Wireless Personal Communications (2020) 113:469–480
https://doi.org/10.1007/s11277-020-07224-2

Real Time Automatic Attendance System for Face Recognition Using Face API and OpenCV

Sikandar Khan[1] · Adeel Akram[1] · Nighat Usman[2]

Published online: 31 March 2020

Abstract
Traditionally, the attendance of students has been a major concern for the colleges and the faculty has to spend a lot of time and is a tedious job to mark attendance manually. Current biometric attendance system is not automatic that's why wastes a lot of time, difficult to maintain and requires a queue for scanning fingerprints to mark their attendance. In Modern era everyone has Smartphone and connected via internet every time. In this paper attendance monitoring will be done through smart phone available with almost all faculty members. Some of popular object detection algorithms are back propagation neural network, region based convolution network (RCNN), faster RCNN, single shot detector. Our unified structure is based on YOLO V3 (You only look once) algorithm for face detection and Microsoft Azure using face API for face recognition (face database). The unique part is camera installed in classroom will take picture twice one at the start and one at the end to ensure students has attended complete class. YOLO V3 will first count the students in an image followed by identifying faces as known and unknown generating spreadsheets separately and an email is send at the end of month to students, parents and faculty. The designed system performs efficient in real time implementation for counting and detection. Our entire system has proven to gather high accuracy in face detection and performance.

Keywords Convolution neural network (CNN) · RCNN · Darknet · Face database · YOLO V3 (You only look once) · SQlite 3

✉ Sikandar Khan
sikandarkhan@cuiatd.edu.pk

Adeel Akram
adeel.akram@uettaxila.edu.pk

Nighat Usman
nighatusman03@gmail.com

[1] Department of Telecom Engineering, UET, Taxila, Pakistan

[2] Department of Computer Sciences, BULC, Lahore, Pakistan

1 Introduction

Maintenance of attendance in all institutions is an important task for checking the student performance in a month and for whole semester [1]. Attendance of students has an important role in performance, regularity towards studies, less delinquent or having destructive behavior [2, 3]. A regular absentee increases failures of students and early dropout [4, 5]. Maintaining attendance manually is in efficient approach due to below reasons:

1. Takes a lot of lecture hours
2. Susceptible to proxies

Every institute or college has its own mechanism for taking attendance. One of the old systems is file, register or paper based approach and some adopts updated method like biometric techniques. Attendance monitoring is a tedious task for faculty as at the end of every month is the duty of faculty to generate attendance for every student, so we introduced a new paradigm to reduce the workload of faculty and automate the process of attendance system. In our system we take advantage of the existing cameras which are installed for security purposes we suggest to use camera in classroom to take images of the students present in class two time one at the start and one at the end of class, subsequently detecting students and identifying them in the image for making their attendance respectively. As it is done automatically so it saves a lot of time for both students and faculty without chance of error.

For detection of faces we are using YOLO V3 algorithm which is basically used for detection of objects almost 9000 objects [6], but in our work we tuned it for detection of faces. Counting is also done via YOLO V3 and system informs us about the number of students present in a class. After that recognition of faces is necessary which is done by using Azure face API that works on facial features to detect and confidently recognize a face for identification. After that face database will match the data of all students and generate a spreadsheet for the specific time and date, attendance will be marked for every student. By doing this practice at the end of every month a report is generated and system will notify through email every student, parents and faculty about their attendance of the month. Without much human interference automatically attendance monitoring can be achieved. Figure 1 shows Block diagram of proposed system.

2 Related Work

Today technology progress is at a faster rate and devices are shifting towards automation. As a result is rapid progress with respect to software technology [7]. There are multiple types of monitoring and taking attendance applied in companies, industries and institutes.

Most of the time attendance of students is taken on attendance sheet or register given to faculty members [8]. It takes a lot of time and work. We are not sure whether authenticated student has responded or not, it also causes manual errors. Also attendance sheet can be lost or stolen by some students [9].

