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# Seamless Security and Convenience: AI-Powered Face Recognition for Smart Office Automation

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**Abstract:** The accuracy of face recognition systems in smart office automation applications is limited by various constraints. These limitations highlight the need of researching mask face recognition. This study presents a groundbreaking deep learning approach called Faster R-CNN, which combines with IoT technology to address security concerns in office environments. The existing employees' photos were collected and stored in a database. These photographs are then subjected to pre-processing in order to train the neural network. The Faster R-CNN algorithm utilises the VGG-16 model as the basis of its architecture to extract structures from pre-processed images. The advancements in Internet of Things (IoT) and deep learning have enabled the use of deep neural networks to tackle the challenges associated with facial recognition. According to the feature classification, when a person who belongs to an organisation styles the gate, it immediately opens. If the person is unfamiliar, the door will remain locked. The cloud saved photographs of both authorised and unauthorised individuals, which were subsequently sent to the office manager for monitoring. The suggested Faster R-CNN model achieves an correctness of 99.3%, which is superior to the correctness of the previous scheme. The proposed Quicker R-CNN demonstrates superior exactness improvements compared to Deep CNN, SVM, LBPH, and OMTCNN. Specifically, it achieves accuracy ranges that are 2.06%, 5.63%, 9.36%, and 3.54% better than the aforementioned methods, respectively.

**Keywords:** Samrt automation face Detection; Machine Learning Algorithms; Logistic Regression; R-CNN

## 1. Introduction

Biometrics has had significant growth in recent years, becoming as a prominent area of research in computer vision and a very successful use of image processing. Biometrics can be split into dual types: physiological and biological biometrics. Traditional methods such as keys, pattern locks, PINs, and ID cards are commonly employed to access doors. These security systems have certain limitations, such as the ease with which anyone can get entrance to the access. Face recognition safety system is employed toward mitigate these drawbacks. Associated on the way to additional biostatistics, a facial recognition system and face detection system are simpler, more cost-effective, non-invasive, and more accurate. The system will consist of two distinct types: face identification and face recognition[1].

There are multiple uses for the face identification model. In this scenario, we utilized a pre-trained CNN for feature extraction and Faster R-CNN for classification. The entire smart home system be situated linked to the cyberspace and cloud computing infrastructure to enhance accomplishment. Cloud computing refers to the delivery of computer system resources, such as processing power & data storage, deprived of the user having direct authority over them. It is a service that allows users to access these resources on-demand[2]. The Raspberry Pi functions as a primary manager. The user can effortlessly control the door lock by utilizing the free Telegram Android application available on the Google Play store then activate the unlocking mechanism. Each individual's entrance log is captured utilize a Pi camera, and

a duplicate of the picture is sent over email towards the specified manipulator's e-mail address. Table 1 presents a judgement of conventional deep education models for classification. Whenever an individual who is not recognized by the database enters the premises, their photograph will be automatically collected and sent to the authorized email address. Nevertheless, the adoption of biometrics as a security solution is hindered by certain limitations. The pi camera is utilized to capture the image and transmit it to the relevant individuals for security purposes. A CNN consists of 3 layers: pooling, fully connected, and convolutional[3].

**Table 1.** Comparative Analysis of Conventional Deep Learning Models Used For Classification

| Model | Specificity | Sensitivity | Accuracy |
|---|---|---|---|
| VGG-16[4] | 98.65 | 99.45 | 99 |
| ResNet-50[5] | 92.5 | 95 | 94 |
| AlexNet[6] | 84 | 88.46 | 87.7 |
| GoogleNet[7] | 88.24 | 90 | 89 |
| MobileNet[8] | 86 | 83.4 | 88.3 |

The home security system utilizes facial authentication to classify users, allowing the manager to remotely and automatically supervise all resource accesses through a mobile request cloud. The IoTs refers to the merging of hardware and software surroundings. The data generated by IoT's devices is immediately stored proceeding either a server or cloud servers. The Internet of Things (IoT) is the term used to describe the capability of sharing information and facilitating communication through the internet. The IoT simplifies the lives of operators by enabling them to manage computers and sensors. In order to be functional, an IoT communication system necessity adhere to the requirement that individual authorized IoT devices and servers are allowed to transmit or obtain info. An encrypted message would be transferred after the sender to the recipient[9].

