Examination of different versions of bird repelling techniques for ultrasonic anemometers

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<u>Abstract:</u>

1. Challenge:
Since the introduction of ultrasonic anemometers in the German Meteorological Service (DWD), each year a lot of the sensors were damaged by bird-attack. For instance in 2012 the number of 47 ultrasonic anemometers of total 146 used were destroyed.
2. Consequence:
Not only incorrect or failing data, also a MTBF of about 1135 days combined with high costs of repair is not acceptable.
3. Activity:
Therefore a lot of bird repelling mechanisms have been tested at DWD since. Some of them were easily outsmarted by intelligent birds like crows or seagulls. Other devices affected the measurement or iced-up in cold conditions. The poster to be presented will show our present results carried out with special devices constructed by DWD.

1. Introduction

Since the Introduction of ultrasonic anemometers in the German Meteorological Service (DWD) in 2007, each year a lot of sensors were damaged by bird-attack. Repair statistics from 2008 to 2014 (first quarter) reveal that along increasing numbers of ultrasonic anemometer installations the amount of bird damages are rising significant too and reached an intolerable level. In 2013 the number of anemometers in operation was 158. During that year 43 bird damages were observed (Table 1). This represents a share of just under 60 percent of all repairs which were made 2013. Each anemometer needed to be repaired by the manufacturer. In 2014 we registered 16 bird damages (first quarter). It has to be noted, that these data don’t take into consideration the actual number of bird damages, because not all bitten ultrasonic sensor elements, called sonotrodes, lead to a malfunction of the anemometer. In some cases the measurement is not affected or measurement errors are not immediately identified.

Table 1: Overview of the allocation of bird damages over the last 6 years

year	mechanical damage	electrical damage	bird damage	calibration necessary	sum of all repairs	bird damage percentage	number of all anemometers
2008		8	0	1	9	0	< 146
2009		11	7	0	18	38.9	< 146
2010	1	4	12	4	21	57.1	< 146
2011	0	11	27	9	47	57.4	< 146
2012	1	3	47	12	63	74.6	146
2013	4	6	43	20	73	58.9	158
2014	1		16 until April			94.1	158

2. Damages caused by birds and its consequences

Figure 1: destroyed membrane

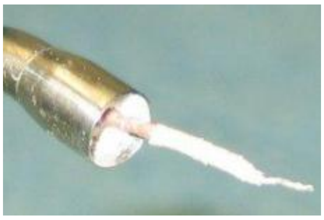

Figure 2: sonotrode ripped out

Most of the damages found were destroyed membranes (Fig. 1) and ripped out sonotrodes (Fig. 2). Each repair gives enormous costs (service trip, costs of repair, calibration) and data loss during replacement. 2012 the MTBF was 1135 days – a little bit more than 3 years. This is not acceptable. Normally MTBF's for anemometers are 10 to 26 years and for this one an MTBF of 15 years is possible[1].

3. Activity: Bird repelling techniques

Therefore a lot of bird repelling mechanisms have been tested at DWD. Some are described in the following. Simple repelling methods are spikes (Fig. 3), tension wires or static wire bows. It is not so easy to find and mount suitable spikes on the sensor arms. Tests in the wind tunnel show that some of them influenced the measurement and exceeded the limits of tolerance. The same applies to wires, especially when ice accretion occurs. A complete wire cage may be a good protection for the anemometer. If an additional net is stretched around the cage even small birds will be repelled. But the measurement can be substantially affected, especially by ice accretion or the effect of contamination. Other methods using birds of prey plastic dummies (Fig. 4) or their crying from a loud speaker. These have quickly been identified by intelligent birds like crows or seagulls as fake.

Figure 3: spikes

Figure 4: owl

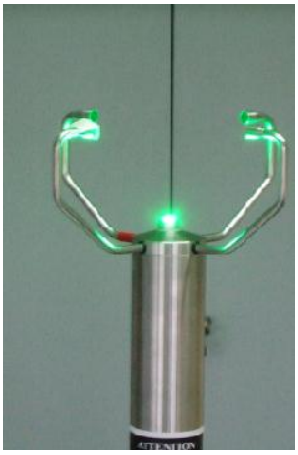

Figure 5: ultra bright LED

A special technique, that used LED light flashes was inspired by repelling methods with a green laser (like the company TONI Bird Control Solutions offers). There is a known sensitivity to green light in the spectrum of a birds eye. Based on this Thies company developed an ultrasonic anemometer with an integrated ultra bright green LED (Fig. 5). To test this we attracted birds with walnuts encapsulated in a small wired cage fixed on the anemometer arm. By this method birds stayed on the anemometer for some time to pick the food out of the cage. It turned out that the led light flashes did't scare the decoyed crows, even when the light was flashing very bright and irregularly. One explanation why the LED light has not the desired effect could be the low contrast to the bright daylight or the green color itself. Normally blue light reflectors are used on signal posts to prevent accidents with wild animals because blue is a terrifying color for them.

