33. Measurement and analysis of nearness among different images using varied probe functions

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ABSTRACT

The focus of this paper is on a tolerance space-based approach to image analysis and correspondence for measuring the nearness among images. The basic problem considered is extracting perceptually relevant information from groups of objects based on their descriptions. Object descriptions are represented by feature vectors containing probe function. This article calculates the Hausdorff Distance (HD), Hamming Measure (HM), tolerance Nearness Measure (tNM) within few set of images of different categories and the result has been analyzed. All of them applies near set theory to images applying Content Based Image Retrieval (CBIR). The set of images are of bus, dinosaur. The motivation behind this work is the synthesizing of human perception of nearness for improvement of image processing systems. The desired output must be similar to the output of a human performing the same task..

Index Terms— *Hausdorff Distance (HD), Hamming Measure (HM), tolerance Nearness Measure (tNM), Content Based Image Retrieval (CBIR), probe functions.*

INTRODUCTION

This paper highlights on perceptual nearness and its applications. The observation of the perceptual nearness combines the basic understanding of perception in psychophysics with a view of perception found in Merleau-Ponty's work [1]. The sensor signals gathered by our senses helps in determining the nearness of objects of an image. The calculation includes the distance measurement among images for perceptual resemblance based on features of the image itself. The features are termed as probe function of the images. The analysis tries to correlate the results with those of human sensation where the values are integrated by the mind. A human sense shown as a probe, determines the physical characteristics of objects in our environment.

Image Resemblance is widely used various fields. Few of them includes query by image, management and search through digital archives of images and videos in personal, commercial and public domain image archives over the internet. Medical applications, its analysis, archive and searching within database uses the concept of image resemblance. Application in "image registration" problem where similarity between images used to determine similarity between an image and its transformation. Image quality assessment where the goal is to assess the similarity (or differences) within a well-positioned image and an inaccurate image. Classification and resemblance of pictures based on content based resemblance between pair of pictures.

The sensed physical characteristics of an object are identified with object features. It is our mind that identifies relationships between object feature values to form perceptions of sensed objects. It is conjectured that perception, i.e. human perception of nearness, can be quantified through the use of near sets by providing a framework for comparing objects based on object descriptions. Objects that have similar appearance (i.e., objects with similar descriptions) are considered perceptually near each other. Sets are considered near each other when they have "things" (perceived objects) in common. Specifically, near sets facilitate measurement of similarity between objects based on feature values (obtained by probe functions) that describe the objects. This approach is similar to the way humans perceive objects and as such facilitates the creation of perception-based systems.Three different distance has been measured among images which includes Hausdorff Distance (HD), Hamming Measure (HM), tolerance Nearness Measure (tNM).

HM calculates the distance between two metrics, the result is 0 if the corresponding bits are the same, otherwise, the result is 1. It is a metric which evaluates the number of bits that differ between two metrics. It is widely used in variety of applications to search images based on the content. Ex: Google, telecommunication to estimate the error by determining the overturned bits number within a fixed-length binary word.

METHODOLOGY

Hausdorff distance is used to measure the dissimilarity between two images on the basis of measuring the distance between sets in a metric space. It is a max-min distance between all possible relative positions. It is defined on any nonempty closed bounded subsets of any metric space [2, 3, 4]. It calculates the distance between two points as follows:

$$d_H(X, Y) = \max\{\sup_{x\in X} \inf_{y\in Y} d(x, y), \sup_{y\in Y} \inf_{x\in X} d(x, y)\} \quad (1)$$

Hausdorff distance metric is frequently used in CBIR. It is used to measure the distance (d) between two points A and B in a metric space E. A and B are two finite point sets such that A= $\{a_1, a_2, \ldots, a_p\}$ and B=$\{b_1, b_2, \ldots, b_q\}$ [3]. It is a measure of the maximum of the minimum distance between two sets of objects [5].

If the two images are same then the value of Hamming distance is zero. Hamming distance is given as:

$$d^{HAD}(i, j) = \sum_{k=0}^{n-1} [y_{i,k} \neq y_{j,k}] \quad (2)$$

d^{HAD} is the hamming distance among two objects *i* and *j*, k is the key of the respective variable which states y out of total variable n. It provides the amount of mismatches within the variable matching by k.

Tolerance classes is calculated using the Perceptual Tolerance i.e., for a given image X as

$$H_{\cong B,\epsilon} = \{(X, Y) \in O * O : \| \phi(X) - \phi(Y) \| \leq \varepsilon\} \quad (3)$$

RESULTS AND DISCUSSION

We have calculated HM, HD, tNM using a database of 100 images of buses and a query image. The subimage size taken is 20, epsilon value is 0.01, probe functions (No. of features) is 1 and the probe function is Average Grey. Figure 33-1, 33-2, 33-3 reveals the graphical view of calculated HD, HM, tNM respectively of buses image.