Other biometric system consists of fingerprint identification [10]. Utilizing this method first fingerprint of each student is collected and it is stored in database that is finger print sensor. After this the finger print is matched with the database and attendance is marked so,

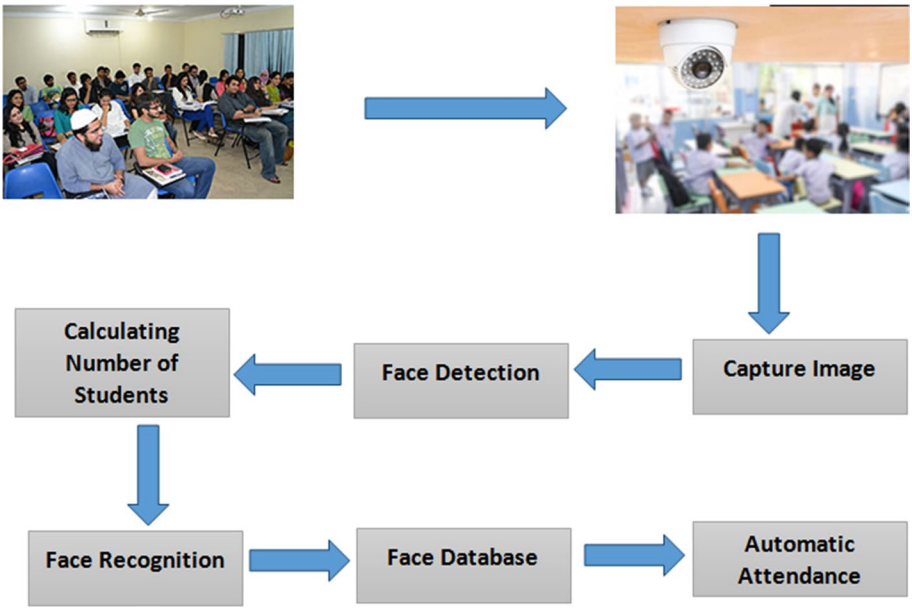


Fig. 1 Block diagram of proposed system

but its main disadvantage is students have to make a queue and wait for their turn which is a lot of work and consumes much time also if the finger print does not recognized properly by the system attendance will not be marked so it is not efficient.

Other biometric system available is detection of Eye ball in which sensor is eyeball, blinking rate and location of iris is sensed. In this system first iris or eyeball for each person is stored in database eyeball is not same for every person. In obtained image eye ball is compared with eyeball in database and attendance is marked, but practically it is impossible to capture eyeball of each student in an image.

Another solution is RFID based attendance system [11]. Every student has its RFID tag and as it passes through RFID reader it mark its attendance. But tag reader is time consuming; also chance of misuse of cards is one student can mark multiple attendance of missing students too.

To overcome above scenarios advanced system to mark attendance is using cameras to capture images of a classroom. Recently image processing is used to extract useful information for an image to mark attendance. As smart phones are becoming popular among people, to use the existing devices without making a dedicated setup to mark attendance from an image attendance is marked. Almost face of every student is unique but may have resemblance in certain features with other person.

There are multiple systems created specifically for face detection and recognition for making attendance system each has certain drawbacks. One way is back propagation neural network (BPNN) and Viola-Jones algorithm. BPNN, uses two weighted propagation one is forward in which input is fed through network to generate output propagation activation and in backward feedback is formed by taking output as input in order to create difference among actual output and target.

Viola–Jones algorithm uses Haar feature selection that matches common features in human faces leading to high chances of inaccuracy. Another approach is Histogram

normalization, Skin classification and Noise filtering using MATLAB. Problem in such system is it is restricted to inbuilt feature of MATLAB.

Deep neural network (DNN) used for face recognition. DNN used Deep face model that tends to be human level accurate taking multiple set of images for its training. Major problem is its requirement of large dataset for training which is not possible to store a big number of images for each student.

We will use a unique combination of YOLO V3 algorithm along with Azure face API for our system to mark attendance automatically that saves time with accuracy in real time environment.

3 System Description

The whole scenario of developing our entire attendance system is we have separated it into multiple stages. First stage is development for face detection module. Next stage is training module that can train itself which is based on input images of a user. This system is followed by face recognition module. The proposed system in this paper is hosted on Tkinter based web application with SQlite 3.