[1] "Wind Tunnel and Field Test of Three 2D Sonic Anemometers", author: Wiel Wauben, R&D Information and Observation Technology, KNMI, 17.09.2007

4. Activity: Other bird repelling techniques

Another repelling technique were PTFE reels around the sensor arms (Fig. 6). The idea was that a bird shouldn't find hold on them because the reels are slick and also rotate when a bird tries to grab them. Some video recordings show the effect, but the clever crows and also the magpies managed it to find a grip by balancing very carefully. But the main disadvantage of this method is that only after some weeks the PTFE reels got stuck due to contamination between reel and arm. A completely PTFE coated anemometer which was prepared for testing wasn't slippery enough to prevent the birds from landing and after a rain shower the slip effect nearly got lost.

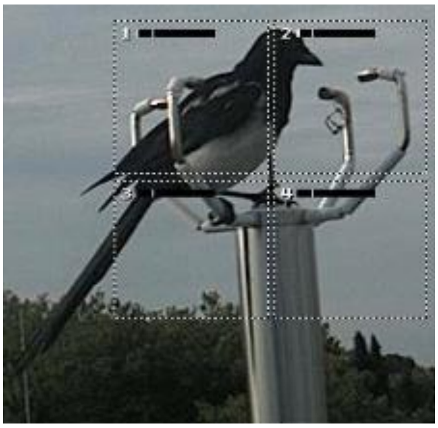

Figure 6: PTFE-reels

5. Special installations:

Figure 7: mounted overhead

Figure 8: another sitting accomodation

- Mounting the anemometer overhead (Fig. 7). This implies an increased mechanical effort and the mast will interfere with the measurement for certain wind directions.
- Offering an alternative sitting for birds above the anemometer (Fig. 8). Company Vaisala especially advises to use a bar made of a natural material like wood, because it is preferred by birds. But the bar near to the anemometer influences the measurement too.

6. Active repelling methods:

Figure 9: automotive antenna

A remarkable note we got from the offshore island Heligoland: The ornithologist Dr. Hüppop had observed that the most effective method to scare away birds is to touch them. They especially don't like an object which touches their upper lying feathers. This was a start point for us to test some mechanical devices. One consists of an automotive motor antenna (Fig. 9) and the other one uses a servo controlled wire bow (Fig. 10) that swings over the whole sensor head. The antenna type was installed on the North Sea island Spiekeroog. It was observed that crows and seagulls avoided to land on the anemometer since then. The antenna can handle rough environment conditions and freezing temperatures because it's constructed for all season cars.

The second repelling mechanism using an aluminum wire bracket was installed at Berlin / Tempelhof - an abandoned airport. There we have excellent conditions because there are always a lot of birds trying to take a seat on the anemometer. Not only crows but also sparrow hawks like the anemometer for sitting. The bow worked fine at first, but eventually the crows identified its weakness and so they stopped the bow e.g. with one claw and catching the sensor with the other (see Fig. 10). Some month later birds tried to land on the bow and damaged it, also its mechanical axes.

Figure 10: wire bracket

7. Meeting with ultrasonic anemometer manufacturers:

In April 2013 there was an exchange of experience between ultrasonic anemometer selling companies and DWD. Repelling techniques were discussed and the manufacturers and DWD presented their solutions. Company Thies designed a mechanical solution that uses a little whip, controlled by a servo (Fig. 11). It is triggered by an integrated radar sensor which detects movements.

Figure 11: mechanical whip

Figure 12: statistic of bird population on the anemometer (about 100 days)

During winter /spring 2013/14 we studied the new Thies bird repelling mechanism for a period of about 100 days and came to the conclusion that it is effective against crows and starlings (see Fig. 12). The sparrow hawks seem to resist the whiplash. It should be noted that on one day a sparrow hawk has attacked the whip but it wasn't broken.

In 2014 we are going to test 6 "whip-" deterrents on ultrasonic anemometers of our ground based synoptical network at locations with increased bird population over a period of 6 months.

8. Conclusion

There is still a need for solutions to keep birds away from ultrasonic anemometers. If there is no proper one, in future, the use of ultrasonic anemometers in DWD could be in question. But a mechanical solution seems to be an effective method to protect the existing 2D anemometer (Fig. 13). This must be proofed.

9. Prospects

It may be possible that a change of the anemometer design could prevent birds from taking a seat on them. The accessability of the sonotrodes for the bird beak could be impeded, e.g. if the anemometer structure is like the one of a 3D ultrasonic anemometer (Fig. 14). DWD plans to install 3D anemometer at a location that is frequently visited by birds and monitored by a camera. The mechanical solution of the rotating bow also seams to be a promising solution, if a more powerful and reliable motor is used, e.g. an automotive wiper motor. Another method going to be tested is using extra long spikes which have an optimized shape, so the total surface area exposed to the wind remains small (Fig. 15). They are simply clipped onto the anemometer arms.

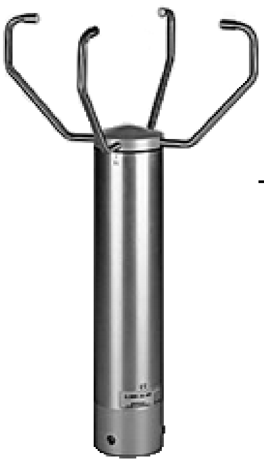

Figure 13: 2D- USA

Figure 14: 3D- USA

Figure 15: extra long thin spikes