# **fioseco**

## Innovative Technology as a Response to the Bird Strike Risk





#### **Bioseco - Genesis**



Challenges of birds protection on wind farms:

Reduction of negative impact to environment. Authorities expecting viable solution to bird mortality risk. Increased public awareness makes pressure on operators. Risk of financial penalties or turbine shutdowns.





**Bird Protection System - concept** 

Thanks to use of stereovision Bioseco system allows to estimate the distance to the system and autonomously undertake various action depending on the bird distance and its flight path

## **Protection area**





#### **Bird Protection System - implementations**

#### Efficiency proved









#### System design and validation – scientific approach

sensors MDPI A Runway Safety System Based on Vertically Oriented Stereovision Dawid Gradolowski <sup>13,6</sup>, Damian Delak <sup>1</sup>, Damian Kanlacki <sup>1</sup>, Adam Jawonki <sup>1</sup>, Michal Skalog and Wiafek J. Kalewa <sup>2</sup> Beauty and a Relationship of the Science Mandalance Additionary (1974) Barran Janishillinov com (212), a danja se ul 40 sectore (31). Dipateo da Udalamina ad Naka Sector, Bring Ludala et Innology (213) Nachten Stevens, Necker ad School Sector, Bring Ludala et Innology (213) Nachten, Stevenska NSTE, N3N Glash, Pilind skonstatistister beidalado com Bondelos, & Borrela NSTE, N3N Glash, Pilind skonstatistister beidalado com Consequencies and a grade law shall be account. Madash in 300, over 10.000 bard drives some apparted in the U.S.A. with everyge report of er meding \$200 million annually, rising to \$1.2 billion worldwide. These officients of avitants with riphone prop a significant threat to farmer safety and withlife. This raticle presents a system the state second and a manife back or and signific The solution is a stemptoist manufact cleaneds logother a To create a high disput of casts http://dx.doi.org/10.5755/j01.ei ELEKTRONIKA IR ELEKTROTECHNIKA, ISSN 1392-1215, VOL. 28, NO. 3, 2022 and appropriate Report while a to nor drawn design radio shi in MATLAR. The long increased relidation of the system pro-Airport Wildlife Hazard Management System apdates The results obtained press the set as well as a high degree of loc Phone Desidence 2, Desk R. A Sensor Fusion Approach Entered (Princessis, Arbiteller, Mr. Kerwoods bird nowkeeing bir and body and W.J. A. General Party of Things one increased as a surger of the US. value, Select 201, 21, 10 Damian Dziak<sup>1,\*</sup>, Dawid Gradolewski<sup>1</sup>, Szymon Witkowski<sup>1</sup>, Damian Kaniecki<sup>1</sup>, he (Alassa hunt-odollik Adam Jaworski<sup>1</sup>, Michal Skakuj<sup>2</sup>, Wlodek J. Kulesza<sup>2</sup> Bioseco S. A. united in the America Re-1. Introduction Budowianych St. 68, 80-298 Gdansk, Poland The first collision of a <sup>2</sup>Ekoaviation, Piecewska St. 30B/16, 80-288 Gdansk, Poland 1985, and then, in 1912 the I has men, presenting a sig-arcidents worldwide [2]. <sup>1</sup>Institute of Mathematics and Nature Sciences, Blekinge Institute of Technology, 371 79 Karlskrona, Sweden Public to A MELL over party ported [3] The reports show damian dziak@bioseco.com Bights, increased from 11 in International Civil Aviation the approach, 37%, take off, courin the singuage under Abrour-Avietion report indicate data between 1965 and data and the second second second second second second best dress was a second Hazard Management (NHAD) is presented in the following district. The proper obsolution is based on the data fixed of distribution and vision interact, which are used to improve the vision is derived in the present second vision is derived and second seco level peculations introduced (EASA) oblige each amport and Hacard Management (2) even reach 10 % of all recorded events 141. From 1988 to Capable II NW by the rations 2019, 292 human deaths and 327 injuries have been owner METIT family inclusioned Currently, different tech reported due to strikes by wildlife with airplanes, around the risk such as the omithelos widespread at meetium and vision based monitoring syster rorld [5]. However, fatalities are not the only consequences o contribute of the France Construction visition haved manufacturing syst Aminetics (3) (5) here (2007)7 the subject performance less interactions between wildlife and airplanes. Between 1988 methodological and any film and the l a cuttace is a research challe