It is already mentioned in Introduction part that face detection and face recognition will be executed with the help of YOLO V3 algorithm and Microsoft Azure face API respectively. Necessary part is to note that actually these are part of convolution neural network (CNN) [12]. Deep understanding of convolution network will give support in deployment of these mentioned modules.

3.1 Convolution Neural Network

CNN is a Deep Learning Algorithm that takes images as an input, gives importance to certain features in image and creates differences among various objects in an image from each other [13]. CNN is been inspired due to connectivity pattern of human nervous system. They are build of neurons along biases and learnable weights. Multiple inputs are accepted by each neuron, weighted sum of all inputs is directed for an activation function resulting in the output. Basically convolution is sliding filter on an image and taking dot product along its way while sliding. Therefore results a scalar quantity. We take input as tensor in CNN which is multidimensional matrix of a number. Convolution layers over tensor input are the major building blocks in CNN. Every layer depends on an unconstrained filter which is achieved by convolution of filter with image. Filters are arbitrary initialized; we make them our parameters by training the network multiple times. In initial layers the filter depicts some basic level of features like colors, edges, gradients etc. While going deep in Convolution layers we sort out high level of features that gives us a system having complete knowledge of the image.

3.2 YOLO Algorithm for Face Detection

Object detection algorithm is broadly distributed into two groups. First group is algorithm based on classification which works in two stages. First stage is selection of regions of interest in the image and after this during second stage classification of those regions occurs with support of CNN [14].

Some of the common examples for such algorithm is FAST R-CNN and Region based R-CNN. Fast R-CNN algorithm is regression based. In this algorithm we are not selecting interesting part in the image besides we like to predict classes along bounding boxes for whole image doing it in a single step. R-CNN with its family does not look into whole image, the attractive part is looking into those part of an image which has maximum possibility of having an object in it. As R-CNN is accurate, but its flaw is its highly slow and end-to-end object detection is not done completely. Single stage detectors (SSD) is also not accurate as two stage detectors (TSD) but it is quiet faster. YOLO is a better paradigm for single stage detector, R-CNN processing speed is very less only 5 FPS on a GPU and YOLO Algorithm processing speed is very high up to 45 FPS on a GPU [15]. Yolo takes an input image after which image is separated into square grids by YOLO frame work. In the image Localization and classification is applied across each square grid. At last YOLO predicts bounding boxes with class probabilities for object detection of object is founded [16, 17].

Presently we have three main implementations in YOLO. Darkflow, Alexery/Darknet and Darknet each along with its pros and cons. Darknet official implementation has been developed by people who are behind this algorithm. It is been written in programming language C with support of CUDA that is parallel computing architecture. Which strength computing performance for Darknet by utilizing greater power from GPU.

In our work we used Darknet's pre trained YOLO V3 model. Researchers can also made their model and train it according to the objects they want in detection.

4 Experimental Results

Entire process of developing automatic attendance system in detail is explained in this section. System consists of Ubuntu 2.6.0 LTS over which OpenCV 2.0 runs. Program is developed in Python 3.0 for the algorithm and implementation in real time. YOLO V3 (You look only once) is used in our system to predict and detect faces in an image. Tkinter is Python interface to build GUI and SQlite 3 is for interacting with database. Tkinter and SQlite 3 libraries comes with standard in Python Library.

To automate attendance system cameras are installed in classrooms to capture images at the start of class and before ending the class. When an image is taken two major tasks are performed over it. First module is counting of students via YOLO V3 in an image whether known or unknown. Second module is recognition of person in an image using face API of Microsoft Azure.

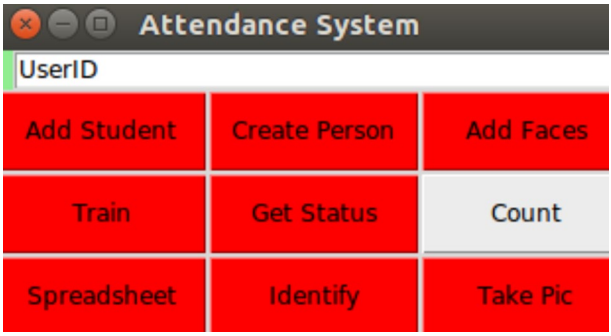
In first stage picture is taken by already cameras installed in a classroom to cover all students. YOLO algorithm detects all faces within an image by marking with a rectangle or square. Counting is done in an image in real time environment as shown in below Fig. 2 along with its GUI in Fig. 3.

