Harnessing Computer Vision Technology to Provide Useful Service to University Students

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***Abstract*— Utilizing advanced technologies in educational institutions improves many existing manual services and thus reduces the burden on staff and students. Numerous online services have been harnessed from educational and administrative aspects. However, most of these services focus on improving the educational aspect and disregard organizational matters related to the educational environment of students. Machine learning is a new concept that has improved the efficiency and security of all electronic services. This experimental study attempts to provide a service that allows students to obtain their exam results by harnessing computer vision technology to simplify the paperwork involved. Most Iraqi universities routinely verify exam results via paper or through websites, both of which entail many problems. This task is tedious and tiresome for students and professors. This study also compares the use of machine learning by computer vision to obtain exam results and the use of a website or other electronic service to obtain the same. For the computer vision system, the study uses Python as a programming language, the OpenCV library, and the Qt5 framework.**

Keywords—Artificial Intelligence, Machine Learning, Computer Vision, Face Recognition, University

I. Introduction

Over the past 25 years, machine learning has become a popular topic in various areas, such as computer vision, entertainment, engineering, pattern recognition, finance, spacecraft, and computational biology for biomedical applications (El Naqa & Murphy, 2015; Erickson, Korfiatis, Akkus, & Kline, 2017). Lee, Taylor, Kalpathy-Cramer, and Tufail (2017) stated that machine learning is a subset of artificial intelligence that *"gives computers the ability to learn without being explicitly programmed."* Electronic machines have proven their capability to learn and even control tasks that were previously believed to be too complicated for machines. This situation suggests that machine learning algorithms are useful for decision support systems. Utilizing modern technologies in the administrative sector enhances the services delivered to customers (Al-Khafaji, Abdullah, & Kashmoola, 2018). Available services vary in terms of information accuracy, reliability, and availability of the means of communication. Websites are the most dominant technologies for providing information and services in educational institutions despite the poor Internet service in several countries. Iraq is one of the worst countries in this aspect. Nevertheless, most educational institutions worldwide remain in the primitive stage in terms of harnessing AI as a service for employees and students. Furthermore, most of what is available in educational institutions is merely research. The objective of this study is consistent with the statement of Kapur (2017), who said that computer vision is a useful technique to facilitate research and development in many fields.

The current study focuses on training a cascade classifier for face recognition by capturing positive and negative images to provide a useful service to students in developing countries, such as Iraq. The trained cascade classifier is then used to process video frames, in which the face of a student is recognized, and the exam results of this student is immediately displayed.

II. Computer Vision

Computer vision has developed remarkably over the past few years. This development has exerted considerable effects on computer science and other areas, such as space exploration, defense, and medicine. In literature, the terms machine vision, image understanding, and high-level image processing are often used to denote computer vision. Computer vision is a rapidly growing field dedicated to editing and understanding images. The main aim of computer vision is to understand occurrences in front of a camera and utilize this understanding to control the computer and automated system and provide users more useful and clearer pictures than the original camera pictures (Achilleas, Eleni, Paris-Alexandros, & Minas, 2017).

In computer vision, a computer vision system accepts an input image and produces several measurements extracted from the image (Snyder & Qi, 2017). These measurements, which are called features, are provided to a pattern recognition system that makes a decision about the object or objects being imaged. Figure 1 illustrates this process.

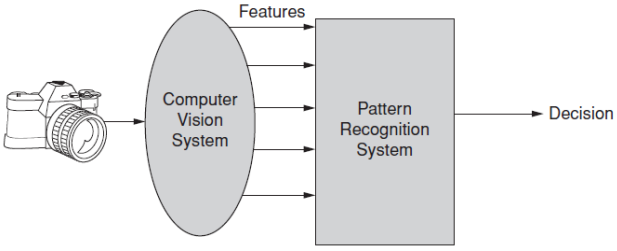

Fig. 1: Computer vision process

Pattern recognition is an essential component of a computer vision system. The input is a description of an

image (e.g., features that describe the object in the image) in a structured format (e.g., a vector), and the output is a recognition result based on the input descriptions. Hence, in pattern recognition, neither the input nor the output is an image.

III. Face Recognition

Among the various identification tasks that computers are required to perform, facial recognition is the most successful. In the past 10 years, facial recognition has become the most popular topic in research on computer vision and is the most successful technique for image analysis and understanding. Owing to the nature of the problem, computer science researchers, neuroscientists, and psychologists are interested in this subject.

Facial recognition for humans is an easy task. The experiments conducted by Turati, Macchi Cassia, Simion, and Leo (2006) showed that even children 1–3 days old can distinguish known faces. Computer devices are required to analyze all features of images then perform classification on the basis of selection categories. According to Fan, Zhang, Wang, and Lu (2012), face detection is a difficult task because of unstable characteristics, such as eyeglasses and beard, which affect the effectiveness of detection. Moreover, different types and lighting angles introduce various types of gloss and shadow areas during face detection, thereby influencing detection effectiveness. Therefore, face recognition systems have become the most focused on research subject in recent years (Fuzail et al., 2014). Face recognition involves obtaining facial features by using statistical or intellectual approaches for building a face model and comparing the level of matching between the detection area and face model. A possible facial region is then obtained. At this stage, numerous algorithms are used to identify the owner of the face.

