PBIR – Perception-Based Image Retrieval

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ABSTRACT

We demonstrate a system that we have built on our proposed **perception-based** image retrieval (PBIR) paradigm. This PBIR system achieves accurate similarity measurements by rooting image characterization in human perception and by learning user's query concept through an intelligent sampling process. We show that our system can usually grasp a user's query concept with a small number of labeled instances.

1. OVERVIEW

Much research has been conducted on content-based image retrieval (CBIR) in the past decade. A CBIR system returns images that are "similar" to a query image. To measure similarity, a system characterizes images using perceptual features (e.g., color, shape and texture) and defines how similarity can be quantified using these features.

The traditional CBIR models have been *content-centric*. A content-centric approach characterizes and indexes images using one fixed set of features, and measures image similarity using a pre-defined distance function. This approach cannot service individuals who have different interests and applications that have different search goals.

To consider individuals' interests and subjectivity in a query, we have proposed a *perception-based image retrieval* (PBIR) paradigm [2]. Two components of this paradigm differentiates PBIR from the content-centric approach; and they are

1: Query concept learner, and

2: Multi-resolution image characterization.

1.1 Query Concept Learner

The design of a query-concept learner must fulfill two primary goals. One, the concept-learner's hypothesis space must not be too restrictive, so it can model most practical query concepts. Two, the concept-learner should grasp a concept quickly and with a small number of labeled instances, since most users do not wait around to provide a great deal of feedback. To fulfill these design goals, we have developed two learning algorithms: MEGA [1] and SVM_{Active} [4], and used them in our PBIR system. Through our demonstration, we show that these algorithms can achieve very high search precision in a small number of user iterations on a multi-category image database.

1.1.1 MEGA

The *Maximizing Expected Generalization Algorithm* (MEGA) models query concepts in k-CNF, which can model almost all practical query concepts. To ensure that target concepts can be learned quickly and with a small number of samples, MEGA employs two methods: sample selection (S-step) and feature reduction (F-step). In its S-step, MEGA judiciously selects samples that can collect maximum information from users to remove irrelevant features in its subsequent F-step. In its F-step, MEGA removes irrelevant terms from the query-concept (i.e., a k-CNF), and at the same time, refines the sampling boundary (i.e., a k-DNF) so that most informative samples can be selected in its subsequent S-step. Unlike traditional query refinement methods, which uses only the S-step or only the F-step, MEGA uses these two steps in a complementary way to achieve fast convergence to target concepts.

1.1.2 SVM_{Active}

SVM_{Active} is an *active learning* scheme that uses support vector machines. This algorithm first selects most informative samples to quickly learn a hyperplane that divides the query concept from the rest of the concept space in a high-dimensional space. To locate the top-k images, it then returns the top-k farthest points that are at the query-concept side of the hyperplane.

1.2 Multi-resolution Image Characterization

For a learner to be successful, feature selection is critical. We employ multi-resolution image characterization for color, texture, shape and spatial distribution [2]. We also employ a high-dimensional indexing schemes [3] to organize these features for achieving efficient retrieval. This muti-resolution image characterization method enjoys two benefits:

1. Flexible query-concept modeling. A query concept learned by MEGA or SVM_{Active} can select a subset of features that satisfy the user's need.

2. Efficient query-concept learning. As pointed out in [1], taking advantage of the feature resolution hierarchy can drastically improve learning performance with little degradation in search accuracy.

2. REFERENCES

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