The detection and recognition procedure can be affected through the uneven illumination on the face resulting from different igniting causes and positions. Throughout the pinpoint phase, the Haar cascade algorithm generates a matrix representing the face characteristics, resembling the head and cheeks, and computes the picture element values. Following credentials process, a series of procedures, including feature extraction, are carried out. Facial recognition plays a crucial role in crime detection, particularly in the identification of perpetrators. There is a growing need for security methods that may provide many protective features within a single system due to the continuous advancement of automation in the security field[10].

Several restrictions significantly restrict the accuracy of face recognition systems, making the field of mask face recognition a crucial area of research. This study specifically addresses the previously described problem, and the created method has demonstrated excellent accuracy in recognizing all faces. The subsequent text provides a concise overview of the primary contributions made in this work:

- ✓ The face images of the prevailing workers are grouped and deposited in a catalogue.
- ✓ In some innovative picture aspect pre-processing methods are practical for removing the clatter of the images.
- ✓ The Faster R-CNN classifier is used to perceive the separate faces.
- ✓ The door is robotically unlocked if the employees face is matched and the door remainders locked if the face is not corresponding.
- ✓ The presentation of the future model was determined accepting distinction, sensitiveness and precision.

## 2. Literature Review

This section provides an overview of different methodologies for facial recognition and IoT technologies. The goal is to identify the issues faced by present office automation approaches in real-time scenarios.

Proposed an advanced arboreal model for facial identification during inclement weather conditions. The incorporation of both internal and external design elements has resulted in a cost reduction for the PC,

while maintaining the image quality at its original level. The trio trials demonstrated that the sample reached correctness levels of 98.64%, 99.18%, and 95.85%. By utilizing databases, this approach attained a remarkable accuracy rate of 99%[11].

Suggested a facial recognition technique employing deep education. The Raspberry Pi served as the primary manager for facial recognition. This method consistently ensures a secure and protected way of life. Two methods were used to test face authentication: picture testing and real-time testing, both aimed at assessing the accuracy of the system. The process of editing the captured image required a significant amount of time[12].

Developed a facial recognition framework for security purposes, specifically designed to identify illegal activities. This approach detects the facial features of all age groups. However, this approach encountered several hurdles, yet it achieved an impressive accuracy rate of 98.89%. This approach employs three stages: picture identification, image tracking, and image authentication. The accuracy of this method can be influenced by the lighting conditions during facial collection[13].

The objective is to integrate electrochromic components with an innovative nanocomposite layer in a wider scale, specifically for educational use in classrooms throughout five cities in Iran, each with distinct climatic conditions. The software for this simulation platform was developed using Energy Plus. During the peak summer months, the average energy consumption plummeted to as low as 42%[14].

It is recommended to employ PRISMI strategy on the Landmass of Deliver in order to expedite the transition to a high-renewable, low-carbon energy system. The toolkit aims to achieve the decarburization goals set by the energy planning strategies through the examination of local renewable energy potential, their compatibility by energy request, and the prioritization of technical results[15].

Suggested the implementation of a bank security locker structure utilizing facial recognition technology. This research presents a technique for enhancing the competences of palm vein identification systems by altering the pattern thinning strategy. The Can-ny edge sensor and conquer approaches are the deuce elements utilized for face recognition. The individual's palm vein pattern was authenticated using Palm Vein Recognition technology, then it corresponds to the facts kept in a database for identifying purposes[16].

Home security utilizing facial recognition technologies. The system utilized passive infrared and ultrasonic sensors to establish a connection between the network camera and the Raspberry Pi. The user can effortlessly observe the ongoing activities within a residence with a straightforward android application. The mechanism was initiated during authority outages using a battery backup. The method does not provide precise facial recognition and requires the use of costly sensors to improve its accuracy[17].

Introduced an Internet of Things (IoT) powered facial gratitude system designed for enhancing house protection. The facial recognition was performed using a local binary histogram. The system was constructed using the Raspberry Pi 3 microcontroller. The image utilized for authentication purposes has dimensions of 480 by 640 pixels. The clarity in typical lightning was measured at 90%, whereas in low lightning it was measured at 80%. One of the shortcomings of this approach is that if the homeowners do not have a functional internet connection, there is nope alternative method to send them an SMS[18].

