Small UAS for Montagu´s Harrier´s (*Circus pygargus*) nests monitoring.

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Abstract

This presentation explains the rationale, objectives and results of Montagu´s Harrier's nests surveillance experiments conducted in the Aeromab Project using small UAS (Unmanned Aerial Systems) in Seville countryside (Southwest of Spain). It presents the situation of the species, whose nests are threatened by harvesters and the observational techniques that are being used nowadays to monitor the animals. We describe how a small UAS was used to get aerial photographs that were georeferenced to locate the nests. We demonstrated that it is possible to use SUAS to complement the nests monitoring, saving a lot of personnel effort and costs and potentially with less impact on the animals than conventional manned aircrafts. This also would avoid the necessity of access by foot to the nests and that minimizes the associated potential risk of predation.

Keywords: *small UAS (Unmanned Aerial Systems), Montagu´s Harrier* (*Circus pygargus*), *civil UAS applications, wildlife monitoring, bird nests monitoring.*

1. INTRODUCTION

The Montagu´s Harrier (*Circus pygargus*) is a medium-sized diurnal raptor. This is a migratory species that uses the Iberian Peninsula to breed, selecting cereal crops for this purpose. In March or April they breed in colonies, and build the nest formed by plant stems, resulting in a platform that leaves several tunnels that serve as shelter for the chicks. On this platform, they lay the eggs that the female incubates for around 30 days.

Figure 1: Montagu´s Harrier, adult male.

In August to September they return to its winter quarters in Africa. [1] From the data obtained by SEO Birdlife in 2006, the total breeding pairs of Montagu´s Harrier in Spain is estimated in the range of 6.093-7.389 pairs (CI 5095-8888) and its population in Andalusia is about 1.300-1.500 pairs. [2]

Since 1.950 the species has declined dramatically in many countries and in the Iberian Peninsula in the last 20 years there has been a major regression. The main cause of mortality in Spain is the crushing of eggs and chicks by harvesters. The fact that the species build their nests on the ground within crops, combined with the advancement in the collection of crops due to the mechanization of agriculture, have the consequence that these tasks are nowadays conducted when the chickens have not yet flown. Although there are no exact data to quantify these losses, they have been estimated in some areas up to 90%. [3]

Predation is one of the parameters that affect the reproductive success of the species. It has been observed that this factor is responsible for nearly 30% of the nests failed during the years 1.998-2.003 (mainly by foxes, dogs and wild boar). [4]

The Montagu´s Harrier is catalogued as "vulnerable" in the National Catalogue of Endangered Species and Red Data Book of Birds of Spain, 2003. It is legally protected by the Birds Directive 79/409/EEC, Annexes I, II, the Berne Convention: Annex II, the Bonn Convention: Annex II and the CITES Convention: C1. [2]

In recent years, several campaigns have been carried out for tracking and locating nests, and some environmental education has been conducted in several areas of Spain. Some regional governments have signed agreements with private property to respect the nesting areas or getting insurance to cover the losses associated to delay harvesting of crops or partial purchase agreements in the winter sowing.

Figure 2: Harvesters and Montagu´s Harrier´s chicks on a nest.

The location of nests of Montagu´s Harrier is nowadays done through the joint efforts of several technicians who monitor the areas where traditionally there have been nests. A technician watches the plot and looks for the adults accumulating material for the nest or for the female perching on the floor to lay down. He gives indication to another technician who covers the plot on foot in order to locate the nest. This effort represents a high cost of personnel working hours.

There are indications that access to the plot by technicians in order to locate the nest and monitor eggs and chicks increases the rate of predation, as it leaves an odorous trail and signs that may attract predators and shows them the route to the nest. Each new visit that is made to the nest increases the trail detection by predator.

The detection of the nest by aerial photography could be a solution to this problem, as it potentially could be used to locate and track the nest without leaving traces that could attract predators.

The potential advantages of using small UAS versus conventional aircraft are several: first: economic and logistical investment is much lower in the case of the UAS, easily transportable by car and not dependent on an airfield to take off. Moreover, the potential impact on wildlife of the UAS looks smaller than the produced by a conventional manned plane.

2. OBJECTIVES

The objectives of this study are to evaluate the detectability of nests, eggs and chicks by aerial cameras embarked on SUAS and to develop a safe methodology for searching and monitoring nests of Montagu´s Harrier by SUAS.

3. METHODOLOGY

General SUAS Requirements for field biology:

A typical mission in field biology is usually quite urgent and not very flexible (animal's behavior and its locations are not easily predictable) and normally has to take place in natural areas. These areas usually have mud, water, scrub or trees, and it's very common that the best available place to take off and land is a trail or just a patch of grass. During field campaigns there is not access to labs or specific installations, so if necessary, the repairs must be solved immediately.

