatic control of dispersal systems

DYNAMIC RISK MANAGEMENT

current methods of calculating risk generally have a statistical value in the long run but do not provide a tool that can be readily used in the tactical phase. B.C.M.S.© VENTUR system, based on the observation and analysis of different factors in real time (type of bird, direction of motion of the obstacle _ Eg when moving away, approaching_, position of the obstacle, contemporaneously with the flight activity) gives an indication of the risk level of that moment _ LOW, MEDIUM, HIGH_ allowing the operator to take the most appropriate actions.

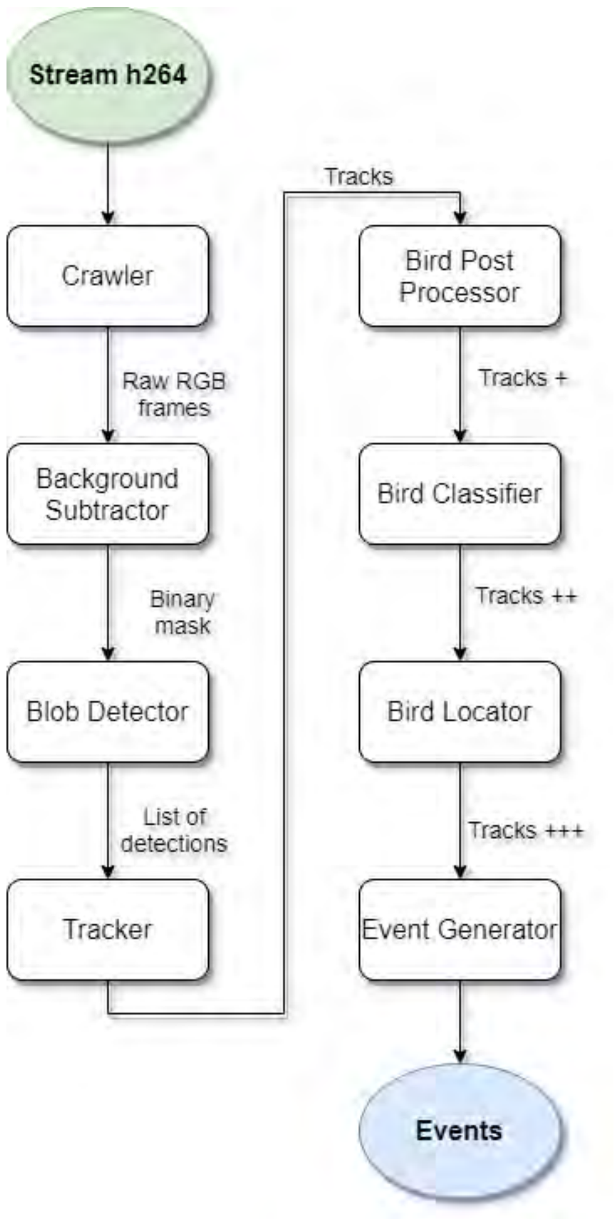
AUTOMATIC PRODUCTION OF REPORTS

daily, weekly, yearly

PROCESS OPTIMIZATION

The entire wildlife management will be automated and enhanced by accurate and always verifiable data collected by the system. the combination of the system and specialized personnel _reduced in number_ will determine a drastic risk reduction.

VIDEO ANALISYS OVERVIEW



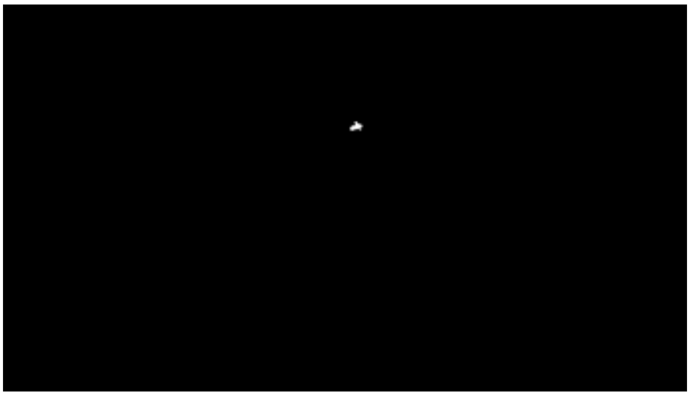
_When birds/obstacles are detected by one of the cameras, the system creates an event

