Human handwritten signature recognition using neural networks

N.A. Smirnov, E.S. Anisimova

Elabuga Institute of Kazan Federal University, Elabuga, Russia

Abstract: In this paper, we present the implementation of a neural network approach to solving the problem of handwritten signature recognition. We analyzed the main approaches to handwritten signature recognition. We identified the features of using a handwritten signature as an identification method, including the variability of a handwritten signature and the possibility of forgery. We identified the relevance of using neural networks to solve the signature recognition problem. We developed a neural network model for recognizing handwritten signatures, presented its architecture containing convolutional and fully connected layers, and trained the neural network model based on handwritten signatures "Handwritten Signatures" containing 2263 signature samples. The accuracy of the developed model was 92% on the test sample. We developed a web application "Recognition of a static handwritten signature" based on the developed neural network model on the Amvera cloud hosting. The web application allows identifying users based on a handwritten signature sample.
Keywords: handwritten signature, neural networks, signature recognition, image processing, machine learning, web application, cloud hosting, identification, verification, artificial intelligence.

Introduction

A handwritten signature is one of the earliest and most widely used methods of identification. The unique features of a signature make it an effective tool for confirming identity.

Handwritten signature recognition is a pressing issue that is widely used in various fields, such as banking, public and municipal services. Due to growing digitalization, automation of the signature recognition process is becoming increasingly popular.

Existing methods for recognizing handwritten signatures can be divided into two main categories: structural and statistical. Structural methods are based on the analysis of geometric characteristics of a handwritten signature, such as the shape of the signature, the ratio of its sides, and the determination of the angles of the strokes. Statistical methods are based on the analysis of global characteristics of the signature, such as the distribution of pixel density, moments of inertia, and discrete Fourier transform.

Existing approaches to recognizing handwritten signatures face a number of difficulties such as signature variability and the possibility of forgery, which complicates the task of effective recognition.

Recently, neural networks [1-3] have been actively used in various recognition tasks, including handwritten text analysis. The ability of neural networks to learn on large amounts of data, extract complex dependencies and patterns makes them a promising tool for solving the problem of recognizing handwritten signatures. In this article, we consider the possibilities of using neural networks to recognize handwritten signatures, present the architecture of the developed neural network model for recognizing handwritten signatures, the results of its training, as well as the main stages of publication in the form of a web application.

The concept of a handwritten signature

There are two main types of handwritten signatures: static and dynamic.

A dynamic handwritten signature is a set of parameters, including pen position coordinates, pressure, tilt angle, and azimuth. All these parameters are recorded using special devices, such as graphic tablets and digitizers. Dynamic signature is actively used in systems that require increased security, such as banking transactions and access to confidential information [4, 5].

A static handwritten signature is a unique graphic image that results from writing it on paper or any other surface [6]. Such a signature serves as a means of authentication and verification of an individual, creating a unique image that contains the characteristic features of a person's handwriting. The uniqueness of a static handwritten signature is expressed in the diversity of its distinctive features, which includes the angles of writing, length, direction of lines, and various features of writing. All these features make the signature unique, which is why it is often used in personal identification systems.

Development and training of a neural network model

To train a neural network model, you must first select a repository with examples of user signatures. In this study, we used the signature database "Handwritten Signatures". This database contains examples of signatures from 27 users, with the number of examples for each user varying from 78 to 90 signatures.

Fig. 1. – Examples of user signatures

To conduct the study, we performed pre-processing of the signature images [7].

We split the signature database into a training and testing sample:

The training sample contains 2036 signature samples, which is 90% of the entire database.

The test sample includes 227 samples, which is 10% of the base.

Neural network model for handwritten signature recognition

To recognize signatures, we developed a neural network model architecture [8] that includes convolutional and fully connected layers. Convolutional layers [9] allow the neural network to learn local features in the signature image. We then performed discretization to reduce dimensionality and prevent overfitting of the model. Next, we placed a classification block that identifies user classes.

