



Title:	Internship proposal.
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Improving topography computation using photometric stereo.

1 Context

Euresys is a leading and innovative high-tech company, designer and provider of image and video acquisition components, frame grabbers, FPGA IP cores and image processing software. Euresys is active in the computer vision, machine vision, factory automation, medical imaging, and video surveillance markets.

This internship will take place in the Vision software team under the supervision of an experienced software engineer. Euresys is located at Liège Science Park.

A product recently developed by the Vision team uses [photometric stereo](#) to compute the topography of an object. Photometric stereo uses several images of the same object under different lights to extract topography information. The topography can then be used to detect holes, bumps, or scratches on the object.

Photometric stereo is an old technique and several improvements have been developed since. In particular, the vanilla method assumes lights to be uniform on the whole image and the object to be perfectly lambertian. These assumptions are not often met in practice. While our team identified several further improvements, only the basic method is currently implemented.

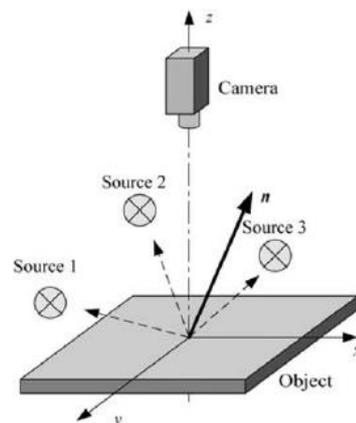


Figure 1: typical photometric stereo setup, taken from https://www.researchgate.net/figure/Principle-of-photometric-stereo_fig7_222422584



Figure 2 Topography (mean curvature) image of a 50 cents coin, taken from our sample images

2 Objective

The objective of the internship is to improve on the current method by implementing and benchmarking (some of) the identified tracks mentioned earlier or new ideas/papers the intern would discover during his/her internship.

In particular:

- Vanilla photometric stereo is based on the least squares minimization of the error of an overconstrained problem. As LSE minimization is sensible to outliers, it allows light reflections on the object to have a particularly big impact. On the other hand, approaches based on mean absolute error minimization or on selecting median of a set of simplified versions of the problem should be more robust.
- The second limitation of the vanilla method is the assumption every pixel is lit by light having the exact same intensity and direction. Under some other assumptions on the light sources (e.g. object is lit by a [square led bar system](#)), a model representing reality more accurately could be built.

3 Requirements

The intern should have knowledge of C/C++ and basic maths/optimization. Experience with image processing and OpenCV is a plus.

The internship will have a minimum duration of 10 weeks.