IV. Related Work

A few empirical studies have used AI or machining learning in the education or management sector. Table I indicates that most of these studies focused on face recognition and computer vision as services for educational institutions.

TABLE I. Related Studies on Face Recognition in Educational Institutions

Author(s)	Year	Title	Objective
Fuzail et al. (2014)	2014	Face detection system for the attendance of class students	This study used real-time face detection algorithms integrated into an existing learning management system (LMS), which automatically detects and registers students attending a lecture.
Surekha et al. (2017)	2017	Attendance recording system using partial face recognition algorithm	A smart attendance capturing and management system based on current partial algorithms of face recognition was proposed to overcome the flaws of biometric attendance management systems.
Sun et al. (2018)	2018	Exploration of facial expression recognition in a distance education learning system	This study investigated how emotion can be effectively recognized by using facial expressions for future distance education learning.

V. Software Used

Computer vision is a dominant field in machine learning, and many algorithms and libraries have been developed to facilitate object detection and recognition in the real world. In this study, several libraries and algorithms were used to detect and recognize faces in real life. The following sections discuss the libraries and programming language used to achieve the main objective of the current research.

A. *Software Library: OpenCV4*

OpenCV (Open Source Computer Vision v.4) is a free computer vision library for commercial and academic use. It is an open-source BSD-licensed library that includes several hundreds of computer vision algorithms. OpenCV libraries for Python programming language enable the implementation of computer vision algorithms in real time. OpenCV's libraries have vast fields, which include 2D and 3D feature toolkits, facial recognition, gesture recognition, object identification segmentation, motion understanding, egomotion estimation and recognition, and motion tracking (Bradski & Kaehler, 2008). OpenCV libraries are originally written in C++ language, but their complexity can be reduced by using an extensive but older C language interface. OpenCV can be executed in cross-platforms, such as Linux, UNIX, and Windows. OpenCV contains libraries of predefined functions helpful in image processing (Palekar, Parab, Parikh, & Kamble, 2017). Given that OpenCV is an open source, we selected it as a platform for building and testing the present prototype system. OpenCV libraries were used to implement image processing tasks, such as erosion, dilation, and conversion from RGB to grayscale.

B. *Programming Language: Python*

A few years ago, Python became the most popular, high-level programming language in the computer vision field. Its design philosophy emphasizes code readability, and its syntax allows programmers to express concepts in fewer lines of code than is possible in other languages, such as C (Summerfield, 2007). The language provides constructs that enable clear programs on small and large scales (Kuhlman, 2009). Python also supports multiple programming paradigms, including object-oriented, imperative, and functional programming or procedural styles. It has a dynamic type system, automatic memory management, and comprehensive standard library. Python allows short code snippets to be written for each processing mechanism. It enables developers to design multi-level processing techniques. Therefore, Python is useful in the digital processing of inventory images because it can be used to write simple and easily understandable codes.

C. *Software Application: pyQt*

The graphical user interface (GUI) of the current project was developed using Qt5 libraries. Qt5 is a cross-platform application with UI libraries developed by Trolltech, and it is used for developing GUI applications (B. Harwani, 2011). Qt5 can be implemented on many platforms, such as Windows, Mac OS, and UNIX. It is also referred to as a widget toolkit because it provides widgets, such as buttons, labels, text boxes, pushbuttons, and list boxes, which are required in designing a GUI. PyQt allows designers to access all of the facilities provided by Qt through Python code. PyQt is a set of Python bindings for a cross-platform application framework that combines all of the advantages of Qt and Python (B. M. Harwani, 2018). Therefore, to build a friendly and interactive user interface, implement the Python code, and run the openCV library, we designed the GUI by using the pyQt framework.

VI. Software Application

The procedures of our project are described through a data flow diagram, and Figure 2 shows the architecture of the RTFR exam results project.

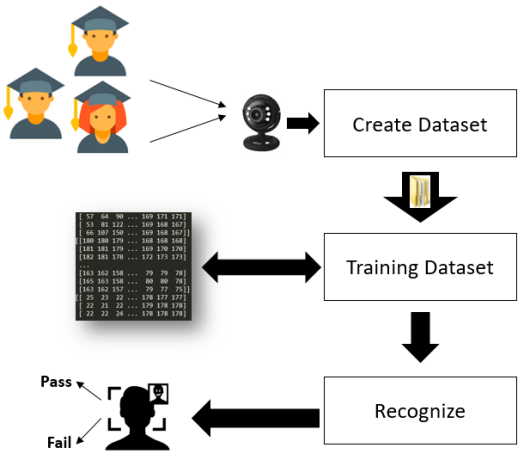

Fig. 2: Procedures of the RTFR exam results project

First, several photos of students with different facial emotions were captured for processing. The images were labeled as positive pictures and included the student's name. Each student's pictures were saved with a label and ID. This procedure facilitated the storage and identification of the exam result of the student. After pictures were captured, the images underwent a preprocessing step where various operations, such as image resizing, grayscale conversion, and image enhancement, were performed. Second, we trained the images by considering numeric vectors, and the final values were exported to a YML file called trainer.yml. After the images were trained, the system was deemed ready for face recognition. If a face was found in the trained file, the student's name would appear in addition to his/her final exam results. If a face was not in the trained file, the image displayed would be that of an unknown person.

