Nature Conservation Drones for Automatic Localization and Counting of Animals

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Abstract. This paper is concerned with nature conservation by automatically monitoring animal distribution and animal abundance. Typically, such conservation tasks are performed manually on foot or after an aerial recording from a manned aircraft. Such manual approaches are expensive, slow and labor intensive. In this paper, we investigate the combination of small unmanned aerial vehicles (UAVs or “drones”) with automatic object recognition techniques as a viable solution to manual animal surveying. Since no controlled data is available, we record our own animal conservation dataset with a quadcopter drone. We evaluate two nature conservation tasks: (i) animal detection (ii) animal counting using three state-of-the-art generic object recognition methods that are particularly well-suited for on-board detection. Results show that object detection techniques for human-scale photographs do not directly translate to a drone perspective, but that light-weight automatic object detection techniques are promising for nature conservation tasks.

Keywords: Nature conservation · Micro UAVs · Object detection

1 Introduction

Accurate monitoring of the distribution and abundance of animal species over time is a key ingredient to successful nature conservation [3,4]. Successful conservation also requires data on possible threats to animals. Such threats can be
Fig. 1. Animal conservation images taken from a drone. From left to right: an elephant, an orangutan nest, and rhinos.

largely divided into habitat loss, disease and poaching. For some iconic species like the rhino, the elephant, and the tiger, poaching has reached proportions that places them at a high risk for local extinctions or even total extinction for some (sub)species as in the case of elephants [2,32].

Animal monitoring approaches typically involve both direct animal counts and indirect counting of animal signs such as nests, dung, and calls. Conventional ground surveys on foot can be time-consuming, costly, and nearly impossible to achieve in remote areas. For example, ground surveys of orangutan populations (Pongo spp.) in Sumatra, Indonesia can cost up to $250,000 for a three-year survey cycle. Due to this high cost, surveys are not conducted at the frequency required for proper statistical analysis of population trends. Furthermore, there remain many remote forested areas that have never been surveyed. Aerial surveys can overcome some of these constraints, although they have their own set of limitations, including the high cost of buying or renting small planes or helicopters, the lack of availability in remote areas, and the risks involved with flying low over landscapes in which landing is difficult, such as forests. There is thus a need for alternative methods for animal surveys.

Conservation workers have started using small unmanned aerial vehicles (UAVs, or “conservation drones”) both for determining animal abundance and to obtain data on their threats [18,20]. Conservation drones are relatively inexpensive and easy to build, which makes drones accessible and affordable for many research teams in developing countries. These drones can fly fully autonomous missions to obtain high-resolution still images and videos. Recent studies have shown that the images from such drones can be used to detect not only large animal species (e.g. orangutans, elephants, rhinos, whales) and animal tracks (e.g. orang-utan nests, chimpanzee nests, turtle tracks), but also threats to animals (e.g. signs of human activity [16,21,26,35]). See Figure 1 for some examples of conservation images taken from a drone. Currently, most drone systems record data on board, which are then downloaded for manual visual inspection once the drone has landed. For animal abundance surveys, the amount of recorded data quickly grows to thousands of photos and hundreds of hours of video. Manually sieving through these data in search of animals is labor-intensive and inherently slow.