After performing counting as shown in above Fig. 4, spreadsheet is generated separately for both known (recognized) and unknown (unrecognized) students, which updates automatically daily with date and time as per requirement. Spreadsheet is shown in below Fig. 5.

Next module is to recognize present students shown in Figs. 6a–d and 7 respectively, in a classroom for which we have written a program in Python 3.0 for registration we first add a student by its Name and allotting Roll Number to student. Up to 600 roll Numbers can be allotted to a specific group of class which is quite enough. After which we add data of student

Fig. 2 Image captured in classroom

Fig. 3 Graphical user interface for attendance system



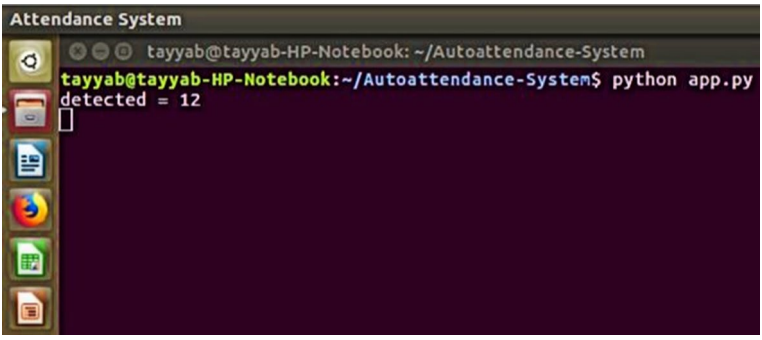


Fig. 4 Detection of faces in image

over Microsoft Azure Cloud and specific ID is generated. To create Database for recognition picture of student is taken it can be SSD (Single Shot Detection) and flexible to take large set of picture to have high accuracy shown in Fig. 8. In over scenario we have taken 20 pictures of each student for training. Once registration is completed and database is created we have

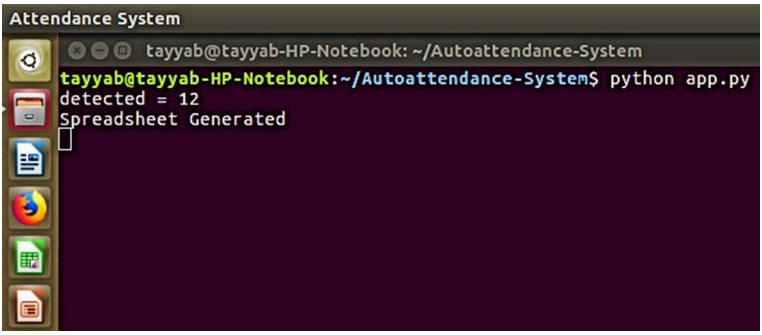


Fig. 5 Attendance spreadsheet generation for students

to identify or recognize a student in a class for making attendance for that face API is used. The results achieved with this system are quite accurate. Some test cases are shown below in Table 1.

Algorithm for Face Recognition in Automatic Attendance System

The algorithm shows step by step working principle of the proposed system, elaborated as below in Fig. 9.

Steps of Proposed System:

Input: Camera captures class room image
Output: Accurate attendance marking
Step 1: Start
Step 2: Add by Name and assign Roll Number to student for face database.
Step 3: Install camera in classroom
Step 4: Image taken through camera
Step 5: Face Detection
- I. Select region of interest in image
- II. Crop faces of student in an image
- III. Counting is performed by YOLO V3
- IV. Separate spread sheet generated for known and unknown student

Step 6: Face Recognition
- I. Compare cropped faces with images in face database
- II. Face API recognizes students

