A SYSTEM FOR MANAGING ATTENDANCE OF ACADEMIC STAFF MEMBERS IN UNIVERSITY DEVELOPMENT PROGRAMS USING FACE RECOGNITION

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Abstract:*The great development in all aspects of the life imposes new changes on various organizations. Since the academic institutions are not isolated from the real world events, they have sought to build an integrated strategy for developing their activities and services to keep pace with the new reality. One of the major development areas in the university sector is the improvement of the academic staff members' skills on both the leadership and academic levels through a series of certified development programs. Until now, recording the members' attendance in these programs depends on traditional manual methods which have many drawbacks. Therefore, the current study presents an automatic system based on face recognition technology to address these drawbacks.The proposed system includes five main steps: capturing member image, detecting member face, extracting facial features, comparing facial features and creating target reports. The system usefulness can be viewed form two major aspects.Aspect-1; is the accuracy rate in which proposed system achieved significant performance under ideal imaging conditions and achieved acceptable performance under un-ideal imaging conditions compared with some other systems in the same field. Aspect-2; is the cost rate in which the proposed system does not require an expensive settings, making it an appropriate choice for various educational institutions.*

Keywords:*Educational Institutions, Academic Staff Members, Development Programs, Managing Attendance, Face Recognition, Haar Cascade Classifier, Local Binary Pattern.*

1. Introduction

In educational institutions, the common methods of taking learners' attendance and generating attendance report are manually by using the traditional paper sheets or calling their names and waiting for response[1]. However, these methods are repetitive, time consuming, unreliable and inappropriate in the classroom environment with distributed branches[2]. Making use of modern technology like ID tag or other identifications can be more practical in solving such problems. Unfortunately, such methods are inadequate because they lack representation with respect to the learner's situation, status and behavior in the classroom[3]. The great progress in science leads to differentiate the human characteristics -which named biometrics- and adapting them to recognize the personal identity effectively[4]. Biometric is a set of persons' recognizing methods based on their unique physiological, behavioral and

morphological attributes. Actually, biometric features provide a number of important advantages such as[5]:

- Cannot be lost or forgotten.
- Difficult to copy, share and distribute.
- Requires the existence of the person during the authentication process.

In fact, biometric data is commonly characterized by the following features[6]:

Universality:
It means every person around the world has his own biometric traits.

Uniqueness:
It means the data should have distinctive properties to distinguish one person from another.

Acceptability:
It means the individuals' acceptance degree for applying biometric technology in different applications.

Reducibility:
It means the data can be reduced to be easily processed.

Reliability:
It means the data can't be changed in all normal cases.

Privacy:
It means the data should maintain the privacy of all the information concerning the person away from others.

Comparable:
It means the data has low similarity ratio in matching process making it more effective in the identification process.

Through the history biometric methods are varied. In the past, biometrics were based on the identification of people by their distinguishing attributes including body dimensions (height, width, weight, etc.), skin color and eye color. Today, biometrics depend mainly on fingerprints, facial features, handwriting and hand geometry, as well as on voice scan, vein scan and the scan of retina and iris[7]. However, the main problem of authentication systems based on fingerprints, voice, iris and DNA is represented in data acquisition where these characteristics require special conditions and settings during the image capturing process. On the other hand, acquiring human face image is non-intrusive, thus the face is the most acceptable and common biometric in recent authentication systems[8].

The first attempts to use face image in recognition applications began in the 1960's with a semi-automated system by setting marks on specific points of photographs to identify the major facial characteristics such as eyes, ears, noses and mouths then computing distances and ratios and comparing them with the pre-existing reference data. In the early 1970's more features such as hair color and lip thickness were used by Goldstein, Harmon and Lesk. That time it was hard to create an automated system based on face recognition technology. After that the attempts of developing face recognition automated system resumed by comparing faces to a generic face model of expected features and creating a series of patterns for an image relative to this model[9].

In general, the facial recognition process includes two major phases. In phase-1, face detection and alignment are performed. In phase-2, feature extraction and matching are performed[10,11]. Generally, face recognition applications have two forms. Form-1; is face verification/authentication where a query face image is compared with a single template of face image. Form-2; is face identification/recognition where a query face image is compared with a set of templates of face images stored in the database[12].Methods used in face recognition systems can be grouped into three main categories: template matching methods, statistical methods and neural network methods[13,14].

The remainder of the paper is organized in the following way: Section 2 discusses the background required for this research. Section 3 describes the research problem. Section 4 presents the methodology of the proposed system. Section 5 includes the implementation scenarios of the proposed system. Section 6 discusses the experimental results. Finally, the last section presents the concluding remarks and directions for future works.

2. Background

An overview about the algorithms which the proposed system based on will be discussed below.

2.1 Haar Cascade Classifier:

Over the years object detection occupies a large part of our daily lives since the humans are always searching for different types of target objects such as people, buildings and automobiles. But human perception of objects lacks of accuracy, takes a lot amount of time and requires an additional effort. This was a motivation to find other alternative methods for detecting target objects using modern technology. One of the most popular methods to satisfy this purpose is automatic object detection. Practically, designing an automatic method for detecting objects is extremely difficult since the detector must deal with both the great variation within the object category and with the enormous diversity of visual imagery that exists in the real world[15].Generally, automatic object detection aims to locate the target objects either in a still image or in a video frame[16].

Techniques for detecting objects automatically are mainly classified into three types: knowledge based methods, template matching based methods and machine learning methods. Type-1; depends on a set of rules of object structures based on the relationship between the common features of the target object to be detected. Type-2; requires a template and the detection process is based on the liaison between the images of the target object and the stored template. Type-3; requires a learning phase and the detection algorithm needs to be trained to detect the target object from the test images[17].

Another classification for automatic object detection techniques are: generative methods and discriminative methods. Type-1; consists of a model of probability with respect to the pose variability of the objects in addition to an appearance model.Type-2; builds a classifier that can distinguish between the images (or sub-images) that contain the object and those which do not[18].