_Each event includes:

- _ Species/class
- _ Number
- _ Location
- _ Direction / speed
- _ Timestamp

_Video streams from cameras are constantly feeding the video analysis pipeline to checks for events

DETECTION AND TRACKING MODULES



_Detects moving objects by using a background subtraction algorithm (GPU accelerated)

_Cleans detections using some morphological filters

_Filters detections applying shape constraints

_Tracks detections between multiple frames to create trajectories

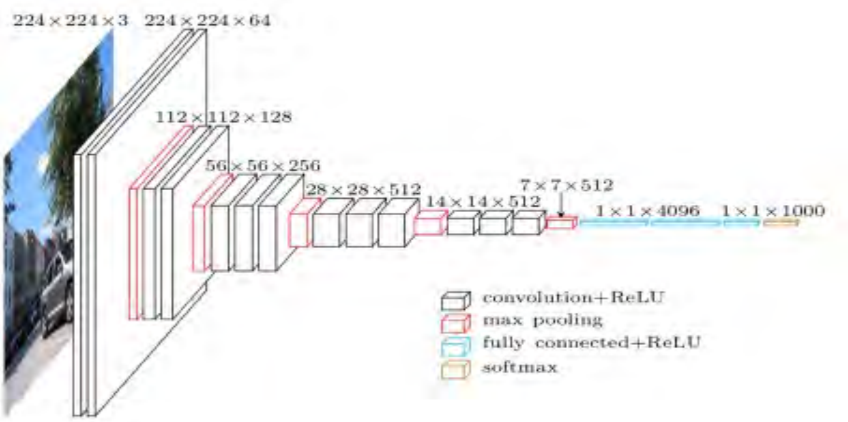
_Predicts the movement of objects even when temporarily occluded

TRACKS POST PROCESSOR MODULE

_Compute track features and classifies each track in different classes (standing and flying birds)

_Removes false tracks that do not correspond to birds

BIRD SPECIES CLASSIFIER MODULE



- Uses a custom CNN to classify each patch forming the track
- Combines the classification results for each track and assigns it a species and a global confidence score
- Uses priors to correct the classification by adapting it to the current airport
- The classification species can be adapted to different sites by fine tuning the CNN and by changing priors
- Species classification is a very challenging task due to:
  - Extremely varying lighting conditions
  - The pose of each bird that can differ a lot during its flight
  - The size of the smallest patches which is 32x32 pixel
- We combine every kind of possible information retrievable from videos (shape, color, movement) with historical prior data
- As we collect more data from the airports, the system learns and improves the quality of its predictions

LOCATOR AND EVENT GENERATOR MODULES

- Assigns a 3D world location to each detection
- Groups detections into events
- Assigns each event to a quadrant of the airport map grid for visualization and risk assessment

BCMS VENTUR
Bird & Drone Detection System

Evaluate the accuracy and reliability of the BCMS© VENTUR system in detecting birds in flight and on the ground in the monitored area

Assess how much the BCMS© VENTUR system is able to recognize, in terms of number of birds, in a given time and space compared to Bird Control Unit personnel on normal monitoring shifts

Evaluate the ability of the BCMS© VENTUR system to recognize and count bird species in a given time and space compared to BCU staff on normal monitoring shifts

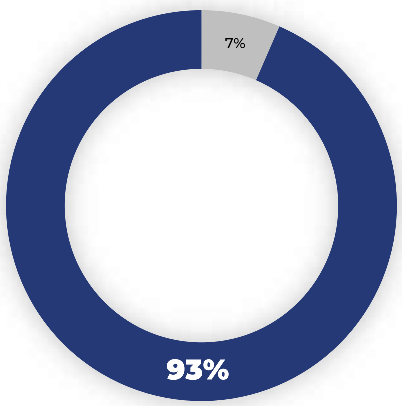
Evaluate the detection capabilities of the BCMS© VENTUR system with respect to BCU personnel in relation to different weather conditions and times of day and therefore visibility

SYSTEM ACCURACY

With data collected during real life operations, an initial and partial re-training of the system was performed to test its ability to improve performance with experience. The retrained system has been tested on all the videos of 60 test days and the performances regarding the detection capacity have been evaluated with performance regarding the ability to detect with the results shown.