Step 7: End

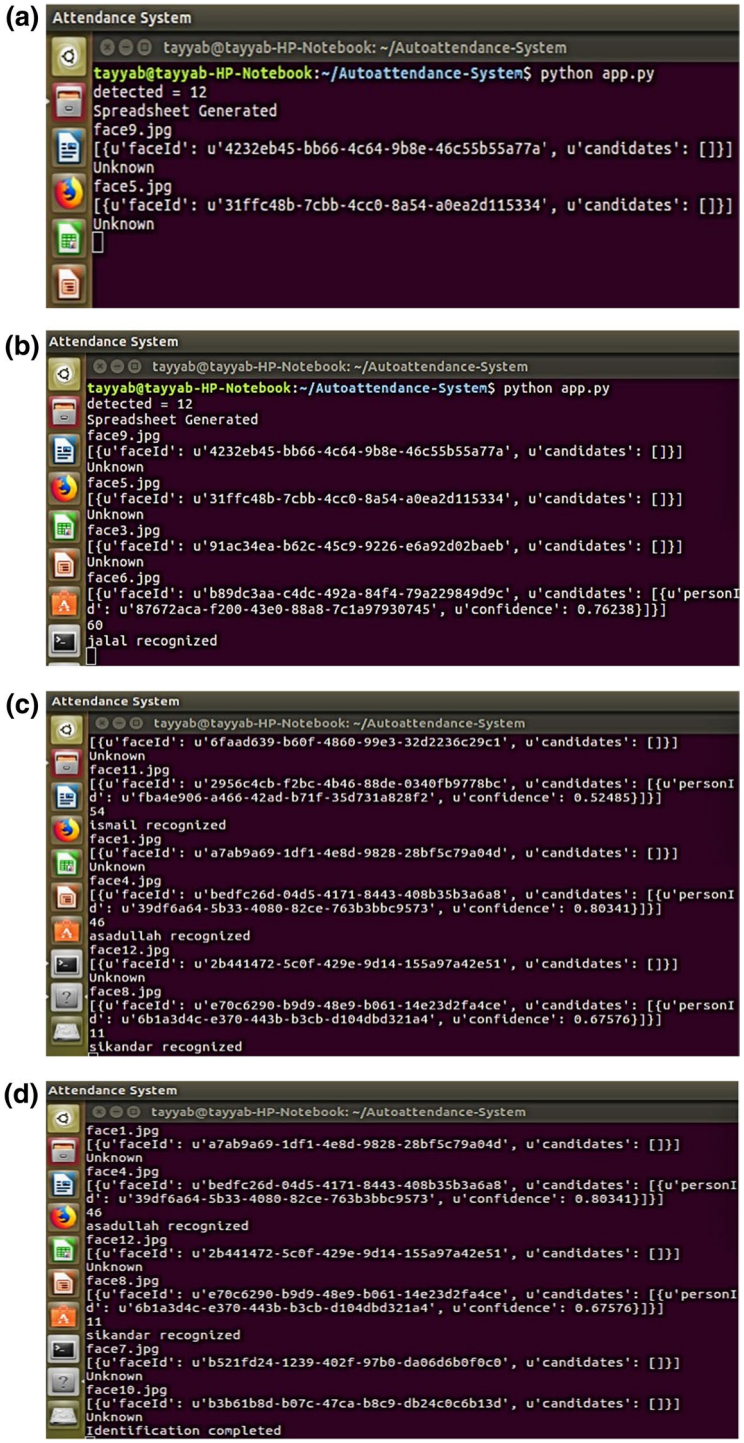
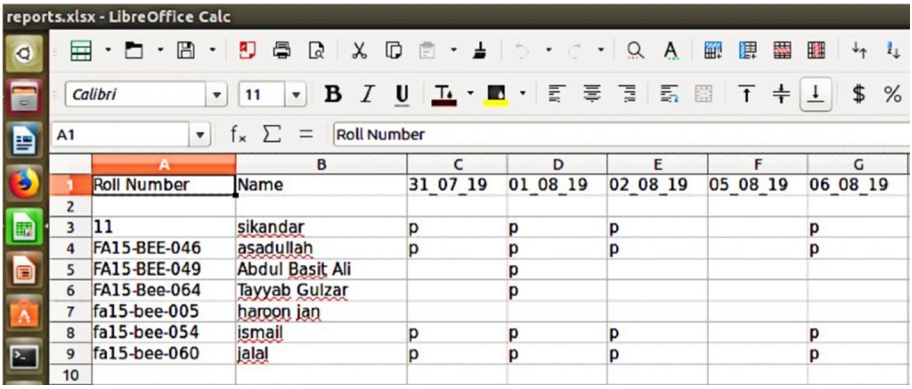
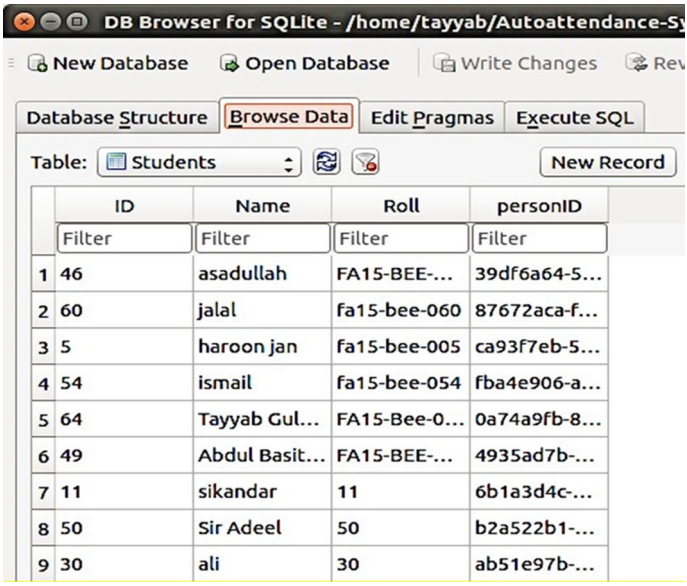


