

# **AUTOMATIC SALIENT OBJECT DETECTION IN UAV IMAGERY**

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## **ABSTRACT**

Due to the increased use of Unmanned Aerial Vehicle (UAV) platforms in land-sea search and surveillance operations a suitable general technique for the automatic extraction of visually significant information is needed in order to augment current human-performed manual analysis of received video imagery. This paper presents a novel image processing based approach that builds on existing salient object detection work within related domains. Our proposed approach uses an image contrast map derived from the combination of seminal work in this area, multi-scale mean-shift segmentation with additional histogram enhancement and additional multi-channel edge information. This is used to construct a robust saliency map from a given UAV aerial image in the presence of environmental, transmission and motion noise affecting image quality. The approach is generally targeted towards the detection of salient objects in the rural, uncluttered and relatively uniform environments. A range of results are presented over such representative environments.

## 1. Introduction

Modern search and surveillance operations can be complex and expensive involving numerous personnel and multiple airborne search platforms. These are often employed to search wide areas of open expanse such as mountainous, oceanic or desert areas. Two recent examples of such operations are the disappearance of Steve Fosset who disappeared in his small plane in the vast Rockies mountain range (2007) and additionally the search-and-rescue operation in the South Pacific for the debris of Air France Flight 447 (2009). In the former example of Fosset's crash the crash scene was only discovered by chance a year after the event and the search and rescue involved among other resources, around 5000 online volunteers providing the analysis of thousands of digital satellite images covering hundreds of square kilometres. As for Flight 447, here it took a prolonged search period of around 5 days before the first debris was found in the Pacific Ocean via search operation involving tens of ships and aircrafts. This is a classic scenario for the automatic image analysis of remotely gathered satellite and airborne imagery.

In both of these scenarios essentially we are looking for something unique in a fairly simple and uniform environment (for example floating wreckage on the ocean in the case of Flight 447). Although the course of events for a given search and rescue mission may vary depending on the scenario, environment and many additional factors some common themes can be found. The most prominent of which is that very often the object being searched for may differ significantly from the environment in which the search is taking place. This makes this scenario particularly prominent as an application for computer vision based saliency detection.

One of the many aims of computer vision is to automatically extract visually important parts of the scene image. Therefore computer vision based saliency detection has been developed as an entity within itself ((7), (1), (3), (10)). Saliency detection is essentially the detection of visually unique objects within a given image and this is well suited to the problem of automatic image analysis for the search and rescue imagery cases discussed. However, although image saliency has already been used within more complex computer vision systems (4), (12) with different goals it has surprisingly not yet been applied

to any system addressing automatic search in Unmanned Aerial Vehicle (UAV) imagery. Here we aim to create such system capable of the automatic detection of salient objects in UAV imagery for search and rescue (or surveillance) operations.

This paper introduces an overview of such a system based on (10), (13). We combine the seminal work in this area, multi-scale mean-shift segmentation with novel histogram enhancement and additionally multi-channel edge information to construct a robust saliency map from a given UAV aerial image. This is then used to highlight salient objects of interest within a stream of UAV video imagery and hence reduce operator workload for manual image analysis. A range of related work has been carried out in computer vision on saliency detection which we will adapt towards our UAV video search purposes (10), (13).

## 2. Related work

Before we detail related work in the area of computer vision saliency detection it is important to make one point regarding the type of images considered by the authors of most work in this area. The majority of computer vision image saliency detection work considers high quality and high resolution colour images with minimal noise where the salient object is the main subject of the image (e.g. Figure 1). By contrast, here we deal with UAV surveillance imagery (Figure 2a/2b) where they may contain multiple salient objects within a lower quality, low resolution image suffering from a range of motion turbulence, transmission and compression noise in addition to environmental noise such as weather and atmospheric conditions.

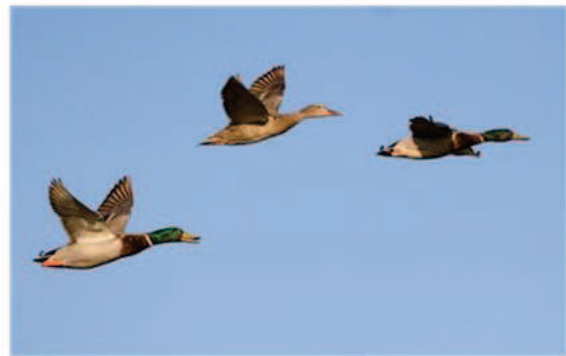


Figure 1 Typical image considered.