Visitor Management System using Convolutional Neural Network

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Abstract **- In this era of the 21st century, the Visitor Management System is very important in almost all the organizations. Visitor management is principal for any organization because it helps to keep a system of record for the visitor. The organization should have the right system to know who's in the facilities, when did they come there and the purpose behind their arrival. However, the information of visitors is recorded manually by either the visitor or the guard using the conventional paper log or guest book when the visitor arrives at the guard house and this physical process takes an enormous time and involves tedious works. Another problem is the increasing number of visitors indicates the security issues which take place mainly because the operators lack time to verify the identification of each visitor at the entry. In this paper, the solution is proposed which aims to provide an automated system by replacing the existing manual way with a computerized system. The solution makes use of the facial features of the visitors.**

keywords **- Deep Learning, Visitor Management System (VMS), Visitors, Face Recognition, Convolutional Neural Network (CNN), Encoding, Feature Extraction, DLib Algorithm**

I. INTRODUCTION

Visitor's recognition is directly related to the authenticity level of the organization. A precise, straightforward and well-defined visitor management calibrate tons for a constructive and worthwhile visitor experience and the minutest disturbance for employees [9]. As a normal practice, visitors visit the organization and there is no digital record because the security guard asks the visitor to register himself by writing his details in a register and takes his signature which consumes large time when the number of visitors exceeds the limit. Moreover, paper log is inadequate to offer greater traceability which cannot be archived or efficiently retrieved after several years [2,4]. The automated and computerized VMS contributes a good solution to solve the problems in the conventional method. So, the paper aims to present a VMS system which maintains a digital record of the visitors using cloud and the easy communication between the employee of the organization and the visitor, based on the processed data which is obtained during the appointment in the application [9].

Proper authentication and authorization and retrieval of the visitor's information is an important task in the VMS [4]. Hence, the proposed VMS captures the image of the visitor during registration and will recognize the correct individuals and matches them against the images that are previously stored in the database. The face recognition module in the system will help in identifying each and every authorized visitor visiting the organization which reduces the frauds and the security breaches within the organization [4]. If the detected image matches with the image present in the database then the visitor is considered as the authorized or the verified visitor and then he/she is permitted to enter the premises.

And solution to the other trouble of the conventional paper log or guest book, the system makes use of online registering the visitor with certain details like name, address, contact number, to whom he/she wants to visit, purpose of meeting and capturing an image of his/her (visitor) face captured through the camera module [9]. Now, the data records of the visitor are stored in a secure manner with never lose features using a cloud system [4]. Retrieval of data records stored is vital and consequently the data is easily accessible from the cloud hence, the purpose of storing the data is accomplished and the physical recording of the data is eliminated completely [2]. Therefore, the objective of the paper is to minimize the need for manual interference within the organization, improve the time required for the data records as it efficiently manages and analyses visitor's records, promote green technology, since it involves paperless record keeping and also improve the flow of the registration process at receptionist desks [2].

Section II discusses existing system. Section III discusses literature survey. Section IV discusses proposed system. Section V discusses proposed methodology. Section VI discusses testing of CNN face recognition and application.

II. EXISTING SYSTEM

1. Traditional Paper and Pen method:

It concerns the usage of conventional paper log or guest book physical entry and exit duration when the visitor arrives at the guard house [1]. This issue with such a system is-

- Lot of scope for non-secure observance in the entry system,
- Physical records cannot always be reliable,
- Non confidential due to un-restricting access since the details of other visitors can be stealing [10],
- No real-time access since the entry manual is present in the organization,

- Time consuming, and
- Involves exhaustive search for visitors and giving the report analysis manually.

2. Barcode System:

In this system, the visitor gets a barcode tag which is scanned by the module and then the visitor gets access to the organization premises [1]. The issue with the system is-

- The module malfunctions if there is a leak or reveal of the barcode copy.
- If the label or the copy is damaged, then the visitor cannot get the gateway.

3. RFID:

RFID stands for Radio Frequency Identification. The module uses RFID tags available in the market embedded with a small chip inside it. The mechanics makes use of RFID tags and RFID readers. When the tag is in proximity of the reader, the reader will scan the statistics present in the tag [10]. The concept is used wherein a card with RFID chip is provided to the individual. Here, the systems with RFID readers are installed at a particular place. The issue with such a system is-

- Causes reader-to-reader interference as when a reader that is interrogating a tag receives strong signals from one or more readers operating at the same radio frequency,
- Highly expensive,
- Overhead in the reading and
- Less accurate and time consuming.

4. Biometric Authentication:

The study of human metrics and using it for authentication purposes is called Biometrics and it provides better security than other conventional approaches of human recognition [5]. It includes:

- Fingerprint:

It is the digitized, automated genre of ink-and-paper system. It uses a comparison pattern between the intersection of the fingertips, an optical scanner which takes the photo of the finger, a capacitive scanner which measures electrical signals, ultrasonic scanners which emit ultrasonic sound and reflect back [1]. In various patterns within the finger arches and whorls, minutiae and delta points are examined.