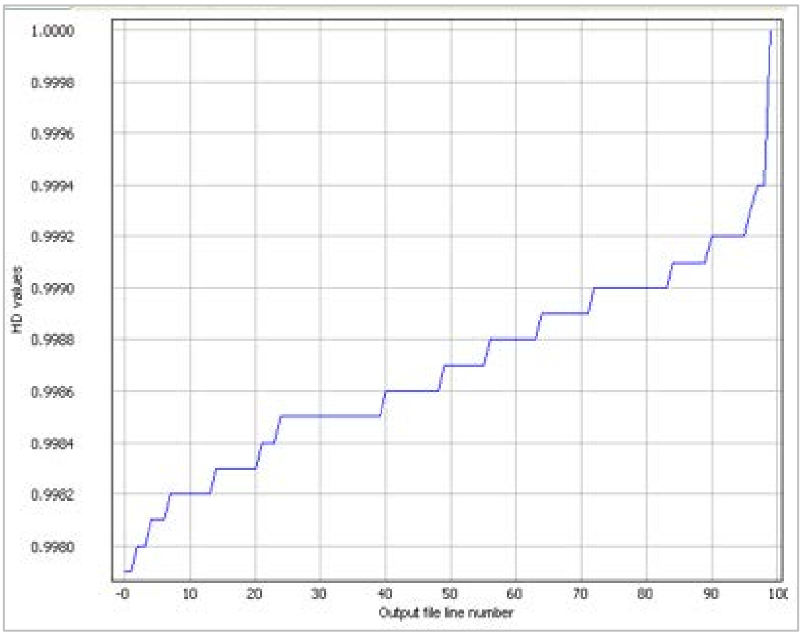

Figure 33-1 Graphical view of calculated HD of Buses image

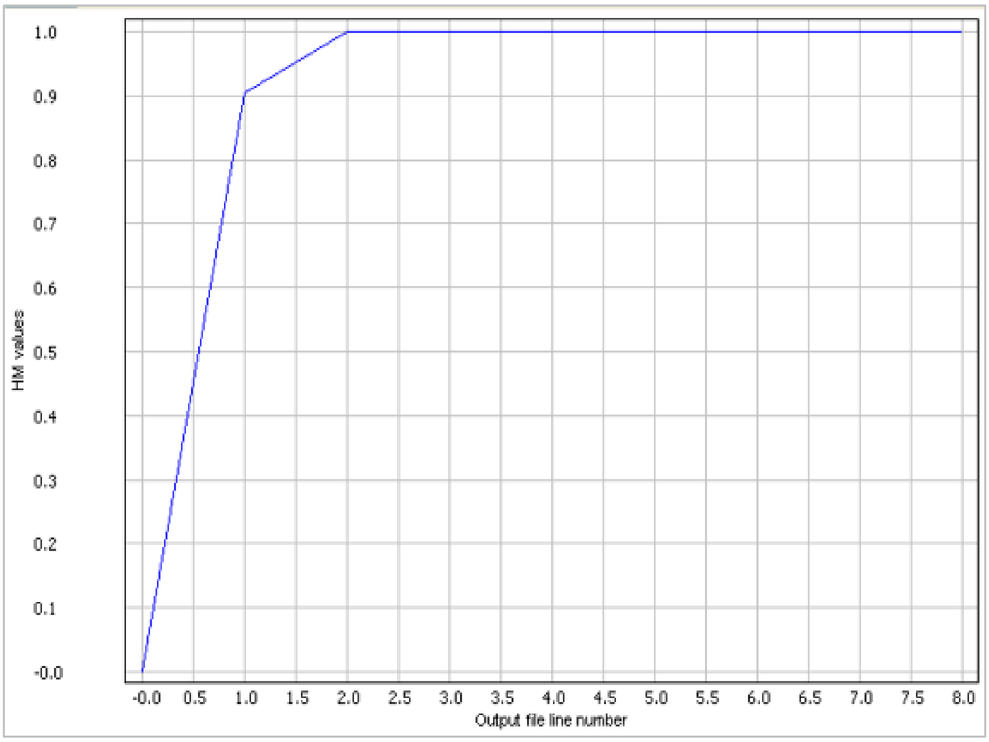

Figure 33-2 Graphical view of calculated HM of Buses image

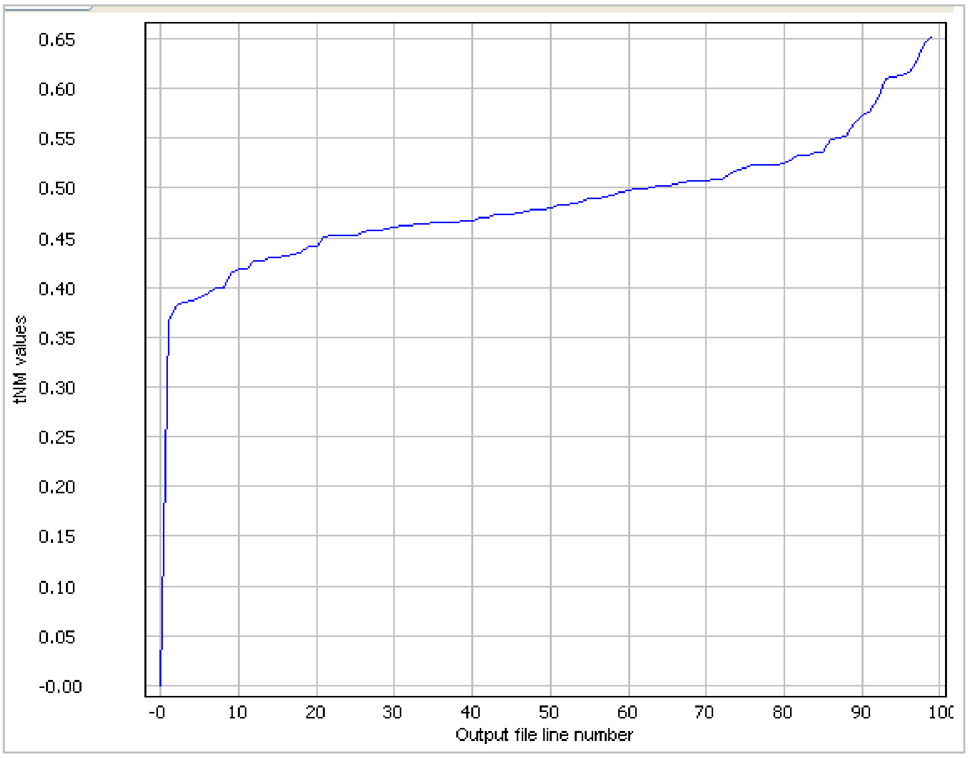

Figure 33-3 Graphical view of calculated tNM of Buses image

Similarly, the HM, HD, tNM of Dinosaur image have been calculated using a database of 100 varied images of dinosaur with a single query image. Here, the subimage size is 20, epsilon value is 0.01, probe functions (No. of features) is 1 and the probe function is Average Grey. Figure 33-4, 33-5, 33-6 reveals the graphical view of calculated HD, HM, tNM respectively of dinosaur image.

