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Surveillance System with Face Recognition Using Hog

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Abstract: ***Due to various suspicious activity, the surveillance system continues to emerge in the technical field. Everyday security threats can have a serious impact on people's day-today activity. In this area, numerous techniques have been developed, however some issues have not yet been overcome. The research described in this white paper offers more precise video surveillance with less processing complexity. The system's most crucial component includes location, recognition and facial recognition. The technology pulls highlighted facial information from a live environment or video dataset. The currently recorded video data will then be used to extract the face and background frames. The extracted facial picture data is then compared to the database's face image. A security alarm or signal is issued to prompt the security team to take action if no data is discovered that fits the already-existing data. The suggested solution outperforms current systems in terms of accuracy, efficiency, and cost.***
Keywords: Surveillance, identification, histogram of gradients, intruder, alert

I. INTRODUCTION

The directed gradient graph has demonstrated great performance across a wide range of study areas, particularly in the detection of pedestrians. However, facial recognition systems hardly ever use this technique. This method aims to apply the original HOG and its variants to assess the impact of different factors and develop new facial recognition features quickly and efficiently. Information-theoretical criteria have also been developed to assess the potential classification of different functions. Although the comparative tests using the feature descriptor are relatively simple, the proposed HOG feature achieves approximately the same detection rate in a much shorter computation time than Haar-Cascade and the others. Other algorithms are widely used specific to do.

Facial recognition has important applications in biometrics and in many security and surveillance related systems. Over time, there will be strong developments in the field of technology, leading to the formation of a smart society. Smart civilizations try to limit the involvement of humans and machines. This concept also introduces a fresh paradigm for monitoring and security. The main issue of policing persons accessing the region must be addressed by all governmental and private security groups. Organizations face many challenges in this regard. Even if a person is authenticated, the employee still needs to be monitored, which affects the performance of the system. The identification of hostile activity in the monitored region in real-time is another significant difficulty in this field. System performance is also impacted by environmental modifications like weather and lightning.

False alarms are another issue. False alarms can bar authorised people from entering. Monitoring authentication based on a variety of criteria is one of the hottest security research topics. Biometrics and radio frequency identification tags are some of these criteria. The biometric technology features fingerprint and retinal eye matching in addition to face detection and identification. Facial recognition is one of the key biometric components in authentication.

The major goal of this study is to suggest a face detection and recognition system that uses facial features to identify a person. In this study, the classification job is carried out using a common multilayer neural network and specific face characteristics. As template vectors for the neural network, the extracted characteristics are recognised and displayed. Regardless of various facial motions, the learning algorithm detects faces by learning the approximate aspects of the face. Based on the movement of the face, the feature matrix alters. The classifier may be trained to recognise a specific individual in a crowd using the data from four separate video sequences. Specific face identification and recognition issues can be resolved using a variety of frameworks, including geometry and pattern matching techniques. In order to make the most information available with the least amount of complexity, Principal Components Analysis (PCA), a feature/variable reduction technique, reduces a big number of features/variables into a smaller number. The linear matching technique and linear discriminant analysis have a connection (LDA).

Almost usually, the sole source that can be utilised to find quiet things is image intensity, which contains both identification and noise.

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The relative value, which takes into account changes in the structure and texture of the item, is what actually counts, not the absolute worth. Numerous feature selection and mining techniques are frequently employed. Both local descriptors and global approaches like PCA and LDA have lately been studied. A wide interlayer distribution and a small intraclass distribution are desirable characteristics for a descriptor for the local face region. In other words, the descriptor needs to be robust against things like low image quality, light alterations, and minor distortion. Information theory has been used to provide criteria for evaluating the possible categorization of various functions.

When used in conjunction with local spatial histograms and normalization in the scale-invariant feature-transform (SIFT) approach scale, HOG offers a fundamental picture patch descriptor for matching scale-invariant key points. The fundamental tenet of HOG features is that, even in the absence of antagonism, the local form and shape of an object may frequently be rather effectively described by the distribution of local intensity gradients or edge directions gradients precise shape or the appropriate edge places. Because the histogram offers translational invariance, directional analysis is effective for changes in light.