- Signature Recognition:

It involves dynamic signature recognition wherein the person signs on a digitizing module [3] that gains the signature in real-time and extracts the characteristics like velocity, pressure, direction of stroke, size and time durations and is verified by generating a user template.

- Voice Recognition:

The module relies on the vocal features and requires proximity since it extracts the custom habits created by the shape of the individual's mouth and throat, vocal tract and nasal cavity [5].

- Retina Scanning:

It produces an image of the blood vessel pattern through an optical coupler to scan the distinct features of the retina in the light-sensitive surface lining the individual's inner eye.

- Iris Scanning:

It uses a unique trait within the ring-shaped region surrounding the pupil of the eye to identify the individual using statistical calculations [5].

In this technology, if the authentication system installed fails to work with proper functionality then the traditional manual entry is taken which is less secure and comes with security violations within the organization since no individual's image recognition takes place [5]. Because of several constraints in the above systems, facial recognition systems are considered to be the best match.

III. LITERATURE SURVEY

In paper [1] VISITX: Face Recognition Visitor Management System Mr.Rikshit Makwana1, Mr.Romil Nandwana2, Mr.Jayshil Jain3, Mr.Tejas Laxmeshwar4, Mr.Shirish Sabnis5, proposed a method for managing the office premises with the help of biometric security systems which involves a high-end face recognition system to identify people in office and to recognize strangers i.e. visitors and make appointments for them. In the case of Unknown face recognition, a token- based authentication method is used via mail.

In paper [2] Secure Cloud Storage and File Sharing 1 Bharat S. Rawal and 2 S. Sree Vivek1 Department of Information Sciences and Technology Pennsylvania State University, Abington, PA 19001, USA 2 ICU Medical, Chennai, India, proposed a secure file sharing mechanism for the cloud with the disintegration protocol (DIP). The paper also introduces new contributions of seamless file sharing technique among different clouds without sharing an encryption key.

In paper [3] FACE DETECTION AND RECOGNITION USING OPENCV Mrs. Madhuram M, B. Prithvi Kumar, Lakshman Sridhar, Nishant Prem, Venkatesh Prasad, Assistant Professor, Department of Computer Science, SRM Institute of Science and Technology, Ramapuram, Chennai, India: developed a face detection and recognition system using python along with OpenCV package. This system contains free modules which are detection, training and recognition. Basically, the detection

module detects the face which gets into the field of vision of the camera and saves the face in the form of an image in JPG format. Then the training module trains the system using Haar cascade algorithm.

In paper [4] A Survey paper for Face Recognition Technologies Ms. Manjeet Kaur, M. Tech. CSE, Assistant Professor RIEM, Rohtak discussed their study about human behavior and features. How we can recognize a face with the help of computers is given in this paper. Also, different ways which are available for face recognition and what are the problems with each technology is discussed.

In paper [5] presents the study based on the automated visitor tracking management system. Their visitor management system was useful at those places where a large number of visitors come and visit like colleges, tourist places etc. Their Visitor management solutions provide an ID to visitors in soft copy format. All of the records of those visitors were stored in the database at the time of check-in. Their modern visitor management system was used for restricting the visitors from prohibited areas by sounding an alarm or through some notification or through S.M.S. at the time of their visit.

IV. PROPOSED SYSTEM

The proposed system deals with the reliability and security in the system and prohibits the presence of unauthenticated or fictitious visitors in the organization's premise. The digitized and automated solution can overcome the limitations faced by the traditional manual methods and grace as the easiest and safest system with guaranteed security [1,2,9]. The complications of the conventional VMS system are examined and accordingly, appropriate measures have been taken.

In VMS System a visitor who wants to visit a particular company can take the appointment through the android application for which he needs to fill certain details like name, address, contact number, to whom he wants to visit, purpose of meeting and upload a photo of his face which will be captured through the camera.

All the details will be stored into the cloud storage system (Firebase) [2]. The system detects faces captured through the camera uploaded in the view and matches them against faces previously stored in the database. The request will be sent to the host for confirmation and a confirmation message with a unique identification number will be sent back to the visitor if the request is approved. Only the verified visitor will get the entry. The system diminishes the need for manual intrusion and improves the response of visitor enrollment at operators end.

Scope of the Application:

- Native Android Application
- Manage visitor and employee profiles
- Take visitor's and employee's profile picture during registration
- Visitor can view employee list
- Employee can view visitor list
- Visitor can request to book appointment for the employee
- Visitor can view his/her current requested appointment
- Employee can view the visitor's request for the appointment
- Employee can take decision response (Accept/Reject) on requested appointment
- Visitor is notified of the conclusion with the decision response (Accept/Reject) for the requested appointment
- Menu list is displayed to the visitor
- Visitor can discover the location of the organization by tracing his current location and mapping with the organization location
- User friendly toast messages (at-a-glance feedback)
- Cloud system (Firebase) to manage visitor's data and employee data

System Algorithm:

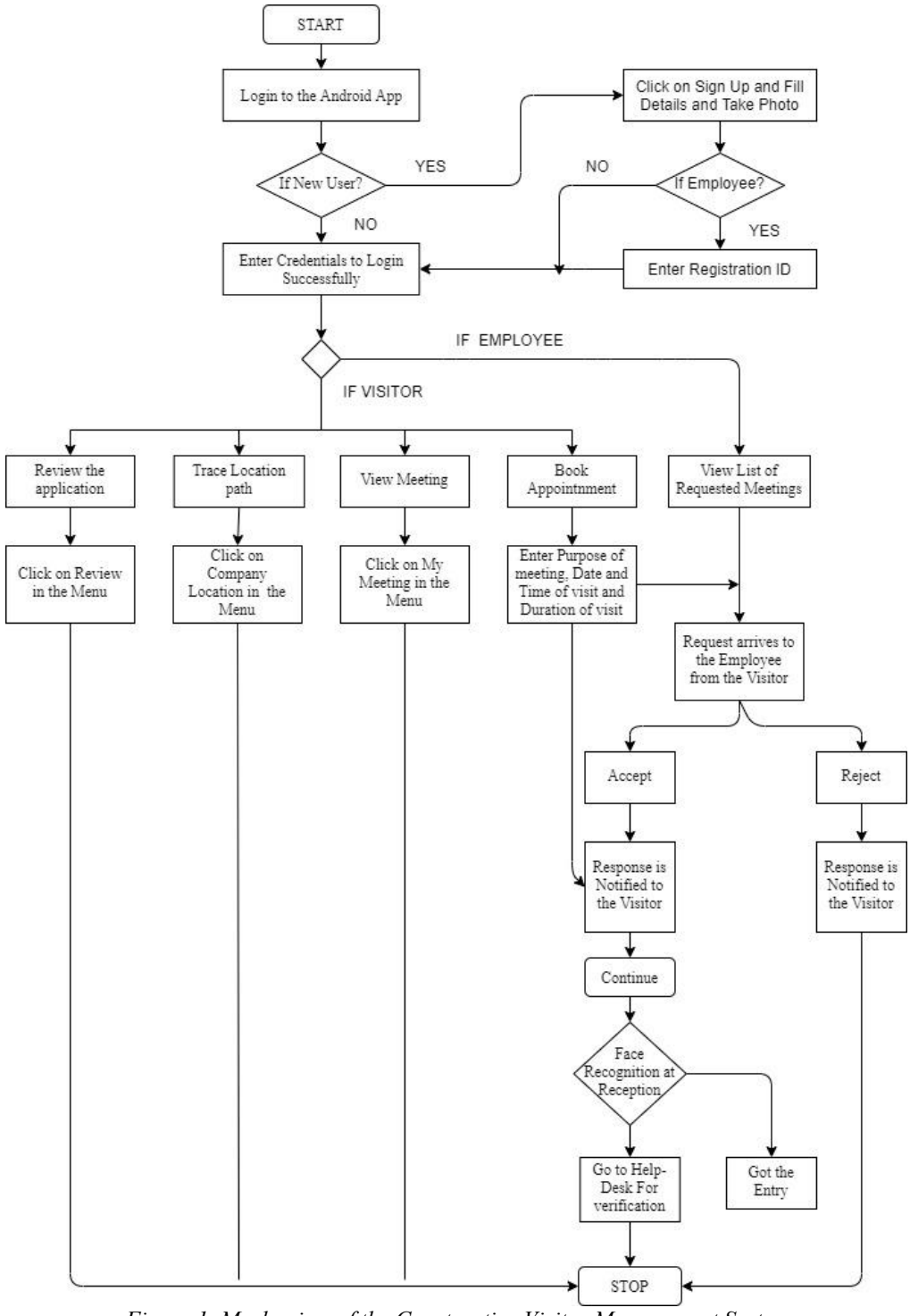

Figure 1. Mechanism of the Constructive Visitor Management System

Face Recognition:

Identification:

A predominant episode of face recognition system is the extraction of characteristic features which uniquely recognizes and discovers the faces as given as input. In order to avoid errors in detection of the faces, it is important to identify the appropriate and applicable language. One of the main troubles is analyzing and examining the region used for feature extraction [1]. It comes up with two options as certain goes in favor with dissecting the images into small intervals known as pixels, from each divided section and is considered as a local feature vector which is extracted and some prefer to extract global statistics from the entire face.

Using CNN for Face Recognition:

CNN makes use of the Face Detection Library DLib which has inbuilt facial landmark detectors for detecting the face landmarks [1]. CNN uses following steps for classification:

1. In the first instance, it extracts low-level characteristics like edges and corners.
2. After the extraction of low-level characteristics like edges and corners is done, high-level layers extract high-level characteristics and continue the process of 3D convolution in CNN.

3. The extraction procedure starts from the top-left corner where each kernel is moved from left to right.
4. After reaching the top corner, considering one element at a time, the kernel is moved one element downward, and then again, the kernel is moved from left to right [1].
5. The process repeats itself until the landmark reaches the bottom-right corner.