system is designed to operate under all environmental conditions and provides advance information on the fauna and 2019, there were 271 civil aircraft destroyed or seriously damaged in total worldwide [5]. The last report presence on the sirport runway. preserve on the aligner remay. The proposed starter finite approach we designed and the proposed starter finite approach with the Schwerer, the developed system has been validated in rest-face scenarios and personally unaited as an aligner. Performed ents proved detection capabilities during day and alight of dog-listed manuality for historic days and alight of dog-listed manuality for historic days and alight of dog-listed characterized and the days of the days of the days of the characterized and the days of the days of the days of the characterized and the days of the days of the days of the days of many starterized and the days of the d shows that annual repair costs in the USA reached more than \$200 million [6], and are predicted to reach more than \$1.2 billion globally [7]. Therefore, in large and medium ware 201, 11, 166, https://doi.org/10.100/01110106 irports, Air Traffic Control (ATC) demands a systematic WHM 141 The results of long-term observations from WHM systems allow identification of hot spots of wildlife activity, which can help to determine and control the effective deterrent and scaring methods. The most widely applied WHM techniques are ornithological observations and rada systems [8], as well as cost-effective vision-based solutions [9], [10]. The latter ones are affordable for small- and Index Terms-User-driven design; Image processing; Thermal sensors; Vision systems. medium-sized airports; however, they may have some environmental limitations, e.g., daylight condition L INTRODUCTION One can state that there is a need for developing a mor robust vision and Al-based real-time monitoring system for Wildlife Hazard Management (WHM) is a key component of the maintenance service of every airport [1] identification, classification, and localization of wildlife [2]. Monitoring bird activity in the vicinity of a runway, as activities. Changing environmental and light conditions, a well as detection of mammals' presence in the vast traffic variety of species, and their distinctive movements make the area, are crucial for flight safety. Fauna-related accidents development of such a WHM system a non-trivial task. A have caused not only damage but also deaths of both thermal imaging-based solution can overcome some of the humans and animals. Even despite the decrease in flight traffic volume caused by the COVID-19 pandemic, more monitoring. than 10,000 bird strikes were still observed just in the USA In the proposed solution, thermal and vision camera data fusion is used to improve the reliability and adaptability of the real-time wildlife monitoring system. User-Driven Lanucrit resol-time wildlife monitoring system. User-Driven is recarly user persent by the Nutsien Carter for Rosenth Design (UDD) methodology shas been applied to determine departed of Poland under Genet for Rosenth approxed of Poland under Genet Tomping est research and the resol time wildlife monitoring system. User-Driven Design (UDD) methodology shas been applied to determine person works noosen y in devide a rost motions for each to satisfy to provide the market lationed solutions for each to satisfy to provide the market lationed solutions for each to satisfy to provide the market lationed solutions for each to satisfy to provide the market lationed solutions for each to satisfy to provide the market lationed solutions for each to satisfy to provide the market lationed solutions for each to satisfy to provide the market lationed solutions for each to satisfy to provide the market lationed solutions for each to satisfy to provide the market lationed solutions for each to satisfy to provide the market lationed solutions for each to satisfy to provide the market lationed solutions for each to satisfy to provide the market lationed solutions for each to satisfy to provide the market lationed solutions for each to satisfy to provide the market lationed solutions for each to satisfy to provide the market lationed solutions for each to satisfy the lation for each to provide the market lationed solutions for each to satisfy the lation for each to market lationed solutions for each to provide the market lationed solutio