The HOG function is very helpful for locating textured objects with flexible forms as it summarises the distribution of measurements over various sections of the picture. Convolutions that are used to find the presence of a feature in an image are comparable to Haar features. Using machine learning methods, Haar-Cascades creates a function from a huge number of both negative and positive pictures. The algorithm's feature extraction step is this one.

II. LITERATURE SURVEY

Due to the rise in daily security dangers, CCTV has turned into an important study subject. Effective security threat mitigation techniques include face recognition and authentication. The first semi-automatic method for developing facial recognition systems was created in 1960. Viola and Jones have developed functional continuous real-time face recognition throughout the years built on wavelet. The initial phase in their system is motion and position detection. Particularly, face detection and identification are necessary for the remaining procedures. Through background removal models, a moving human face is detected and localised in the video.

Any object identification approach is based on the basic idea that pictures from a digital camera feed are first subjected to a set of rules using a background subtraction sample. This technique yields a picture devoid of any transfer components. Analysing the bottom pattern will reveal further information. Background exclusion has a number of drawbacks, including low-resolution cameras' bad signal-to-noise ratios, motion blur in the camera's lens, background noise, compression artefacts, altered illumination, and tree vibrations.

Additionally, recognition comes after face recognition and involves verifying a person's personality by asking if their facial coordinates are present in a dataset or database. Face recognition technology is becoming increasingly crucial in a variety of hot spots, and as a result, several extremely trustworthy everyday life apps are being created. Artificial neural networks have recently been used to a variety of facial recognition applications in an effort to get more accurate results. It is made up of various parts that cooperate to provide the intended purpose. The classification of gender and human facial expressions has also been done using neural networks. In order to improve accuracy, neural networks perform well on photographs taken under various lighting situations. The main disadvantage of NN is that you need a lot of time to train it. ANN realized facial care through learning ancient skills. NN and advanced intelligence have been used jointly for facial recognition purposes. Probabilistic Neural Network (PNN) method devised by Vinitha and Santosh to detect and recognize faces from grayscale images containing face-to-face faces. The biggest advantage of PNN mining is that it requires a short training time.

Because the network in the PNN is not completely linked, it is partitioned into subnets. An artificial neural network called SOM (Self-Organizing Map Neural Network) with topological conservation qualities is utilised for face recognition. RBFN or FFNN are two common alternative NN classifiers that make the work of face recognition simpler and more accurate after feature extraction from face photos.

III. METHODOLOGY

A technique for recognising or validating a person's identification based on their face is facial recognition. There are many different facial recognition algorithms, however they can all be inaccurate. The suggested approach uses a histogram of gradients to recognise faces (HOG).

The fundamental tenet of HOG properties is that, even in the absence of exact information of their edge gradients or locations, the shape and shape of a local object may frequently be defined reasonably well as a distribution of local intensity gradients or edge directions.

Because histograms offer translational invariance, orientation analysis is resistant to changes in illumination. The HOG function is particularly helpful for detecting textured deformable objects and for summarising the distribution of measurements in an image region. You can compute the histogram rapidly using this approach since it is straightforward and quick. Each important location in the image is given its own initial HOG function. Each key point's immediate vicinity is partitioned into a number of evenly spaced cells, and for each cell, a local one-dimensional histogram is gathered for each pixel in either the slope direction or the edge direction. The distinguishing feature of this key point is histogram recordings of all cells surrounding a single key point. The representation of the image is created by the histogram function of all the important points combined.

The main steps in this process are:

Step 1: The Main objective of HOG is to break the image into parts that can be converted to small-small cell

Step 2: Calculate the histogram by frequency of the gray level of the image when the image is in hog format

Step 3: Combine all histograms to form a feature vector. That is, it creates one histogram from each small histogram that is unique to each face. The process is shown in the figure 1.

