Context Aware Drone Mobility for Area Survey

Alessandro Montanari
University of Cambridge
Cambridge, United Kingdom
alessandro.montanari@cl.cam.ac.uk

Fredrika Kringberg
KTH Royal Institute of Technology
Stockholm, Sweden
frekri@kth.se

Alice Valentini
University of Bologna
Bologna, Italy
alice.valentini7@studio.unibo.it

Cecilia Mascolo
University of Cambridge
Cambridge, United Kingdom
cecilia.mascolo@cl.cam.ac.uk

Amanda Prorok
University of Cambridge
Cambridge, United Kingdom
amanda.prorok@cl.cam.ac.uk

ABSTRACT

We present an approach to aid area surveying which relies on autonomous drone mobility. We illustrate the two main components of the approach. An efficient on-device object detection component, built on Convolutional Neural Networks, capable of detecting human settlements and animals on the ground with acceptable performance (latency and accuracy) and a path planning component, informed by the object identification module, which exploits Artificial Potential Fields to dynamically adapt the flight in order to gather useful information of the environment, while keeping optimal flight paths.

1 INTRODUCTION

Developing regions are often characterized by large areas that are poorly reachable or explored. The mapping of these regions and the census of roaming populations in these areas are often difficult and sporadic. Traditional area surveying through human observation can be a costly and difficult operation.

UAV-based solutions for area surveying and remote sensing have many benefits. The employment of drones facilitates reaching remote and dangerous areas without any risk to people. Given the simplicity of drone surveying it allows to carry out monitoring more frequently. For these reasons, it often constitutes a cheaper solution compared to traditional methods, such as helicopters or ground based surveys.

Additionally, the advantages of UAVs make them a perfect tool to monitor the movements and settlements of populations and animals in developing regions. The information gathered is very useful, for example, in emergency situations as it permits rescuers to know where to send aid or supplies like medicines, food and water. Also, if the number of people living in an area is known, rescue efforts could be scaled to the specific needs. Area survey is especially important to monitor nomadic populations living in those areas. Their constant migrations require rescuers to be in possession of timely and accurate pictures of the conditions of the area and the location of the settlements. In addition, the information could also be used to study the behaviour and the culture of these populations and eventually to understand how they adapt to harsh conditions.

Despite UAVs' benefits there are still several unsolved problems. Even if they are simpler to operate than other vehicles (i.e., full size airplanes or helicopters), they still require someone with enough knowledge to pilot them and to process the generated data. The main issue in this context regards the availability of knowledgeable operators capable of efficiently flying the UAV, especially when considering developing regions. Power consumption constitutes a considerable limit as UAVs could fly only for a limited period of time and inefficient paths or manoeuvres could further reduce their flight time [1]. Additionally, in applications that involve image capture, smoother flights are required to ensure high quality images [4]. While autonomous waypoint navigation could guarantee a more streamlined operation, it might miss important features on the ground because it blindly follows the pre-defined waypoints. Also the data processing usually requires trained personnel and the availability of results few days later might not be convenient when timely information is crucial, for example, in emergency situations or to monitor illegal activities.

The fundamental problem of these approaches is that they rely heavily on manual operation and the data processing is done offline. The goal of our work is to develop a system to mitigate these problems. Our vision, is to devise *a completely autonomous, efficient and affordable system which combines context sensing and on-device processing in order to autonomously generate optimal flight paths with respect to energy, dynamic goals and latency trade offs*. The system should be simple enough to be used by local populations to gather data periodically or in case of exceptional conditions. Processed data will be available immediately after each flight and could be used for various decision making processes.

2 PRESENTATION OVERVIEW

We will present the architecture design and initial results of our system to efficiently detect human settlements in developing regions with UAVs following an adaptive flying path. The foundation of our system consists of the on board visual perception through the use of Convolutional Neural Networks (CNNs) [3] for the accurate and robust detection of ground-level objects. The detection output is subsequently used by a reactive navigation approach based on Artificial Potential Fields [2] to dynamically adapt the flight in order to gather useful information of the environment, while keeping the flight smooth and efficient. We will show also a prototype platform based on a fixed-wing aircraft and initial results for the deep learning-based perception and for the reactive navigation.

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