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FACE RECOGNITION IN LOW LIGHT CONDITIONS

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Abstract. This paper is devoted to an urgent problem of biometric authentication – face recognition in conditions of poor visibility and low light conditions. The article analyzes the main difficulties, such as sensory noise and loss of key image features. The Head Pose Image Database dataset was used to study the effectiveness of the algorithms. Special attention is paid to the method of expanding the training sample using data augmentation in the OpenCV library. The process of programmatically adjusting the brightness and contrast of images is described, which allows simulating extreme shooting conditions to improve the accuracy of modern computer vision systems.
Keywords: biometric authentication; low light conditions; machine learning; data augmentation,

Introduction

Authentication is one of the most effective and widely used access control mechanisms in information systems. Traditional systems use either some secret information (password) or special hardware and software keys such as smart cards, RFID cards, USB tokens, etc. for these purposes. Biometric methods of human identification and authentication are becoming more relevant every year. Facial recognition is an automated process of identifying or verifying an individual based on facial image analysis. Compared to other biometric methods, facial recognition has a number of advantages, including the absence of physical contact and the ability to be implemented using standard equipment [1]. However, despite the existence of various approaches and libraries for face recognition, the issue of recognition in conditions of poor visibility (severe weather conditions and darkness) is still relevant.

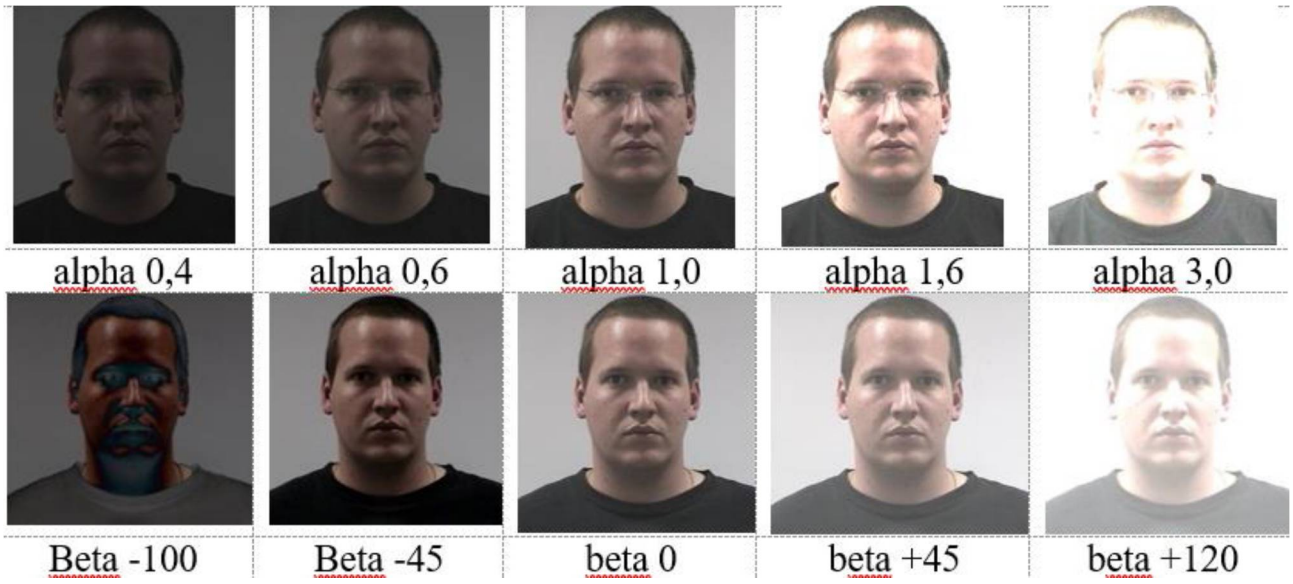
Main Part

The primary difficulty lies in the domain gap between high-quality training data and degraded real-world inputs. Dark images often suffer from sensor noise (random fluctuations in pixel values that obscure facial features), color distortion (incorrect representation of skin tones and textures), information loss (shadows often hide critical landmarks like the eyes or nose shape, making feature extraction nearly impossible for standard CNNs).

The Head Pose Image Database dataset, created by James L. Crowley, Professor Emeritus at the Polytechnic Institute of Grenoble (France), was used to study the effectiveness of detection. The database contains 2790 images of

fifteen people's faces with different angles of rotation and tilt from -90 to +90 degrees. 2 series of 93 images are available for each person. There are images with and without glasses for each person. The database was created for training and testing machine vision algorithms.

When creating a dataset to study the effectiveness of detection algorithms at different brightness and contrast values, the data augmentation technique was used. The image contrast and brightness are changed using the cv2.convertScaleAbs(image, alpha, beta) function. Image is the original input image, alpha is the contrast value, beta is the brightness value. Alpha values (0; 1) are used to reduce contrast. To increase – alpha>1. In this work, the alpha parameter ranged from 0 to 5 in increments of 0.1. The brightness varied in the range (-200, 200) in increments of 1. An example of the figure design and the caption to it is presented below.



a *b*

Figure capture: An example of changing brightness and contrast

The convolutional neural network showed the best detection results. Lowering the contrast ratio (alpha) by 0.7 reduced the detection accuracy, which is a predictable result. The increase in reliability only slightly increased the detection accuracy. With a significant increase in contrast (alpha>3), the detection accuracy begins to decrease. reducing the brightness level of the image reduces the accuracy of face detection faster. Increasing the brightness only slightly increased the accuracy of the detector. With a significant increase in brightness (overexposure), the detection accuracy also decreased significantly.

Conclusion

We applied the augmentation method to create a dataset for the purpose of teaching the model to detect and recognize faces in low light conditions. This makes it possible to create specialized datasets based on existing ones.

References

1. Li S. Z., Jain A. K. Handbook of Face Recognition. 3rd ed. Cham : Springer, 2024. 479 p. DOI: 10.1007/978-3-031-43366-7

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