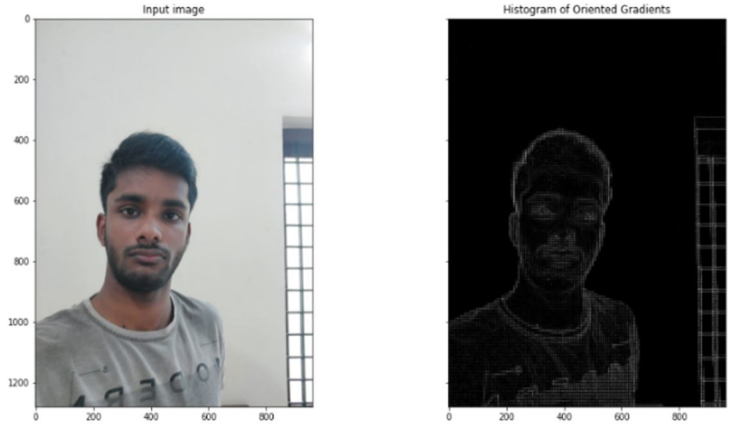


Figure 1: Input image converted to Histogram Of Gradient

Figure 2 shows the methodology of the system

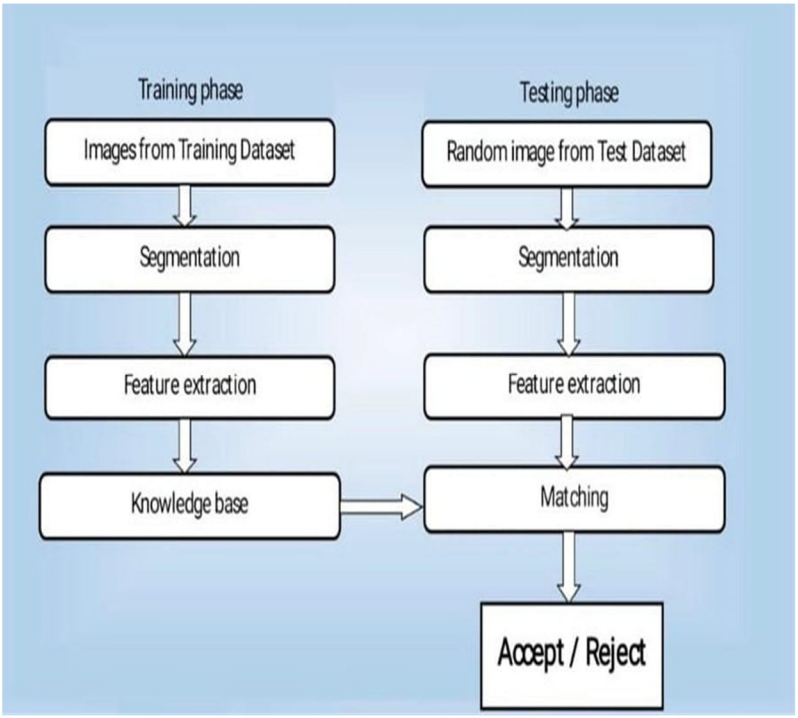


Figure 2: System working represented through flowchart

The briefing of the methodology of the system can be done step which are involved while designing the system. These steps are

1) Database design and creation.
2) Training dataset.
3) Face detection from the livestream.
4) Converting that face to desired dimension
5) Feature extraction of face been detected.
6) Face recognition by comparing the data of face with trained database
7) If match is there, then authorize the access.

IV. DESIGN CONSIDERATIONS

Every modern automated home must include a security and surveillance system. The fundamental design of a security system starts with an examination of the demands of the occupants, followed by surveys of available hardware and software, cost analyses, options for monitoring, and installation planning.

A security system's perimeter and interior protection are complemented by surveillance monitoring tools that let residents monitor the surroundings inside and outside of their home whether they are home or away.

Most contractors view video cameras and display systems as optional components in a home surveillance system. Depending on the homeowner's preferences, surveillance equipment may be used without the essential components of home security monitoring.

The general constraints that should be considered while designing the system

1) Detection vs. recognition vs. identification: A key factor influencing the system design is determining what a project requires of each camera. Identification, recognition, and detection are the factors to consider.
2) Illumination Constraints: Light quality is the first step in video quality. Planning should be done to ensure that there is enough illumination to provide clear video pictures since light triggers the pixels that produce the images. On the other hand, it might be challenging to control too much light.
3) Network Requirements, Plan Retention and Storage Requirements:
4) Type of Camera for surveillance
5) Camera Resolution and Sensitivity
6) Configuration and Settings
7) Zone Layout
8) Camera Locations

V. SYSTEM ARCHITECTURE

There are different levels in the system architecture specifically four. The details about this layer are briefed below,

The suggested face detection system has a real-time surveillance camera configuration. We tried to keep the architecture for implementing each step in the suggested design as simple as possible. We also took into account the role that hardware resource consumption played in the performance-performance trade-off. The suggested technique does not require a significant overhaul of the system to identify faces in cameras. Only the incoming video signal from the camera is read by our approach, which also identifies faces in each input frame.

