B-FINDER - automatic bats & birds mortality monitoring for wind power

Michał Przybycin[1]

[1] B-finder Team, EMPEKO S.A. info@b-finder.eu

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Résumé

Cet article présente les résultats du test du prototype du système B-finder. Le système B-finder est une technologie révolutionnaire d'automatisation pour la surveillance postconstruction de la faune basée sur des capteurs. La technologie B-finder permet une surveillance automatique de la mortalité des chauves-souris et des oiseaux pour les projets onshore et offshore. Les résultats des tests de 30 mois du prototype sont présentés.

Introduction

Post-construction fatality of bat and bird on wind turbines monitoring methods are based on searching on the ground. Manual searching on the ground is low effective and time-consuming.

In this presentation breakthrough solution for automated counting and mapping of bat and bird collision in real time is described. B-finder system establish a global measurement standard in area of environmental monitoring for wind farms. B-finder system introduces automation, efficiency and transparency of bat and bird collision monitoring on wind farms.

Methods

Field test description

Tests of B-finder prototype were performed between 11.11.2017 and 30.05.2020.

During the test period the system was in operation day and night and in variable weather conditions. The prototype was installed on the tower of wind turbine Enercon located in western Poland (temperate climate zone). The long tests in real conditions provided the information about the hardware endurance and gave the opportunity to perform series of tests, leading to further improvements of the software. Because of the limited number of real collision cases and fixed length of the wind turbine's blade, the main research was based on simulated collisions at different distances from the wind tower. This way, the results of the tests are universal and applicable to all turbine types with different blade dimensions.

In October 2017, the research area was prepared. Square area of 150x150 m with the turbine in the center was harrowed and covered with white agrotextile. The edges of the research area are 75 meters away from the turbine tower, which equals the height of the tower and three times the blade length. Such research area made the inspections more effective. After 7 months, in June 2018, the agrotextile was destroyed by weather factors and vegetation development. Then the agrotextile was removed, the vegetation cut down, moved, ground plowed and rolled. This way the test field was still flat and easy to monitor. The field had remained in such condition until the crops had been cultivated in the test field at the beginning of 2019. Wheat appeared within 25 meters from the south edge of the area, while the rest of the field was occupied by corn.

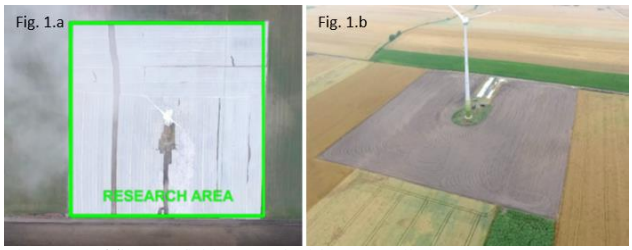

Figure 1: a) The test field covered with agrotextile between 11.11.2017 and 25.06.2018; b) The test field between 25.06.2018 and 11.11.2018.

Real collisions detection

Continuous activity of the prototype installed on the wind turbine made possible to observe real fatality cases. Regular field inspections had been held by the team during the first year of tests, in order to validate the efficiency of real collisions detection and accuracy of the automatic solution. After the first year of tests the efficiency of the system was high enough to reduce the frequency of field inspections to the cases of automatically detected fatalities. Besides the field inspections, the recordings collected by the system had been analyzed every 12 hours by the B-finder team, to

verify the correctness of collision recognition and distinguish real collisions from another events and noise. The results of analytical work were the most important source of information for the software's development and configuration during the operation.

Inspections of the test field had been performed everyday between 11.11.2017 and 03.05.2018 (6 months), every other day between 04.05.2018 and 15.09.2018 (4 months) and once a week between 16.09.2018 and 11.11.2018 (2 months). During every inspection the following information was collected:

- date and time of inspection;
- inspector name;
- weather conditions;
- live animals activity (i.e. species, sex, number, behavior, scavenger activity);
- GPS supervision information.

Since 11.11.2018 field inspections had been performed only in case of collisions reported by the B-finder system.

Simulations of collisions

The real collision factor is random phenomena and the average number of collisions make difficult to tests the system based on the results of real fatality only. For the assessment of the efficiency in detection of collisions more than 1300 series of simulation-tests was performed.

Freshly dead zebra finches Taeniopygia guttata, Barbary doves Streptopelia risoria, domestic pigeon Columba livia and swan goose Anser cygnoides, as well as plastic test tubes and bottles have been used as the objects for the simulation. Real animals used for the tests were direct equivalents of real collisions. To reduce the number of freshly dead animals, plastic equivalents were calibrated and used in the majority of simulations.

Figure 2: Simulation of collision of small animal. A temperature-calibrated test tube falling down after being dropped by the drone. Its flight is recorded not only by the prototype but also by the camera attached to the drone.