FAUNA MONITORING SYSTEM (AFMS) reducing the number of collisions between alternaft and birds and mammals" No. POIR.01.01.01.00

#### sensors **Comprehensive Bird Preservation at Wind Farms**

to satisfy to provide the marked tailored solutions for each

individual medium- and small-sized airport. The unit has been designed to handle the large monitoring area for robus

#### Dewid Gradelewski <sup>(2,4</sup>), Damian Daiak <sup>(2)</sup>, Milosz Martynow <sup>1</sup>, Damian Kaniecki <sup>1</sup>, Aleksandra Seurlej-Kielanska <sup>1</sup>, Adam Jawonki <sup>1</sup> and Wiedek J. Kalesza <sup>1</sup>

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- Remaining and indexes of the Control of the Control
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Abstrack Wind as a discr and excessible energy new three yes, in pour i wars with the new sec in the particle and and discharges. But report become worrisone. Researchers estimated that in the U.S. up to \$00,000 blids to-colligants with wind turbands. This article proposes a system for mitigating

and wind fames. The solution is based on a stated-vision watern embedded in sting and hill paradignet. Alter a birdly data tion in a defined score, the devicing treates a collision availance routine composed of light and second delements out ng procedure. The development process applies a User-Driven Design approach new of completent tobality and hearith adjustment. This proposal includes nethod and localization procedure. The bird identification is carried out using to algorithms. Validation uses with a facel wing shows and verifying observations moved the system's desired reliability of deterring a bard with wengepoint over 1.8 m a. Moreover the suitability of the system is classify the size of the detacked bard impar megnics, unall, radius and large, was confirmed.

MDPI

al intelligence bid ministration system. distributed connecting continuousla where gill overlage and sub-by spectrum the second second system.

owth of the human population, the robust expansion of urban facilities me, power lines and alreports into the natural environment of animals, is and bats, may be observed [1-7]. Therefore, mutual cohabitation of mans increasingly leads to unsearied conflicts and close antiact. Und held; structures are datagerous altuations for both. Un the one hand, harbing e citebes cause horizon problems. On the other hand, human expansion he local ecosystem leading not only to habitat loss and fingmentation but adfering and death of hinds [1] te may believe that wind power is a green and renewable energy source.

e the death of rare species of birds and bats. Rotating high speed wind re handly visible for harring precatory birds. It is hard to estimate the to rate, but the ratest recent studies show that in the U.S. between 160,000 is discontrally [4-11]. With the increase of wind energy capacity, inte-ter, each 1 (million, Therefore, there is an introduct need for technical age the impact of word turbures on local actions [9] levelopment requires not only the reduction of orders donalde emissions, orducted without the depletion of nature and wildlife [12]. Therefore,

High developments and particulation



inable development of

ction at wind farms

energy-automated bird

"NatForWINSENT – Nature Conservation Research at the Wind Energy Test Site,

September – October 2019, 330 LRF track, 4 birds species,

#### Aleksandra Szurlej-Kielańska,

May – October 2020, 28 observation days, 117 birds



Bio-consult independet tests for PNE.

February – September 2022, 38 observation days, 786 birds detected, 10 063 LRF samples



## System design – research





#### System design – research and scientific approach





**Table 6.** Test results of CNN performance evaluation, where the bolded row highlights the selected configuration; the values in red highlight the best values for a given parameter.

