Automatic localization of tombs in aerial imagery: application to the digital archiving of cemetery heritage

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October 25, 2013

Digital Heritage - International Congress 2013

28 Oct - 01 Nov, Marseille, France.

Cemeteries and built tombs

Lecey cemetery.

- Cemeteries = History of a local population,
- Need to digitally archive,
- 1st step : localize and map all the tombs.

$\rightarrow$ Automate using image processing.

Image processing challenges

An aerial view of Lecey cemetery.

Tombs are:

- variable in size,
- variable in shape,
- variable in color,
- not evenly aligned,
- tiny in a high dimension image,
- very close.

And there are:

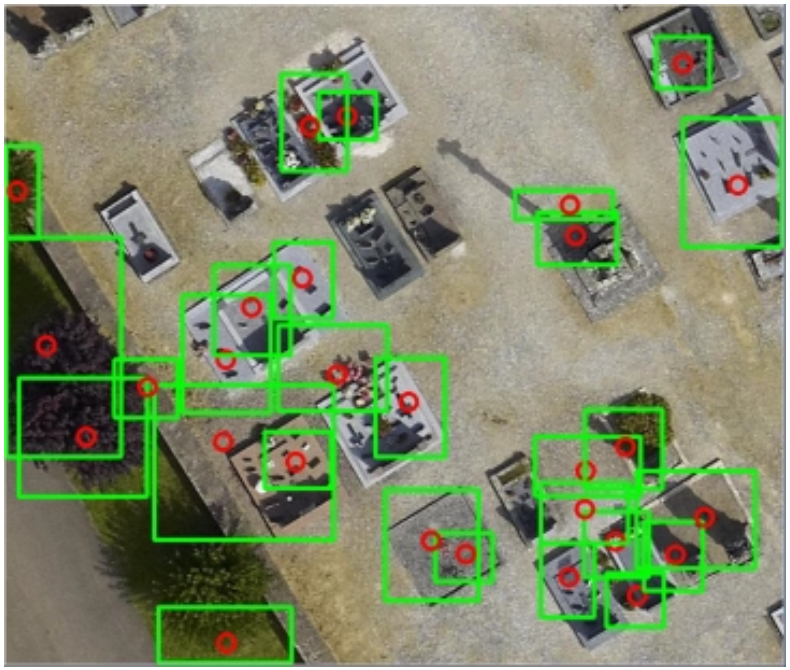
- shadows associated with buildings,
- occlusion (vegetation, flower pot).

A first experience

Compare

- A low-level image processing approach : Watershed,
- A learning-based approach : Viola & Jones.

Evaluation on Saint-Gatien cemetery (636 tombs).



Watershed approach

Viola-Jones approach

Quantitative results

- Watershed:
  Precision: 23% Recall: 24% F-score: 24%
- Viola & Jones:
  Precision: 72% Recall: 49% F-score: 53%

$\rightarrow$ Results have to be improved for automation.

Recent approaches

Viola Jones, 2004:

- long learning time,
- empirical adjustment of false positive and false negative rates,
- use of cascades of classifiers which reduces the classification performance.
- simple features,

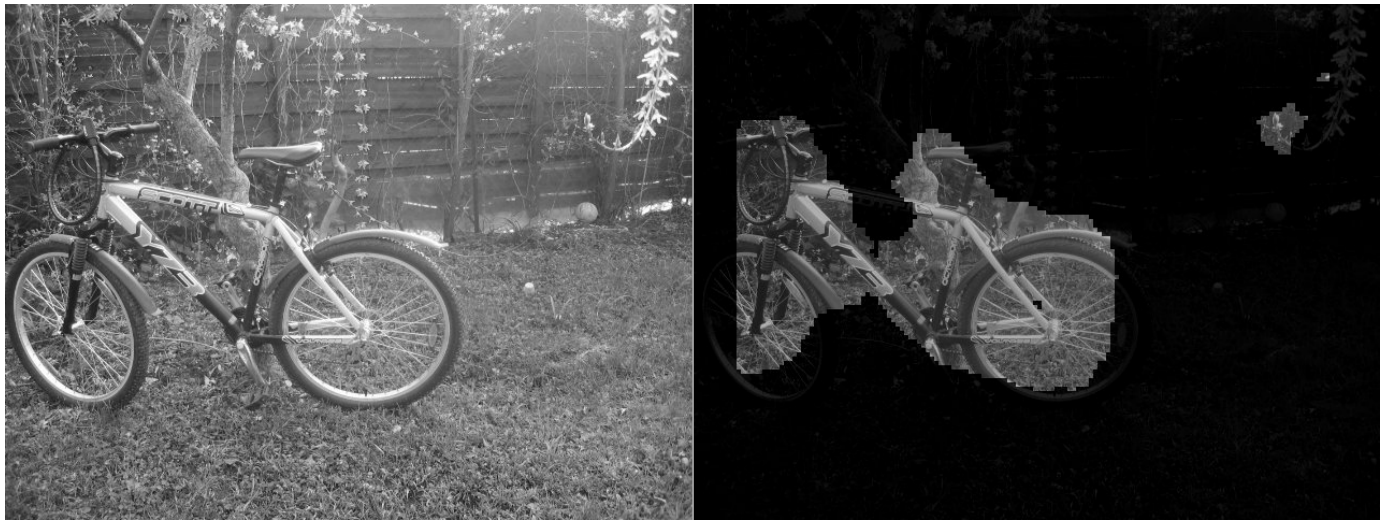
Recent approaches:

- more descriptive features,
- integrate the concept of bag of visual features,
- low complexity solution.

