Ergonomic Support for Logo Development Based on Deep Learning

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Abstract. Every year rendering logos becomes an increasingly important task in various fields. One of the most interesting methods for rendering logos is the use of neural networks. This paper proposes a method for rendering logos using a convolutional neural network (CNN), specially trained to classify objects based on a single keyword and to select parametric characteristics of the logo. Special attention is paid to the ergonomic evaluation of resulting logos and the feasibility of the proposed method is experimentally confirmed. The research has shown that the results obtained are superior compared to the most modern approaches.

Keywords: Ergonomics, Design, Logo, Vector Graphics, Expert Analysis, Usability Testing, Color, Font, Shape, Visualization, Convolutional Neural Network, Deep Learning.

1 Introduction

Logos, also known as trademarks, are important in today's marketing world. Logo rendering is a key issue in a wide range of areas.

Today, the logo is one of the best tools for illustrating what a commercial organization does, what its nature, politics and purposes are. In fact, professional logo design provides its recognition and an organization can build its brand on it.

As a rule, the most discussed logos are aesthetically appealing, distinctive, memorable, scalable, easy to use, adaptable (in color and black and white), and they effectively convey the characteristics of the organization. Based on the mentioned above, it can be argued that creating an effective visual representation of the brand requires much more than just graphic design. For this reason, the paper emphasizes the rules that were laid down in the basis of functioning the developed system [1].

1. Balance. Balance is important in logo design, because the brain perceives a balanced design as pleasant and attractive. One can achieve balance by maintaining the" weight " of graphics, color, size, and symmetry.

2. Size. A logo is not effective if it loses too much clarity when reduced or increased in size in the case of being applied to printing and other advertising materials.
3. Sequence of color palettes. When using colors in the logo design, one should maintain a constant color palette.

When operating with colors while rendering logos a number of rules should be considered:

1. Use colors that are additional and similar.
2. Make sure that the logo looks good in a grayscale, black and white, and a two-color palette.
3. Select colors based on the color circle.
4. Use fonts. Using fonts allows to add identity to the created logo.
5. Form. Using simple forms makes it as easy as possible to perceive and remember the logo.

2 Methods of system operation

The logo rendering method is based on sampling the output space of bounding boxes into a default set, depending on the location of the map of objects [2]. During rendering the network generates ratings for each logo element in each box and makes adjustments for the box according to the specified parameters to design and visualize the shape of the object better. In addition, the network combines forecasts from a variety of characteristic charts for natural rendering of various logo sizes. Experimental results for data sets confirm that the developed network has competitive accuracy, while providing a unified structure for learning and output [3,4].

At the moment, almost no work has been found on rendering logos using ANN (artificial neural networks). Most of works are dedicated to recognizing logos on images and in video streams rather than rendering them. [5] Fig. 1 shows the architecture of one of the logo recognition networks, which is based on the multibox concept.

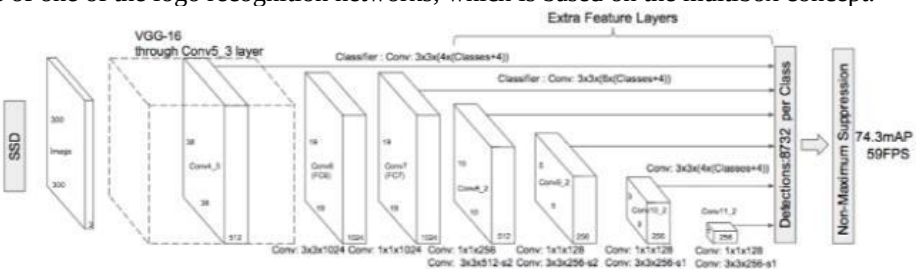

Fig. 1. Model architecture

3 Logo rendering process

Logos of garden centers were selected for training the neural network. The total number of logos is 1582. As the next step, the images were annotated. To do this, we used

LabelImg, a tool for annotating graphic images written in Python, which uses Qt for its own graphical interface. The created annotations are saved as XML files in PASCAL VOC format used by ImageNet. It also supports YOLO format [6].

When working with large data sets, using a binary file format for storage can have a significant impact on performance, import, and, as a result, on the learning time of our model. Binary data takes up less disk space, less time is spent on copying it, and they can be read more efficiently. TFRecord file formats were selected for operation. They allow to combine multiple data sets easily and are integrated with the import and preprocessing functions provided by Tensorflow library [7].

All the objects on the logos of competitors were classified. At the next stage, the neural network was trained to select an object on the basis of a database of graphic icons that can be added to the created logo. In the general case the following classes of objects were obtained:

- Harvest
- Equipment
- Vegetables
- Fruits
- Flowers
- Font elements

4 Converting XML into TFRecord

To convert XML files into TFRecord, they are first converted into CSV. Typically, XML files are converted into two CSV files, one for the final version and one for the test. After XML files have been converted into CSV files, they are converted into TFRecords using Python script.

To render a logo based on pre-defined characteristics, transfer learning can be used if it is necessary to study a new object. The advantage of transfer learning is that learning can be faster, and the required data that may be needed is not as large. TensorFlow has quite a few pre-trained models with available checkpoint files as well as configuration files [8].

The last thing that is necessary to do before starting training is create a placemark map. The placemark map is basically a dictionary that contains the class ID and name.

