Video detection technique for common swift nests.

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This file, the installer file for the PC VideoFusion 1.1 application, and the application manual are available at https://github.com/edemargerie/videoFusion

The problem

Common swifts (*Apus apus*) nest in cavities inside the facades and roofs of houses and buildings, making it difficult to detect nest activity. More often than not, there is no external evidence of the nest, and the birds' entries/exits are quite discreet. Detecting a swift nest therefore requires long and patient observation. When there are several nests on the same facade, it is difficult to detect all nests unambiguously.

A video-based solution

We have developed a video technique* that makes it easier to detect swift nests. The facade is filmed from a fixed point, continuously for a period of 1 to 2 hours. The video file then undergoes a *fusion* process: the successive instantaneous images (*video frames*) are merged into a single still image, retaining only the darkest value of each pixel over the merged duration. This process reveals the trajectory of birds that are darker than the façade (fig. 1).

This technique can be useful for counting nests, as part of population monitoring, or for ecological diagnosis prior to renovation/demolition work (In several countries, the law requires the implementation of compensatory measures in the event of the destruction of the habitat of protected species).

Fig. 1 Top: the façade of a building where we want to detect the presence of swifts' nests. A video of the facade is taken from a fixed point so that the entire facade can be framed. The video images were then merged, revealing the swifts that had entered and left the building during the video. 7 nests were detected (A-G).

Technical implementation

Here are some key points for successfully implementing this solution:

- **Camera**: Any digital camera or smartphone that can record at high resolution (.mov or .mp4) is suitable. We are using a GoPro Hero8 black, filming in 4K resolution at 30 frames per second. To avoid running out of battery, we're connecting the camera to a *Powerbank* battery via a USB-C cable. You will need a large memory card, depending on the resolution you choose and the compression applied by the camera (128 GB card in our case).
- **Tripod**: Shooting stability is critical, so you need a good tripod that is stable enough (Manfrotto 190 or 055 for example). To connect the camera to the tripod, we use a GoPro gooseneck, but any solution that ensures that the framing does not change during the video is possible.
- **Framing**: It is useful to frame the facade fairly tightly, so that as many pixels as possible are used to detect the entries/exits. Watch out for image quality in the corners of the frame, especially with ultra-wide-angle or fisheye lenses. It is always worth doing a few tests, with different viewpoints and/or settings.
  Avoid including the sun or too much sky in the frame, which can seriously skew the camera's exposure metering and make the façade too dark. If necessary, use the camera's **exposure compensation** to ensure that the facade is sufficiently bright in the video (+1.0 Ev for example).
- **Shooting period**: In French Brittany, we record these videos at the end of June - beginning of July, when the adults make relatively regular trips to the nest to feed the young (note that this period varies according to your study location: later in the north, earlier in the south).
- **Shooting hours**: We were able to detect nests at any time, between 10am and 7pm. In the classic literature (Lack 1956, *Swifts in a Tower*), it is reported that in good weather, there is more feeding in the late morning. In bad weather, there is more activity in the late afternoon. Beware of periods of very bad weather, when adults are known to sometimes leave their nests for several days before returning.
- **Video duration**: In favourable periods/weather, 1 hour of video (continuous) may be enough to reveal the majority of nests. We opt for 2 hours of video if the detection has to be quite exhaustive. It remains always possible for nests not to be detected, if the period or the weather is unfavourable, for example.
- **Video files**: Most cameras will split the video into segments of a few minutes (4GB). This is not a problem for analysis.
- **Video frame fusion**: Merging an entire video file into a single still image is possible, but not ideal, as the numerous bird passages can make it difficult to understand the entry/exit events. Instead, we merge by 1-minute segments, which summarises 1 hour of video into 60 still images, a number that is quick enough to inspect. For the fusion process, we share (free of charge but without guarantee) a simple ***VideoFusion 1.1*** application (windows® PC compatible). For instructions, please refer to the document **videoFusion_v1p1_user_manual_EN.pdf**. The installer file and manual are available at https://github.com/edemargerie/videoFusion. The computation time is long (millions of pixels per image and thousands of images), and depends on the computer used. For several hours of video, it's best to launch the operation in the evening and let the computer work overnight.
- **Analysis of images produced by fusion**: Inspect the still images on a good screen, without hesitating to zoom in at more than 100%, especially if the façade was large or distant. To identify an entry into the facade, you need to see a trajectory close to the facade and

disappearing into a cavity (example: fig 1A). The same applies for an exit from the facade (example: fig 1B). Beware that non-breeding birds may very well just pass in front of the facade (*screaming parties*), or even cling to the cavity without entering it (*banging* behaviour). On the merged image, this can produce ambiguous results (fig.2). If in doubt, view the original video file at the precise moment of the event (using the name of the still image file, which gives the interval in seconds). Playing back the video will allow you to check that the bird actually entered the facade and remained there for some time (feeding the young usually takes a few minutes).

Fig.2 Chasing and banging behaviour, where immature individuals fly close to the nests, screaming, sometimes clinging to the facade, but without entering the cavities. When these activities are intense, the merged images can be difficult to interpret, and it may be useful to reduce the merging time to e.g. 30s.

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(*) The present video fusion technique was inspired by the artistic work of photographer Xavi Bou https://xavibou.com/ornithographies/