Chapter 9
A Fuzzy Relational Classifier Based Image Quality Assessment Method

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ABSTRACT

Fuzzy classification techniques are used for image classification for quite a long time back by allowing pixels to have membership in more than one class. However, handling information at the pixel level is time consuming and there is a high chance of biased assessment of images if class labels are assigned by a single human observer. Even considering multiple observers' opinions don't able to reflect an individual's perception in assessing quality of images, if it is crisp. In this chapter, the fuzzy relational classifier (FRC) is used to assess quality of images distorted by information loss or noise, unlike the earlier methods where images are preprocessed to remove the noise before classification.

1. INTRODUCTION

Fuzzy classification techniques (Spearman, 1904) are used for image classification for quite a long time back by allowing pixels to have membership in more than one class. However, handling information at the pixel level is time consuming and there is a high chance of biased assessment of images if class labels are assigned by a single human observer. Even consideration multiple observers' opinions is not able to reflect an individual's perception in assessing quality of images, if it is crisp (Chakraborty et al, 2008, Gilles, 1998, Huang & Wang, 1995). In subjective image quality assessment methods, the human subjects are utilized to evaluate the image for assessing its visual quality. The method is most reliable and provides better understanding of mechanisms underlying the quality perception of human beings. The methodology used depending on the opinions of human observers regarding quality of an image and mapping the opinion as image quality metric. In the procedure, a set of images are displayed to a group of human observers and asked to rate the quality on a particular scale. The mean rating for an image is referred to as the mean opinion score (MOS) and is representative of the perceptual quality of that visual

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stimulus. Such assessment of quality of image is referred to as subjective quality assessment. Another prominent approach to assess subjective quality of an image is based on stimulus namely, single stimulus (SS) and double stimulus (DS) method (ITU-R BT.500-13,2012). In SS procedure, a set of stimuli is taken one at a time and include a reference image in that set without the knowledge of the observers. Observer evaluates the quality and score is expressed in a numerical category rating. Single judgment is required per assessment and then the average score has been calculated. The quality range will be spanned by the stimuli. However, this method generally induces inconsistency in findings.

In Double Stimulus (DS) method the panel of subjects is watching two images in the same time: one is the reference, the other one is the test. If the format of the images is SIF (standard image format) or smaller, the two images can be displayed side by side on the same monitor, otherwise two aligned monitors should be used. Subjects are requested to check the differences between the two images and to judge the fidelity of the signal information by moving the slider of a handset-voting device. When the fidelity is perfect, the slider should be at the top of the scale range (coded 100), and in case of null fidelity, the slider should be at the bottom of the scale (coded 0).

Subjects are aware of which is the reference and they are requested to express their opinion while viewing the sequences, throughout the total duration. A non stimulus based subjective IQA method is Quality Ruler (QR) composed of a series of reference images whose scale is already known and they are closely spaced in quality, but span a wide range of quality all together. It detects the quality difference between them. The observer find the reference image closest in the quality to the test stimulus by visual matching and quality score is noted. Compared to SS method it is more consistent and QR scores are highly correlated to objective measure of distortions than the SS scores.

Fuzzy based approaches (Fan & Xie, 1999) have long been used to model human perception about the given tasks by transforming human observations into mathematical understanding. In general, the basic difference between perceptions and measurements is that, measurements are crisp whereas perceptions are fuzzy. One of the fundamental aims of science is to progress from perceptions to measurements. Pursuit of this aim has led to brilliant successes. So it may be inferred that fuzziness of perceptions reflects finite ability of sensory organs and the brain to resolve detail and store information. A concomitant of fuzziness of perceptions is the preponderant partiality of human concepts in the sense that the validity of most human concepts is a matter of degree, therefore not exact but approximate. For example, we have partial knowledge, partial understanding, partial certainty, and partial belief and accept approximate solutions, approximate truth and approximate causality. Furthermore, most human concepts have a granular structure and are context-dependent. In essence, a granule is a clump of physical or mental objects (points) drawn together by indistinguishable behavior, similarity, proximity or functionality. A granule may be crisp or fuzzy, depending on whether its boundaries are sharply defined or not. For example, age may be granulated crisply into years and granulated fuzzily into fuzzy intervals labeled very young, young, middle aged, old and very old.

In this chapter, the fuzzy relational classifier (FRC) is used to assess quality of images distorted by information loss or noise, unlike the earlier methods (Kuncheva, 2005, Nakashimaa et al, 2007) where images are preprocessed to remove the noise before classification.

Any image quality assessment method which does not require reference image for comparison with test image is known as no reference image quality assessment method. A no-reference image quality assessment technique has been developed in the work using entropy of significant features, captured based on local information variation in training images. The proposed quality metric is estimated by a fuzzy relational classifier (FRC) where variations of human perceptions to assess a particular image