1) *Dataset Creation Level:* Webcams are used to take pictures of inhabitants at this level of dataset creation. A single resident will be captured in several pictures from various perspectives and motions. They have already been processed. The photographs are cropped in order to get the Region of Interest (ROI), which will be used in the identification process. After that, the clipped images need to be enlarged to a certain pixel size. Then, grayscale counterparts of these RGB images will be created. These photos will then be kept in a folder together with the names of each inhabitant. The faces of each input frame.
2) *Face Detection Layer:* The Histogram of Gradients is used in this instance to detect faces. The first and most crucial stage in determining whether or not there is a human face in a picture is facial detection and localisation. The resulting face picture is a monochromatic grayscale created from a 3D RGB colour space. This research compares a grayscale fixed intensity image to a true colour image (colour map). The grayscale image is also produced by applying histogram equalisation, which automatically adjusts intensity values. This technique includes transforming histogram intensity values. The intensity values of the created face picture are also roughly similar to the histogram's values. The median filter of the face picture in two dimensions is applied using the histogram matrix.

3) *Face Recognition Level:* The technology uses a specific proprietary format to normalise the image. In the given method, the feedforward backpropagation neural network classifier is used to retrieve face attributes from a histogram of directed gradients. For the purpose of detecting a picture, a sliding window approach is used. The sliding window may distinguish important image pixels from the whole face image. There are two sections to the analysis. First, using the histogram of directed gradients feature technique, the descriptor value is calculated for each sliding detection window. The following is how the HOG feature extraction process operates:
   The little clusters of connected pixel values that make up the recovered face image are referred to as cells. A cell's HOG edge direction pixels are identified. Each cell is separated into an angular bin based on the gradient's edge. The weighted gradient of the related angular bin, which is taken into consideration for determining block sizes for neighbouring group cells, includes the pixels of each cell. The division of cells into blocks serves as the basis for normalising histograms. The normalised histogram group serves as a representation of the block's histogram. The building up of these blocking histograms improves the HOG feature of a picture.
4) *Alert Level:* Following the facial recognition procedure, the timestamps of the identified faces are sent out, and if any unrecognised people are present, an alert message is sent.

a) The input layer/image acquisition layer scans and takes a person's image as part of the system design.
b) Application Layer/Database Layer: An organisation in charge of data compression, processing, storage, and data comparison between acquired and stored data.
c) Output layer: If it recognizes a person, this layer will send a notice; if not, it will send an alert.

We need to work in four stages to develop a real-time facial recognition model:

- Face Detection and Data Gathering
- System Training
- Recognition of the face that are present in database
- Send Alert or notice.

Figure 3 shows design of system architecture.