Suggested a method for unlocking doors using facial recognition. The LBPH-algorithm was employed to analyze the image. The LBPH algorithm converts the image from a colored representation to a grayscale representation. The microcontroller was efficiently programmed using embedded C with Keil Vision software to achieve a facial recognition gate unlocking system. It offers increased adaptability toward accommodate various requirements and possesses a high level of dependability[19].

A deep learning-based method for facial identification. The OMTCNN algorithm was implemented for image pre-processing. The exercise accuracy of OMTCNN was 95.79%, while the LCNN achieved a training accuracy of 98.13%. The ORL face dataset was selected for drilling, whereas the LFW dataset was chosen for testing. Several datasets are associated with face verification and face detection. It strategy yields a lower average recognition accuracy and requires a longer recognition time. Therefore, this technique is not applicable in real-time scenarios[20].

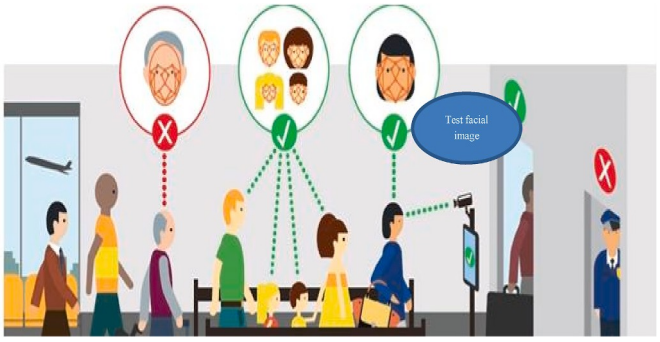


**Figure 1.** Model Office Mechanization via face Recognition

An intelligent cooling map is created by utilising an electronic water pump to enhance the efficiency of the chilling system in spark-ignition engines. In order to create the clever freezing chart, the machine load was taken into account together with the speed. Numerical simulations were employed to guesstimate the performance map of the chilling approach. These imitations utilised both one-dimensional (1D) and three-dimensional (3D) interactions and accounted for the boiling phenomenon.

An intelligent security system utilising the Internet of Things (IoT) to address challenges such as remote video monitoring, facial recognition, and control outage recognition. Furthermore, this arrangement will alert the manipulator in the event of a power loss. These literature above indicates that the factors that need improvement for realtime automatic smart-office door opening are recognition accuracy and recognition time. This research study introduces the Faster R-CNN technique as a means to improve automation accuracy.

2.1. Proposed Faster R-CNN for face recognition system

In this segment presents a proposal for implementing a facial recognition system in an organisation using a deep learning network. Implement workplace automation using facial recognition, as seen in Figure 1. The suggested model's workflow is illustrated in Figure 3. When an employee positions themselves in front of the office, the camera records their image. Subsequently, the acquired image is transmitted to the Quicker R-CNN for classification, utilising the previously retrieved appearance. If the categorization outcome determines that a person is a member of the organisation, the door will open automatically. If the individual is unfamiliar, the door will remain shut. The architecture diagram is provided in Figure 2.