In computer vision and pattern recognition the first attempts to detect object in images were based on a color distribution, but this type of detection is inappropriate for different real world applications because the lighting and other imaging conditions cannot be controlled easily specially in outdoor imagery based systems making the ability of distinguishing object colors is more difficult in actual environments[19]. Therefore, there is a need for more sophisticated methods to detect objects from images depending on the object's features or specific structures. Viola and Jones managed to develop such a superior method, which they called ''Haar Cascade Classifier'', which is based on the proposal published by Papageorgiou et al in 1998, which depended on the important image features rather than the raw data[20].

The important contribution of this method lies in the good trade-off between speed and accuracy[21] making it the most popular method for modeling complex objects such as human faces and pedestrian images[22]. According to [1], Haar Cascade Classifier can be employed effectively in face detection applications after passing four main steps: Integral Image, Haar Like Features, Adaboost Selector and Cascade Classifier as shown in figure (1).
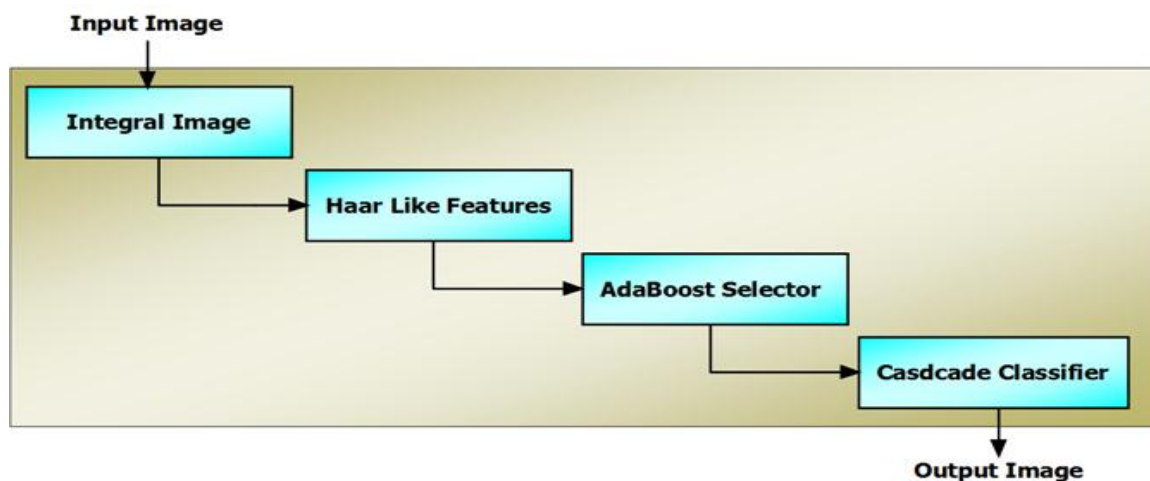

Figure. 1:Steps of Face Detection using Haar Cascade Classifier[1].

Each step in the previous figure will be explained in detail below.

Step1.Integral Image:

This step aims to create a new intermediate representation of the input image as a preliminary process to extract the like features effectively and rapidly[23]. In this representation, the integral value for each pixel in the original image is computed by adding its value to the sum of all pixels above and to the left of it[16] as illustrated in the example shown in figure (2)[17].

Original Image

5	2	3	4	1
1	5	4	2	3
2	2	1	3	4
3	5	6	4	5
4	1	3	2	6

Integral Image

5	7	10	14	15
6	13	20	26	30
8	17	25	34	42
11	25	39	52	65
15	30	47	62	81

Figure. 2:An Example of Integral Image Representation[17].

One of the major advantages provided by the integral representation is that calculation of every rectangular sum within an image can be computed with the use of an integral image by only four reference values at the corner of the rectangle[24] which improves the process of extracting features. An illustration example for calculating sum of all pixels in part D is shown in figure (3)[25].
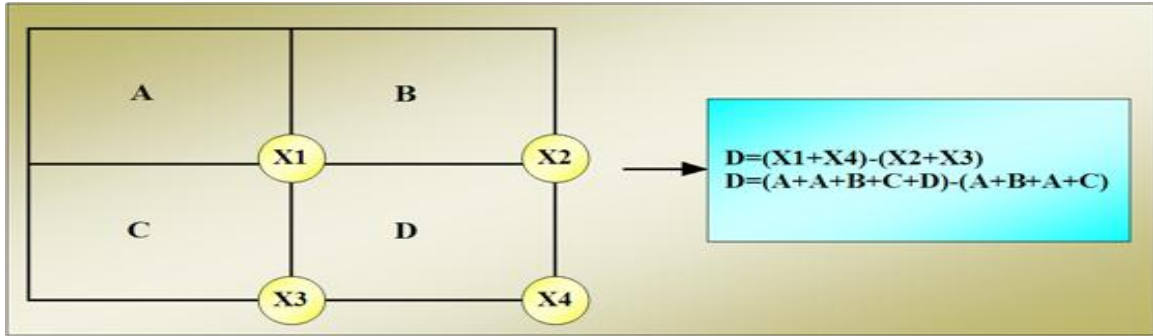

Figure. 3: Summation of Integral Image Block[25].