CN	N Parame	ters	IT Time [ma]	Dussision	Pacall	11	Sussificity	A	
$L_{C1}$	$L_{C2}$	$L_{FC}$	II IIme [ms]	Frecision	кесин	FI	specificity	Accuracy	
32	32	32	0.80	0.987	0.989	0.988	0.987	0.988	
32	32	64	0.97	0.990	0.989	0.989	0.990	0.989	
32	32	128	1.09	0.996	0.989	0.993	0.996	0.993	
32	32	256	1.59	0.995	0.989	0.992	0.995	0.992	
32	64	32	1.28	0.995	0.989	0.992	0.995	0.992	
32	64	64	1.42	0.998	0.988	0.993	0.998	0.993	
32	64	128	1.93	0.995	0.989	0.992	0.995	0.992	
32	64	256	2.85	0.998	0.989	0.994	0.999	0.994	
64	32	32	1.54	0.979	0.989	0.984	0.979	0.984	
64	32	64	1.65	0.961	0.989	0.975	0.960	0.975	
64	32	128	1.84	0.997	0.989	0.993	0.997	0.993	
64	32	256	2.31	0.987	0.989	0.988	0.987	0.988	
64	64	32	2.33	0.997	0.989	0.993	0.997	0.993	
64	64	64	2.51	0.994	0.989	0.992	0.994	0.992	
64	64	128	3.32	0.987	0.989	0.988	0.987	0.988	
64	64	256	3.84	0.998	0.989	0.994	0.998	0.994	
	min		0.80	0.961	0.989	0.975	0.960	0.975	
	max		3.84	0.998	0.989	0.994	0.999	0.994	



## **Bird detection - Validation**



![](_page_7_Picture_3.jpeg)

![](_page_7_Figure_4.jpeg)

![](_page_7_Figure_5.jpeg)

![](_page_8_Picture_0.jpeg)

## **Bird detection - Validation**

#### **Detection capabilities**

Birds Size	BPS Version	0- 100m	100- 200m	200- 300m	300- 400m	400- 500m	500- 600m	600- 700m	700- 800m	Source
Small	Standard	92%	50%							[1-3]
Silidii	Premium	100%	100%	80%						[4]
	Long Range	data during analysis								
	Standard	66%**	83%	38%						[1-3]
Medium	Premium	100%	92%	100%	90%					[4]
	Long Range	data during analysis (av			erage > 85%	%)				
	Standard	91%	100%	68%	-	-				[1-3]
Large	Premium	100%	100%	100%	100%	75%				[4]
	Long Range	-	100%	91%	98%	95%	86%	83%	85%	

![](_page_8_Picture_4.jpeg)

Fixed – wing drone

![](_page_8_Figure_6.jpeg)

![](_page_8_Figure_7.jpeg)

![](_page_8_Picture_8.jpeg)

![](_page_9_Picture_0.jpeg)

#### **Bird Protection System – Bird identification in database**

![](_page_9_Figure_2.jpeg)

![](_page_10_Picture_0.jpeg)

## Airport Fauna Monitoring System Artificial eyes for Wildlife Hazard Management

Automated Wildlife detection

![](_page_10_Picture_3.jpeg)

Prompt notification and data collection

Bird deterrent system

![](_page_10_Picture_6.jpeg)

Automated Big Data analysis

![](_page_10_Picture_8.jpeg)

![](_page_11_Picture_0.jpeg)

#### Wildlife Monitoring System – what about aerodromes

Aerodromes – vast areas to be constant monitored The concept of "Wildlife Control Unit's second eye"

Aerodromes monitoring

Constant collecting data and live fiew

![](_page_11_Picture_5.jpeg)

![](_page_12_Picture_0.jpeg)

### **Airport Wildlife Monitoring System - Concept**

![](_page_12_Picture_2.jpeg)

![](_page_13_Picture_0.jpeg)

(a)

#### **Airport Wildlife Monitoring System – Safety First**

![](_page_13_Picture_2.jpeg)

![](_page_13_Picture_3.jpeg)

Figure 11. (a) The prototype computer drawing of the monitoring module; (b) the system installation composed of three monitoring modules and one control unit.