VII. GUI Design and Implementation of the RTFR Exam Results Project

All of the elements related to the subject in this study have been highlighted. The following section describes the practical aspects of this work. As previously mentioned in the Software User Section, the current GUI was designed using PyQt designer. Fig. 3 illustrates the interface of the Qt designer and the RTFR exam result system.

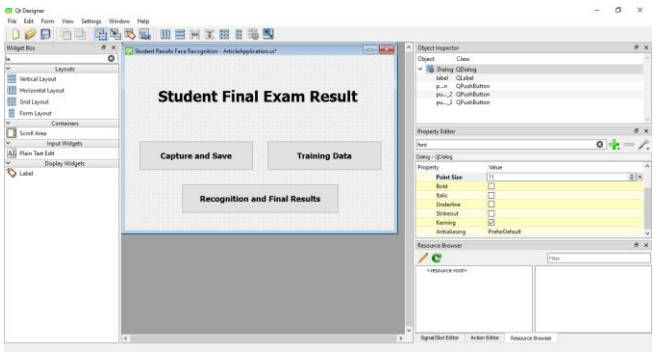

Fig. 3: GUI for the RTFR exam results system

The UI file extension was then converted to a .py file extension. This conversion is extremely important for facilitating the handling of the Python language and integrating the interface codes and OpenCV library. In the capture and save button, the system identifies the face region and saves it in the database. Approximately 40 positive images are saved for training. Fig. 4 shows how the system determines the area of the face.

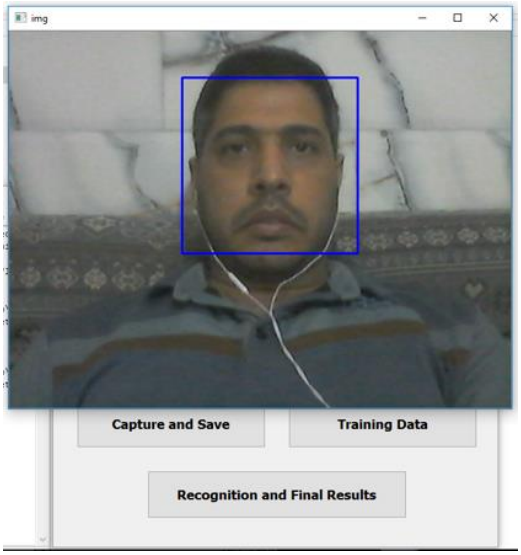

Fig. 4: Capturing and saving images

After facial images are captured and saved, data training is performed. The system determines the owner of the face, as depicted in Fig. 5; that is, the system performs detection and recognition. Finally, the student's result directly appears on the screen.

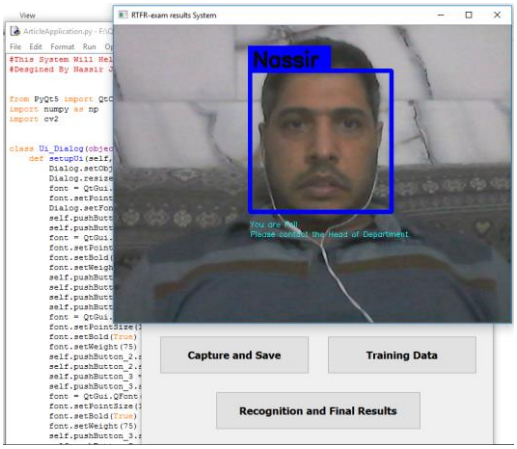

Fig. 5: Face detection and recognition

VIII. Conclusion

Recognition is a common technique in biometrics that can uniquely identify a person by extracting different facial features mathematically through the use of various algorithms. This technique has elicited widespread attention due to the high application value and great market potential.

In this study, the OpenCV4 library with Python language was utilized for computer vision, and the Qt5 framework was used to design the user interface for capturing and saving faces, training data, and recognizing and displaying the final exam results. This face recognition system is less time consuming than traditional methods of preparing and displaying final exam results for students. It merely involves asking a student to stand in front of the camera, and the results are then displayed on the screen immediately.

However, the system can be further improved in the future. We are looking to develop this project so that it can be made available via mobile applications. A student can determine his/her result just by scanning his/her face with a mobile camera, and the results would be immediately displayed.

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