Step2.Haar Like Features:

This step aims to generate a large set of like features by comparing the image pixels with one of the special patterns[1] shown in figure (4) to generate 0 or 1 binary representation[16, 23, 25]. Every resulted feature represented in a single value by subtracting the sum of pixels in white part from the sum of pixels in black part[24].
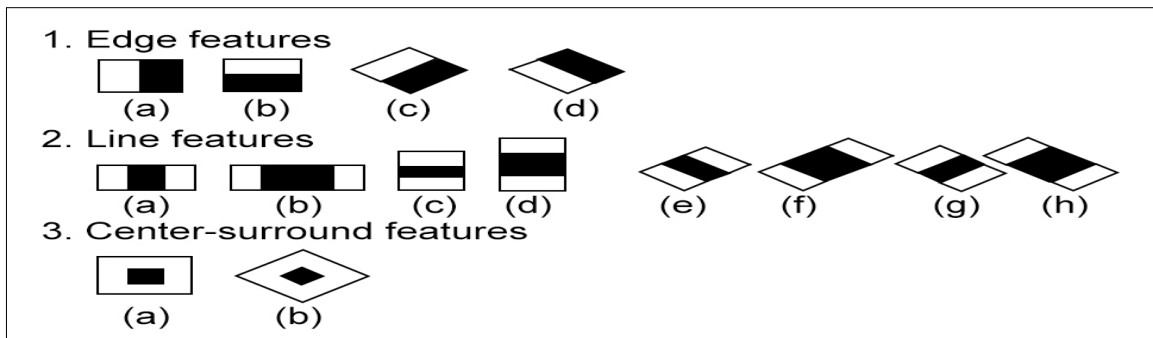

Figure. 4:Common Types of Haar Like Features[16, 23, 25].

Step3.AdaBoost Selector:

This step aims to select the best features that describe the face image among a large number of calculated features and transforming them into an appropriate classifier. Viola – Jones algorithm uses 24x24 window as a base window size to evaluate the importance of image features. Assuming the position, type and scale are the important parameters of the Haar features that will end up calculating about 160,000 features in this window, which is impractical. Therefore, the adaboost algorithm is used to select the useful features and ignore the irrelevant features. In principle, the strongest classifier uses the strongest features-which are the best Haar features- the Adaboost algorithm aims at creating a strong classifier by merging a group of weak classifiers using the following formula[26]:

$$F(x) = \alpha1F1(x) + \alpha2F2(x) + \ldots(1)$$

5

Step4.Cascade Classifier:

This step aims to scan the whole image and only detect the face image. A cascade classifier is a series of successive stages moving from weak to complex filters or classifiers. The process of detecting face image is performed by moving a window over the image and each stage of the classifier labels the area to be tested by the current location of the window as either positive, which means that the face image is found or negative, which means that the face image is not found. If the labelling of a specific area yields a negative result, this means that the classification of this area is finished with rejection and the window moves to the next location. On the other hand, if the labelling result is positive the current area is accepted and moves to the next stage, which contains a higher level of classification with complex filters. Actually, the classifier yields a final decision of positive if the target area passing all the tests successfully as shown in figure (5)[16, 17, 20].
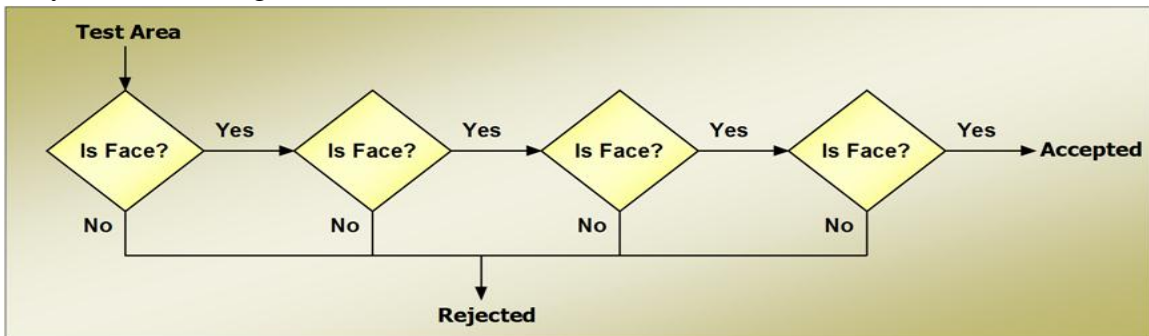

Figure. 5: Stages of Cascade Classifier[16, 17, 20].

2.2 Local Binary Pattern:

Once the object detection phase is completed, the object recognition phase starts[1]. The basic goal of object recognition is to determine the identity of a specific object from the others in the image under various conditions (background, lighting, occlusion, etc.)[27, 28]. Several image descriptors have been proposed in the literature, Local Binary Pattern(LBP) operator is one of the most powerful means of recognizing objects by describing the texture information of the image[29]. The main idea of the original LBP operator is based on labelling the image pixels with decimal numbers by thresholding the 3-by-3 neighborhood of each pixel with the center pixel value and considering the output as a binary number where its corresponding decimal equivalent is used for labelling process. Thus, the histogram of the labels can be enough to describe the image texture effectively. An illustration example of the original LBP operator is shown in figure (6)[30].
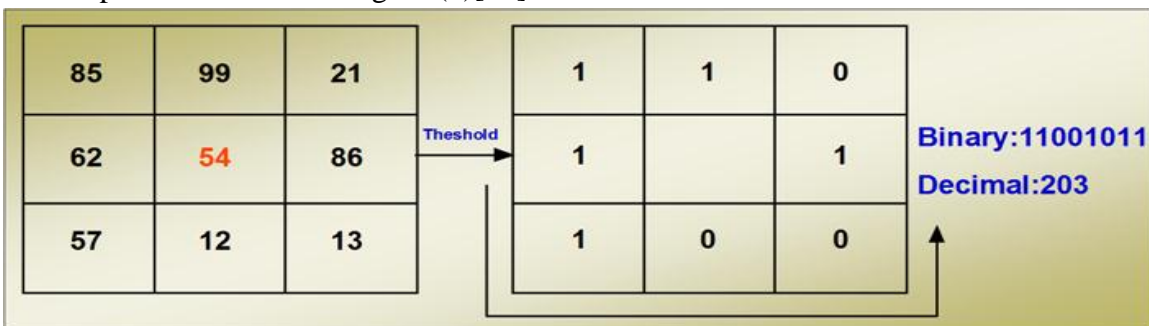

Figure. 6: An Example of Original LBP Operator[30].

