

Sketch2Tag: Automatic Hand-Drawn Sketch Recognition

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ABSTRACT

In this work, we introduce the Sketch2Tag system for hand-drawn sketch recognition. Due to large variations presented in hand-drawn sketches, most of existing work was limited to a particular domain or limited pre-defined classes. Different from existing work, Sketch2Tag is a general sketch recognition system, towards recognizing any semantically meaningful object that a child can recognize. This system enables a user to draw a sketch on the query panel, and then provides real-time recognition results. To increase the recognition coverage, a web-scale clipart image collection is leveraged as the knowledge base of the recognition system. Better understanding a user's drawing will be of great value to a variety of applications, such as, improving the sketch-based image search by combining the recognition results as textual queries.

Categories and Subject Descriptors

H.3.1 [Information Storage and Retrieval]: Content Analysis and Indexing

General Terms

Algorithms, Design, Experimentation

Keywords

Sketch Recognition, Sketch-based Image Search

1. INTRODUCTION

Sketching is an innate ability of human beings, as a way of thinking, creating, and communicating. It has become a very natural way for human to interact with machines, especially as the popularity of touch-screen devices. Thus, it is highly desired to study how a computer can automatically understand a hand-drawn sketch. An effective sketch recognition system can perceive human intentions through sketching, and thus will be of great value to a variety of applications, such as human-computer interaction, sketch-based search, game design, and children education.

Sketch recognition has been studied since 1990s in computer vision and graphics. Most of existing approaches [3,

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Figure 1: Examples of hand-drawn sketches. The sketch recognition system targets at recognizing any reasonable hand-drawn sketch.

4] mainly focused on recognizing basic shapes in specific domains such as UML diagrams and mechanical engineering. The dependency on domain-specific knowledge makes it difficult to adapt these algorithms to solve problems in other domains.

In this work, we study the problem of hand-drawn sketch recognition. There is no particular constraint, and any semantically meaningful object a child can recognize might be a drawing target, as shown in Fig. 1. Since there are unlimited objects with typical shapes in the world, existing domain-specific methods are inappropriate here. Moreover, hand-drawn sketches always exhibit variations and ambiguities, and thus the recognition process has to be robust enough to an imprecise sketch.

We present the Sketch2Tag system in this work, which is a real-time sketch recognition system [5]. To increase the recognition coverage, we collected one million clipart images from the web as the knowledge base, for the contours in clipart images have a similar style to hand-drawn sketches. An effective sketch-based image search technology [1, 2] is adapted to discover the visually similar images to the hand-drawn sketch from the database. We propose a hierarchical topic model to mine the typical objects and shapes related to the sketch [5], based on the visually similar images and their noisy surrounding texts. As the result, the most representative tags could be derived by the topic model, and considered as the recognition result for the sketch.

Besides sketch recognition, Sketch2Tag can also recommend related tags for an ambiguous sketch to narrow down a user's search intent. It can also improve sketch-based image search by combining the recognition result as a text query.

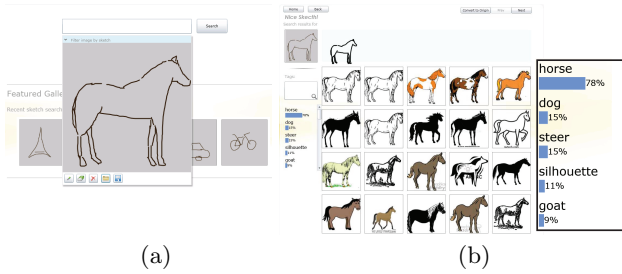


Figure 3: Examples of sketch recognition. (a) Draw a ‘horse’ in the query panel. (b) The result page. The recognition results are shown in the left part of the page, which is zoomed in on the right for a better view. The image search results are also shown. We can see that Sketch2Tag successfully recognize the sketch as a ‘horse’.

2. SYSTEM OVERVIEW

In this section, we briefly introduce the major functions of Sketch2Tag step-by-step.

Sketch Recognition

Draw a sketch in the query panel in the main page, as show in Fig. 3(a), and click the ‘search’ button to start the recognition. Then, the result page will come out, in which the recommended tags with corresponding probabilities to be the object name of the sketch, will be listed in the left part, as shown in Fig. 3(b). Meanwhile, the sketch-based image search results are also shown, which are retrieved by combining the sketch query and the top one recognition result. We also zoom in the recognition results for a better view in Fig. 3(b). We can see that, besides the correct recognition result ‘horse’, we can also provide some tags of animals with similar shapes to the drawing, such as ‘dog’ and ‘goat’ with smaller probabilities.