Fig. 6 **a–d** Identification of known (recognized) and unknown (unrecognized) students



	A	B	C	D	E	F	G
1	Roll Number	Name	31_07_19	01_08_19	02_08_19	05_08_19	06_08_19
2							
3	11	sikandar	p	p	p		p
4	FA15-BEE-046	asadullah	p	p	p		p
5	FA15-BEE-049	Abdul Basit Ali		p			
6	FA15-Bee-064	Tayyab Gulzar		p			
7	fa15-bee-005	haroon jan					
8	fa15-bee-054	ismail	p	p	p		p
9	fa15-bee-060	jalal	p	p	p		p
10							

Fig. 7 Spreadsheet of present and absent students



	ID	Name	Roll	personID
	Filter	Filter	Filter	Filter
1	46	asadullah	FA15-BEE-...	39df6a64-5...
2	60	jalal	fa15-bee-060	87672aca-f...
3	5	haroon jan	fa15-bee-005	ca93f7eb-5...
4	54	ismail	fa15-bee-054	fba4e906-a...
5	64	Tayyab Gul...	FA15-Bee-0...	0a74a9fb-8...
6	49	Abdul Basit...	FA15-BEE-...	4935ad7b-...
7	11	sikandar	11	6b1a3d4c-...
8	50	Sir Adeel	50	b2a522b1-...
9	30	ali	30	ab51e97b-...

Fig. 8 Face database with SQL log

Table 1 Accuracy results for face detection

Test cases	Image	Students count	No of Stds known	No of Stds unknown	False recognition (%)	Accuracy (%)
Case 1	2 person	2	2	0	0	100
Case 2	4 person	4	2	2	0	100
Case 3	7 person	7	3	4	0	100
Case 4	10 person	10	4	6	0	100
Case 5	11 person	11	4	7	0	100
Case 6	12 person	12	5	7	0	100