The major properties of the original LBP are the high performance under monotonic illumination and the simplicity of computation[31], making it one of the recommended choices for powerful and advanced applications such as texture classification, human detection and facial recognition[32].On the other hand, the main disadvantage of the original LBP operator is the inability of its small 3x3 neighborhood to extract dominant features with large scale structures. Therefore, the operator was later developed to use different neighborhoods with respect to size for describing the image texture at different scales. A local neighborhood is a number of sampling points evenly spaced on a circle which is centered at the pixel to be labelled. The sampling points that fall outside the pixels are interpolated by bilinear interpolation, thus allowing for any radius and any number of sampling points in the neighborhood. Some examples of the modified LBP operator are shown in figure (7), where the notation (P, R) refers to a neighborhood of P sampling points on a circle whose radius is R[33].
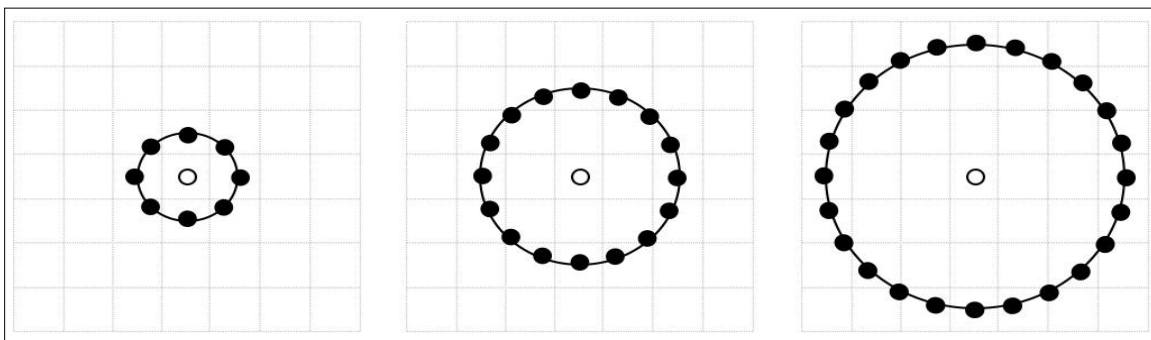

Figure. 7: Examples of Modified LBP Operator: The Circular (8, 1), (16, 2) and (24, 3) Neighborhoods[33].

According to [34], the LBP operator can be effectively employed in face recognition applications, where the face image can be divided into micro-patterns (or small regions) based on specific parameters such as shape information then the LBP histogram is calculated in two ways. In way-1; the LBP histogram is calculated over the whole image easily. In way-2; the LBP histogram is calculated for each sub-region separately then the results are merged into a single histogram, called "Overall Histogram".

3. Problem Definition

A well formulated of the research problem is one of the major challenges in the most scientific publications. Thus, the problem of the current study can be described simply and accurately as follows:
The current era is characterized by the rapid of development steps and change requirements. Also it's full of new techniques which weren't known before. That encouraged the governmental officials of the Egyptian higher education sector to develop the activities of the university community by creating special units known as "University Development Centres".
These centres have a technical, financial and administrative independence to develop the performance of the university completely including training and qualification activities, administrative and technical activities, analysis studies and research activities and evaluating all activities of sub-units and academic staff members.

These centres include a number of different units that provide a set of university services. One of the most important units is "Faculty and Leadership Development Program(FLDP)" which aims at improving the leadership and academic skills of the academic staff members by providing them a set of certified training programs which covers the most important daily activities.

In all cases, the mechanism of recording the academic staff attendance in these programs depends on traditional common methods such as manual signature in paper attendance sheet. Despite its simplicity, this mechanism is now ineffective for a number of important reasons such as:

- Requires a great effort.
- Takes a lot of time.
- Exposes the attendance sheet to damage or loss.
- Allows the academic staff members to sign for each other.
- Enables the program supervisor to edit the attendance data.

Disadvantages of manual enrollment system used in university development centres leads us to find alternative practical solutions for recording the attendance of academic staff members in development programs in various universities of Egypt.

4. System Design

To handle the real problems in traditional systems used for registering the attendance of academic staff members in university development programs, an automated computerized attendance system based on face recognition technology is proposed. According to the operation to be performed, the proposed system consists of two main parts as shown in figure (8).Part-1; aims at storing the facial information of the new members into an XML file for future facial analysis.Part-2; aims at managing the members' attendance and viewing the target reports in a simplified form.
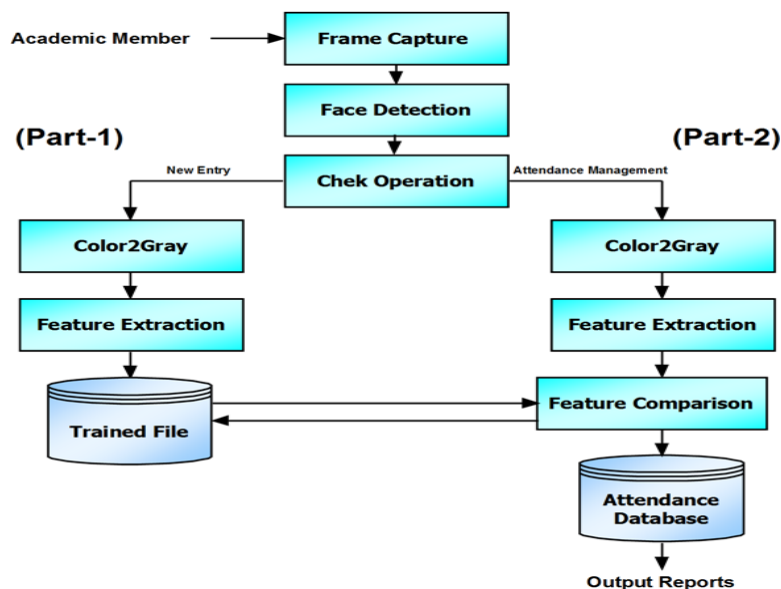

Figure. 8: Design View of Proposed System.

