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SmartPaint: a co-creative drawing system based on generative adversarial networks

Key words: Co-creative drawing; Deep learning; Image generation

Corresponding author: Wei XIANG

E-mail: wxiang@zju.edu.cn

 ORCID: <http://orcid.org/0000-0003-2058-5379>

Motivation

1. Most humans express their ideas as rough sketches, and lack the professional skills to complete pleasing paintings. Existing AI approaches have failed to convert varied user sketches into artistically beautiful paintings while preserving their semantic concepts.
2. To collaborate with humans, a machine must master the domain knowledge of a certain painting. It can then understand the semantic concepts of the user sketch and transform a rough sketch into a vivid painting with a specific artistic style.

Main idea

1. SmartPaint, a co-creative drawing system, is developed, enabling a machine and a human being to cooperatively create cartoon landscape paintings. It uses triples of cartoon images, their corresponding semantic label maps, and edge detection maps to train a GAN. Therefore, the machine can simultaneously understand the cartoon style and semantics, and can identify the spatial relationships among objects in the landscape images
2. An edge map synthesis algorithm is proposed to synthesize edge maps based on the semantics of users' input sketches.
3. Experiments confirm that the proposed SmartPaint system can generate high-quality cartoon paintings.

Method

SmartPaint contains three key functionalities:

1. Painting producer consists of a conditional GAN trained on cartoon images, their corresponding semantic label maps, and edge detection maps.
2. Edge synthesizer automatically synthesizes edge maps from the user's input sketches.
3. Reference recommender recommends eight similar semantic label maps to guide the user's creative process.

Method (Cont'd)