All these conditions determine that the UAS requirements for field biology are: easily transportable: light and small, durable, modular, easy launchable and recoverable, operable with minimal training, able to collect georeferenced imagery, easy to maintain, repair and substitute parts and silent (electric powered). [5]

The technical characteristics of the UAS we used are resumed on the following table.

Table 1: UAS Characteristics

Autonomy	30-90 minutes
Range	Data Link: 35 Km
Video Link:	18 Km
Altitude	50-200m
MTOW	Max 4,5 Kg
Flight Control System and Navigation	GPS+Inertial
Telemetry	Diversity in frequency OSD XBee 868
Ground Control Station and GDT	Portable Netbook with Google Earth
Payload	0,5 Kg
Type of payload	Cameras, sensors

Figure 3: SUAS and GCS.

-1. Simulated nests experiment:

In April 2011 we conducted an experiment in the airfield of Bollullos de la Mitacion (Seville), which has some cultivated areas around it.

We simulated the appearance of:

-A nest: using three hen eggs placed together.

-An adult Montagu´s Harrier: using a brown leather object of the same size.

The UAS performed several flights at various heights between 200 and 30m AGL over the area where the targets were placed. The plane was equipped with a digital camera Panasonic Lumix LX3 10 Mpixels resolution with a focal length of 24mm (35mm camera equivalent). Positional parameters including barometric altitude were recorded with an Eagletree data logger. The images and data were downloaded and analyzed using specific software (Arc GIS for georeferencing of images and EagleTree Software for the tracks of the aircraft).

2. Real nests experiment:

The study area of the real experiments was located in the municipality of Gerena, (Seville). It is an agricultural area of dry cereal, mostly wheat and corn.

We dedicated two days in spring 2011 to locate nests by technicians, observing with binoculars from a car, recording their position by GPS, and registering the distance and angle to the places where breeding activity was detected with a rangefinder and a compass. This data were processed to determine the possible nests´ areas using Arc GIS software.

In a first review of the images obtained, it was not possible to distinguish clearly what was a real nest and what was a hole in the crops. There were many silhouettes that were labeled as possible nests. So in order to get a clear real nest reference to compare, we made a second experiment in the breeding area. One of the technicians accessed a real nest on foot and we took photographs of it from the UAS. Then, with that reference, we analized the images of the area again, discarded the dubious nests and located the real ones.

3. RESULTS

1. Simulated nests experiment:

The optimum height of the plane for taking pictures of the targets was 70 meters. At this altitude it was possible to discern the objects, and zooming on the picture we were able to identify the simulated nest and the eggs. Flying at lower altitude, obviously the quality of the pictures is better, but the risk for the system in case of any malfunctioning is higher, as is the potential impact on the animals. We decided a 70m altitude, which is the minimum for acceptable results and the maximum for avoiding risk and impact.

Figure 4: Simulated nest and Montagu´s Harrier. Top: simulated adult. Bottom: eggs.

2. Real nests experiment:

Fifteen possible nests were located in Gerena by direct observation of breeding activity. We flew over eleven of them with the SUAS a week later in order to cover the whole area with the aerial photographs obtained.

After the comparison of all the possible nests labeled with the real nest, we applied a filter with the criteria obtained and seven targets were identified as real nests. One of them was photographed with an adult female on it, probably incubating the eggs. No reactions of the animals in the area were detected during the flights.