Results

Real collisions

During the tests six real collision victims were found, four in 2018 and two in 2019.

Two bats and two birds were found in 2018 and two bats were found in 2019. Out of six victims found on the test field, five were detected by the B-finder system. The one victim not detected was falling down in few parts after the crash with a blade. The reason why the system missed that case was that wide-angle cameras were inactive at that time. Wide-angle cameras are crucial for the detection of animals falling within short range from the tower, where gaps occur between the fields of view of the main cameras. After this event the wide-angle cameras had been introduced to the system to monitor the short range space.

Simulations of collisions

The range of detection depends mainly on the sensors used, parameters of the falling object and environmental factors.

The major parameters of the sensors are:

- optic parameters;
- array parameters;
- framerate;
- video codec.

In this research the sensor parameters were fixed. However, B-finder system can be potentially built using different sensors.

The parameters of a falling object affecting the detection are:

- size;
- temperature;
- material.

The results presented in this presentation are given for the objects described in B-finder system 24 month test report for T-series.

The environmental factors that have the biggest influence on the detection are:

- air temperature;
- rain, snow and hail;
- fog.

The factors had been varying continuously according to the weather and sunlight exposure. To take into account different environmental factors, test series were performed during different weather conditions, at different hours and seasons.

The results presented in this presentation are proper only for sensors used in the prototype, objects described in B-finder system 24 month test report for T-series and environmental conditions described there.

Increase of air temperature decreases the detection range by up to 10% for 15x5 cm objects and up to 40% for 4x3 cm objects. On the other hand, decrease of air temperature increases the detection range. The 4x3 cm size objects are the equivalent of the smallest European and North American bats (pipistrelles Pipistrellus sp.) and birds (crests Regulus sp.), the 9x6 cm objects are the equivalent of most common bird species in rural landscape skylark Alauda arvensis or the biggest European bats (greater noctule bats Nyctalus lasiopterus).The 15x5 cm size objects (bottles and Barbary doves) are the equivalent of the smallest European and North American diurnal raptors - respectively: lesser kestrel Falco naumanni and american kestrel Falco sparverius. Species bigger than 15x5 cm (the great majority of diurnal raptors in Europe and North America) are always detected within range of at least 100 m, regardless of weather conditions. The provided dimensions of objects are corresponding to the length of birds' body without the tail, because the tail is poorly visible on a thermal camera.

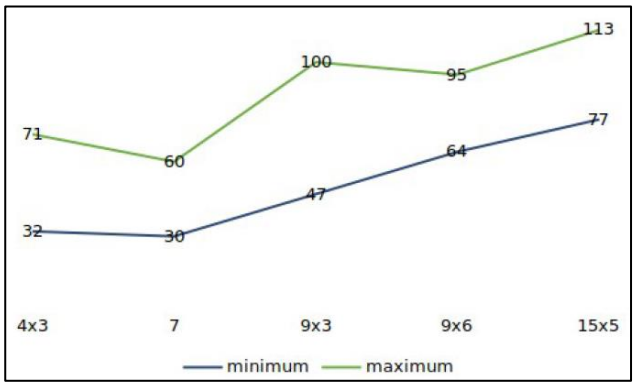

Figure 3. The minimum (in the worse conditions) and maximum (in the best conditions) detection range of the prototype [m] for objects of different size [cm].

Interpretation, conclusion, perspectives and possible applications

B-finder system can use different sensors to detect the collisions, for example: video, thermal, lidar. The results of the research show, that the thermal sensor are the most effective and universal for this application.

Besides the detection of fatality, the B-finder system calculates the approximate location of the carcass on the ground. The precision of the estimation is 10-20 m on average. The precision of azimuth is very high and equals up to 5 degrees. That make the B-finder very efficient background for the carcass searching and species recognition.

B-finder is up to 120x faster in compare to traditional searching method on 50 m radius and up to 453x faster in compare to traditional searching on 100m around wind tower.

Figure 4. Results of comparison of traditional searching on the ground and B-finder species recognition for 50m and 100m radius of the searching and for 24, 30 and 40 surveys/year.

The B-finder system in the basic configuration enables:

- detection of all bats species up to 50 m from the wind tower (min. 95% efficiency);
- detection of smallest bird species up to 50 m from the wind tower (min. 95% efficiency);
- detection of all bigger bird species up to 100 m from the wind tower (min 95% efficiency);
- detection of all raptor species up to 100 m from the wind tower (min 95% efficiency);
- localization of the carcass on the ground with precision about 10 m.

The system advantages:

- automation;
- transparency;
- measurement standard;
- immediately information about collision;
- no scavenger activity influence;
- onshore and offshore ready;
- evidence;
- time savings;
- workforce savings.

B-finder system is commercial ready and hold CE certificate since 2019.

References

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