Contextual and Non-Contextual Performance Evaluation of Edge Detectors

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Abstract

This paper presents two new evaluation methods on edge detectors. The first is non-contextual and it concerns the evaluation of performance of edge detectors in terms of detection errors. The second method is contextual and it concerns the evaluation of performance of edge detectors used in image compression. In both methods, we studied the influence of the image characteristics and edge detector properties on its performance. Seven detectors have been evaluated and their performance compared.

1 Introduction

Several edge detectors have been proposed, often different by their goals and their mathematical and algorithmic properties [19]. Consequently, a problem encountered by vision systems developers is the selection of an edge detector to be used in the considered application. This selection is primarily based on the definition of the influence of image characteristics and properties of detectors on their performance, which we call the performance evaluation of edge detectors [18]. Consequently, several performance evaluation methods have already been proposed. These methods can be regrouped in three classes. The first regroups subjective methods [11, 6], borrowed from the field of psychology, which use human judgment to evaluate the performance of edge detectors. More precisely, it consists of presenting a series of edge images to several individuals and asking them to give a score according to a given scale [11]. Even if these methods seem easy to put in practice, they have some inconvenience. The number of characteristics a human eye can distinguish is limited. For example, the eye cannot differentiate between two gray levels that are slightly different. Also the judgment depends on the individual's experience, his attachment to the method, and on the image type (e.g., multi-spectral, x-rays). The second class regroups objective methods [1, 8, 9, 13] that uses synthetic images to evaluate the performance of edge detectors by measuring different types of detection errors. This can be completed by experimentation or by using mathematical developments. The third method is hybrid. It combines a subjective method and an objective one [7]. These three evaluation methods can be completed taking the further use of edges into account [17, 15].

This paper presents two new performance evaluation methods on edge detectors: contextual and non-contextual. The non-contextual method concerns the evaluation of the performance of edge detectors in terms of detection errors. The detection errors include classical errors (omission, localization, multiple responses and sensitivity) and two new errors related to false edge suppression and orientation of the edges. The basic idea behind this method consists of running a given detector several times on an image with a known structure by varying the parameters of the detector and the image, and then to measure its performance. The back draw of this approach is that it does not completely characterize the performance of edge detectors, and it seems important to take into account their further use, that is to know if they satisfy the requirements of a particular application. For this reason we proposed a contextual performance evaluation method. This method concerns the evaluation of the performance of edge detectors in the context of image compression. It consists of measuring the performance of an edge detector according to the mean square difference between the reconstructed image from edges and the original one. In both methods, we studied the influence of the image characteristics and the detector properties on the performance of this latter. This paper is divided in six sections. The next describes the non-contextual method of performance evaluation. Section 3 describes the experimental results du to this evaluation method. Sections 4 and 5 are devoted to the contextual performance evaluation method and the experimental results obtained. Lastly, section 6 summarizes the main results.