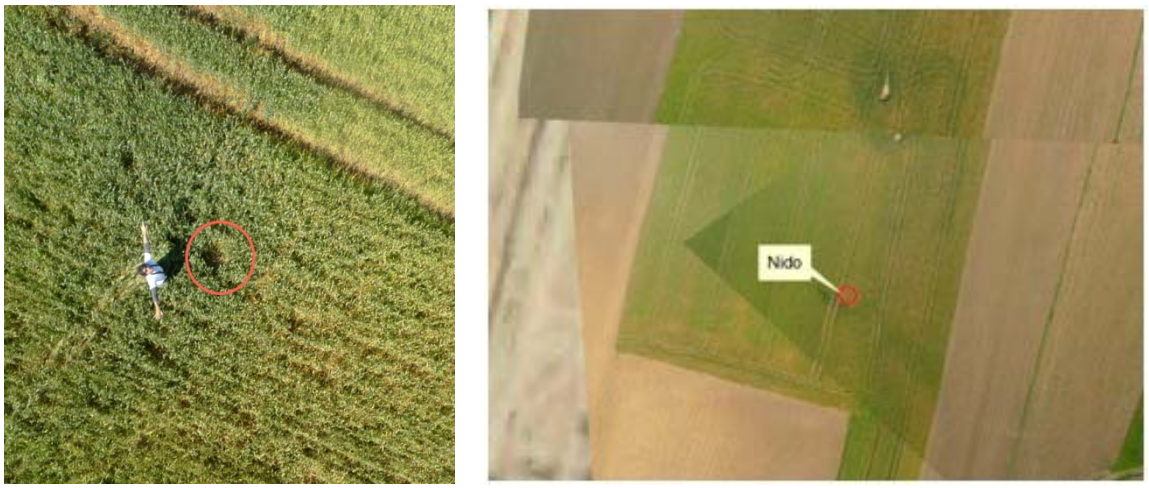

Figure 5: Left: Montagu´s Harrier´s nest located and observer. Right: nest located on a mosaic of pictures of the area.

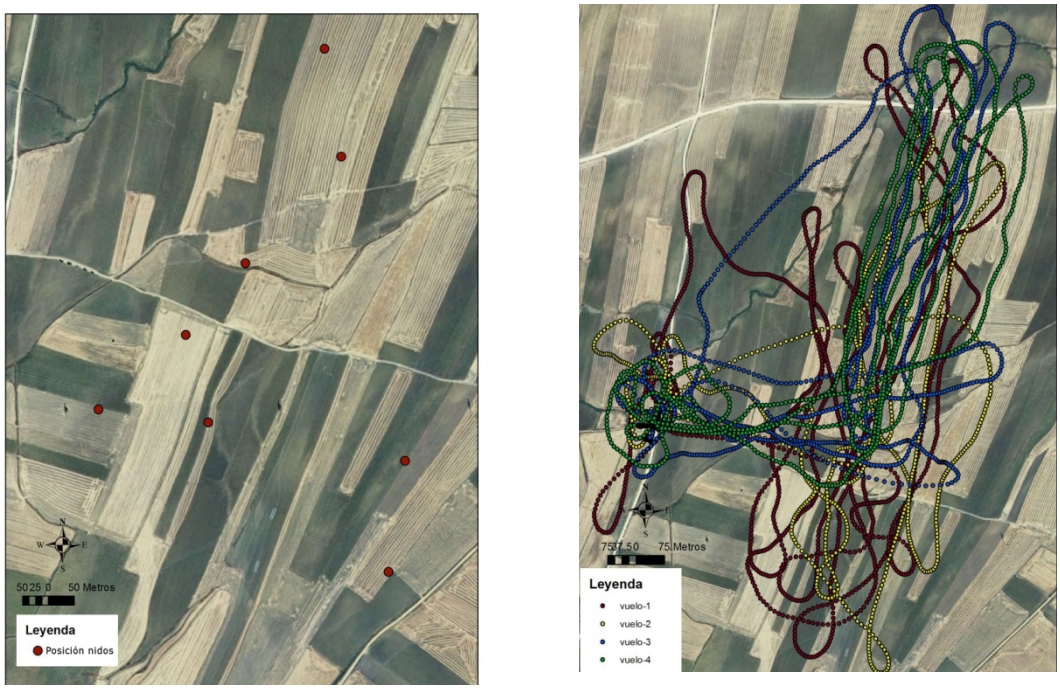

Figure 6: Left: 8 Montagu´s Harrier´s nests located. Right: map of the tracks made by the UAS in the area.

Figure 7: Left: Montagu´s Harrier´s female. Right: Montagu´s Harrier´s nest.

4. CONCLUSSIONS

It is possible to locate a nest of Montagu´s Harrier using aerial photography on an unmanned aircraft flying at an altitude of 70m AGL.

The animals in the working area did not show any escape, alarm or attack reactions to the plane, which indicates that the impact of the drones on the fauna is very low. The results suggest that the use of this technology could be very interesting in areas of difficult access or to avoid possible predation associated with nest entrance by foot.

This task would be more difficult later on when the crop is dry (yellow grass) because there would be less color contrast between the nests and the environment, so other tests will be necessary in those conditions.

We conclude that SUAS can be a very useful tool in field biology. SUAS offer the attractive possibility to obtain high quality data in quasi-real time, and sometimes substitute or improve the traditional methods for wildlife monitoring.

UAS manufacturers and developers should take into account that field biologists demand low cost equipment, as the budgets in these kinds of projects is usually low compared with other fields. Also, should consider that due to the urgency and unpredictability of their typical missions, they generally prefer to buy the equipments and be independent than to rent the services. We highly recommend a multidisciplinary approach, and to consider the opinion of the end users on development projects.

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