Because the major goal of the proposed system is to create adequate and attractive visual reports, a brief description about the entire steps for the second part of the system will be provided as follows:

Step1.Frame Capture:

The main goal of this step is to capture the source image using a high definition webcam. Practically, once the academic staff member reaches the office specified for recording the member's attendance he/she will stand/sit alone and look straight into the camera. Then his/her image is easily acquired to be the input of the system.

Step2.Face Detection:

The main goal of this step is to automatically detect the frontal member face from the source image depending on the standard key-points of human face such as eyes, eyebrows, nose, lips, etc.

Step3.Feature Extraction:

The main goal of this step is to extract only the most important features that accurately describe the main facial elements in the detected face image.

Step4.Feature Comparison:

The main goal of this step is to find the correct matching face to the test one by comparing the extracted features of each detected face with the stored features in the training dataset.

Step5.Attendance Database:

The main goal of this step is to record the daily attendance of a recently recognized member in the attendance database.

Step6.Output Reports:

The main goal of this step is to view two types of desired reports. Type-1; is the FLDP report which displays a detailed information about the academic staff members who were previously registered in a certain university development program. Type-2; is the Member report which displays a detailed information about the attendance status of a particular academic staff member in a certain university development program followed by the final attendance status.

5. System Implementation

The plan of implementing the proposed system methodology firstly requires a precise definition and description of the standard requirements needed for achieving the optimal performance. Secondly, an attractive connection mean between the end user and the system components is created.

5.1 System Requirements:

To accomplish the desired objectives of the proposed system, several special prerequisites are necessary. These prerequisites are called "recommended requirements" and are commonly identified in two types as follows:

5.1.1 Hardware Requirements:

The standard specifications of hardware requirements include:

- **Processor:** Intel® Core™ i3-370M-2.40 GHz.
- **Storage:** 500 GB Internal Hard Drive.
- **Memory:** 4GB RAM.
- **Input Device:** Internal or External Webcam, Standard Keyboard and Mouse.
- **Output Device:** 15.6-Inch HD Screen with 1366 x 768 Resolution.

5.1.2 Software Requirements:

The standard specifications of software requirements include:

- **Operating System:** Windows 7(64-bit).
- **Programming Language:** Visual C#.NET 2012.
- **Database Management System:** SQL Server 2005.
- **Framework:** Latest Versions of .Net Framework.

5.2 Implementation Scenario:

To make the proposed system user friendly, a visual representation of the system processes is designed. This representation is commonly known as "Graphical User Interface(GUI)" and aims at enabling the end user to access, interact and control the system units easily. The following figures show sample screens of the proposed attendance management system. The main screen displayed in figure (9) shows the proposed system includes three basic menus: File, Tools and Reports.
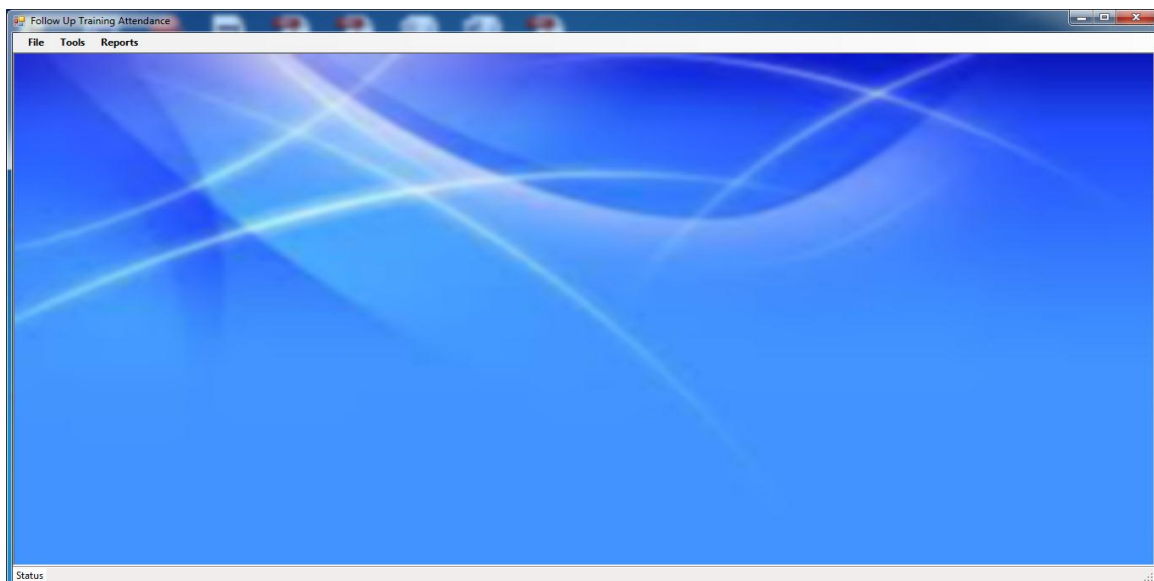

Figure. 9: Main Window of Propsed System.