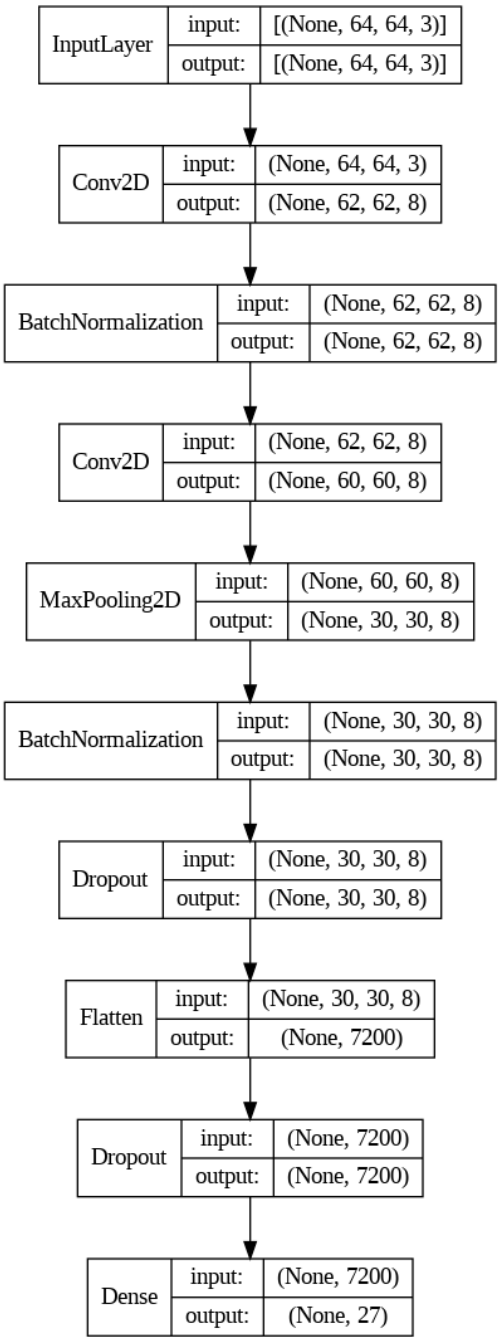

Fig. 2. – Architecture of the neural network model for handwritten signature recognition

The accuracy of the developed neural network model for recognizing handwritten signatures was 92%, which indicates the high efficiency of the developed model.

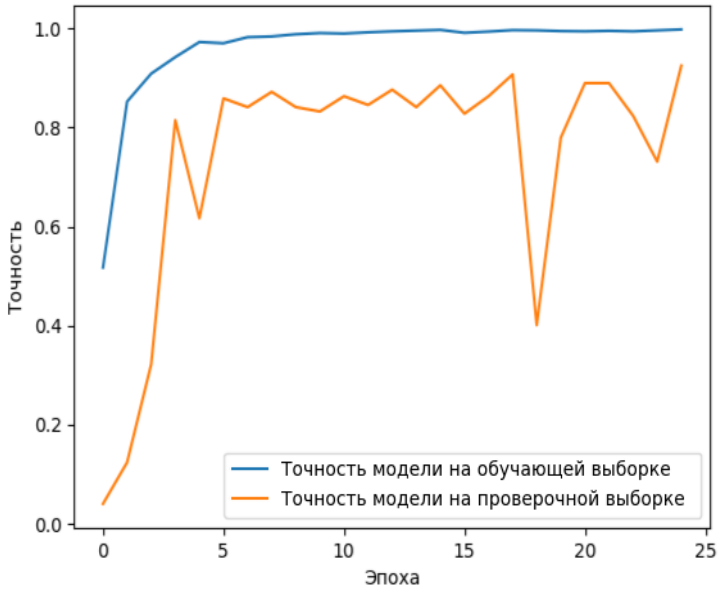

Fig. 3. – Model accuracy on training and testing samples

Developing a web application for handwritten signature recognition

To ensure the availability of the signature recognition application, we used cloud hosting. Its use provides such advantages as scalability, reliability and the ability to access the system from anywhere in the world.

We chose the Amvera service, which provides the necessary tools for deploying web applications [10].

We have prepared the necessary files, including the neural network prediction file, the application file, and defined settings for the server where the web application will be hosted, defined the libraries required for operation, and specified the project configuration settings on the Amvera service.

After downloading the created files, we built the project on the Amvera service.

An example of the application's operation is shown in Figure 4.

Fig. 4. – Web application “Recognition of a static handwritten signature”

Conclusion

Thus, in this work we obtained the following results:

1) developed and trained a neural network model for recognizing handwritten signatures using the Handwritten database Signatures. The accuracy of the developed model was 92%;
2) published a web application «Recognition of a static handwritten signature», which allows you to perform recognition of handwritten signatures.

Литература (References)

1. Ismagilova A.S., Lushnikov N.D. Inzhenernyj vestnik Dona, 2024, №1. URL: ivdon.ru/ru/magazine/archive/n1y2024/8961.

2. Plugotarenko N.K., Varnavskij A.N. Inzhenernyj vestnik Dona, 2012, №4. URL: ivdon.ru/ru/magazine/archive/n4p2y2012/1351.

3. Nejronnye seti: raspoznavanie obrazov i izobrazhenij c pomoshh'ju II [Neural Networks: Pattern and Image Recognition Using AI]. Centr2M URL: center2m.ru/ai-recognition?ysclid=lgjir3fgny261269867 (accessed 27/10/2024).

4. Anikin, I.V. and E.S. Anisimova, 2022. Studies in Systems, Decision and Control, 417: 219-231.

5. Borovik I.G., Zubareva M.G., Cvetkov A.A. Molodoj uchenyj. 2016. №11 (115). pp. 150-154.

6. Bharadi, V. and H. Kekre, 2010. Off-Line International Journal of Computer Applications, 1. Date Views 03.11.2024 ijcaonline.org/archives/volume1/number27/499-815/.

7. NumPy references. Date Views 03.11.2024 numpy.org/doc/1.26/reference/index.html#reference.

8. Keras 3 API documentation. Date Views 03.11.2024 keras.io/api.

9. Dychkov I.N. Tendencii razvitija nauki i obrazovanija. 2021. №73-1. pp. 38-41.

10. Rukovodstvo Amvera Cloud [Amvera Cloud Management]. URL: docs.amvera.ru (accessed 03/11/2024).

Дата поступления: 27.09.2024

Дата публикации: 14.11.2024