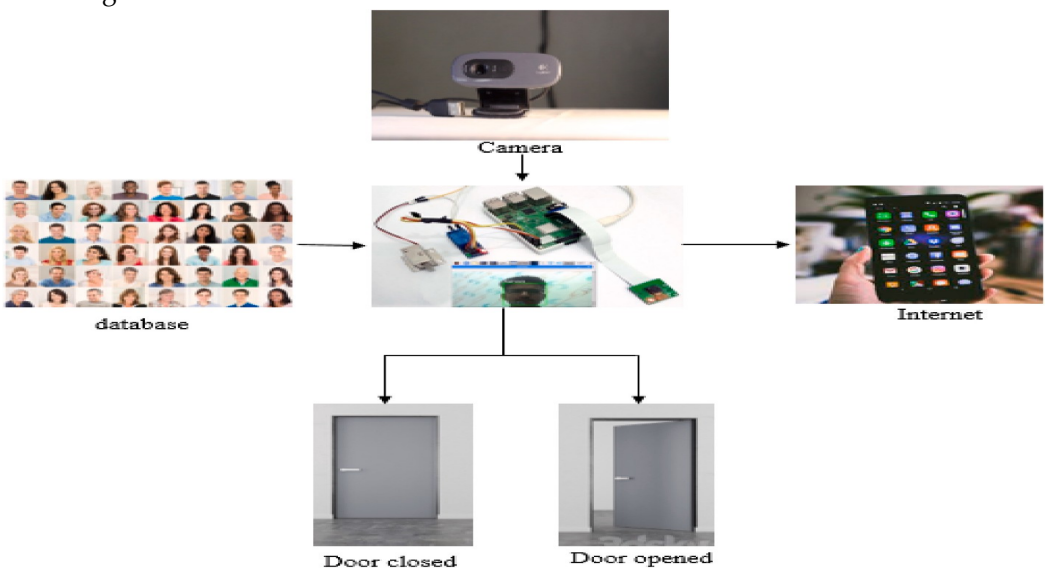


**Figure 2.** Architecture Diagram

2.2. Dataset Description

Face photos of multiple individuals were gathered in the RGB arrangement. The camera records the facial images, and the face open CV library automatically trims the pictures. The distribution of an photo dataset is divided in the direction of three categories: 15.0% for testing, 15.00% for authentication, and 70.0% for training. Respectively category consists of 5895 training photographs, 1263 testing pictures, and

1263 endorsement pictures. Every photo contains a variety of dimensions and circumstances. To improve picture credentials, photographs are captured in different locations and under varying lighting circumstances. Most investigations focus on comparing databases collected in written and controlled situations. Based on the present data, the accuracy of detection diminishes while testing with faces in natural environments. The present study use a small dataset to effectively showcase the successful implementation and practical applications of the suggested research.

2.3. Data pre-processing

Image processing enhances the likelihood of achieving a flawless match and decreases the period required for processing. Face images undergo pre-processing to facilitate feature extraction. The phases intricate in image pre-processing include reading the image, resizing, removing noise, performing segmentation, and applying morphology.

Image alter: The optimal image size requirement be meticulously assessed as various image sizes convey distinct info. Image resizing is performed to reduce the data magnitude, thereby decreasing dispensation period.

Image enhancement: Single of the most basic pre-processing techniques involves modifying the brilliance. Luminosity is the term used to describe the overall brightness or darkness of an image. In order to increase the brightness of the image, a specific value must be added to each individual pixel. The illumination rate ranges from -255 to 255, with positive values representing sunnier areas and bad values representing shadier areas of the photo.