Ambiguous Sketch Recognition

Sometimes, hand-drawn sketches may be somewhat ambiguous. In this case, the system will recommend object names related to the sketch. For example, in Fig. 4(a), the recognition results contain ‘cone’, ‘triangle’, and ‘boat’, all of which have similar shapes to the sketch. The systems enable users to click any recommended tag, and then return images of the particular object with similar shape to the sketch. For example, as shown in Fig. 4(b), the user can click the tag ‘boat’ to see ‘boat’ images with similar shapes to the sketch.

Enhance Sketch-based Image Search

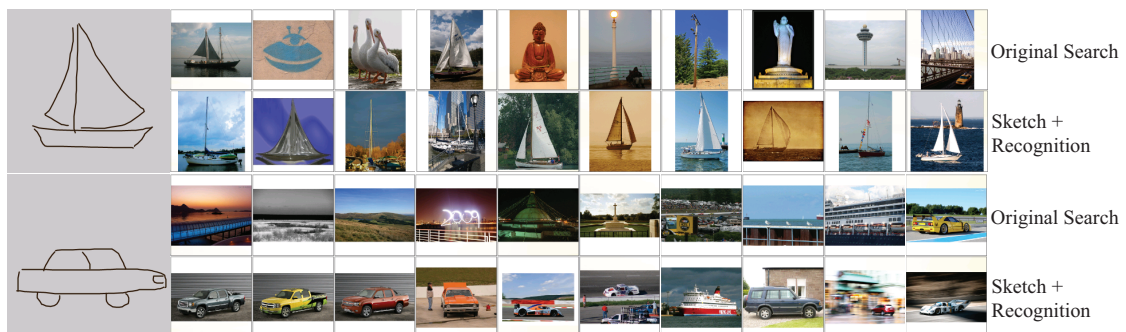


Figure 2: Examples of enhanced sketch-based image search. The top ten search results are shown. We can see that, the refined results leveraged by Sketch2Tag are much more relevant than the original results.

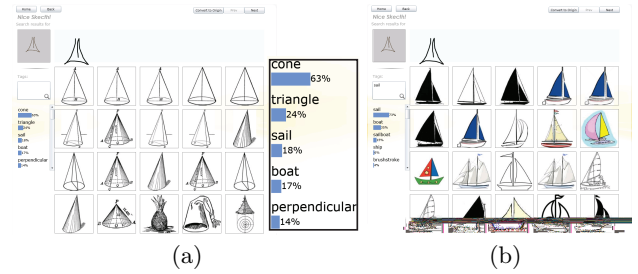


Figure 4: Examples of ambiguous sketch recognition. (a) Draw a ‘sailboat’. The recognition results contain ‘cone’, ‘triangle’, and ‘boat’. (b) Click ‘boat’ to refine the search results.

Sketch2Tag system can be used to improve the sketch-based image search engine. In sketch-based image search [1], the retrieved images are just similar to the sketch in terms of shape. However, due to the imprecision of the hand-drawn sketch or some intrinsic problems of the image search algorithm, the highly ranked images might contain irrelevant images, as shown in Fig. 2. Sketch2Tag can refine the search results by searching using the original sketch query together with the recognition result as the keyword query. Fig. 2 shows the comparison results of sketch-based image search in a two-million natural image database [1].

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4. REFERENCES

- [1] Y. Cao, C. Wang, L. Zhang, and L. Zhang. Edgel index for large-scale sketch-based image search. In *CVPR*, 2011.
- [2] Y. Cao, H. Wang, C. Wang, Z. Li, L. Zhang, and L. Zhang. Mindfinder: Interactive sketch-based image search on millions of images. In *ACM Multimedia*, 2010.
- [3] R. Davis. Magic paper: sketch-understanding research. *Computer*, 2007.
- [4] T. Hammond and R. Davis. Ladder, a sketching language for user interface developers. *Computers & Graphics*, 2005.
- [5] Z. Sun, C. Wang, L. Zhang, and L. Zhang. Query-adaptive shape topic mining for hand-drawn sketch recognition. In *ACM Multimedia*, 2012.