Final year project synopsis

Internship from July 1st 2013 to December 27th 2013 in Morpho, Osny, France

Image Restoration

Estimation and Correction of Point Spread Function

13/01/2014

CONFIDENTIAL

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This internship of 25 weeks was realized in Morpho, in Osny (France). As a pioneer in identification and detection systems, and a major player in e-documents, Morpho is recognized for its excellence in key technologies, advanced skills and benchmark expertise.

My project is part of ATI team objectives, in CET X where Morpho biometric sensor products are designed to control access to various applications such as biometric terminals. The ATI (Acquisition et Traitement d'Images) team must enhance some parts of the image workflow.

One of the products studied is the CBM-E2, Second Generation of Compact Biometric Module Sensor. This biometric sensor is a high performance optical sensor that allows the capture of fingerprint images and processes matching. The acquisition part of CBM-E2 must provide to the coding/matching part an image with a good quality and a certain shape.

However, the CBM-E2 structure generates three types of defects: geometric deformations, non-uniform illumination and blur due to the point spread function (PSF). They are respectively due to the path of light, the LEDs repartition that light the subject and lens aberrations, for example. These defects are specific to each sensor.

These defects are corrected in real-time during the user workflow, when the CBM-E2 is used to authentication or identification. Nevertheless, only the geometric and uniformity correction are learned to each sensor. PSF deconvolution corresponds to a Wiener filter that is a restoration method. In image, restoration is reducing or eliminating degradations thanks to the knowledge of their cause in order to recover the closest image to the true/real image.

Currently, the Wiener filter is the same for all products, which does not take into account the specificities of each sensor.

Thus, the aim of this internship was to make PSF deconvolution specific to each sensor in a constrained and embedded environment. Taking into account the constraints and requirements of this environment, there are two parts: a PSF estimation during the learning workflow and a PSF correction during the user workflow.

Thanks to the implementation constraints, one PSF estimation method was selected. It is based on a least-square minimization between the acquired image and the true image convolved with a PSF that is controlled by the minimization.

The first step was to test it with synthetic images in order to be familiar with it and to know its limits in a controlled environment. The acquired image variability (geometric deformations, non-uniform illumination and noise) impacts heavily the estimated PSF. Then, this synthetic study permits to determine the type and the size of patterns to perform the best PSF estimation

A second step aims to validate the method with acquired image in order to find methods to narrow the gap between synthetic and real cases. Two main problems are that the true image is not known and the acquired image variability is not controlled. However, a list of hardware and software methods were proposed and tested in order to be independent of this variability or to minimize its impact. The first results are encouraging, but, axes of improvements were proposed to follow this study.

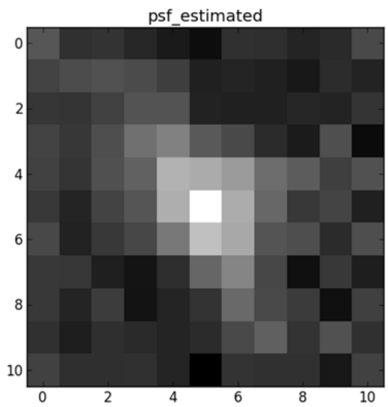

Figure 1: Result of PSF estimation for the acquired best pattern