Image Edge Based Wireframe Automatic Generation System

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Introduction

Paint by Number is a decompression game that colors the area by fixing the corresponding numbers. It has been downloaded more than 50 million times and proven to reduce stress and relax. However, According to statistics, a designer can produce only 2-3 wireframes a day, which is not suffice for users' need. In order to lighten the workload of designers, we develop a new product to help designers draw wireframes, get rid of boring work, and have more time to create.
Our products realize the precise extraction of closed outer frame and internal details, which is helpful for users in the level one (fig.1) process of drawing (imitating original picture, the most boring and cumbersome one). However, due to the limitations of AI, we can not make computer act as a designer to achieve level two (fig.2), creation.

Figure 1: Low level works can be replaced by algorithm

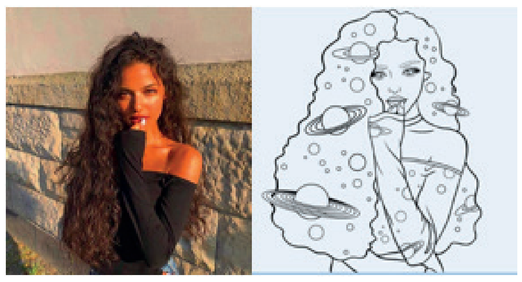

Figure 2: High level works which can show designer's creativity

Problem

Contrary to human beings, the algorithm is far less intelligent to draw wireframes. The algorithms based on low-level features such as gradients and colors tend to be poorly robust, resulting in unnecessary boundary or large-scale information lost, and the results are simply unusable. Another difficulty is that various pictures have different styles. The learning-based algorithm may solve some problems well, but lacks generalization ability.

Methods

We tried to solve these problems through traditional image processing methods, such as Canny, region growth, but the comparison is still not as effective as learning- based algorithms. Based on this, we have adopted two ideas:
The first one is to treat this problem as an edge extraction problem. Using BDCN methods[3], we can achieve good results on natural images. We also tried the poolnet method[4], the edge of the outermost layer is well presented.
The second idea focused more on details in source pictures. Edgeboxes[2] is a method of local detection. It uses a patch-based cluster to find a mapping (here, original image is domain and the wireframe is codomain). After that, the result can be better removed by the maximum value suppression. And Cyclegan[1] achieves amazing results to generate wireframe-style pictures. We can not find any way better than it in detail extraction today!

Here is a detailed introduction to our approachs:

BDCN

BDCN is a method specifically used to solve the edge extraction in computer vision. the related algorithm was first proposed in the 2015 ICCV (Hed), Later, RCF, CED were successively released. This method is also in the same vein, and it has achieved the state of art result in BSDS. Figure 3 is the network architecture of BDCN. It is also divided into 5 satges, and then the training results of 5 different stages are respectively obtained. The weighted average is finally crossed with groundtruth. Considering that the part of edge accounts for a small number of pixels of the image will use weighted methods for better training.