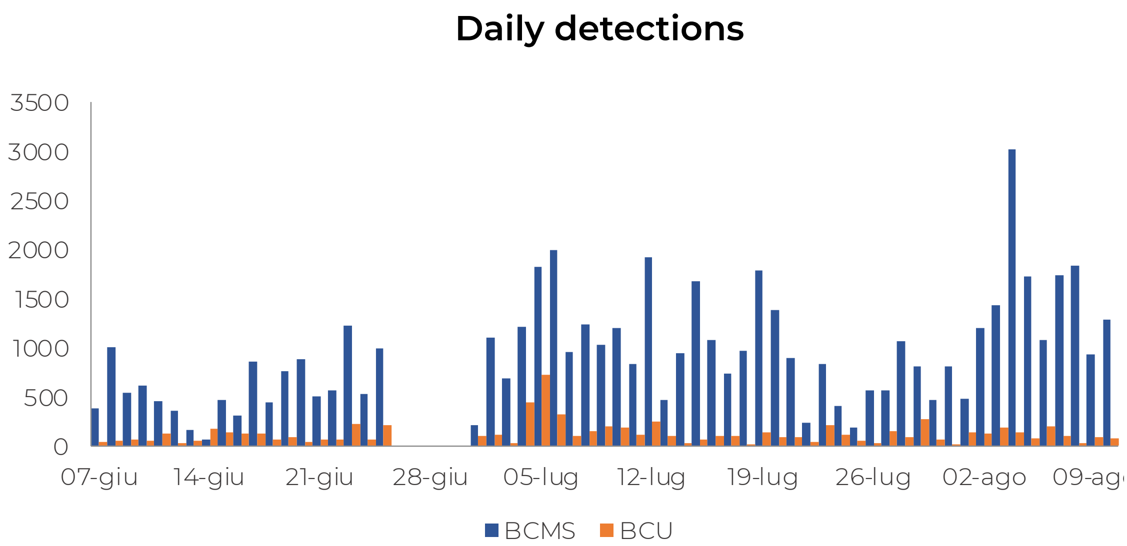
All 136,381 events recorded by the system were retrospectively analyzed (both events recorded as birds and those discarded as “other”). We can deduce that the system not yet retrained, from 07/06/2021 to 10/08/2021, identified with an accuracy of 92% the birds on the ground or in flight that frequented the airport area, with the retraining there was an improvement in the accuracy of detection to 93%. NOTE. Retraining wasn’t complete but only few parameters were considered. A full retraining will provide an increase in performance to bring the true positive rate up to >95%.

