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Localizing Face Recognition with Haar-Cascade Classifier and LBPH using Python

Rex C. Legaspi
Faculty, College of Engineering and Information Technology,
Surigao del Norte State University-Del Carmen Campus, Philippines
rclegaspi@ssct.edu.ph

Abstract: *This paper experimented with the combination of the Haar-Cascade Classifier and Local Binary Pattern Histogram in creating a Face Recognition System using Python programming language. Images were gathered using Python script from the 10persons selected while facing the camera. Each individual had 1000 photos that were used to train a model. Another Python script was created for training, identification and recognition. The overall efficiency rating of the model was 84% which denotes a practical recommendation for utilization. The findings of this study contribute as a reference for further development of face recognition with other image classification algorithms.*

Keywords: Computer Vision, Haar-cascade Classifier, LBPH

I. INTRODUCTION

In this digital age, the combination of Artificial Intelligence (AI) and machine vision pointed to significant innovations in face recognition technology [1]. While this area of recognizing humans has gained interest from researchers, continuous exploration of facial features in images or video frames in localized datasets [2][3]. This crucial procedure serves as the cornerstone of many applications, from strengthening security systems to improving user interfaces for interactive software.This paper examines the integration of two potent tools—the Local Binary Pattern Histogram (LBPH) and Haar-Cascade Classifier—within the Python programming environment to accomplish precise and effective face recognition.

Face Recognition is a branch of computer vision and pattern recognition that evolved to meet the demands of security and authentication applications [4][5].From enhancing the security of our devices to reshaping the landscape of surveillance and biometrics, the implications of this technology are intense [6].This can be applied to law enforcement to track and apprehend individuals of interest [7]. With this, the ability to accurately pinpoint key facial attributes within a crowded scene can make a substantial impact on public safety [8]. The crucial experiment to localize the data sources needed for training in machine learning is essential to add more insights to this application.

The purpose of this study is to experiment with the two indispensable components: the Haard-Cascade Classifier and LBPH, implemented using Python programming language. The Haar-Cascade Classifier is a computer vision-based object detection which has a proven capability of locating objects in an image of video frames [9][10]. The detected features are formed as a classifier to discriminate between positive and negative samples[9][10]. On the other hand, LBPH constitutes a texture-based approach that centers on capturing intricate patterns in the identified regions in faces from an image [10]. Lighting variation in an image or video qualityis well-suited to use the LBPH algorithm [10].

Throughout the study, ten local individuals participated in forming the classes for datasets. The generation of sample images for the class representation is obtained from the script generated using Python programming language with the integration of OpenCV libraries along with TensorFlow. The datasets were trained based on a machine-learning approach to create a model. The face recognition was evaluated using the efficiency of the system as to its detection in real-time.

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II. METHODOLOGY

2.1 Hardware

TABLE I: Hardware requirements

Hardware Components	Specification
CPU	Intel® Core™ i7-8700 CPU @ 3.20Ghz 3.18Ghz
Memory	16 GB RAM
Storage	1 TB HDD
GPU	6GB NVIDIA GTX-1660
Scanner	Epson L3210

2.2 Software

TABLE III: List of software

Name	License
64-bit Windows 10	Proprietary
Anaconda Navigator 2.3.2	Open-Source
Spyder 5.3.3	Open-Source
Python 3.9.15	Open-Source
OpenCV 4.6.0	Open-Source
Tensorflow 2.10.0	Open-Source

2.3 Dataset Gathering

Gathering and preparing a dataset for machine learning involving local personalities is one of the challenging tasks. This paper created a Python script designed to generate images from a person facing the camera. The dataset was composed of ten local individuals labeled for class representation with 1000 face images per class. The samples of images are shown in Fig. 1.