- Overall structure of SmartPaint

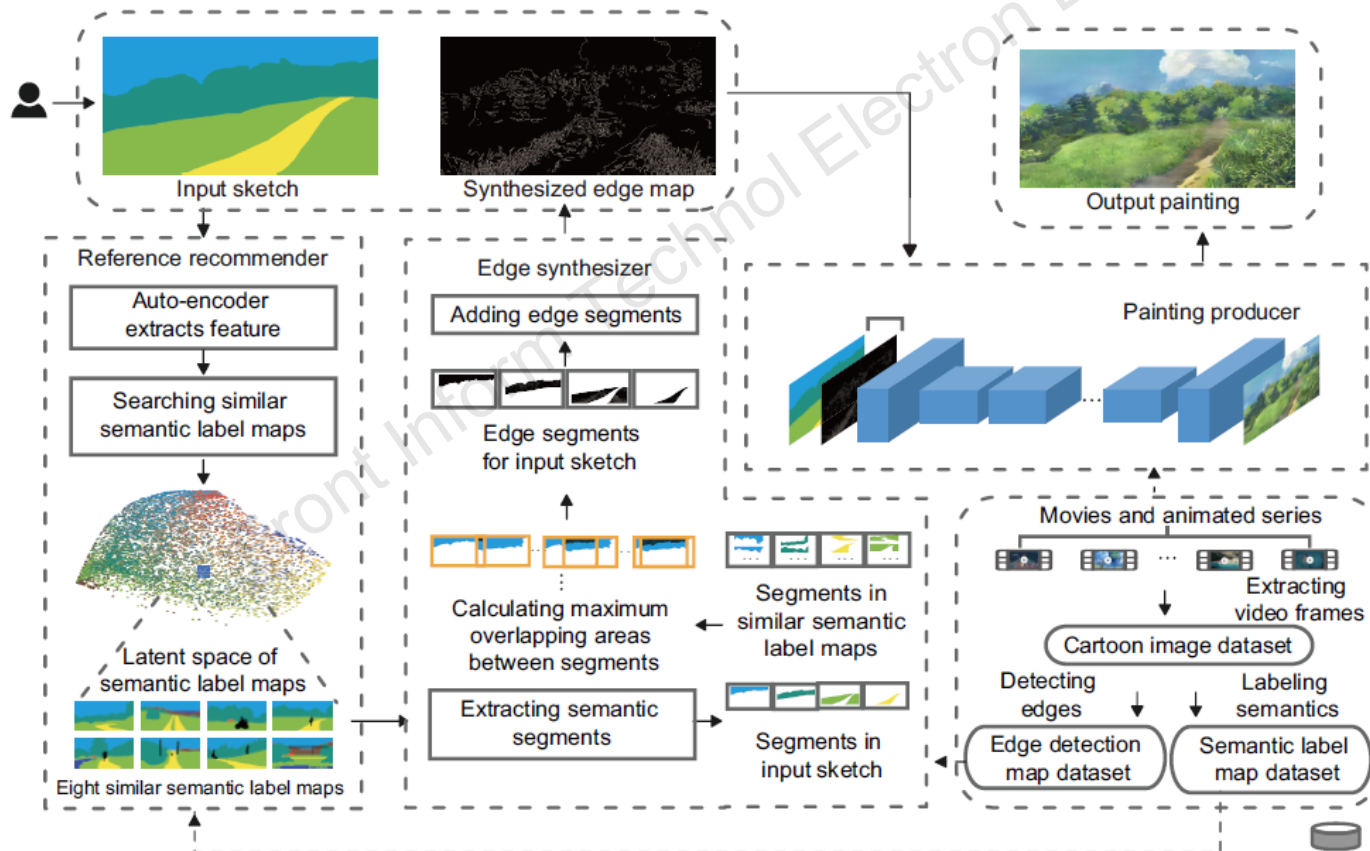


Fig. 2 Overall structure of SmartPaint

Major results

- The system display of SmartPaint



Fig. 3 The system display of SmartPaint: (a) SmartPaint interface (area 1: palette of drawing tools; area 2: shared canvas; area 3: display for the reference images); (b) a user drawing in the system

Major results (Cont'd)

- Comparison with the original pix2pixHD method

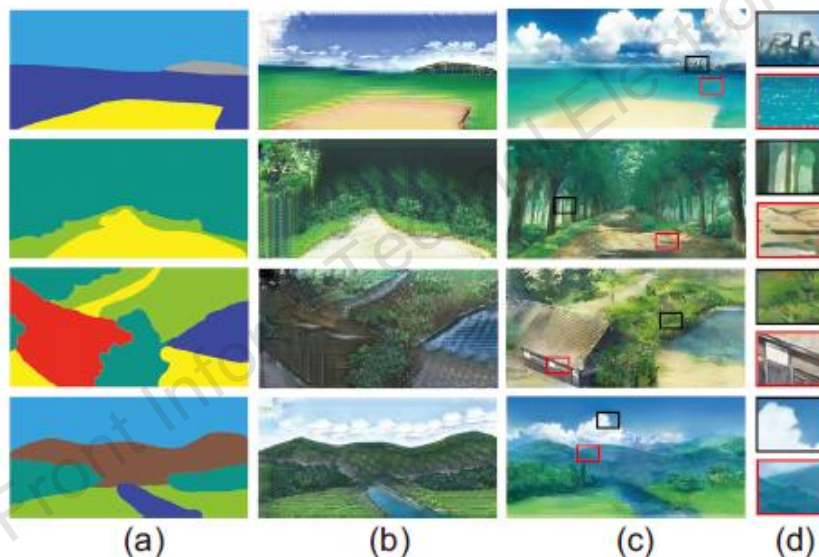


Fig. 6 Visual comparison of our method and the original pix2pixHD method. Given input sketches (a), pix2pixHD (b) and our method (c) generate paintings independently. The right panel (d) shows two magnified insets of (c)

Major results (Cont'd)

- Paintings from user study 1, created by participants with no restrictions on subject.

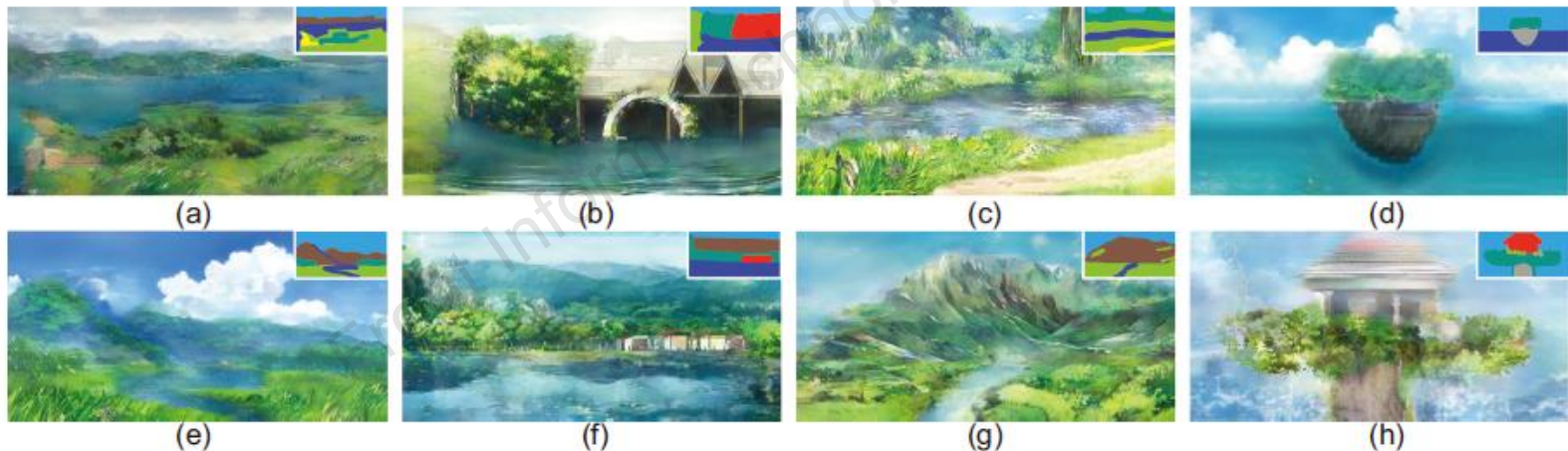


Fig. 7 Paintings from user study 1, created by participants with no restrictions on subject. (a)–(d) are paintings created by novices and (e)–(h) are paintings created by experts. In each example, we show the sketch drawn by the participant and its generated painting