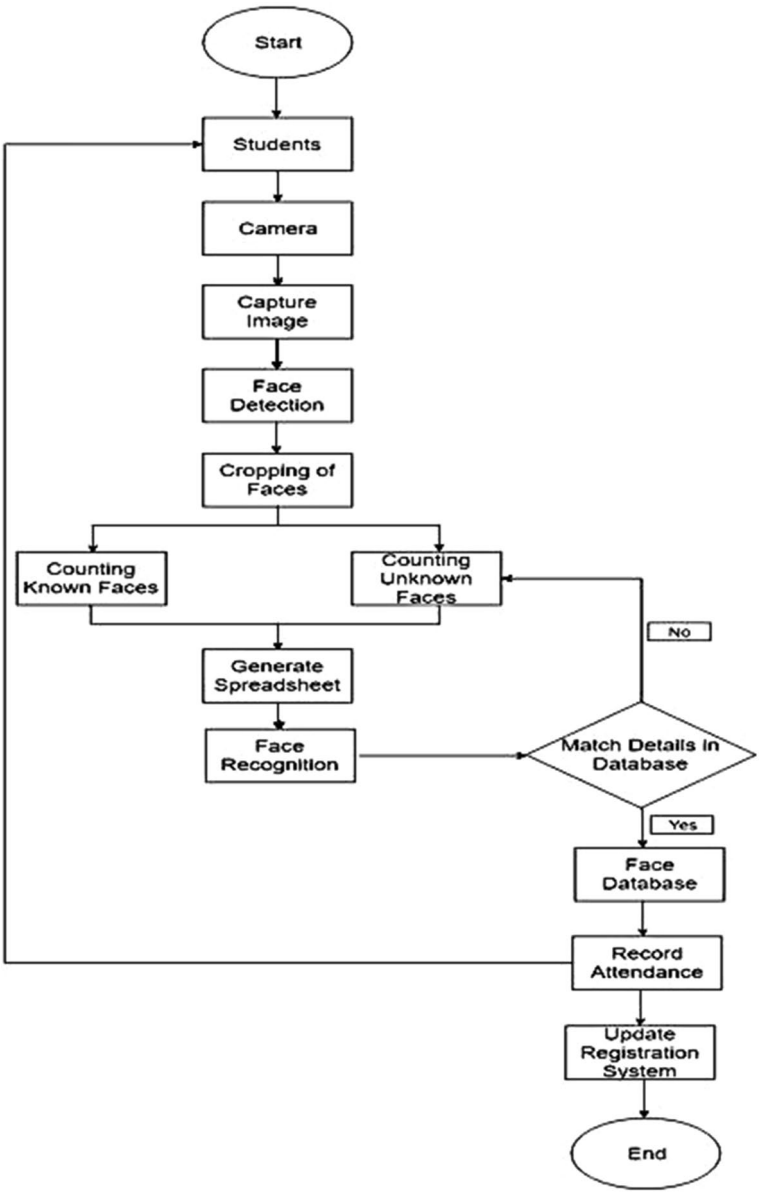


Fig. 9 Flowchart for proposed system

5 Conclusion

A system is designed and implemented in real time environment to automate and monitor attendance system. Major goal behind taking attendance automatically is to rectify drawback in conventional method which is time consuming, that causes proxy attendance and wastage of paper. In this work we tried to eradicate all challenges and attendance will be

marked using camera in a classroom. Counting of students is done and faces are recognized in image to mark attendance automatically.

There are various types of seating arrangement, environment and lightning condition in different classroom. Most conditions are tested and system shows 100% accuracy in most cases. In a classroom student may portraying different facial expressions beard, spectacles, varying hair styles etc. all cases are tested and obtained high efficiency and accuracy. Thus concluded from above discussion is that our proposed system is cost effective, secure, reliable, fast, better and efficient module is developed to replace unreliable and manual system.

Acknowledgement The authors are thankful to Ms. Nighat Usman for the valuable reviews, suggestions, and comments.

