Photo-Sketching: Evaluation Project

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**Abstract**—Edges, boundaries and contours are important subjects of study in both computer graphics and computer vision. On one hand, they are the 2D elements that convey 3D shapes, on the other hand, they are indicative of occlusion events and thus separation of objects or semantic concepts. In this paper, we aim to leverage an existing framework titled PhotoSketch which generates contour drawings (boundary-like drawings), that capture the outline of a visual scene. We use these contours to propose a solution to problems that plague neural networks, namely adversarial images that aim to trick a neural network into misclassification. <TODO: Add some more stuff here>

**Index Terms**—PhotoSketch, Contours, <TODO: Add some more stuff here>

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# 1 Introduction

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dge-like visual representation appearing in form of image edges, object boundaries, line drawings and pictorial scripts, is of greate research interest in both computer vision and computer graphics. Contour drawings of images contain object boundaries and salient inner edges such as occluding contours and salient background edges. These sets of visual cues convey 3D perspective, length, width, thickness, and depth. This paper explores, studies, and evaluates the possibilities of image contours.

Deep learning algorithms such as Convolutional Neural Networks (CNNs) are powerful models that are trained on terabytes of data to be able to classify an image. They consider the entire image when classifying and can recognize complex shapes and patterns no matter where they appear in the image. In many image recognition tasks, they can equal or even beat human performance. However, it is very easy to fool a neural network. A hacked image can cause a neural network to misclassify an image that it would in normal circumstances classify correctly.

In this paper, we will evaluate the potentials of using image contours to prevent hacked images from tricking convolutional neural networks. We will also evaluate the effectiveness of training a neural network on its contoured counterparts in relation to classification.

<TODO>

# 2 PhotoSketch

Mentian et All. [1] proposes a learning-based method named PhotoSketch that resolves diversity in the annotation, and unlike boundary detectors, can work with imperfect alignment of the annotation and the actual ground truth.

Specifically, they propose a contour generation algorithm to output contour drawings given input images. The generation process involves identifiying salient boundaries and is connected with the salient boundary detection in computer vision.

## 2.1 Dataset

The dataset consists of 5000 high-quality drawings made by humans of 1000 outdoor images crawled from Adobe Stock. To collect this dataset, they used a popular crowd-sourcing platform called Amazon Mechanical Turk [2]. Turkers were allowed to trace over a fainted background image to ensure that drawings are roughly boundary aligned.

## 2.2 Method

The paper leverage conditional generative adversarial networks (cGAN), and a novel MM-loss (Min-Mean-loss) to generate the contours.

For cGANs, the generator aims to generate “real” images conditioned on the input images. Adversarially, the discriminator network is trained to tell the generated images from the actual ground truth images. This method expects a 1-to-1 mapping between two domains. However, to accommodate the extra images in each training example, they used a MM-loss to account for this.

In the novel MM-loss, two different aggregation functions are used for the generator and discriminator respectively. The “mean” aggregate function asks the discriminator to learn from all modalities in the target domain, and treat those modalities with equal importance. The “min” aggregate function allows the generator to adaptively pick the most suitable modality to generate on-the-fly.

## Model

In this paper, we will be using the original authors pre-trained model. This model is trained on the dataset mentioned in the previous section, which mainly contains pictures of humans and dogs. Thus, the contours generated will most likely be most accurate when generating contours of humans and dogs.

# 3 Hacked Images

Generating hacked images is essentially the same as “generating an adversarial example”. It is intentionally crafting a piece of data such that a machine learning model will misclassify it as something completely different. This can be used for something harmless such as a prank, but it can also be used for something malicious such as uploading an image (e.g. a pornographic image) that violates a websites terms of services. A deep neural network would normally be able to catch something like that; however, a hacked image is a way to bypass that defence. Hacked images can even fool neural networks even when they are printed out on a piece paper! [3] This means that hacked images can not only fool systems that upload an image file directly, but also fool physical cameras or scanners.

## 3.1 Hacked Image Generation

The generation of hacked images is suprisingly simple, we just need to change a few pixels in an image to be darker or lighter. One would expect that changing a couple of pixels would not matter to a deep neural network. However, in a famous paper in 2014 by C. Szegedy et all. [4] discovered that it isn’t always true. If one knew exactly which pixels to change and exactly how much to change them, you can intentionally force the neural network to predict the wrong output without making any obvious changes to the human eye.

## 3.2 Pipeline

For this task, we use and aim to trick the Inception v3 image recognition model. This model was created by Google and has been shown to attain greater than 78.1% accuracy on the ImageNet dataset. [5] The model itself is made up of symmetric and asymmetric building blocks, including convolutions, average pooling, max pooling, concats, dropouts, and fully connected layers.

The following is a pipeline of how we will generate the hacked images:

1. Feed in a training photo.
2. Check Inception v3’s prediction and see how far off the image is from the fake prediction.
3. Tweak the photo using back-propagation to make the final prediction slightly closer to the fake prediction.
4. Repeat steps 1-3 with the same photo until the Inception v3 network gives us the fake prediction we want.

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Fig. 1. Magnetization as a function of applied field. Note that “Fig.” is abbreviated. There is a period after the figure number, followed by one space. It is good practice to briefly explain the significance of the figure in the caption.

Figure axis labels are often a source of confusion. Use words rather than symbols. As an example, write the quantity “Magnetization,” or “Magnetization *M*,” not just “*M*.” Put units in parentheses. Do not label axes only with units. As in Fig. 1, for example, write “Magnetization (A/m)” or “Magnetization (Am−1),” not just “A/m.” Do not label axes with a ratio of quantities and units. For example, write “Temperature (K),” not “Temperature/K.” Table 1 shows some examples of units of measure.

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TABLE 1  
Units for Magnetic Properties



Statements that serve as captions for the entire table do not need footnote letters.

aGaussian units are the same as cgs emu for magnetostatics; Mx = maxwell, G = gauss, Oe = oersted; Wb = weber, V = volt, s = second, T = tesla, m = meter, A = ampere, J = joule, kg = kilogram, H = henry.

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Theorems and related structures, such as axioms corollaries, and lemmas, are formatted using a hanging indent paragraph. They begin with a title and are followed by the text, in italics.

**Theorem 1.** *Theorems, corollaries, lemmas, and related structures follow this format. They do not need to be numbered, but are generally numbered sequentially.*

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**Acknowledgment**

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**References**

1. M. Li, “Photo-Sketching: Inferring Contour Drawing from Images” 2019 IEEE Winter Conference on Applications of Computer Vision. (2019) Available: https://arxiv.org/abs/1901.00542
2. Amazon Mechanical Turk. [Online] Available: https://www.mturk.com/
3. Adversarial Examples in the Physical World. [Online] Available: https://www.youtube.com/watch?v=zQ\_uMenoBCk
4. C. Szegedy, “Intriguing properties of neural networks” (2014) Available: https://arxiv.org/abs/1312.6199
5. Advanced Guide to Inception v3 on Cloud TPI. [Online] Available: https://cloud.google.com/tpu/docs/inception-v3-advanced

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