Figures (10 to 12) show the major processes under file menu. In figure (10 and 11) adding a new member process is performed. In this process, the input data is stored in different data stores where the basic data of the new member is saved into the database while the important facial features of the new member are saved into the trained file.
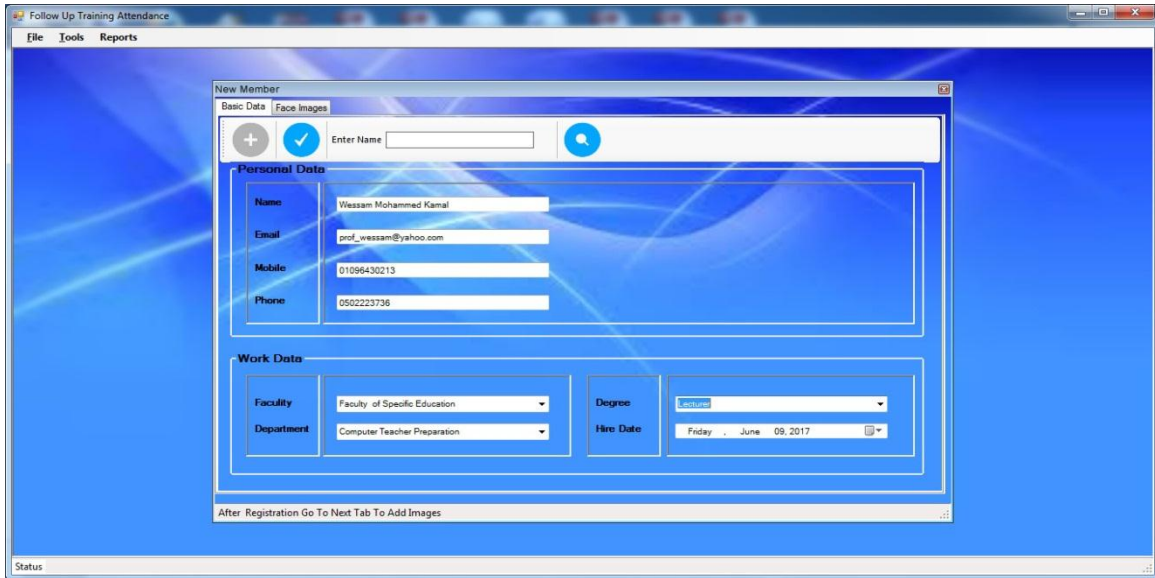

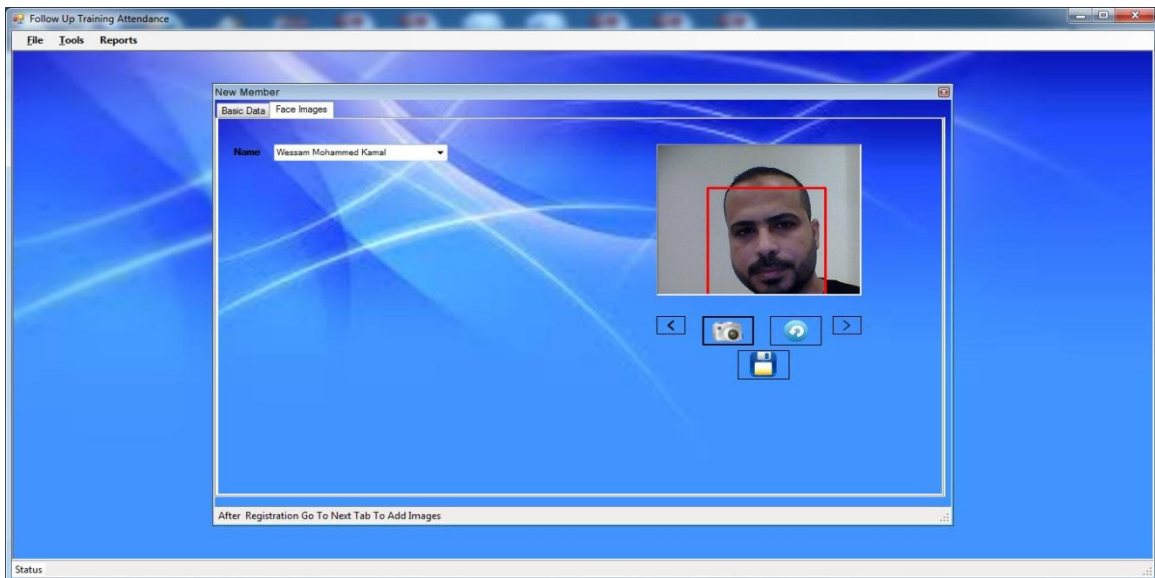Figure. 10: Window of First Step of Data Entry Process.

Figure. 11: Window of Second Step of Data Entry Process.

On the other hand, in figure (12) a new registration process is performed. In this process, the target member is registered into the desired program and the member registration data is saved into the database.
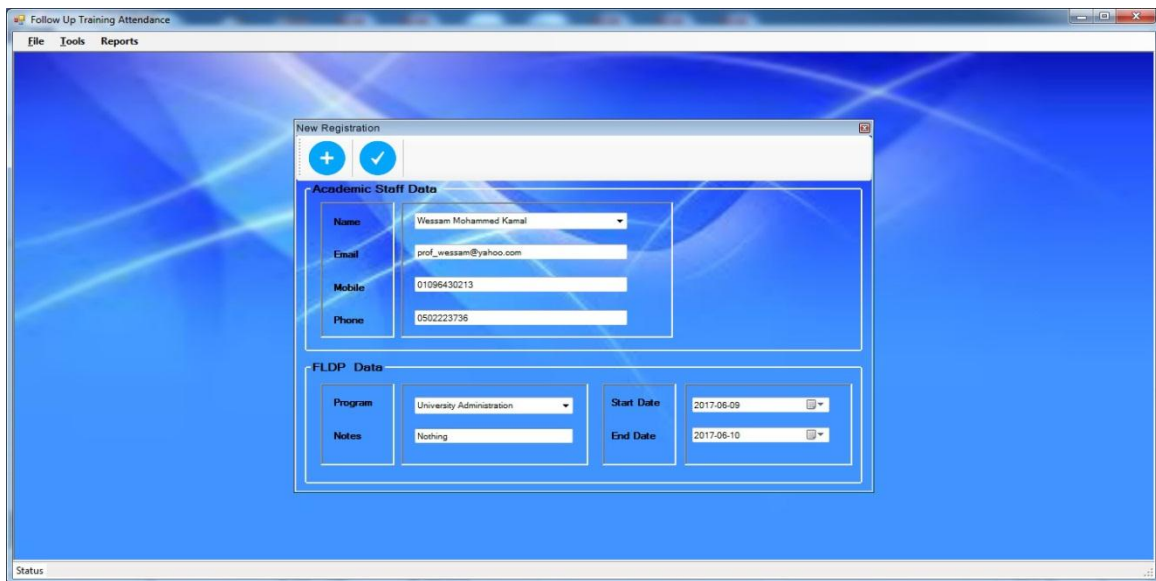
Figure. 12: Window of Registration Process.