Training Stage:

1. The individual's image is pre-processed after acquiring the input.
2. To convince that there is no undesirable data or information, preprocessing filters are used.
3. With the help of CNN, the refined or processed images which are extracted are stored in the database correlated with that characteristic.
4. Same approach is followed for all the characteristics which are given as input and a group of output is composed [1].

Testing Stage:

1. The input image is extracted.
2. In order to get the processed image as homogenous to that in a training pattern, the images are pre-processed [1].
3. After acquiring the processed image in the testing stage, the images are mapped with the previously stored in the database.

The distinction between the tested image and the image in the database is measured depending on the characteristic [1]. Once the map to face is found, the image is recognized with a particular characteristic and the equivalent output is flashed on the screen.

V. PROPOSED METHODOLOGY

A visitor who wants to visit the company can take the appointment through the android application for that first visitor needs to register himself by filling certain details as name, address, contact number, email and set the username and password and click a photo of his face for verification purpose at the time of visit.

At the time of taking appointment the visitor just needs to login and enter to whom he wants to visit, purpose of meeting and meeting date and submit it. The request will be sent to the employee for approval and a confirmation message with a unique identification number will be sent back to the visitor if the request is approved or else the rejected notification will be sent [1].

- Stage 1:

On the day of visit, the visitor needs to enter his id and the camera setup will detect a human face which will be done by clicking a photo of the person.

- Stage 2:

The photo captured will be refined and processed with the face detection algorithm which helps to generate a group of binary code which will be then verified with the characteristics of the stored database to find a correct match.

- Stage 3:

If the appropriate match is mapped, then the individual is recognized and accepted by the system and the details like date, time, image, etc. will be stored in the database for record management.

- Stage 4:

If the characteristic record does not match the individual then he/she will enquire at the help desk.

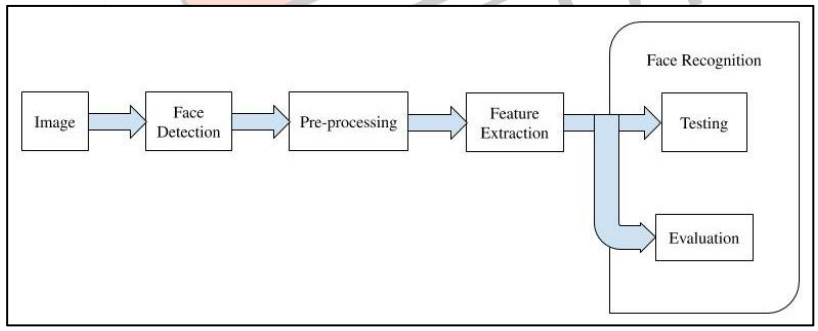

Figure 2. Phases of Face Recognition

1. Image Detection:

Image acquisition process initiates with capturing an image dynamically during runtime through the camera and in this procedure, it will store the images in the directory. The captured image will be mapped with the existing image stored in the directory using the DLib algorithm and provide the required face image [1]. The images are captured using a webcam through frames per second. The images will be stored in another directory and then comparison is made between captured images and images already stored in the directory.

2. Character Extraction:

An extracted image has many landmarks, these characteristics provide description of the image. DLIB approach generates characteristics of an image by taking a picture and transforming it into a collection of local feature vectors [1,2]. With the help of DLIB, characteristic vectors never change to any of the transformations of the image.

3. Orientation Detection:

Here, input of face is taken in any of the form or any orientation and the face will be detected [1] by the desired section of feature extraction since the DLIB algorithm has a unique feature to detect only a single face.

4. Face Recognition

When the entire process is completed, the input will be converted into its recognized points from the face. Face detection framework is a combination of integral image and cascading classifiers [1]. Faces are trained for five different poses (left, left+45deg, front, right+45deg and right) and face detectors are obtained for all poses.

VI. TESTING OF APPLICATION

Both the images are detected named "neha1" and "neha2" and with the help of DLib Algorithm the characteristics of the image are extracted. Both images are of the same person.

Figure 3. Face extraction of Image1 (neha1) and Image2 (neha2)

Using face_location operation in the library we get the coordinates of the face and the face_encoding function is used to get the encoding of the features in a matrix or vector form. Both the images are processed and an encoding matrix is generated.

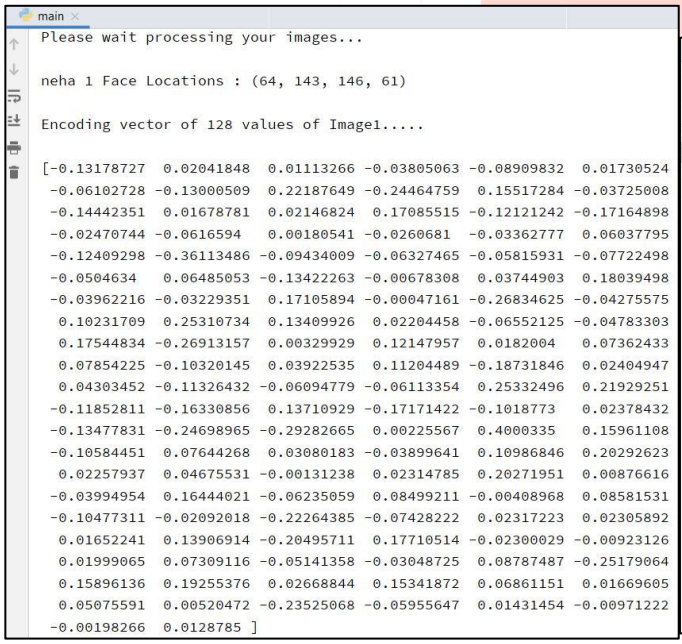

Figure 4. Face Location Coordinates and Feature Encoding Matrix of Image1 (neha1)

