

# SmartVisio: Interactive Sketch Recognition with Natural Correction and Editing

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## ABSTRACT

In this work, we introduce the SmartVisio system for interactive hand-drawn shape/diagram recognition. Different from existing work, SmartVisio is a real-time sketch recognition system based on Visio, to recognize hand-drawn flowchart/diagram with flexible interactions. This system enables a user to draw shapes or diagrams on the Visio interface, and then the hand-drawn shapes are automatically converted to formal shapes in real-time. To satisfy the interaction needs from common users, we propose an algorithm to detect a user's correction and editing during drawing, and then recognize in real time. We also propose a novel symbol recognition algorithm to better recognize or differentiate some visually similar shapes. By enabling users' natural correction/editing on various shapes, our system makes flowchart/diagram production much more natural and easier.

## Categories and Subject Descriptors

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

## General Terms

Algorithms, Design, Experimentation

## Keywords

Sketch Recognition, Sketched Diagram Recognition, Correction and Editing, User Interface

## 1. INTRODUCTION

Sketching provides a natural way for us to create flowcharts and diagrams in the early design process. In the informal

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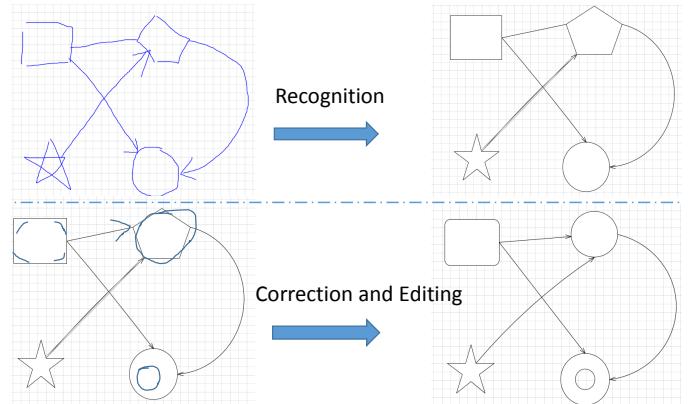
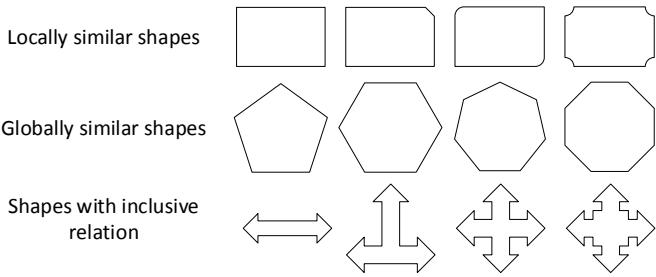


Figure 1: Illustration of the SmartVisio system. Users can draw various shapes and connectors in this system, which can be automatically segmented, recognized, and replaced by formal shapes. Users are also able to add strokes to correct or edit any part of the diagram, which will be refined in real time.

environment of sketching, we can use a pen to explore and refine our rough ideas through natural corrections and editing from time to time. It is highly desired if we have a practical system to recognize sketched symbols and then interactively convert to formal shapes. It will make flowchart/diagram production more natural and easier, especially with the increasing popularity of touch-screen devices.

There has been a significant amount of work in recognizing diverse hand-drawn shapes, such as symbols [2], flowcharts, diagrams, or general objects [4]. From the view of sketch complexity, it can be classified to two categories, i.e., isolated hand-drawn symbol recognition [2], and full hand-drawn sketch recognition [1, 3]. The former one has the assumption that there is only one shape in the sketch, while the latter one is not based on this assumption and thus needs to segment and recognize the strokes at the same time.