Figure (13) shows the major processes under tools menu. In this figure the attendance management process is performed. In this process, the daily attendance of the recognized member into the selected program is recorded and the member attendance data is saved into the database.
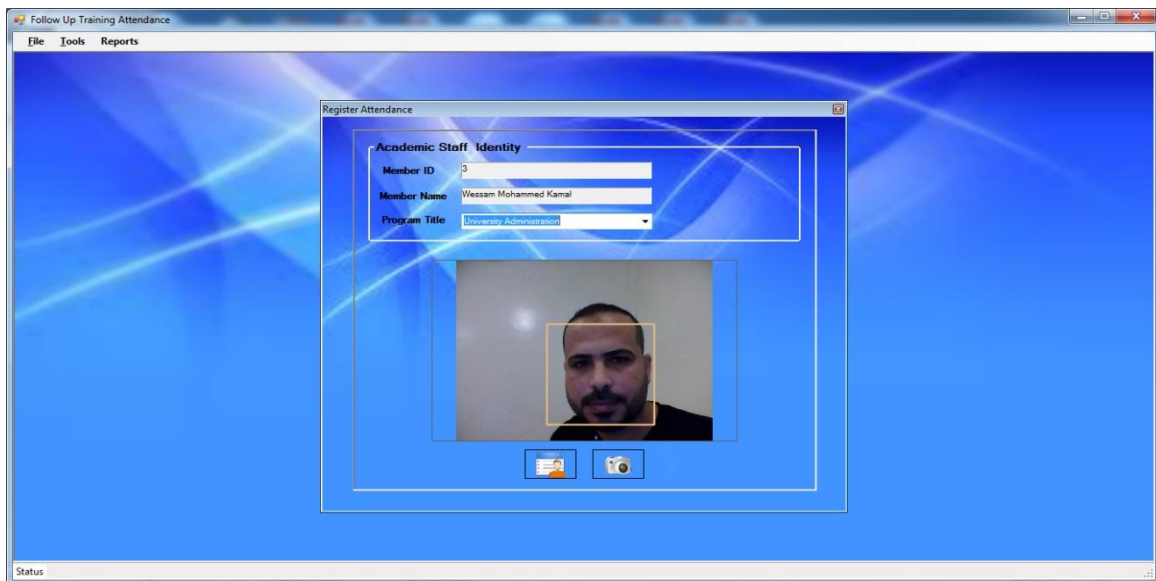

Figure. 13: Window of Attendance Mangement Process.

Figures (14 and 15) show the major processes under reports menu. In figure (14) the FLDP report is prepared and viewed. In this report, the data of all registered members into the requsted development program retrieved from the database and visually displayed.
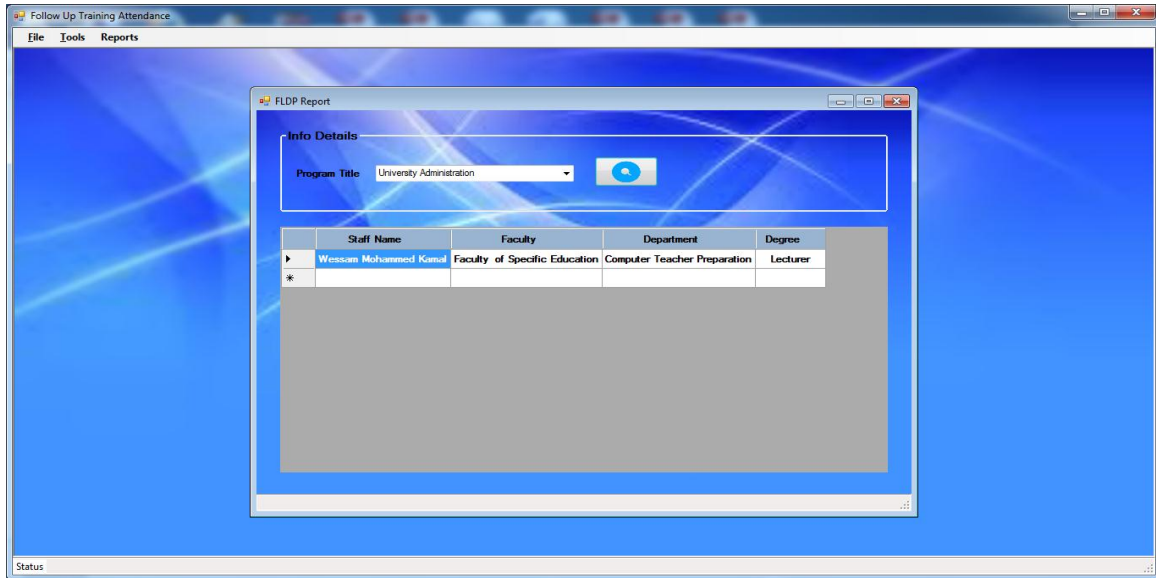
Figure. 14: Window of FLDP Report.