![](_page_14_Picture_0.jpeg)

### Bird Detection System – data collection and database

![](_page_14_Figure_2.jpeg)

![](_page_15_Picture_0.jpeg)

#### **Bird Detection - Real View application**

#### bioseco

![](_page_15_Figure_3.jpeg)

![](_page_16_Picture_0.jpeg)

2021-07-22 06:04:11 Module: 1 Station: AIR

> Real Monitoring Detection Example - Gdańsk Airport -

![](_page_16_Picture_3.jpeg)

![](_page_16_Figure_4.jpeg)

![](_page_17_Picture_0.jpeg)

#### **Bird Protection System – Bird identification**

Aerodromes are attractive to various wildlife However only some bird species are hazardous Therefore, it is important to monitor their presence

![](_page_17_Picture_3.jpeg)

![](_page_17_Picture_4.jpeg)

![](_page_17_Picture_5.jpeg)

![](_page_18_Picture_0.jpeg)

## Bird Monitoring and Bird Deterrence Testing in Gdańsk Airport

Solution that includes various tools The system is focused on efficiency

![](_page_18_Picture_3.jpeg)

![](_page_18_Picture_4.jpeg)

![](_page_18_Picture_5.jpeg)

![](_page_18_Picture_6.jpeg)

![](_page_18_Picture_7.jpeg)

![](_page_19_Picture_0.jpeg)

#### **Annual Bird Activity Analysis**

![](_page_19_Figure_2.jpeg)

![](_page_20_Picture_0.jpeg)

## Birds Activity as Hourly, Daily and Monthly Pattterns

#### Bird/wildlife species distribution and abundance

![](_page_20_Figure_3.jpeg)

![](_page_20_Picture_4.jpeg)

![](_page_20_Picture_5.jpeg)

![](_page_20_Picture_6.jpeg)

![](_page_21_Picture_0.jpeg)

### **Deterrent efficiency & monitoring**

![](_page_21_Figure_2.jpeg)

![](_page_21_Picture_3.jpeg)

![](_page_21_Figure_4.jpeg)

![](_page_21_Picture_5.jpeg)

![](_page_22_Picture_0.jpeg)

### **Hot-Spots of Bird Activity**

# 4.00-10.00

![](_page_22_Figure_3.jpeg)

# 16.00-22.00

![](_page_22_Figure_5.jpeg)

![](_page_22_Figure_6.jpeg)

![](_page_22_Figure_7.jpeg)

![](_page_23_Picture_0.jpeg)

## System development – Thermal Vision Wildlife Monitoring

#### Constant monitorig of critical areas

- 1. Live fiew day & night
- 2. Data collecting
- 3. Wildlife identification

![](_page_23_Picture_6.jpeg)

![](_page_23_Picture_7.jpeg)

Test pictures <u>not from</u> Gdańsk Airport

![](_page_23_Picture_9.jpeg)

![](_page_24_Picture_0.jpeg)

#### Site specific customized cost **External validation based** effective solution on a scientific approach Station S1 ap style: streets 2022-11-26 13:10:48 Date Number of birds single 120 53 Size category Larae span [px] 100 Show video 80 60 Dimension 40 Miniatures **Functionalities and Constraints** stance Absolute Distance Vertical Distance Horizontal 20 Distance Absolute big 600 0 medium 550 Collision Avoidance 2 500 small **Detection System** 450 1 System Ê 400 1.5 350 Pmin 300 -Wingspan [m] 1 400 <sup>350 300 250</sup> 200 <sup>150</sup> 100 250 200 Sensor 150 Focal Length Field of View Baseline 0.5 Resolution Distance [m] **User Driven Design** User driven design WHM not just sophisticated tool

![](_page_25_Picture_0.jpeg)

#### Interested in testing bioseco AFMS SYSTEM?

#### contact me:

![](_page_25_Picture_3.jpeg)

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![](_page_25_Picture_8.jpeg)

2019

![](_page_25_Picture_10.jpeg)

![](_page_25_Picture_11.jpeg)

2020

2021

Polski

Produkt

Przyszłości

![](_page_25_Picture_13.jpeg)