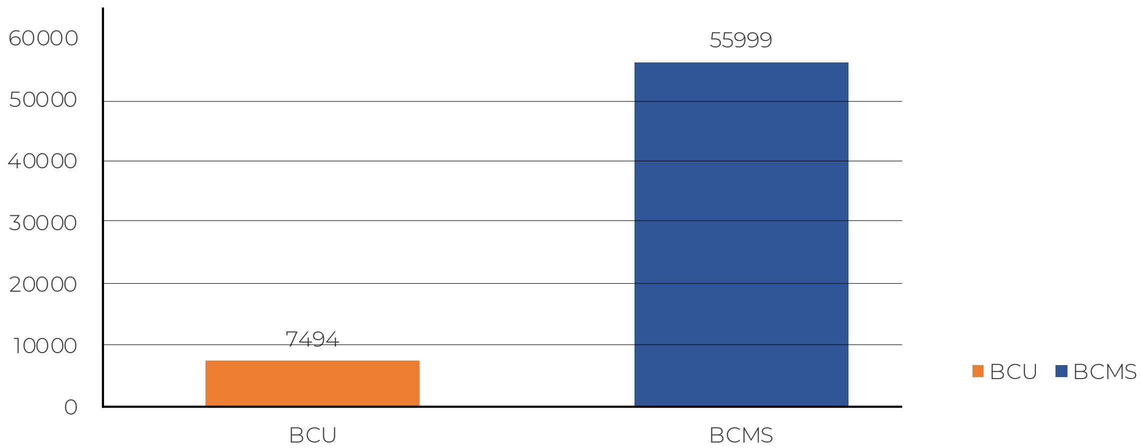
System precision after retraining



true positive rate

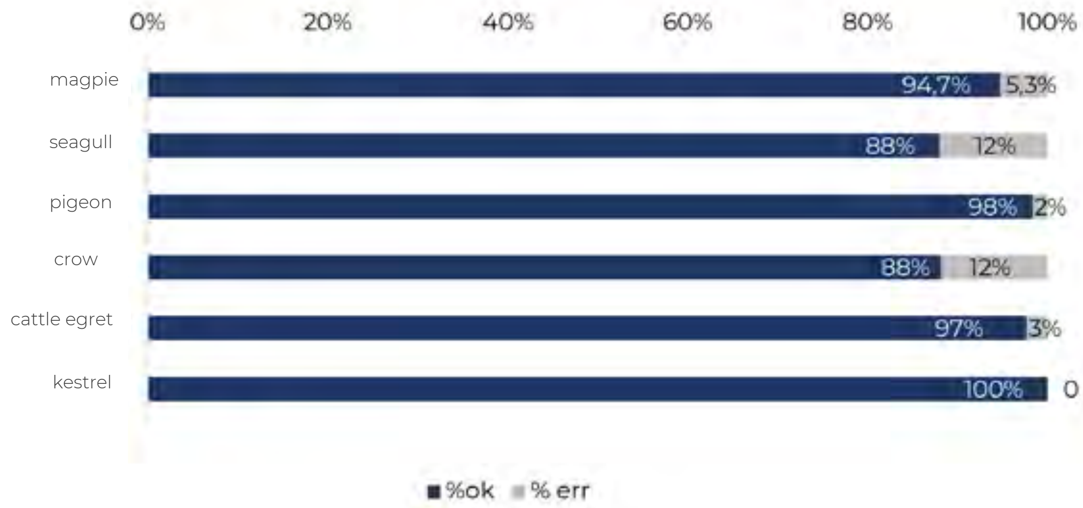
DETECTION BY PERIOD





BCMS® VENTUR detected 7,49 time more birds than BCU

SPECIES CLASSIFICATIONS

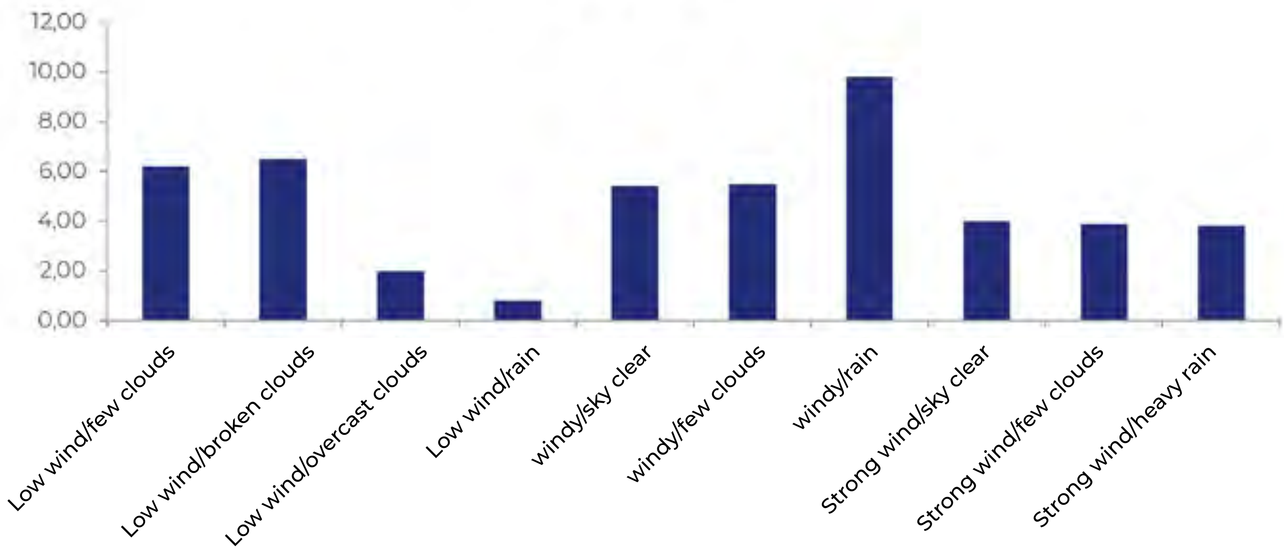


The System recorded an accuracy in the Ccassification of the 6 species for which it was trained of about 94.2%. In detail, it made 756 correct sightings of Thieving Magpie, 607 of Herring Gull, 184 of Pigeon, 671 of Cornacchia, 425 of Heron Guardbuoi and 1 of Kestrel.

The margin of error is further reduced if the groups to which the various species belong are examined.
This was between species of the same group as for example Magpie and Carrion Crow or Pigeon and Wood Pigeon.

WHAT IF THE WEATHER CONDITIONS ARE NOT THE BEST?

BCMS vs trained personnel with adverse weather conditions



IN THE END

If we compare the data acquired by the BCMS© VENTUR system also with the radar systems usually used at airports, we can highlight that the performances of the latter are definitely lower. Radar is not able to classify the species, while the BCMS© VENTUR is able to do so with a very good accuracy. Radars detect and track a bird the size of a duck (as suggested by the main studies carried out) with 50% accuracy, while the BCMS© VENTUR demonstrated a 93% accuracy and against birds both in flight and the ground. FAA Circular 11/23/10 AC No: 150/5220- 25, states that for a radar system to be influential