5 Logo rendering

To check how well the model works, it is necessary to write a word describing the main activity of the organization in the input field. This paper deals with an example of "garden" direction and botanysad.ru keyword (Fig. 2). The main parameters of the logo are:

- Color scheme (rgb)
- Brightness

- Contrast ratio
- Shape
- Symmetry/asymmetry
- Size
- Type

Fig. 2. Examples of the obtained logos

To evaluate the result from the point of view of ergonomics and applicability, the expert evaluation method was used [9].

Given the requirements for the competence of experts, as well as organizational factors, it is not entirely appropriate to involve a large number of experts to evaluate the results of the proposed neural network. It is optimal to involve 10 to 15 experts for this task. On the one hand, such a number may already show a certain range of opinions, on the other hand, the organization and processing of the results of such research will be relevant to the scale of the task.

At the same time, the members of the selected expert group should be paid attention to. It is necessary to attract experts with different competencies – they can be ergonomists, designers, and representatives of the target audience.

Experts are invited to evaluate the logo for compliance with the following criteria [10]:

1. Scalability is one of the most important ergonomic requirements for logos, which characterizes the possibility of using it. The logo should look complete in different formats and sizes.
2. Producibility is the criterion that evaluates the possibility of reproducing the logo on different surfaces and using different printing technologies.
3. Succinctness is one of the first perception criteria, which is responsible for the harmonious combination of elements.
4. Aesthetics is a fairly subjective criterion that assesses the overall perception of the logo.
5. Memorability is the most important criterion for the logo success. In case of successful implementation, it turns out to create a close relationship between the image and the brand.
6. Protective power determines the possibility of using the logo for brands from a particular area. A logo can be recognized as non-protectable based on the criteria of

protective power provided in Article 6 of the Law of the Russian Federation "On trademarks, service marks and appellations of goods origin".

7. Unique character is one of the most important criteria for evaluating a logo. Only a unique logo can be registered and protected. In Russia, this is done by the Federal Service for Intellectual Property, Patents and Trademarks.
8. Associativity is a fairly subjective criterion that assesses how well the brand and its symbolic image in the form of a logo correspond to each other. What associations it causes in the target audience. One of the most difficult criteria in terms of automated assessment.
9. Relevance. This criterion is used to evaluate the compliance of the logo's application area and its visual image.

Experts are asked to evaluate whether the logo meets or does not meet the above criteria in binary format.

Various methods can be used for statistical processing of expert evaluations. As a part of this work, expert evaluations themselves are not the subject of research, but only a tool for evaluating the results of the developed neural network, the first important criterion for evaluating expert responses is their consistency. The most common way to assess the consistency of expert opinions is Kendall's rank correlation coefficient. Taking into account mentioned above, we decided to focus on evaluating the consistency of expert opinions using Kendall's rank correlation coefficient without using more complex tools from the apparatus of reducing the number of variables and methods of multidimensional data analysis. Concordance coefficients W for the corresponding groups of logo requirements are calculated using the following formula:

$$W = \frac{n}{m^2 * (n^3 - n)} \sum_{i-1}^{n} \left(\sum_{j=1}^{m} r_y - \frac{m(n-1)}{2} \right) \wedge 2$$

where n is the number of respondents (experts), m is the number of parameters, according to which the evaluation is made, ry is the total evaluation of the logo by n-expert.

To evaluate the statistical significance of the coefficient of evaluation consistency W, we should calculate the inverse one-way probability of the distribution that is X2= m*(n-1)*W. The calculated indicator X2 can be obtained using MS Excel table editor using X2ОБР function. The actual indicator should be higher than the calculated one, which will indicate that the concordance coefficient is statistically significant.

The logo proposed by the neural network was evaluated by a pre-selected expert group. Based on the results, the final evaluation (compliance/non-compliance) was set for each criterion and the concordance coefficient was calculated for each of the criteria (Table) [11].

Table 1. Expert evaluation of the logo for compliance with the logo main criteria.

Logo evaluation criterion	Expert evaluation	Concordance coefficient
Scalability	+	0,97
Producibility	+	0,87
Succinctness	+	0,67
Aesthetics	+	0,67
Memorability	+	0,78
Protective power	+	0,67
Unique character	-	0,67
Associativity	+	0,87
Relevance	+	0,67

It should be noted that expert evaluations are quite consistent, which speaks in favor of their statistical significance. From the point of view of further development of the algorithm, it is worth paying attention to such criteria as protective power and unique character. These requirements for the logo are necessary to take into account additionally. It is possible to connect a wide database of registered trademarks and logos and requirements for their registration.

6 Conclusion

The proposed model for developing logos and brand names using a convolutional neural network and deep learning methods makes it possible to simplify and reduce the cost of developing various logo variants significantly. Using this model, it is possible to generate a large number of different variants of logos, then on the basis of expert evaluation method and usability testing to choose the best option and, if necessary, to evolve it using classic computer graphics tools. This approach allows to develop quickly unique logos for a variety of brands in the case of appropriate training of the neural network.

At this stage, the developed information system allows to render fairly simple logos. The service takes into account the main ergonomic requirements for creating logos and modern approaches of designers to drawing logos. The existing services for automatic logo rendering are inferior to the developed system in the following indicators:

1. The number of independent unique images that use the same elements. The system does not create logo repetitions.
2. Combining color schemes based on a color circle.
3. Construction of a logo of any size.

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