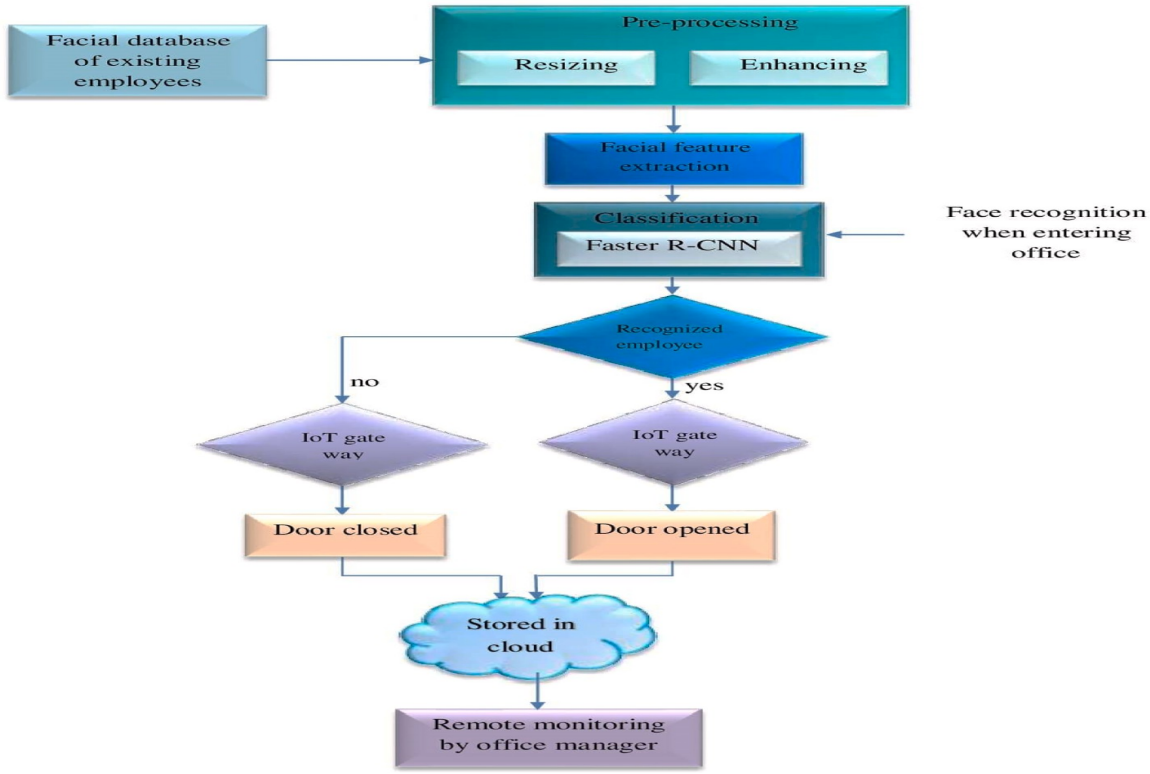


**Figure 3.** Data Pre-Processing

## 3. Proposed Methodology

3.1. Faster RCNN

Among the most sophisticated object identification net-works is the FRCNN. Techniques of detection are used in two stages. Various bounding boXes known as region proposals are initially created using the region proposal network. The facial features including eyes, eye-browns, nose, mouth, and jaw are extracted using Resnet 50 or VGG-16 in the Faster R-CNN. The Pretrained model VGG-16 with ImageNet database provides the best network layer performance. The whole exertion movement of the face recognition system is illustrated in Fig. 4. The image taken to the Faster R-CNN aimed at feature extraction and classification. Should a person be classified as belonging to the organization, the door unlocks robotically. If it is an unidentified somebody, the gate remains locked.

The next step involves classification using a classifier and a regressor. The color image is sent into a convolution network. By increasing the architecture's complexity throughout the object identification process, Faster RCNNs can reach the maximum concert metrics. The RPN is intended to be a conventional, neural network that is fully shared. It reduces the marginal costs and executes various region proposal procedures. Any image can be used by the RPN to create object offers that compare a range of object modules to the background. Main adjustments are made to the system's pooling layer to enhance the proposed boX forms. The right offset values of the bounding boX are determined by the classification layer. Therefore, the detection methods accuracy metric can be raised by using the Faster R-CNN design. Construction of rapidly R-CNN is bare in Figure 4.

In place of the previous technique of locating regions and executing CNN, the Wild R-CNN has been familiarized to shorten the drill progression duration. The region proposals are developed using a small gliding window that spans the whole complication feature chart productivity coating. Another name for the little downhill window is a lesser dimensional feature. Regression and classifier layers are the two fully linked layers into which these attributes are separated.

