Conservation drones

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THE USE OF UNMANNED AERIAL VEHICLES BY ECOLOGISTS

Conservation Drones

Global land-use changes continue to be a major driver of biodiversity loss and greenhouse gas emissions, and remote sensing technology is increasingly being used to assess changes in land use, species distributions and carbon stocks. However, satellite and airborne sensors can be prohibitively costly and inaccessible for researchers and/or might not acquire imagery of sufficient spatial resolution. This article describes inexpensive (i.e. costing less than approximately USD3,500) unmanned aerial vehicles (UAVs) used in conservation projects and outlines some of the initial achievements. These drones are equipped with cameras to record video images at up to 1,080 pixel resolution (high definition) and acquire aerial photographs of less than 2cm pixel resolution. Aerial photographs can be stitched together to produce near-real-time georeferenced land use/cover maps of surveyed areas and 3D models.

Globally, biodiversity continues to decline, with a disproportionate amount of biodiversity loss occurring in the tropics, where the vast majority of global biodiversity is found. One urgent challenge for conservationists is to be able to accurately assess and monitor changes in forest cover, species distributions and population dynamics. To obtain such data, conservationists currently rely on satellite-based remote sensing for mapping and monitoring land use changes, and ground surveys for determining and monitoring species distributions and population dynamics. Although low-resolution satellite images are freely available at certain time intervals,

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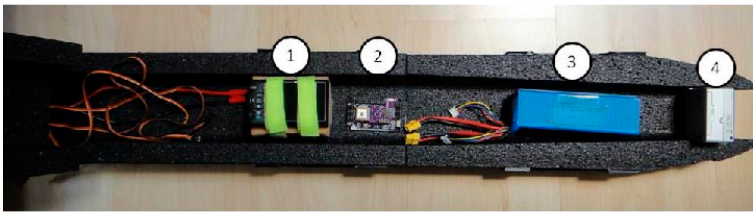
◀ *Figure 1, Lian Pin Koh (left) and Serge Wich (right) doing the final checks before launch.*



▲ *Figure 2. Basic set-up of the main equipment in the fuselage of the Conservation Drone Maja Edition. 1) Canon SX 230, 2) APM board, 3) LiPo battery, 4) GoPro video camera.*

sub-metre resolution images can be prohibitively costly – yet such high-resolution data are often critical for accurate landscape-scale detection and tracking of land use change. Furthermore, much of the humid tropics is often obscured from remote sensing satellites due to persistent cloud cover, meaning that cloud-free satellite images for a specific time period/series and location are often not readily available.

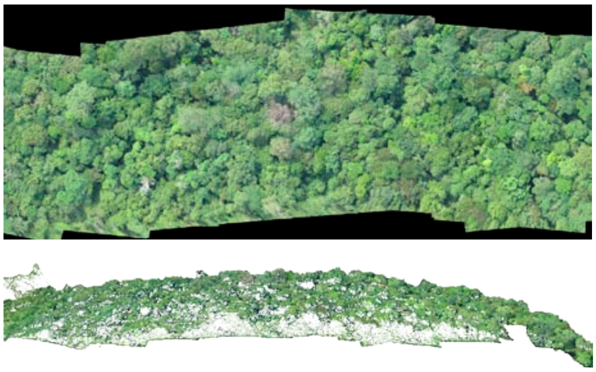
The second major conservation challenge concerns assessing and monitoring biodiversity. Currently, this is largely achieved through ground surveys, which are often time-consuming, financially expensive and logistically challenging in remote areas. As a result, surveys are not conducted at the frequency required to monitor population trends, and some remote tropical forests have never been surveyed for biodiversity due to their difficult and inaccessible terrain. An additional challenge for conservation is the illegal encroachment of human activities into protected areas, including illegal hunting of prized animals such as tigers, rhinos and elephants. To effectively curb such illegal activities, ground or aerial surveys need to be conducted at much higher frequency than is currently the case. These challenges have resulted in the development and use of inexpensive, autonomous UAVs, hereinafter referred to as 'Conservation Drones' [1] for surveying and mapping forests, biodiversity and potentially illegal activities.

THE DRONES

Inexpensive airframes (Figure 1) have been used to keep costs down and ensure that the technology is affordable for conservation organisations and researchers in developing countries who often do not have the funding needed to acquire and maintain more expensive, commercially available UAV systems. Although several airframes have been used for the drones since the start of the project, the system's 'brain' has remained the same: it is an autopilot system (APM, Figure 2) developed by an online community of amateur drone builders [2]. By combining the APM with open-source mission planner software (APM Planner), remote-control model airplanes can be converted into drones.