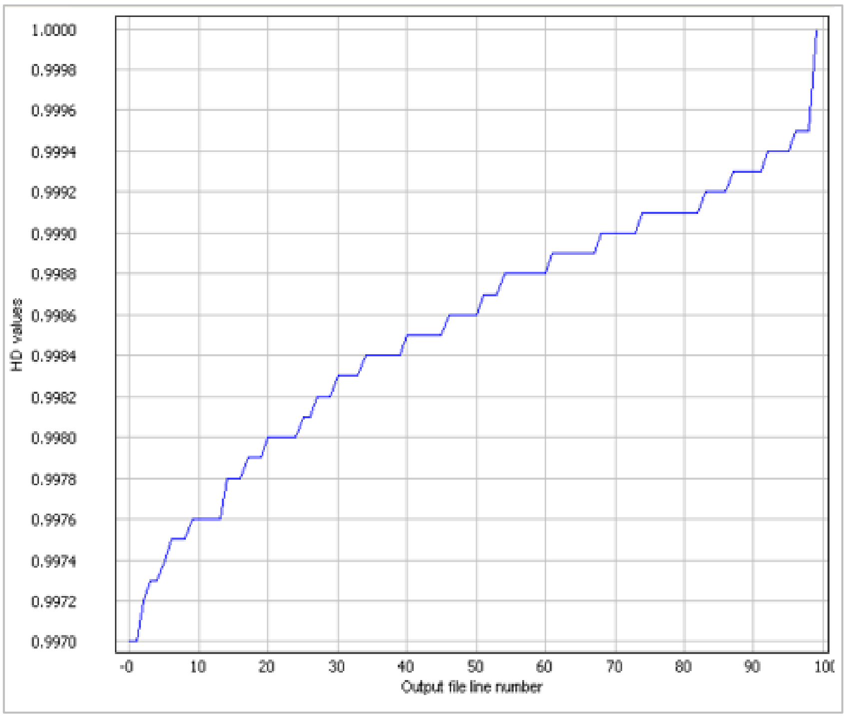

Figure 33-4 Graphical view of calculated HD of Dinosaur image

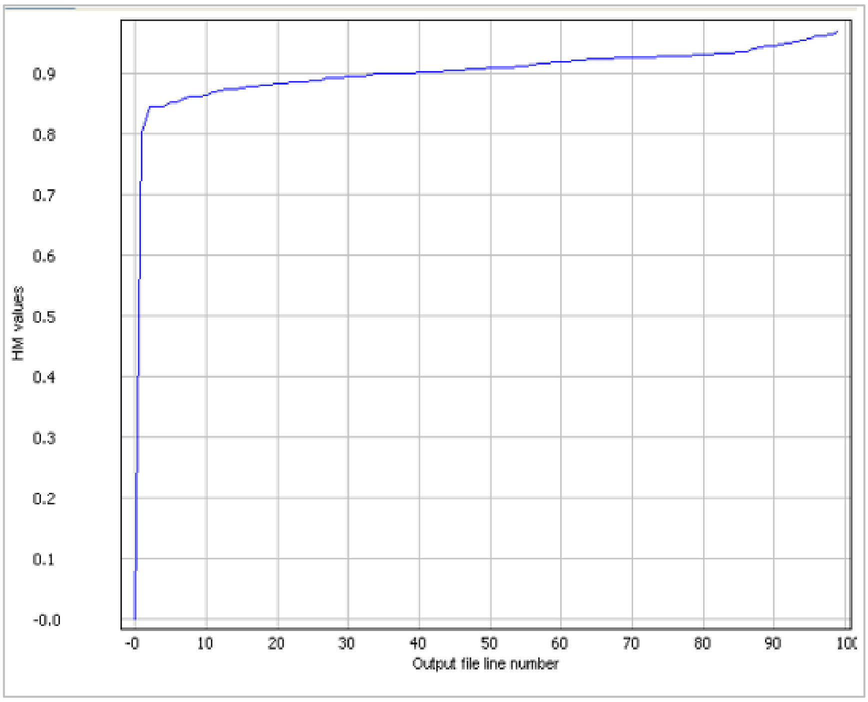

Figure 33-5 Graphical view of calculated HM of Dinosaur image

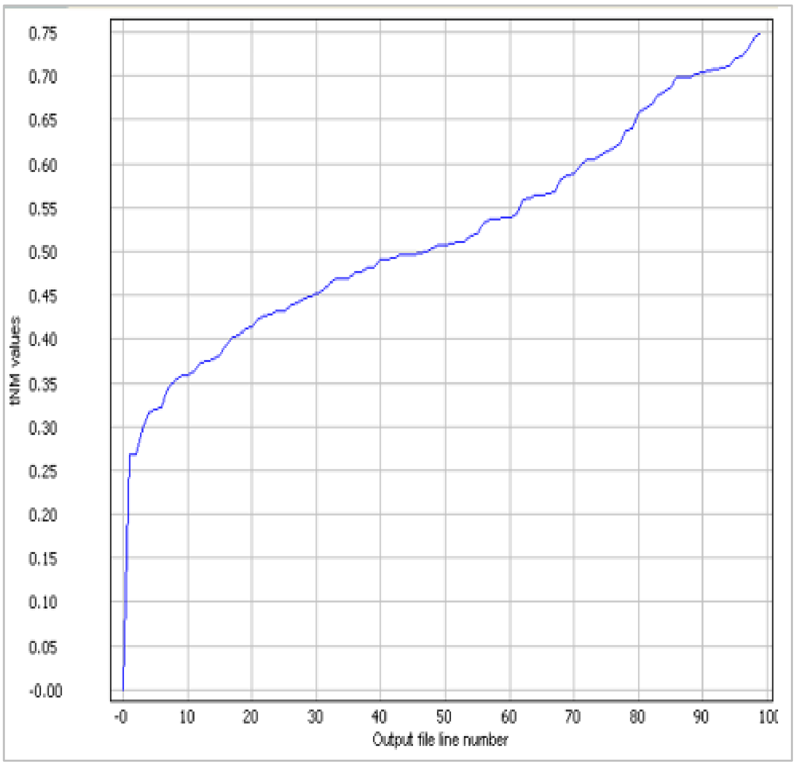

Figure 33-6 Graphical view of calculated tNM of Dinosaur image

After experiment, we concluded that we may fix the value of threshold 'ε', in tolerance relation. Further experiments can be made by considering different geometrical shapes as objects, with an intention of obtaining results which matches best with perceptual satisfaction of human beings.

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