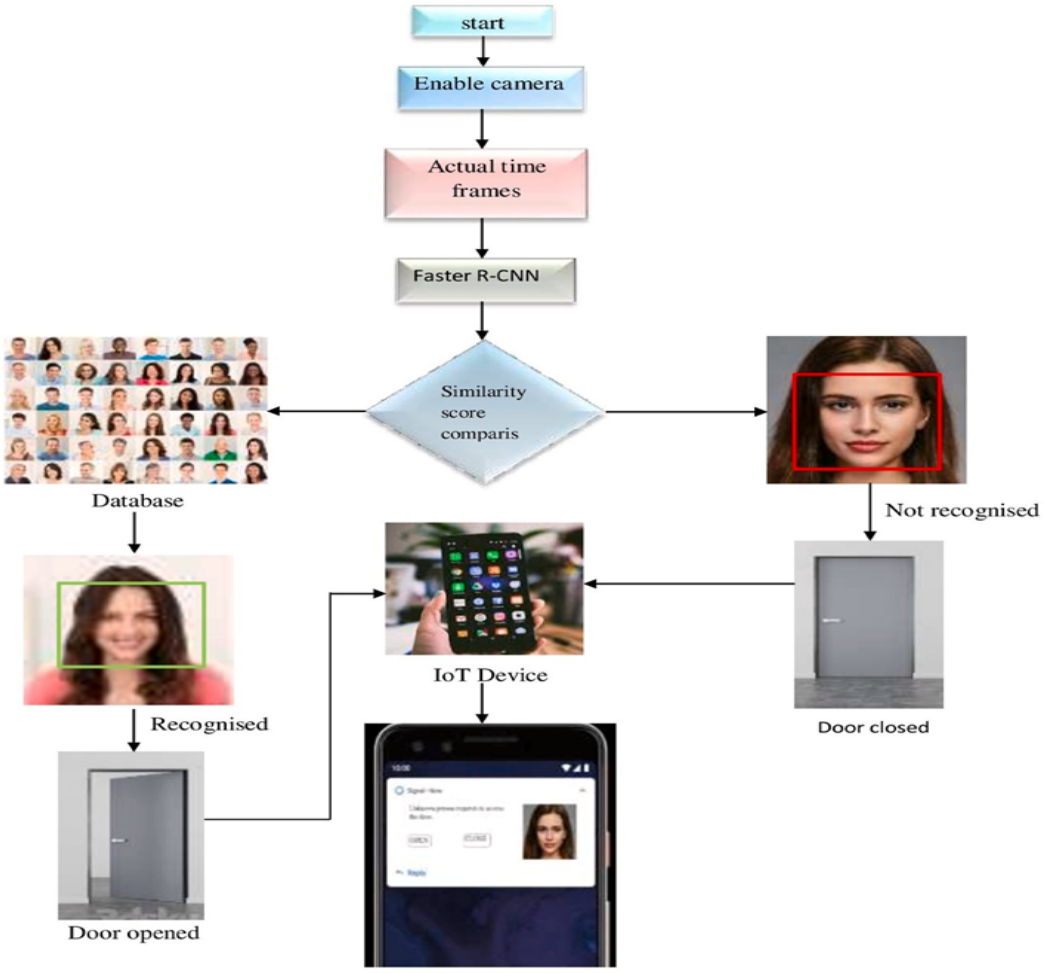


**Figure 4.** Faster RCNN

The classifier is used to sense and way quite a few looks of a worker. To rise the makeover acknowledgement procedure's correctness, Faster R-CNN is used.

**4. Presentation investigation**

The productivity of the planned look appreciation model can be restrained via calculation metrics correctness, specificity and compassion.

Robotically opened if the confidence score is above 90% and the door leftovers shut if the confidence notch is underneath 90% and it accumulates both imageries in the cloud and allocate these imageries to administrator via IoT device.

| | | |
|---|---|---|
| **Specificity** | $\frac{TN}{TN + FP}$ | 1 |
| **Sensitivity** | $\frac{TP}{TP + FN}$ | 2 |
| **Correctness** | $\frac{TP + TN}{TN + TP + FN + FP}$ | 3 |

**Figure 5.** Performance Analysis

4.1. Outcome and Conversation

This section describes the model that was effectively installed in the IoT-skilled bottle, as well as the implementation outcome of the system development. The deep learning toolboX, MATLAB 2019b, was utilized in the experimental setup of this investigation. The necessary datasets can be used to train a system that recognizes employee faces in real-time video frames.

Here are the photos of the current staff members that were saved in a way that shows the correct positives and rejections (TP and TN) and untrue positives and rejections (FP and FN) of the examples.

Figure 8 displays the accuracy training and testing curves, whereas Figure 9 displays the loss exercise and challenging curves. A chart of testing and drill exactness values contrasted with photos shows the accuracy in drill and testing on various pictures. The testing correctness chart is displayed in ginger, whereas the training accurateness graph is displayed in blue. The orange line illustrates how training accurateness tends to increase as the number of images increases. The accuracy of the tests did not considerably increase at the same period. With 50 photos, the accuracy curve yields a 99.3% accuracy rate. The training database for current staff is displayed in Figure 6.