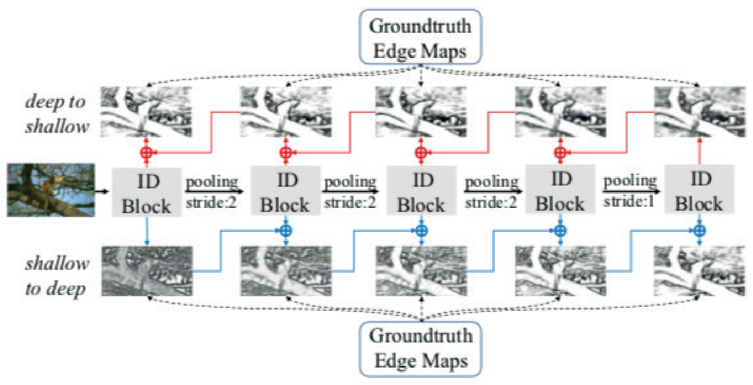

Figure 3: BDCNStructure

Poolnet

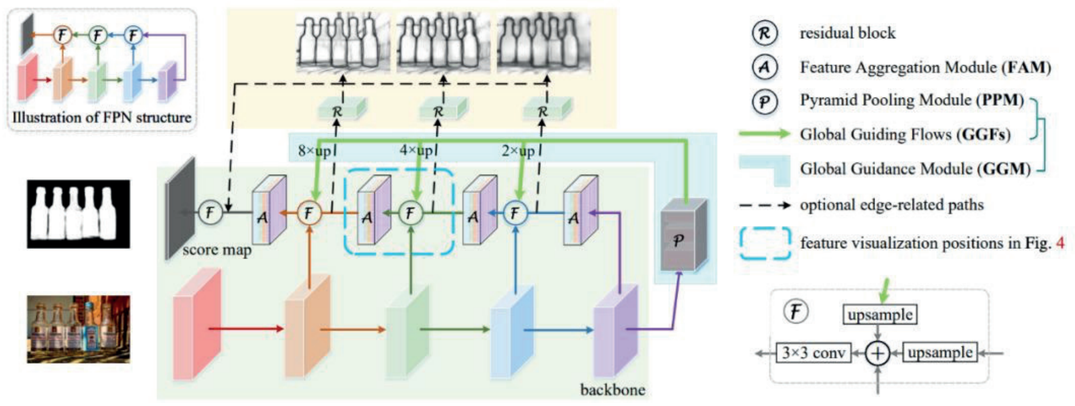

Figure 4: Poolnet Structure

Poolnet is a feature network considering U-shaped structure. The location information of high-level semantic feature capture may be gradually diluted in the bottom-up propagation process. This model introduces two modules based on pooling operation GGM (Global Guidance Module) and FAM (Feature Aggregation Module) to sharpen the details of significant objects. GGM is actually a PPM (Pyramid Pooling module) improvement and adds a series of GGFs (Global Guiding Flows)
The PPM module combines four different pyramid-scale features. In order to add high-level semantic information to each horizontal connection, the GGF is designed to map the different scale features in PPM to the top-down process through different scales of up-sampling.
Considering that GGF introduces impurities in high-multiple upsampling, feature integration is performed by performing different multiplication downsampling and upsampling operations to reduce impurities.

CycleGan

Cyclegan is used to learn a mapping G : X → Y, such that the distribution of images from G(X) is indistinguishable from the distribution Y using an adversarial loss. Because this mapping is highly under-constrained, we couple it with an inverse mapping F : Y → X and introduce a cycle consistency loss to enforce F(G(X)) ≈ X (and vice versa). In this way, we realize the transformation from the original picture to the edge map.

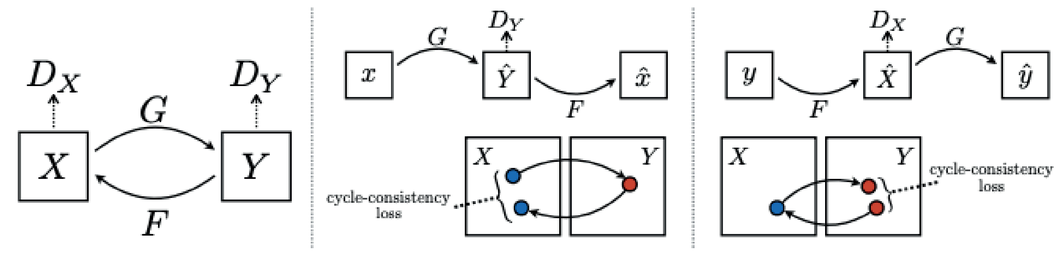

Figure 5: CycleGan Structure

Edgeboxes

Edgeboxes is a technical based on a traditional algorithm published on "Fast Edge Detection Using Structured Forests" . This algorithm is a local detection method, which uses supervised learning to determine which pixels are edges. However， in view of the lack of consistency of single pixels, this method expands pixels to patches, and finds a hidden state from patch.That is to say the author designs a mapping from patch to pattern (such as line） by clustering, and then obtains the results by learning patterns. Unfortunately, the result extracted by this method are too dense to be a contour, so the edge boxes abtain sparse lines from the previous result by using non-maxima. And then, line pixels are clustered into edgebox, and edgeboxes with similar clustering weights are connected and coarsened as a continuous edge of the same object.

Results

Here are some results using the methods we mentioned above:

Figure 6: BDCN is a method for extracting edges. It has already exceeded the level of ordinary people in the BSDS dataset. It can extract edges better and retain details to a certain extent.

Figure 7: Based on the PoolNet method, the outer contour can be proposed very accurately and it is guaranteed to be closed. This method has been recognized by the designer, which can effectively complete the low-level border extraction task and reduce the designer's labor.

Figure 8: Edgeboxes perform well in detail extraction, which is very accurate, almost reaching end-to-end tasks.

Figure 6: The results of cycle gan which can get amazing results when dealing with more cumbersome pictures.

Conclusion

The first exploration to generate the boundary wireframe of images has achieved preliminary success. Our products realized the precise extraction of closed outer frame and internal details, which greatly reduced the designers' workload and improved the efficiency of the creation.
Imperfect results still exist, our production can not completely replace the designers to generate available uncolored wireframes at present. However, we believe AI will liberate human from repetitive labor with the development of deep learning. And, help designers spend more time on creating pictures, which focus on emotions and spirits.

References

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