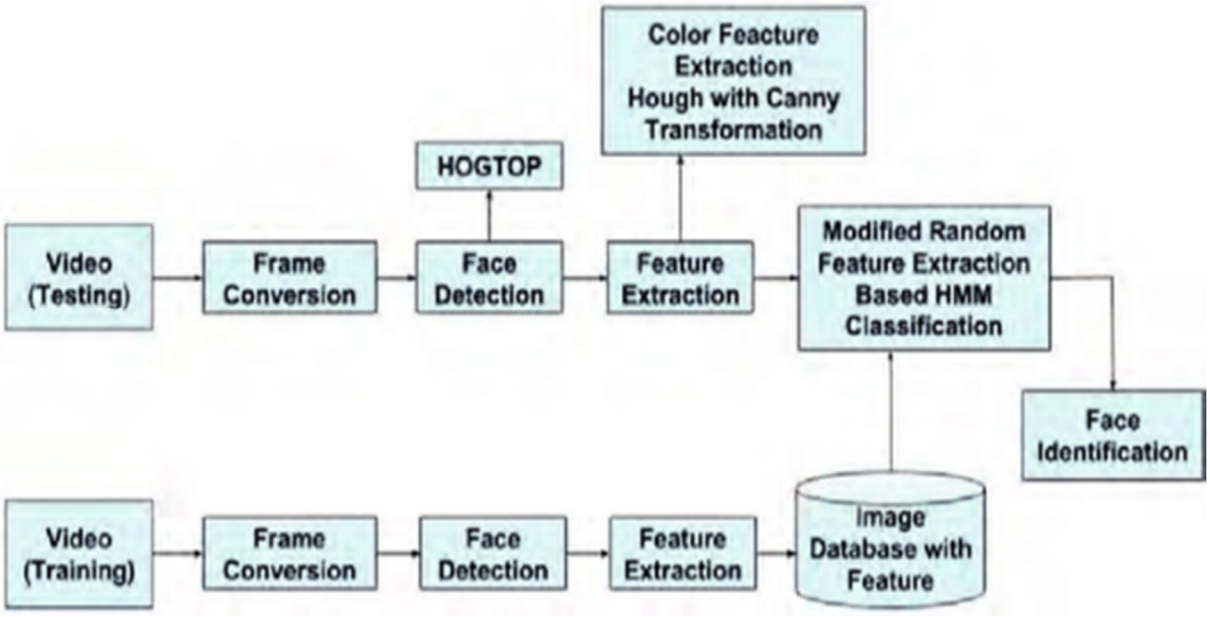


Figure 3: Detailed design of the surveillance system architecture.

Figure 4 shows different phase of face recognition system. The system includes steps detailed below,

- *Frame Conversion:* It is a process of modifying the properties frame mainly the dimension. This is mainly done to reduce the size of image for easier computing.
- *Face Detections:* Whether a face is present alone or in a group, the camera can find and identify it. When someone is staring directly into the camera, it is easiest to discern their face. The development of technology has made it possible for minor variants of this to also function.

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- *Face Analysis and Feature Extraction:* Next, a picture of the face is taken and examined for feature extraction and face analysis. Due to the ease with which a 2D image may be matched with other 2D photos or photos in a database, most facial recognition systems employ 2D images rather than 3D ones. Each face is composed of distinguishing markers or nodal points. The nodal points on your face, like the space between your eyes or the contour of your cheekbones, will be examined by facial recognition software. Then, a mathematical formula based on the examination of your face is created. The libraries and algorithm that are currently in use are used in this phase. These characteristics of the face are encoded as numbers. A faceprint is a numerical representation of this. Everybody has a different faceprint, which is akin to the distinct structure of a fingerprint.
- *Face Identifications:* The unique code generated in the previous step's result is next checked against a database of other faceprints. Photos with identification are available in this database and may be compared. If a match is made, the recognized face with the name attached is displayed.