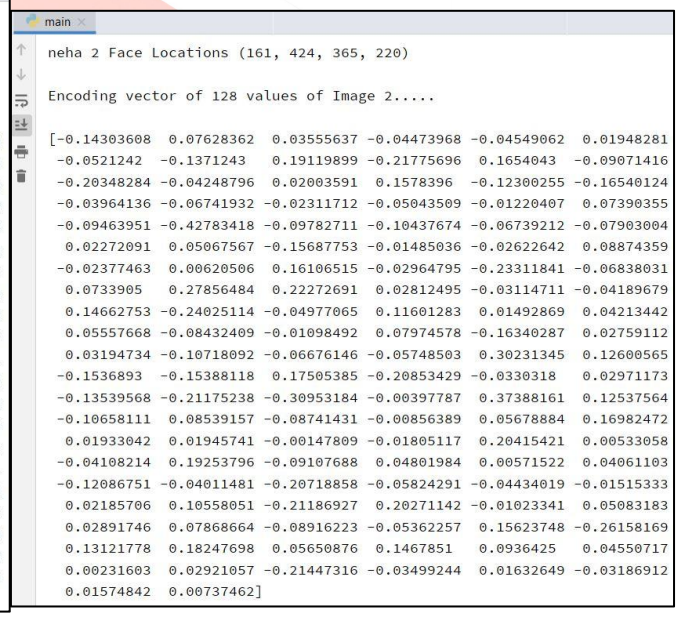

Figure 5. Face Location Coordinates and Feature Encoding Matrix of Image2 (neha2)

After the entire encoding process, the face detection framework matches the landmark points of the face. Since both the images belonged to the same person the final result of extraction is TRUE. Both the images are detected named "image2" and "neha1" and with the help of DLib Algorithm the characteristics of the image are extracted. Both images are of different people.

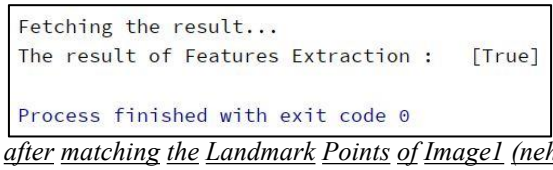

Figure 6. TRUE Result after matching the Landmark Points of Image1 (neha1) and Image2 (neha2

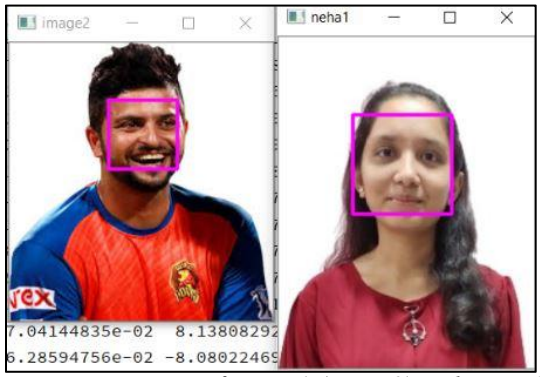

Figure 7. Face extraction of Image1 (image2) and Image2 (neha1

We get the coordinates of the face and encoding of the features in a matrix or vector form. Both the images are processed and an encoding matrix is generated. After the entire encoding process, the face detection framework matches the landmark points of the face. Since both the images belonged to the different person the final result of extraction is FALSE.

```
main
neha 1 Face Locations : (64, 143, 146, 61)

Encoding vector of 128 values of Image1.....

[-0.13178727  0.02041848  0.01113266 -0.03805063 -0.08909832  0.01730524
 -0.06102728 -0.13000509  0.22187649 -0.24464759  0.15517284 -0.03725008
 -0.14442351  0.01678781  0.02146824  0.17085515 -0.12121242 -0.17164898
 -0.02470744 -0.0616594   0.00180541 -0.0260681  -0.03362777  0.06037795
 -0.12409298 -0.36113486 -0.09434009 -0.06327465 -0.05815931 -0.07722498
 -0.0504634   0.06485053 -0.13422263 -0.00678308  0.03744903  0.18039498
 -0.03962216 -0.03229351  0.17105894 -0.00047161 -0.26834625 -0.04275575
  0.10231709  0.25310734  0.13409926  0.02204458 -0.06552125 -0.04783303
  0.17544834 -0.26913157  0.00329929  0.12147957  0.0182004   0.07362433
  0.07854225 -0.10320145  0.03922535  0.11204489 -0.18731846  0.02404947
  0.04303452 -0.11326432 -0.06094779 -0.06113354  0.25332496  0.21929251
 -0.11852811 -0.16330856  0.13710929 -0.17171422 -0.1018773   0.02378432
 -0.13477831 -0.24698965 -0.29282665  0.00225567  0.4000335   0.15961108
 -0.10584451  0.07644268  0.03080183 -0.03899641  0.10986846  0.20292623
  0.02257937  0.04675531 -0.00131238  0.02314785  0.20271951  0.00876616
 -0.03994954  0.16444021 -0.06235059  0.08499211 -0.00408968  0.08581531
 -0.10477311 -0.02092018 -0.22264385 -0.07428222  0.02317223  0.02305892
  0.01652241  0.13906914 -0.20495711  0.17710514 -0.02300029 -0.00923126
  0.01999065  0.07309116 -0.05141358 -0.03048725  0.08787487 -0.25179064
  0.15896136  0.19255376  0.02668844  0.15341872  0.06861151  0.01669605
  0.05075591  0.00520472 -0.23525068 -0.05955647  0.01431454 -0.00971222
 -0.00198266  0.0128785 ]
```