in airport risk prevention, it must be capable of intercepting an average-sized bird within 1.8 km with 90% accuracy. The BCMS© VENTUR can do this with 93% confidence, having the ability to do so even for ground obstacles while classifying them. Obstacles such as swallows that are surely little than a duck.
All this without any full re-training yet implemented, which will surely increase the performance of a system that already represents a substantial added value in the prevention of wildlife strike risk.

WHY IT IS REVOLUTIONARY COMPARED TO METHODS IN USE

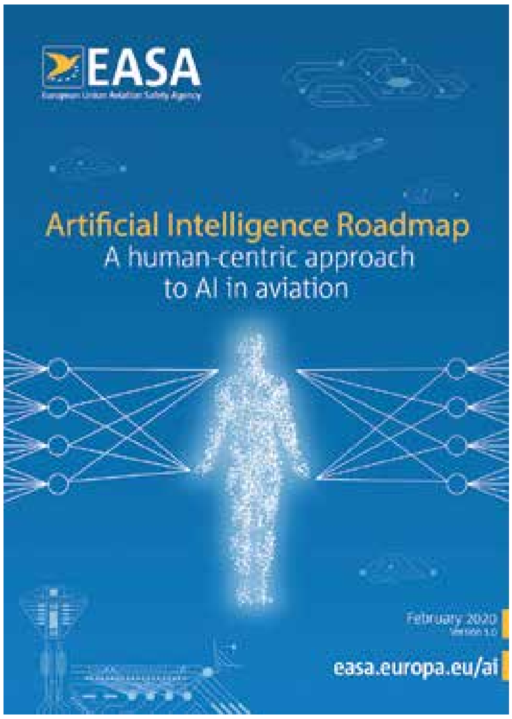
	Monitoring by Bird Control Unit's PERSONNEL Current status in airports	**Monitoring using RADAR**	**Monitoring BY BCMS® VENTUR, based on AI and TELECAMERE HD** AI
_Airport coverage	PART	TOTAL , 100%	**TOTAL, 100%**
_Ability to detect birds and drones: - in flight - on the ground	LOW LOW	MEDIUM NO SKILL	**HIGH, 95%** **HIGH, 95%**
_Accuracy of bird and drone detection:	LOW	NO ACCURACY	**HIGH**
_Responsiveness hazard detection:	LOW	HIGH	**HIGH**
_Responsiveness of hazard communication (with towercontrol tower and with assigned personnel and Deterrent Systems):	LOW	MEDIUM	**IMMEDIATE**
_Activation of Deterrent Systems:	DELAYED	DELAYED	**IMMEDIATE**
_Birdstrike and Drone Impact Risk:	MEDIUM	MEDIUM	**STRONGLY REDUCED**
_Cost of Risk Management:	HIGH	HIGH	**STRONGLY REDUCED**
_Cost / benefit	LOW	VERY LOW	**VERY HIGH**
_Environmental Impact	LOW	HIGH	**GREEN, ZERO EMISSION**