REFERENCES

1. Fawaz, A. (2019). A smart classroom of wireless sensor networks for students time attendance system. In *IEEE integrated STEM education conference (ISEC)*.
2. Helmi, R., Yusuf, S., & Jamal, A. (2019). Face recognition automatic class attendance system (FRACAS). In *IEEE international conference on automatic control and intelligent systems (I2CACIS 2019)*, Selangor, Malaysia, June 29, 2019.
3. Xing, Y. (2019). A class attendance system based on SL4A. In *IEEE 4th international conference on cloud computing and big data analytics*.
4. Mijić, D., Durutović, J., Bjelica, O., & Ljubojević, M. (2019). An improved version of student attendance management system based on RFID. In *18th international symposium INFOTEH-JAHORINA*, March 20–22, 2019.
5. McCluskey, C. P., Bynum, T. S., & Patchin, J. W. (2004). Reducing chronic absenteeism: An assessment of an early truancy initiative. *NCCD News, 50*(2), 214–234.
6. Li, J., Gu, J., Huang, Z., & Wen, J. (2019). Application research of improved YOLO V3 algorithm in PCB electronic component detection. *Applied Sciences, 9,* 3750. https://doi.org/10.3390/app9183750.
7. Arsenovic, M., Sladojevic, S., Anderla, A., & Stefanovic, D. (2017). FaceTime—Deep learning based face recognition attendance system. In *IEEE 15th international symposium on intelligent systems and informatics*. University of Novi Sad, SISY 2017, September 14–16, Subotica, Serbia.
8. Varadharajan, E., Dharani, R., Jeevitha, S., Kavinmathi, B., & Hemalatha, S. (2016). Automatic attendance management system using face detection. In *Online international conference on green engineering and technologies (IC-GET)*.
9. Shoewu, O., & Idowu, O. A. (2012). Development of attendance management system using biometrics. *The Pacific Journal of Science and Technology, 13*(1), 300–307.
10. Yadav, V., & Bhole, G. P. (2019). Cloud based smart attendance system for educational institutions. In *2019 international conference on machine learning, big data, cloud and parallel computing (Com-IT-Con), India*, Feb 14th–16th, 2019.
11. Albuhairi, T., & Altameem, A. (2019). Using RFID technology in vaccination cards for Saudi children. In *First international conference on sustainable technologies for computational intelligence*, pp. 125–137.
12. Das, S. (2017). *CNN architectures: LeNet, AlexNet, VGG, GoogLeNet, ResNet and more* ….. Medium, November 16, 2017 [Online]. Retrieved September 22, 2018 from https://medium.com/@sidereal/cnns-architectures-lenet- alexnet-vgg-googlenet-resnet-and-more-666091488df5.
13. Zhao, Z.-Q., Zheng, P., Xu, S., & Wu, X. (2019). Object detection with deep learning: A review. *IEEE Transactions on Neural Networks and Learning Systems, 30*(11), 3212–3232.
14. Rosebrock, A. (2018). YOLO object detection with OpenCV. *Py Image Search*. Retrieved December 20, 2018.
15. Maj, M. (2018). What is object detection? Introduction to YOLO algorithm. *Appsilon Data Science.* Retrieved December 18, 2018 from https://appsilon.com/object-detection-yolo-algorithm.
16. Geethapriya, S., Duraimurugan, N., & Chokkalingam, S. P. (2019). Real-time object detection with Yolo. *International Journal of Engineering and Advanced Technology (IJEAT), 8*(3S), 1–4. https://www.ijeat.org/wp-content/uploads/papers/v8i3S/C11240283S19.pdf.

17. Kim, C., Lee, J., Han, T., & Kim, Y.-M. (2018). A hybrid framework combining background subtraction and deep neural networks for rapid person detection. *Journal of Big Data, 1,* 1. https://doi.org/10.1186/s40537-018-0131-x.

Sikandar Khan received the B.Sc. degree in Telecommunication Engineering from UET Peshawar, Pakistan in 2009, the M.Sc. degree in Telecommunication Engineering from UET Taxila, Pakistan in 2013. He is currently doing his Ph.D. from UET Taxila and research area is Internet of Things (Software defined Network).

Adeel Akram B.Sc. Electrical Engineering, UET Lahore, CE&ME (Campus), Rawalpindi, Pakistan in 1995, the M.Sc. degree in Computer Engineering, NUST, College of E&ME, Rawalpindi, Pakistan in 2009 and the Ph.D. degree in Electrical engineering, UET Taxila, Pakistan. He is currently Dean/Professor, Faculty of Telecommunication and Information Engineering in UET Taxila. His research interests are Wireless and Mobile Communication, Adhoc Networks and Internet of Things.

Ms. Nighat Usman is currently working as a Lecturer in the Department of Computer Sciences at Bahria University Lahore Campus since January, 2018. Prior to that, she did Masters in Information Security from CIIT Islamabad campus in the batch of 2015–2017. She has published a research paper in the domain of IoT. Furthermore, She has gained a pretty good knowledge regarding IBM QRadar, OSSIM, Elasticsearch. She was rewarded with an Award by Trillium Pakistan for her research contribution in rule mining technique for profiling log behavior.