Figure 8. Face Location Coordinates and Feature Encoding Matrix of Image2 (neha1)

```
main
image 2 Face Locations (47, 139, 104, 82)

Encoding vector of 128 values of Image 2.....

[-1.80221975e-01  6.83423784e-03  9.66793224e-02 -3.10673527e-02
 -2.96253487e-02 -6.23663515e-02  2.29488276e-02 -7.31916502e-02
  2.44889051e-01 -1.36263266e-01  2.36472815e-01  1.54017303e-02
 -2.31757820e-01 -1.10815503e-01 -1.22961747e-02  8.51979554e-02
 -7.54859596e-02 -1.37649298e-01 -9.99499857e-02 -1.20186314e-01
  1.03939269e-02 -2.23844536e-02  4.30874676e-02 -2.52429079e-02
 -1.33219123e-01 -3.50513309e-01 -9.59859565e-02 -1.37927189e-01
  2.69868448e-02 -7.27241859e-02  2.29797605e-02  6.67293891e-02
 -1.65054262e-01 -1.06711820e-01 -4.05026674e-02  8.02754015e-02
 -1.46540403e-02  1.47815067e-02  2.56690681e-01 -4.13563997e-02
 -1.06029198e-01 -5.14220297e-02  5.69214225e-02  2.61128306e-01
  8.57271701e-02  7.47811347e-02  7.68974423e-02 -2.48445421e-02
  9.96864960e-02 -2.25787997e-01  1.27237383e-02  1.10192157e-01
  1.33317947e-01  4.82382551e-02  1.18253395e-01 -1.34537145e-01
  7.04144835e-02  8.13808292e-02 -2.22226024e-01  1.61683932e-01
  6.28594756e-02 -8.08022469e-02 -9.64052454e-02  4.34963703e-02
  2.65971899e-01  5.86552694e-02 -8.12272877e-02 -9.74468961e-02
  1.89806551e-01 -1.60230368e-01  2.88431961e-02  1.55329540e-01
 -1.04313336e-01 -1.83469146e-01 -2.21188828e-01  1.37917027e-02
  3.96037042e-01  1.28321663e-01 -9.73748714e-02  1.79610886e-02
 -1.44301519e-01 -6.08268827e-02  1.18746907e-02 -3.86524089e-02
```

Figure 9. Face Location Coordinates and Feature Encoding Matrix of Image1 (image2

```
Fetching the result...
The result of Features Extraction :   [False]

Process finished with exit code 0
```

Figure 10. FALSE Result after matching the Landmark Points of Image1 (neha1) and Image2 (neha2)

Application System:

Figure 11. Splash Screen

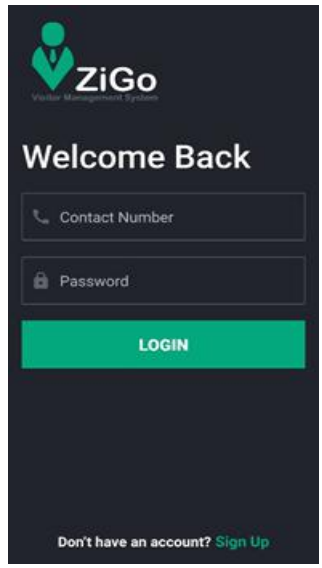

Figure 12. Login Activity

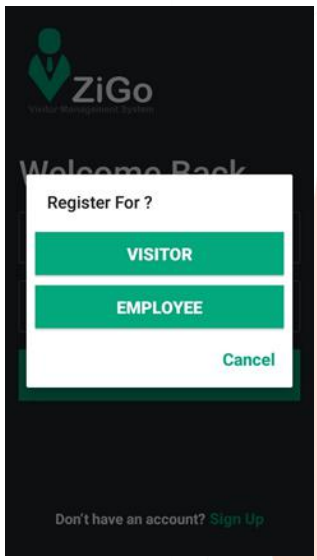

Figure 13. Select Registration for Visitor and Employee Activity

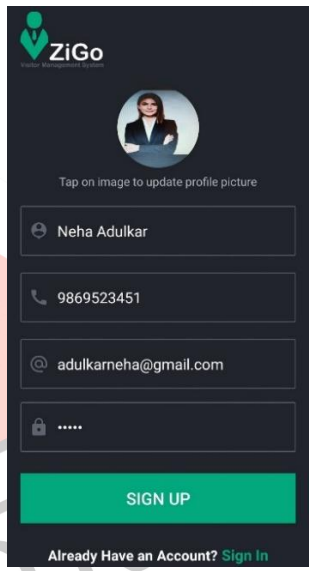

Figure 14.1. Visitor Profile Activity during Sign Up

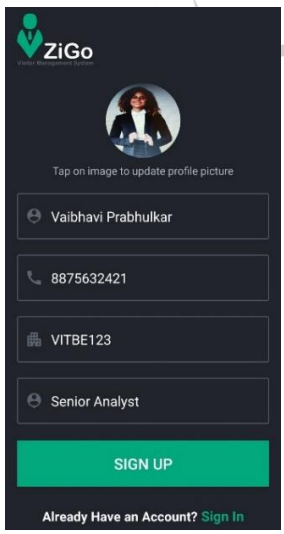

Figure 14.2. Employee Profile Activity during Sign U

Figure 15. Home Page for Visitor Activity (Employee List)

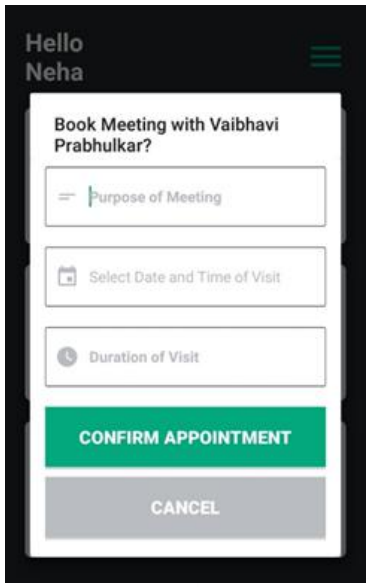

Figure 16. Visitor Books Appointment for Employee with basic details Activity

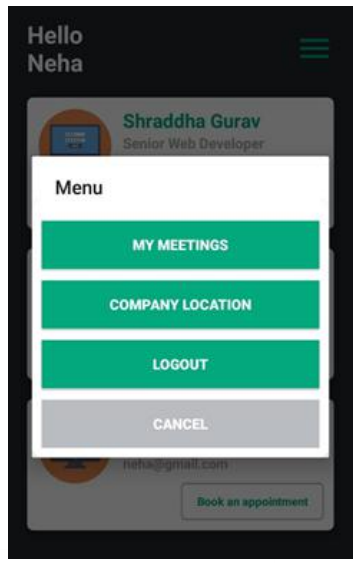

Figure 17. Menu List for Visitor Activity

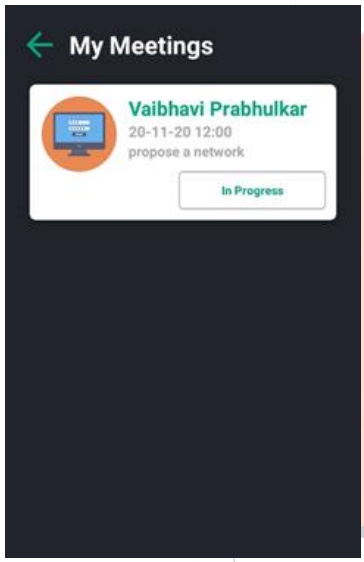

Figure 18. Requested meeting displayed at the Visitor end Activity

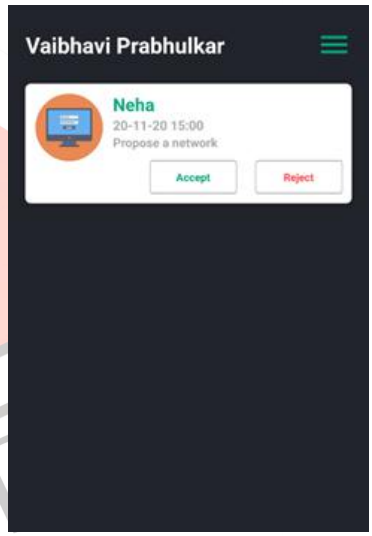

Figure 19. Requested meeting displayed at the Employee end with decision criteria Activity