A state-of-the-art segmentation approach

[Aldavert *et al.* 2010][1] :

- faster learning step (42 times faster on middle-price laptop),
- a state-of-the art approach.



But, what about the tombs segmentation?

Harder problem than the detection of 1 big object!

[1] D. Aldavert, A. Ramisa, R. Toledo, and R. L. De Mantaras, "Fast and Robust Object Segmentation with the Integral Linear Classifier," in IEEE CVPR'2010, San Francisco, USA, Jun. 2010, pp. 1046-1053.

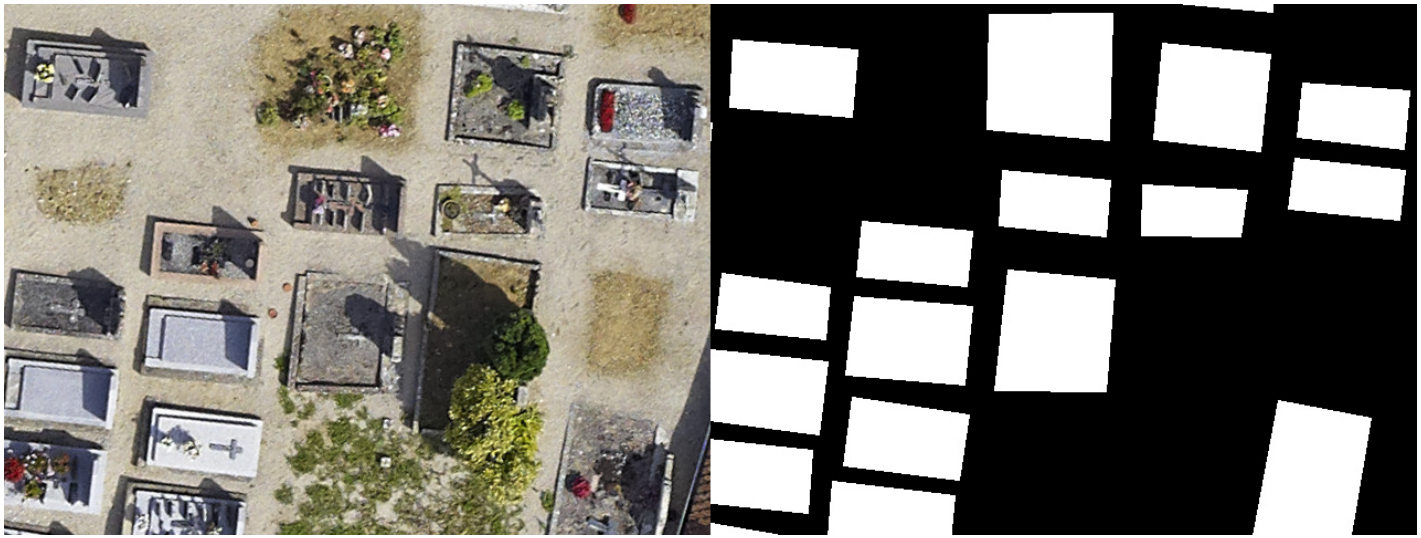
Interesting technical parts

Learning; Four major steps:

- A **pixel** is described by a vector of **32 scalar features**, (HOG),
- Creation of a **dictionary** of representative, vectors (= **visual words**),
- Compute on small area the **histogram of visual words**,
- **Linear classifier** learn on a subset of the histograms.

Experiments: Learning database

- 19 cemeteries located in the Haute-Marne department,
- 150 images of 640*480 pixels with their ground truth.



Results on Lecey cemetery

Figure : Results obtained on an aerial view of a part of Lecey cemetery. Green rectangles represent the bounding boxes of the detected tombs.

Quantitative results

Signy-lePetit cemetery in the Ardennes department:

- Viola & Jones :
  Precision: 0.724 Recall: 0.582
- Aldavert et al. :
  Precision : 0.764 Recall: 0.530

$\rightarrow$ Equivalent performances.

Conclusion

- Most of cemetery are not described in an digital database,
- Automate tombs localization by using image processing algorithms,
- Learning-based more efficient low-level approaches,
- A difficult problem (tombs are small, variable, ...),
- Future work should adapt learning based approaches,
- Lots of work to do for cemetery digital archiving.