THE SENSORS

All drones have been equipped with a number of cameras for still photography and videography. For still photography, the Canon SX230HS was mainly used since its built-in GPS enabled all the photos to be geotagged. The original firmware of the Canon camera was replaced with a Canon Hack Development Kit [3], which allowed the implementation of a customised intervalometer script to command the camera to take photographs at user-specified time intervals (e.g. every 3 seconds). This script also allows the user to define several other parameters including: i) time-delay before the camera begins taking pictures, ii) focal length of camera lens, and iii) time before the camera automatically shuts down and retracts its lens. The camera was placed inside the aeroplane's fuselage, and a window was cut into the floor to allow for extension of the camera lens. Video cameras such as the GoPro Hero and the Contour were also used to take high definition video at 1,080 x 720 pixels, and the cameras were placed either inside the fuselage or attached underneath/to the side of the fuselage (Figure 2). Using the APM Planner, the flight path for each mission was created by clicking on waypoints in a Google satellite map interface. The drone can be programmed to take off (simply launched by hand) and land autonomously, and circle over any waypoint for a specified number of turns or duration. Users can also program other flight parameters such as ground speed and altitude of each waypoint.



▲ *Figure 3. Showing mosaic of several photos from transect flight (top image) and 3D model from the photos (bottom image). (Image courtesy: www.dronemapper.com)*

CONSERVATION DRONE ACHIEVEMENTS

Since the start of the Conservation Drone project in January 2012, over 200 flights have been made in several countries (Switzerland, The Netherlands, Indonesia, Malaysia and Nepal). These flights produced a large number of photos and videos which we have examined with respect to the three main initial goals. Our findings are described below.

MAPPING LAND USE

In order that the sets of high-resolution photos (1-10cm/pixel) obtained for various areas could be used in geographic information system (GIS) software, they were stitched together into georeferenced mosaics in a two-step approach. Firstly, the Autopano Giga ▶

Figure 4, From left to right: Orang-utan in top of palm tree in Sumatra, two rhinos in Nepal, Sumatran elephant.

software [4] was used to prepare the mosaics, which were then later manually georeferenced in ArcGIS. Secondly, a US-based company [5] specialised in mapping photos taken from drones created the mosaics and 3D model. Such mosaics give detailed information on the type of land use, such as forest (even some tree genera), agriculture (oil-palm plantations, corn fields), settlements and so on. In addition, the images can be used to create 3D models of the areas covered during missions thanks to the overlap between the photos (Figure 3). Such models can potentially be used to calculate a number of characteristics of different land uses such as tree height, tree density, etc.

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Thanks to the high resolution of the images, it has been possible to detect signs of several important species on the photos. During flights in the tropics, for instance, photos were captured of orang-utans and their nests, as well as elephants and rhinos (Figure 4). Although this is an important first step, the next step is to conduct follow-up studies that allow for automatic calculation of the distribution and density of such species over large areas so that this technique can become a standard application for conservation workers. As a first move towards reaching this goal, a project has been initiated to automate the detection of certain objects (e.g. orang-utan nests).

ILLEGAL ACTIVITIES

Up-to-date information on illegal logging or poaching in protected areas is extremely important to conservation workers, and the video film and photos captured by the drones can be used to detect both illegal activities of this kind. Logs and planks can be seen in the photos, for example, and because the photos are geotagged, they provide clear evidence of where such activities are occurring. Poachers, meanwhile, often cook or smoke bushmeat over a fire, so identification of smoke in a forested area could offer a useful indication of where poachers might be located. Although no flights have yet been conducted over a forest where such activities were occurring, smoke from fires many kilometres away was detected on a video from one of the drone flights in Sumatra, so it is conceivable that smoke detection above a forest could be possible.

FUTURE DEVELOPMENTS

Rather than allowing for real-time video transmission, the drone systems assembled so far have stored video images in the onboard camera which are then viewed upon the drone's return. To shorten the response time for certain drone applications, including poacher patrols, a live video link is currently being developed for use in future drone models.

Furthermore, work is ongoing to develop new drones featuring thermal camera systems to offer night vision capabilities. In addition to allowing large mammals such as elephants, orang-utans or tigers to be monitored in forests, this enhancement will also enable the irregular or illegal presence of humans (e.g. poachers) to be detected.

Finally, work is underway to equip the drones with VHF and other radio receivers. The purpose of doing so is to use the drones as 'data mules' that could fly over a forest and pick up radio signals from tagged animals' radio collars. Since the signals would be registered by the drone from different locations in the air, it might also be possible to triangulate the precise locations of the animals, which would be particularly beneficial to research and conservation projects.

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MORE INFORMATION

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FURTHER READING

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