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Defect Detection Enhancement, A Survey

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Abstract

This paper investigates several methods that can improve the segmentation of defects. The literature in terms of defect detection is quite rich but often the method involved introduces approaches that will facilitate the defect detection. Few papers introduce methods involving the segmentation of images. These papers nevertheless are dependant on many priors, offer partial detection when the defect's surface has non homogenous physical features. Robusts approaches are extremely time consuming. In the recent years, several works have proposed approaches that have rendered previously time consuming methods more reasonable in terms of execution time. These approaches such as Dense Conditional Random Fields are well known for their ability to make quite robust segmentation. Because these methods take into account the area surrounding the defect, they have the ability to reconstruct the topology of defects that have been segmented into different regions e.g. due to an inhomogeneity at the surface.

1. Introduction

In Non Destructive Testing (NDT) it is well known that due to the numerous types of distorsions that the sensors are sensitive to, a clear detection is not an easy task. Among the first works to tackle this task the Thermogenic Signal Reconstruction (TSR) [1] and the Partial Least Square Thermography (PLST) [2] lead to a significant improvement of the quality of the defect segmentation. Both the reconstruction of the signal and the PLST, make the detection of defect easier, by removing the non-uniform heating. These methods do not need any prior information to function well. In their work Krähenbühl et al. [3] proposed a fully connected model of Conditional Random Field (CRF). Their work reduces the computational cost that previously existed with CRF while keeping the precision. In their paper the Krähenbühl et al generate the unary energy from the output of a classifier. In NDT due to the large variety of material and applications, it is difficult to create databases that are representative and consequently, suitable to train classifier algorithm, efficiently. It is however possible to replace the classifier by the labels that come from a clustering algorithm. More recently Barron et al. [4] have presented the Bilateral Solver, which is an optimization algorithm based on a bilateral filtering concept. This algorithm allows to the data to be reconstructed using a confidence and a reference map. The confidense map can be seen as a probability of defect map while the reference map can be seen as a ground truth estimation. Both maps can be computed from the image being analyzed.

2. Method

In this study both DenseCRF [3] and the Fast Bilateral Solver [4] are used after application of the Principal Component Thermography (PCT) [5] has been applied on a sequence of images relative to the application of a standard pulse thermographic experiment.

DenseCRF

In order to replace the classifier used by Krähenbühl et al. [3], a segmentation algorithm is apply in order to obtain a label map. The label map is processed in order to compute a unary energy matrix. As shown in figure 1 this approach allows the topology of the defect to be preserved in terms of image.

Fig. 1. *Application of the algorithm DenseCRF to the reconstruction of a segmentation image. From left to right, Original image, segmentation mask, segmentation labels, reconstructed labels using denseCRF.*

Fast Bilateral Solver

The Fast Bilateral Solver is also a very powerful tool that allows the topology of a region to be reconstructed based only on the original image and partial pre-segmentation mask. Combined together as illustrated in figure 3 these approaches

Fig. 2. *Application of the Fast Bilateral Solver to the segmentation of animals. From left to right, the original image, the segmentation mask refine, the segmentation mask raw.*

are able to provide reconstructed regions very accurately from a topological point of view.

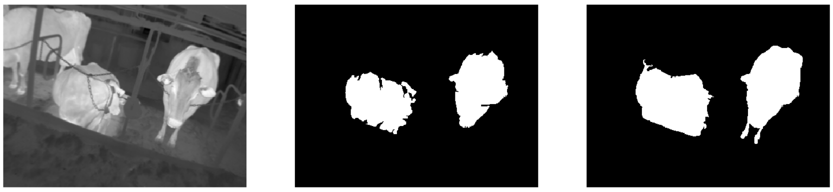

Fig. 3. *Association of both DenseCRF and the Fast Bilateral Solver to the segmentation of animals. From left to right, original image, refinement of the raw segmentation mask using DenseCRF, improvement of the output of the DenseCRF algorithm using the Fast Bialteral Sover.*

From a computational point of view, the experiments conducted have remained acceptable by giving results within a few seconds. One can note that the computation time is dependent on the size of the image. Preliminary experiments both on material and other applications gave very interesting results. The authors wish to further investigate the potential of such methods in order to evalutate their interest in the everyday applications of IRNDT.

3. Results

The preliminary results show that it is possible to greatly improve the results of segmentation of existing methods. Such an ability makes existing automatic segmentation approaches more accurate, and allows for a better preparation of datasets studies involving supervised methods. It may also improve studies involving self supervised approached.

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