DEVELOPMENT OF EMBEDDED COMPUTER VISION SOLUTIONS FOR SURVEILLANCE UAVs TO ASSIST OPERATORS IN THEIR MISSION

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Abstract : UAVs are getting more and more known and used, for civilian or military purposes.
My research addresses a wish from customers for a more automated and simple way to operate surveillance UAVs.
In my PhD I am working on a system that will be able to detect moving objects and to track them, tracking has been extensively studied by researchers for years, but I have the opportunity of working with both an industrial UAVs designer company, and researchers. Merging information available onboard UAVs with state of the art computer vision can lead to satisfying results. A first algorithm is presented in this poster.

1 – Who am I?

I graduated from the engineering school TELECOM St-Etienne (France) in 2013 and I started my Ph.D. studies in October 2013.

I am part of the “CIFRE Défense” program (DGA), funded by the French Department of Defense. Students selected work in both a company and a laboratory.
In my case, I am employed by Survey Copter, known for its UAVs, and I share my time on my research between the company and the lab.

The main upside to this program is that students can benefit both from research and industry worlds, enabling them to bring the cutting-edge science of research to the industry with the will to end-up with a finished product.

2 – What I am working on?

The subject I choose has one main goal : make the job easier for UAVs operators.

What would be helpful?
I think that embedded computer vision, in sync with UAVs’ probes and captors, can grant operators one of their strongest wishes, a reliable automatic moving object detection and tracking system.

How do I plan on doing that?
Several challenges are to be studied and solved :

- How to detect moving objects in an unknown scene, where the image is from a camera that has its own image processing (unknown to customer) leading to unreliable pixel values, where illumination can change rapidly, where the whole image is moving with most of the time a perspective effect?
- How to be able to compute such a intense processing on a mini-UAV that has very strong SWaP constraints?

To answer that, since last October I tried to wrap my mind around existing techniques of moving object detection and tracking. I also developed a solution, which I will present in the following sections.

3 – Database

I am working on images from a few Survey Copter UAV flights (Fig. 1 to 3), as well as the known VIVID dataset (Fig. 4 and 5).

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

4 – Algorithm

- **Detection**

To be able to detect mobile objects from a small UAV, we need to differentiate the global motion from the rest. I used dense optical flow to estimate the motion of each pixel, then I worked on the resulting vectors (Fig. 6).
I extracted the pixels that weren’t consistent with the modeled normal distribution (Fig.7) of the vectors’ intensities. The object’s pixels were detected using a threshold of a value of 2,5 sigma (defined by experiments performed on datasets) (Fig.8).

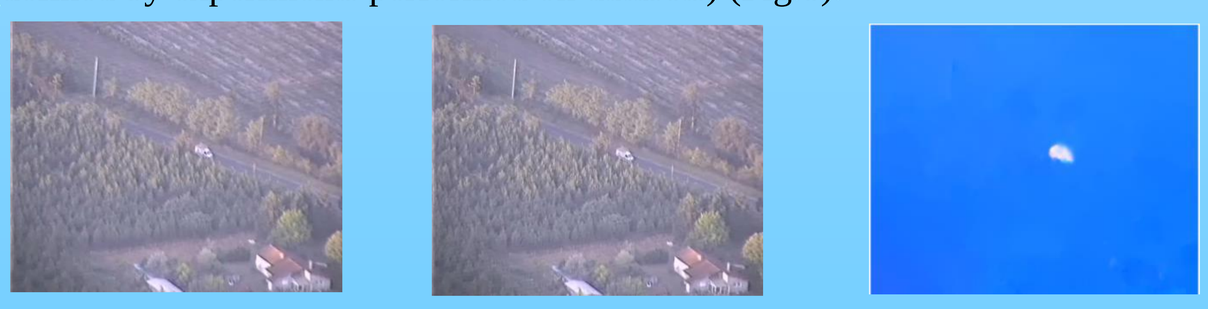

Fig. 6 : Two consecutive frames and the result flow image

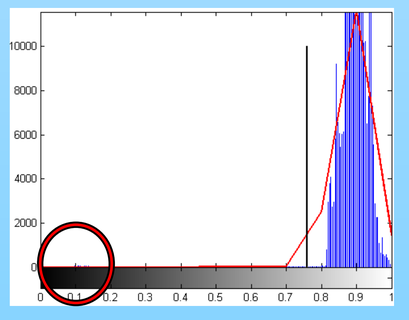

Fig. 7 : Histogram with, in x the intensity of each flow vector and, in y the number of pixels for each intensity.
Inside the red circle the pixels highlighted in red in figure 8, corresponding to the moving object.

Fig. 8 : Warp image with pixels detected highlighted in red.

- **Tracking**

I have tried to do some very simple template matching tracking, it worked efficiently from one image to the next, but it has proven insufficient for long term tracking.

5 – Conclusion

The work I present in this poster is a first draft of approach and represent the beginning of my research, it has proven to give satisfying results but needs to be studied deeper and developed further before it can be described in a publication.

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