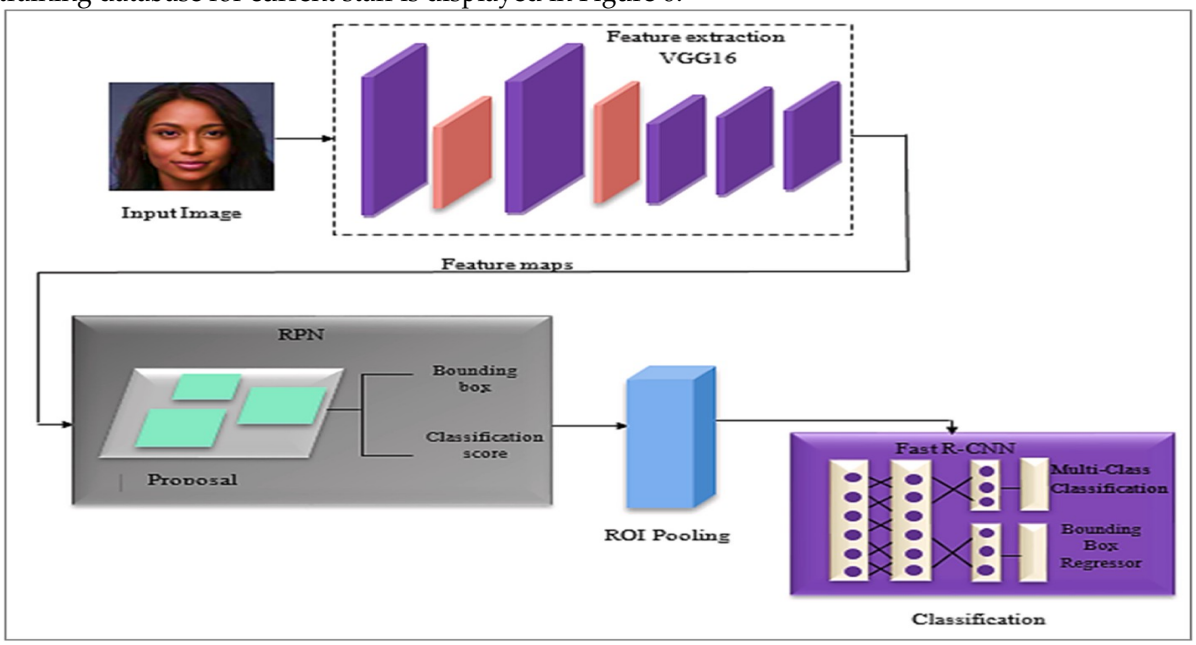


**Figure 6.** Drill data-database of current workers.

4.2. Relative analysis

The proportional calculation is achieved amongst the planned model and the current deep education and mechanism education models in this partition. Testing data-results of Faster RCNN as shown in Figure 8.

Contrast-specificity, understanding, and correctness as shown in Figure 9. The overall accuracy ranges of the suggested Faster R-CNN are improved by 2.06%, 5.63%, 9.36%, and 3.54% in comparison to Profound CNN, SVM, LBPH, and OMTCNN, in that order. Table 2 presents a comparison of the proposed model with the current models. Compared to the current system, the suggested Quicker R-CNN model has a precision range improvement of 99.3%. It is evident from this that Quicker R-CNN outperforms the additional methods.