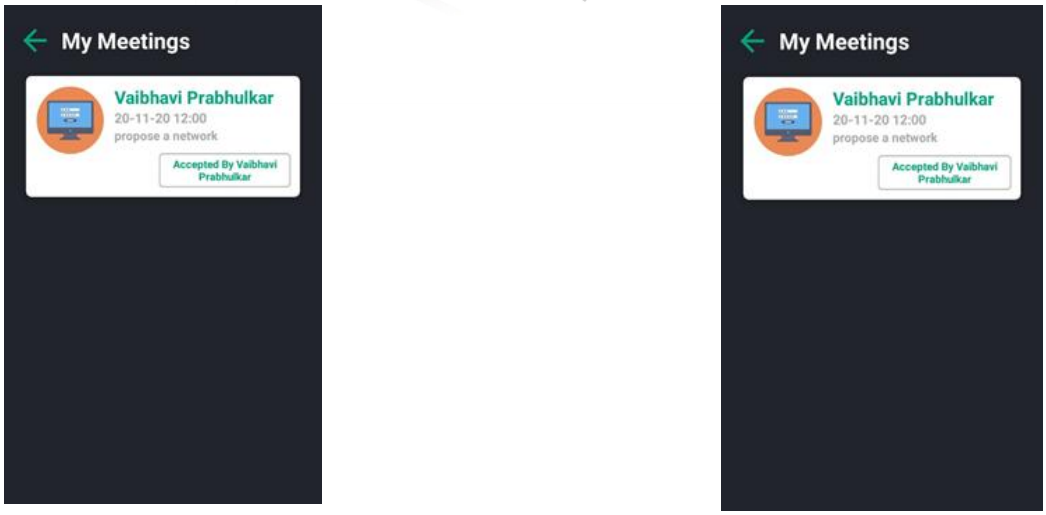

Figure 20. Requested meeting displayed at the Employee end with decision criteria Activity

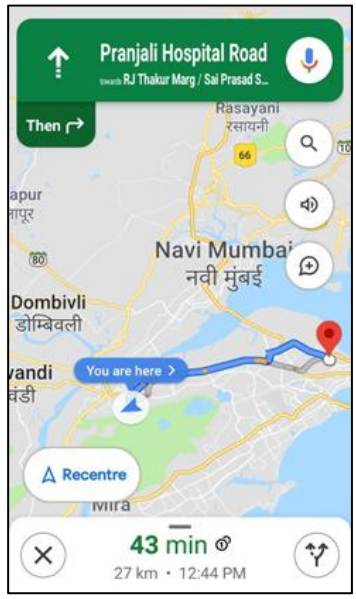

Figure 21. Discover the route by tracing current location and mapping with the company's location Activity

VII. CONCLUSION AND FUTURE COPE

The systems work with numeric encodes and faceprints with landmarks which identify 128 nodal values [7] based on the location and the shape of the facial features like nose, lips, jaw, chin, eyes and the spatial association the module recognized and distinguishes human faces. Security of the personnel recognition is one of the important identities of every individual specification [1]. The oneness of an individual can be used with the combined application to produce a facial recognition-based visitor management system. The proposed system aims to resolve the frauds and human intervention in the organization in a professional manner. By improving the precision, the construction of the system can be improvised. However, this automated system would shrink the need of the labor pool so having a greater number of jobs available goes in favor of the physical or manual visitor management system [2]. The security of the system is improved, if the organization supports security physically, electronically and procedurally.

Significance of the system is- Visitors get high quality service, easier to generate overall report, efficient, effective and timely services, reduce corruption contributing to the entire organization security [7]. As a principle, the foremost visitor management system must be capable of proper authentication and recognition, not compromising visitor's data, easy to use and appropriate retrieval of client's data.

VMS can be integrated with a virtual assistant (Chatbot) to which can takes visitor's experience to the next level by accompanying them through the Visitor Management System Application. VMS can have smart recommendation and real time ratings for the application can be displayed to help users make better management choices [7]. Any institutions can make use of VMS for providing information, content and registration of the visitor E.g. office premise environment and modifications can be easily done according to the requirements and further integrated with the employee's records/information and a complete office management system can be implemented [1,2]. VMS can also be utilized at schools where maintaining records is important and at railway Stations, Airports, Toll Stations, etc. to maintain record of the people entering and exiting a city. It should now be a necessary, part of the brand strategy to build a visitor experience that's effective, efficient, and seamless – from the first invitation they receive from an organization to their lobby experience, and beyond [7]. A growing need for workplace security and increasing regulatory compliance are pushing companies to drastically change how they approach visitor management [1].

Reschedule meeting:
If an employee will not be available on the visitor's requested date then he can postpone the meeting and rescheduled dates which will be then forwarded to the visitor [14].
Meeting start and end time:
Start and end time can be recorded and after the meeting ends employee can fill the form of minutes of the meeting. that will help to keep the meeting records.
Admin login:
With this login, the admin can keep watch on all the meetings also he can get details about what is the outcome of particular meetings, etc.
Allow Repeat Visitors to Enter Without Registering:
Once a visitor registers, there is no need for them to go through the entire process all over again. VMS should store their details for faster check-ins [8].
Delivery Management:
Keeps Employees informed about the delivery date, time, location of their package, so they can focus on work.

Staff Attendance:
Capture employee attendance in a secure, digitalized touchless manner, ensuring safety, speed, and compliance [3].
Visitor Feedback:
Capture feedback from clients, vendors, employees to improve the overall workplace experience [2].

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