Major results (Cont'd)

- Paintings from user study 1, created by participants following text descriptions.

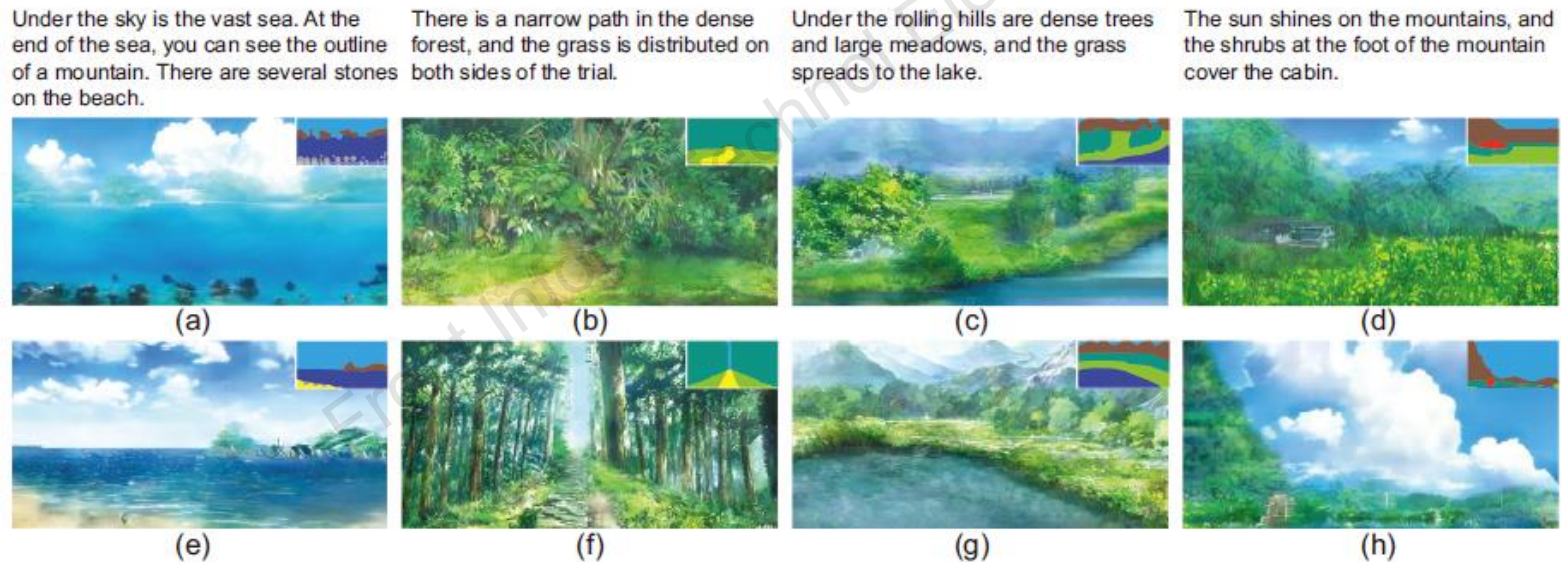


Fig. 8 Paintings created by the participants following text descriptions. (a) and (e), (b) and (f), (c) and (g), and (d) and (h) are pairs of paintings created by participants after reading the same text descriptions. (a)–(d) are created by novices and (e)–(h) are created by experts. In each example, we show the sketch drawn by the participant and its generated painting

Major results (Cont'd)

- Paintings from user study 2, produced by a professional illustrator using our system.



Fig. 9 Paintings produced by a professional illustrator using our system. First row: source paintings created by the illustrator and our system. Second row: adjusted paintings optimized by the illustrator in Photoshop. The optimization times of each painting (from left to right) are 10, 20, 25, 15, and 15 min, respectively

Conclusions

1. A co-creative drawing system is presented, in which computers and humans collaborate to create cartoon landscape paintings.
2. The comparison experiments demonstrate that the proposed method produces more vivid cartoon paintings than the original pix2pixHD method does.
3. User study results show that SmartPaint can assist creative drawing by both novice users and professional users.
4. Four guidelines for building a cooperative machine-human system are proposed.