**Figure 7.** Testing data-results of Faster RCNN

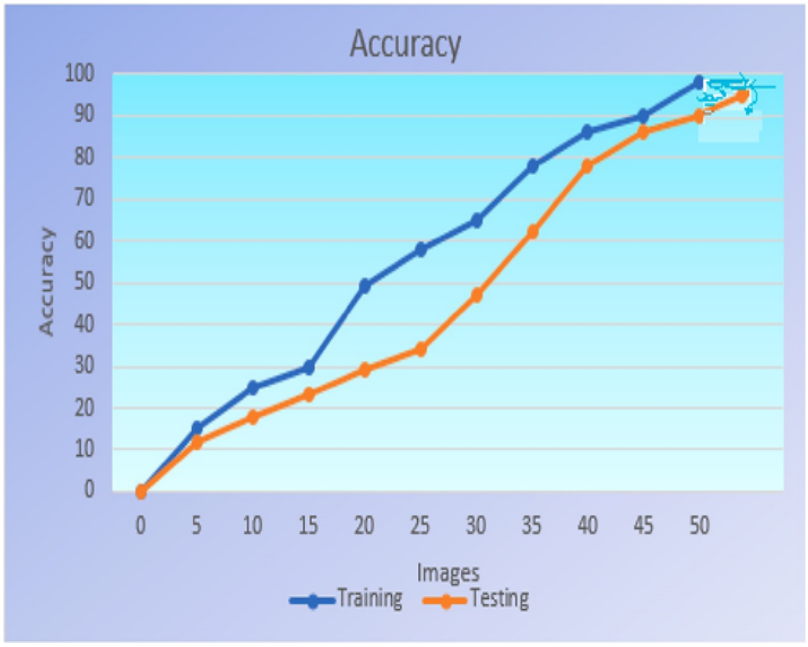


**Figure 8.** Training and testing-accuracy arc

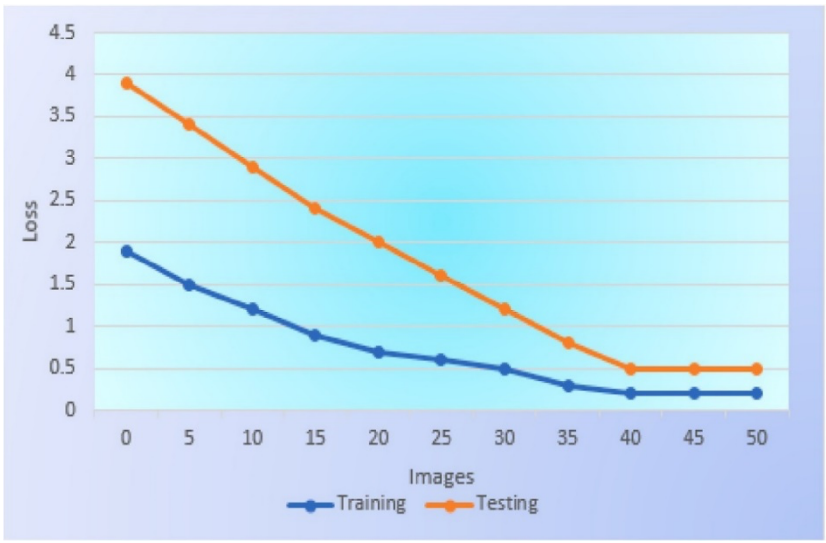


**Figure 9.** Exercise and testing-loss arc

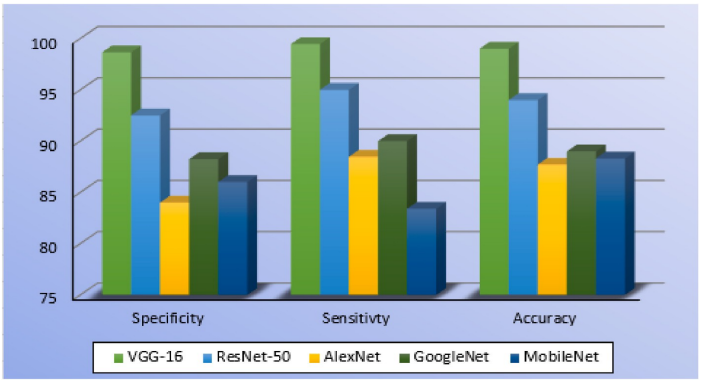


**Figure 10.** Comparison-specificity, warmth, and precision

**Table 2.** Difference between Proposed Model and Current Models

| Author | Methods | Accuracy |
|---|---|---|
| Li Mao | Deep CNN | 97.25% |
| Muhammad Sajjad | SVM | 93.7% |
| Prayag Bhatia | LBPH | 90% |
| Xeu Lu | OMTCNN | 95.78% |
| Proposed model | Faster R-CNN | 99.03% |

## 5. Conclusion

We have effectively implemented a security system that uses Faster R-CNN to automatically open the office door in this suggested work. Using photographs from the database, the facial recognition algorithm recognizes both the known and unknown individual. Faster R-CNN can be used to construct a face recognition system that is lighter, more portable, and requires less power. To extract facial features and reduce image noise, VGG-16 is utilized. The suggested Earlier R- CNN attains 99.3% exactness for face acknowledgment, based on the testing data. We intend to expand the quantity and diversity of our training and testing datasets in the future.

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