In spite of continuous research efforts, we still cannot see much technology transfer of sketch recognition in real products, even in the current era of touch screens. For example, the leading software for flowchart/diagram creation, Visio, still relies on the traditional point-click-drag style of interaction. This gap mainly comes from the following two aspects, 1) **the challenges from shape data in real sys-**



**Figure 2:** Visually similar shapes in Visio. Top row: similar shapes with local difference. Middle row: globally similar shapes. Bottom row: shapes with inclusion relation.

tems. In Visio, there are about 70 shapes only in stencil ‘basic shapes’ and ‘arrow shapes’, and thousands of shapes in total, in which some shapes are quite similar, such as the rectangles with different corner types in stencil ‘basic shapes’, as shown in Fig. 2. **2) The interaction needs from common users.** It is observed that users often make corrections or editing by simply adding strokes to an existing symbol without erasing the original shapes [1, 2]. In a real system such as Visio where very similar shapes exists, it will be more natural for a user to change a shape (e.g. pentagon) to a related shape (e.g. circle), because of a correction or mind changing.

In this work, we present SmartVisio system, which is a real-time sketch recognition system [5] based on Visio, to recognize hand-drawn flowchart/diagram with *flexible interactions*, as shown in Fig. 1. In order to meet the interaction needs from common users, we propose an algorithm [5] to detect users’ natural correction and editing on existing shapes, and then recognize the symbols in real time. We also propose a novel symbol recognition algorithm [5], in order to better differentiate and recognize some visually similar shapes. Besides isolated symbol recognition and correction, SmartVisio can also recognize full diagrams/flowchart based on the proposed full diagram recognition framework.

## 2. SYSTEM OVERVIEW

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

### Isolated Sketch Recognition

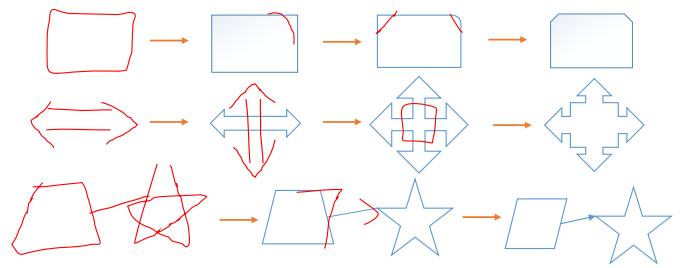
Draw a shape in the visio interface, as shown in Fig. 3. Then, the sketch will be converted to the recognized formal shape. This mode assumes that the user draws one object each time. The system starts to recognize strokes after the user stops sketching for 700 ms.

### Full Sketch Recognition

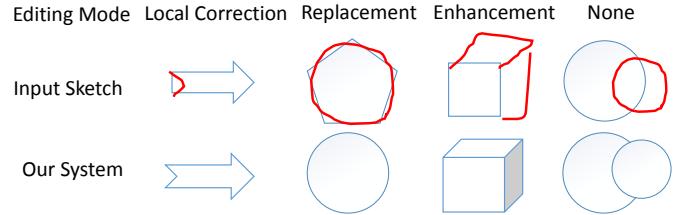
Besides the isolated sketch recognition, the SmartVisio system can also recognize hand-drawn full diagram. This mode acts like a piece of paper. After a user draws all things and click the ‘recognize’ button, the full sketch recognition is performed, and formal shapes automatically replace the hand-drawn sketches in real time. Note that the shapes also have connectivity relationships. For example, in Fig. 1, the arrows are connected to the nearby shapes, facilitating diagram production.

### Correction and Editing

In our system, user can easily add strokes to existing shapes,



**Figure 3:** Illustration of the online interactive correction and editing on formal shapes in SmartVisio system.



**Figure 4:** Visual examples of adding correction/editing on formal shapes for each of the four editing modes in SmartVisio system.

to change a shape (e.g. rectangle) to a related shape (e.g. ‘single snip corner rectangle’), because of a correction or mind changing. Due to this powerful function, user can perform a series of online correction/editing interactively, which is convenient for diagram production as shown in Fig. 3.

User can perform any of the four editing modes we defined according to visual similarity between shapes: 1) *local correction* for similar shapes with local difference, 2) *replacement* for globally similar shapes, 3) *enhancement* for shapes with inclusion relation, and 4) *None* for shapes that are not similar at all. The example results of adding correction/editing on formal shapes are shown in Fig. 4.

## 3. ACKNOWLEDGEMENTS

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