On the other hand, in figure (15) the Member report is prepared and viewed. In this report, detailed information with conclusion about the attendance of a single member into the requsted development program retrieved from the database and visually displayed.
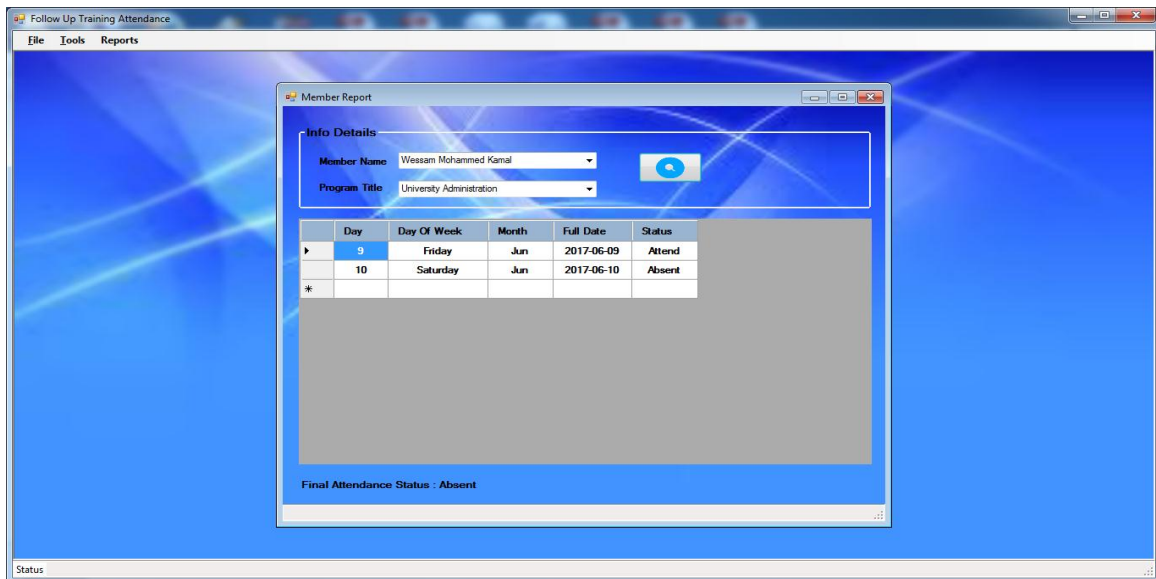

Figure. 15: Window of Member Report.

6. Results and Discussion

The practical implementation of a stand alone attendance management system with face recognition in academic organizations involves two early stages. In stage-1, the initial sample of training dataset is prepared by extracting the significant facial features from a large set of input images. In stage-2, the

system performance efficiency is evaluated by performing several experiments and the obtained results are presented in a tabular form followed by the analytical comments.

6.1 Experiment Settings:

To test the proposed system, a preparation of training dataset is prerequisite. Therefore, a dynamic XML file is created and used as a training dataset which initially includes the important relevant facial information of a larg numer of academic staff members.In practice, each member initially is represented by ten facial images in different forms for better performance.Moreover, all initial facial images are characterized by three main characteristics. Characteristic-1; the intial images are taken under similar lighting conditions. Characteristic-2; the intial images are normalized to align the meaningful parts of the human face like eye, nose, ears, mouth, etc., in the same position.Characteristic-3; the intial images are resampled to the desired level of image resolution.

6.2 Experimental Results:

The primary evaluation of the proposed system is carried out through several experiments on a set of academic staff members at Mansoura university. The test sample is divided into two groups according to imaging conditions such as lighting level, head orintation, distance from the camera, etc. Group-1; includes a number of intentionally selected face images that are captured in ideal imaging conditions. Group-2; includes a number of randmoly selected face images that are captured under unsuitable imaging conditions.The experimental tests are directed to measure two common factors: detection accuracy rate and recognition accuracy rate.The results of all experiments are recorded, organized, summarized and shown in table.1.

Table. 1:Performance Evaluation of Proposed System.

Test Set	Detection Accuracy Rate (%)	Recognition Accuracy Rate (%)
Group-1	100%	98%
Group-2	92%	87%

The above results show that with ideal imaging conditions the proposed system achieved a perfect performance on the level of detecting members' faces and achieved a nearly perfect performance on the level of recognizing members' identity. The results also show that the ability of the system to achieve superior levels of face detection and recognition negatively affected by the un-ideal imaging conditions. The obtained results under un-ideal imaging conditions agreed with the results obtained from the published study in [9], where the empirical results in this study indicate that increasing the face angle according to the camera decreases the accuracy rate of face detection and recognition dramatically.
Finally, the proposed system efficiency is evaluated by comparing it with some other systems that cover the same research area.The comparison procedures concluded that the overall results by the proposed

system are better than the overall results presented in [1], because the latter achieved an overall efficiency up to 83.2% which is less than what the proposed system achieved clearly.

7. Conclusion

Promotion rules in Egyptian universities impose the university development programs as one of the basic requirements for the promotion to the next higher scientific grade. This motivates the academic staff members to attend the "FLDP" required for each scientific degree (6 programs per degree). During my attendance of these programs since 2007, several interesting problems related to the manual system used for managing the members' attendance were observed. Therefore, an automated computerized system based on face recognition technology has been proposed. The proposed system uses "Haar Cascade Classifier" algorithm in face detection step and "Local Binary Pattern" algorithm in face recognition step. The results of preliminary experiments show that the proposed system achieved significant performance under ideal imaging conditions and achieved acceptable performance under unsuitable imaging conditions compared with some other systems in the same scope.

Future work will focus on developing the current system for monitoring and evaluating the member activity rate every specific period of time (e.g.15 minutes) during the implementation of the university development programs not just recording the member attendance at the beginning. The future development strategy will depend on a continuous monitoring system using a high definition rotating camera-based microcontrollers. The captured images by the camera are transmitted to the performance analysis unit for measuring the member activity rate in the classroom either by a set of pre-defined criteria or by a performance appraisal form introduced by the program supervisor. Finally, the new form of the target reports are generated.

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