BCMS® VENTUR CONSTANTLY STORES EVERY OBSERVATION IN ITS NEURAL NETWORK. BASED ON THE DATA IT COLLECTS, THE SYSTEM'S DEEP LEARNING ALGORITHMS CONTINUOUSLY IMPROVE ITS ACCURACY AND CAPABILITIES OVER TIME.

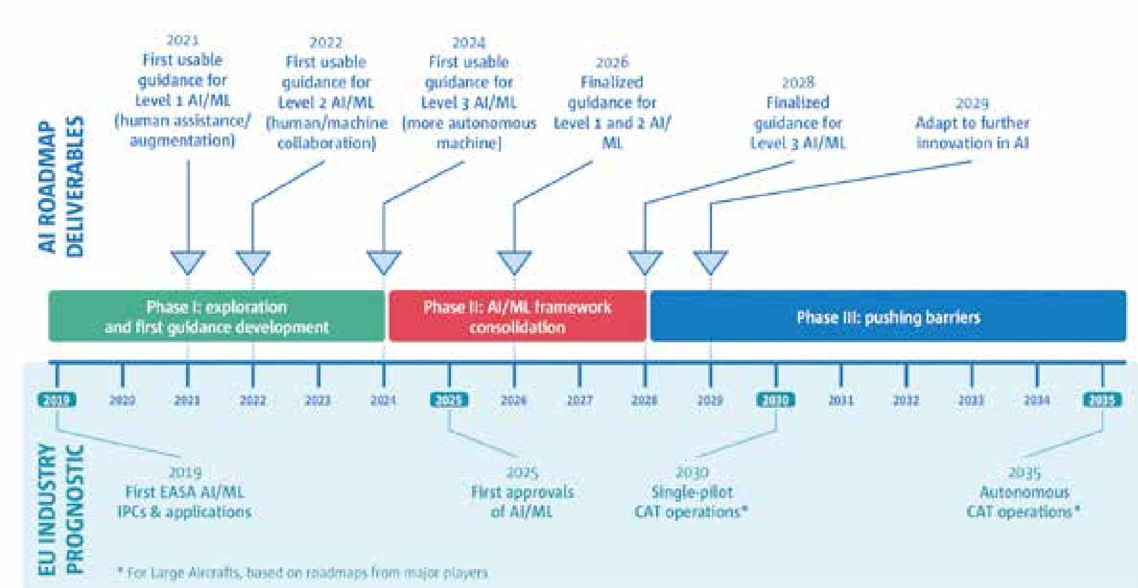
FROM EASA

Below is the introduction of the recent EASA publication:

Artificial intelligence (AI) is coming with a fast pace and being adopted widely, including in the aviation domain.
While the concept of AI has been in existence since the 1950s, its development has significantly accelerated in the last decade due to three concurrent factors:
• Capacity to collect and store massive amounts of data;
• Increase in computing power; and
• Development of increasingly powerful algorithms and architectures.
AI systems are already integrated in everyday technologies like smartphones and personal assistants, and we can see that the aviation system already starts to be affected by this technological revolution.
As concerns the aviation sector, AI will not only affect the products and services provided by the industry; it will also trigger the rise of new business models. This will affect most of the domains under the mandate of the Agency. Its core processes (certification, rulemaking, organisation approvals, and standardisation) will be impacted. This will in turn affect the competency framework of Agency staff.
Beyond this, the liability, ethical, social and societal dimension of AI should also be considered.
In October 2018, the Agency set up an internal task force on AI, with a view to developing a roadmap that would identify for all affected domains of the Agency:
• the key opportunities and challenges created by the introduction of AI in aviation;
• how this may impact the Agency in terms of organisation, processes, and regulations; and
• the courses of action that the Agency should undertake to meet those challenges.
The purpose of this Roadmap is not only to establish the Agency vision on the development of AI in the aviation domain, but also to create a basis for interaction with its stakeholders on this topic. In this perspective, this AI Roadmap 1.0 is intended as a dynamic document, which will be revised, improved and enriched with time as the Agency will gain experience on AI developments and stakeholders will provide their input and share their vision with the Agency.



ARTIFICIAL INTELLIGENCE ROADMAP HUMAN-CENTRIC APPROACH TO AI IN AVIATION



1st STEP
by 2021 have systems decision support

2nd STEP
by 2022 to have systems that interact with the actors

3rd STEP
by 2024 to have fully automatic systems

THE BCMS VENTUR IS ALREADY A SYSTEM THAT RESPONDS TO STEP 3: IT IS AUTOMATIC IF YOU WANT TO USE IT ALONE BECAUSE IT RECOGNIZES SPECIES AND ACTIVATES ITS OWN DANGER CALLS TO WARD OFF IDENTIFIED SPECIES.

FUTURE DEVELOPMENTS

1. Improvement and generalization of system training through unsupervised domain adaptation.

2. Intelligent movement of cameras. To improve its performance and make it even more effective, an intelligent and self-programmable system will be implemented based on previously recorded data.
In particular:
- periodic modification of the route based on the statistics on the data collected to increase the probability of sightings:
- setting the sensor patrol path based on what is on stage and the movement of the other cameras;
- dynamic zoom for the classification of distant birds, only when necessary;
- multi-chamber triangulation to improve localization;

3. Simulator in Virtual Reality.
It is a useful system both during training with summary data and for the system design of the systems in the different airports, allowing to evaluate in advance the best strategic positioning of the sensors according to the desired results and the orography of the site (presence of obstacles , eg).

4. Detection of immobile obstacles.
The system is currently able to detect the presence of moving obstacles. The identification of immobile obstacles through the integration of further artificial intelligence algorithms (the possibility that a bird remains immobile for long periods is reasonably low. However, the prompt detection allows to further improve the management of the processes both in the tactical phase in the strategic phase _prevention_), it constitutes a further performance improvement of the system.

5. Improvement of the training module
• Classification of other bird species
• Temporal aggregation of similar events (i.e. determine if it is the same event)
- Contiguous pre-sets and same pre-set at different times
• Automatic learning of roads and other sources of false positives to be excluded (car, foliage)
• Detection of large flocks (starlings)
• Determination of mixed tracks “in flight” / “on the ground”
• Classification based on trajectories (clustering of tracks)
- Approach similar to flapping wings (info a priori)
- Stationary flight determination (kestrel)
• Reasoning for multiple hypotheses (bidirectional)
• Classification (go back to the species decision)
• Location (return to the bird in flight / ground decision)

HOW THE BIRDS ARE DISPERSED AWAY

The integrated architecture of BCMS VENTUR is able to recognize even at a distance of 1 km the species of birds in real time and to control with extreme precision the dispersal systems that use the specific call of the species to disperse the specimen and free the area avoiding cruel actions.
If human intervention is necessary, BCMS® VENTUR is able to immediately inform the BCU of the airport about the species of birds and their position allowing precise and timely interventions.

OUR PARTNERS

Lenovo and **Nvidia Artificial Intelligence** and **Augmented Reality** solution partner, and **Bosh Security Division** partner.

Nothing has the power to broaden the mind as the investigation of observable facts.

Marco Aurelio

BCMS VENTUR
Bird & Drone Detection System

Rev1_10-2021

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