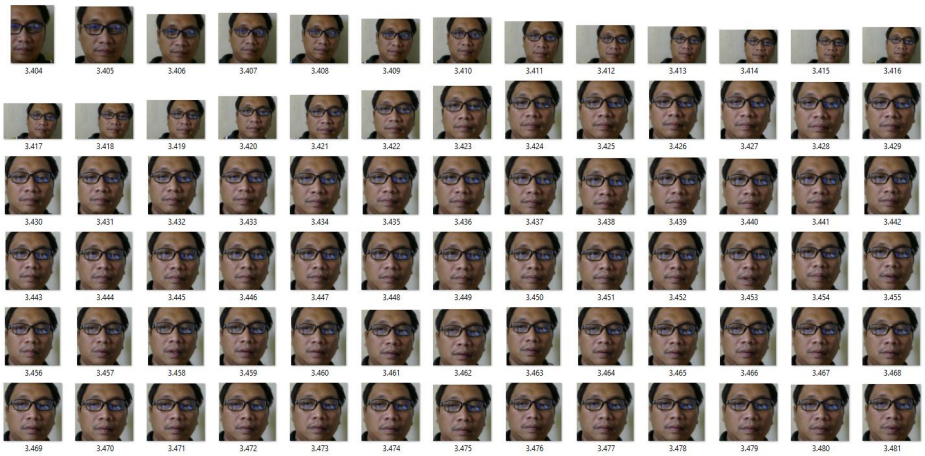

Fig. 1. Sample of the face images generated by Python script

2.4 Development Process

The development process of face recognition with the combination of the Haar-cascade classifier and LBPH strengthens the power of compute vision and machine learning to achieve an efficient recognition system [9][10]. It originated with the preparation of a different and well-organized dataset containing samples of images from local personalities. The dataset was generated from a datasetCreator.py file. The variable declared was incharge of the number of sample imagesthat could be generated during the data gathering. The powerful Python libraries such as OpenCV are instrumental in forming the foundation for training and testing the model. After the model was created it was tested for its identification and recognition in real-time. The validation of the testing process was evaluated using the model's efficiency.

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2.5 Efficiency Analysis of the System

Ten attempts of the individual to face the camera for identification and recognition. The detected face images are divided by the total number of attempts, multiplied by 100%. The calculated mean scores from the detection and recognition represented the overall efficiency of the system

$$Efficiency = \frac{\#\ of\ face\ images\ detected}{\#\ Total\ number\ of\ attempts} 100\%$$

III. RESULTS AND DISCUSSION

3.1 Face Detection and Recognition

Fig. 2 presents the detected face in the developed face recognition system. It represents the region of interest defined and matches against the database.

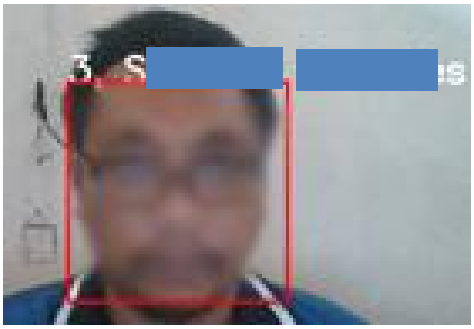

Fig. 2. Sample of detected and recognized face image

3.2 Efficiency Analysis Result

An efficiency rate of 84% indicates that the model successfully identified and recognized human faces from the camera in realtime. However, factors such as dataset size, diversity and quality of the image used can all impact the result. While not perfect, this level of accuracy is often considered satisfactory. The results of the evaluation are presented in Table III.

TABLE IIIII: results after the system evaluation

Classes	Total Number of Attempts	Number Images Detected	Efficiency
Person 1	10	9	**90%**
Person 2	10	8	**80%**
Person 3	10	7	**70%**
Person 4	10	8	**80%**
Person 5	10	9	**90%**
Person 6	10	9	**90%**
Person 7	10	8	**80%**
Person 8	10	9	**90%**
Person 9	10	9	**90%**
Person 10	10	**8**	**80%**
Average Efficiency			**84%**

IV. CONCLUSION

This research on facial recognition marks a positive turning point with an average efficiency score of 84% across 10 classes. This degree of precision illustrates the method's efficacy in identifying faces within a varied collection of local personalities. Although the score is not perfect, it still demonstrates the combined Haar-Cascade Classifier and Local Binary Pattern Histogram (LBPH) method potential and points to its applicability for real-world uses. Further, exploration of the different image classifications is necessary to increase the performance of the model.

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