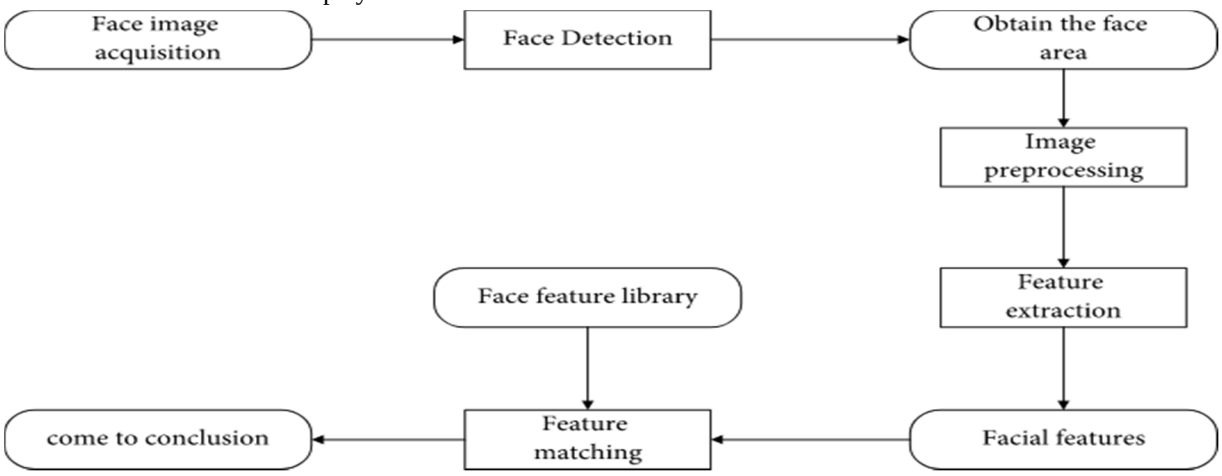


Figure 4: Flow chart of the face recognition system

VI. INTERFACE/EXPORTS

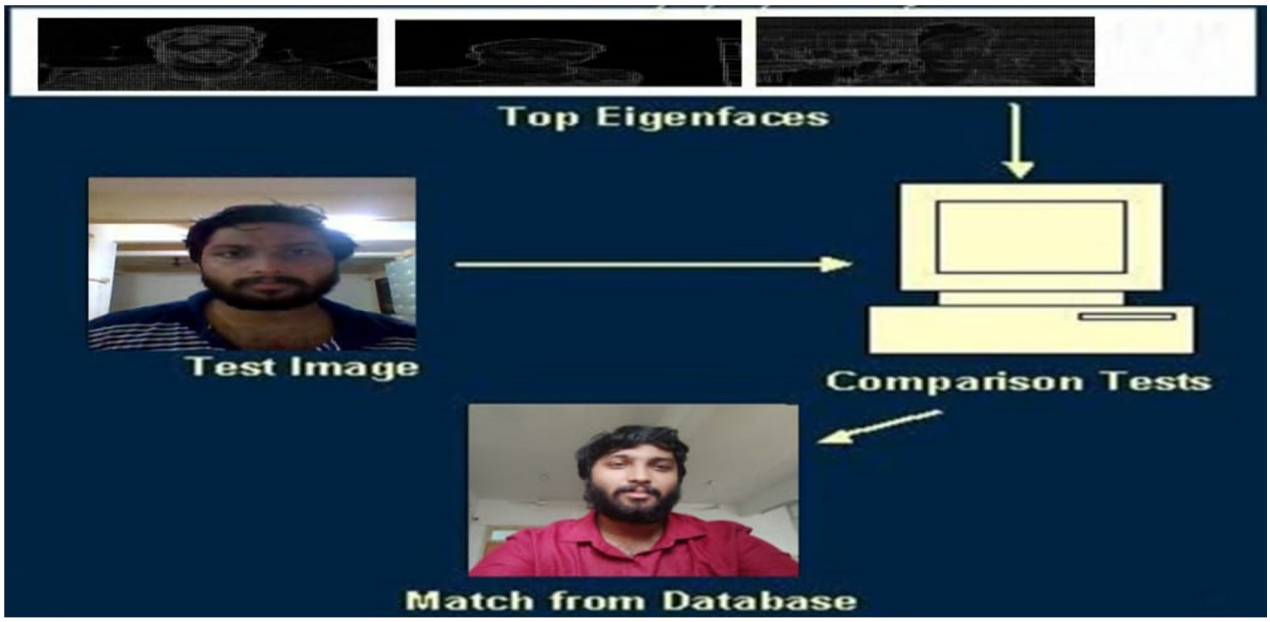


Figure 5: Sample working of the process

Above shown figure 5 gives brief explanation about the process. Here it includes most of all the components that are required for the system to work. By using the algorithm and library packages, we extract the features which defines the frame and it is then computerized. This is passed for the face matching process where it compares it with the data that are present on the dataset or the storage system. The conclusion is then been made and will be displayed on monitor.

VII. RESULTS

The system detects and identifies authorized individual by face recognition using the histogram of gradients method.
If any unidentified individual is found, the system alerts the authorized persons in form of an alert message send through media. The system labels unauthorized person as intruder. All the authorized persons facial data and recordings of the monitored area are stored in the database. The system intend to secure the monitored area by preventing unauthorized access. The figures show how the system works.



Figure 6: System detects the authorized individual

Figure 6 shows the stage of system recognize individual whose data is saved on database and labels the individual on live stream.



Figure 7: System detects the intruder

Figure 7 defines the intruder being detected, the system understands that there is no match after comparing with the database and labels as intruder.
Figure 8 shows the alert message being send to the specific user through after detecting intruder.

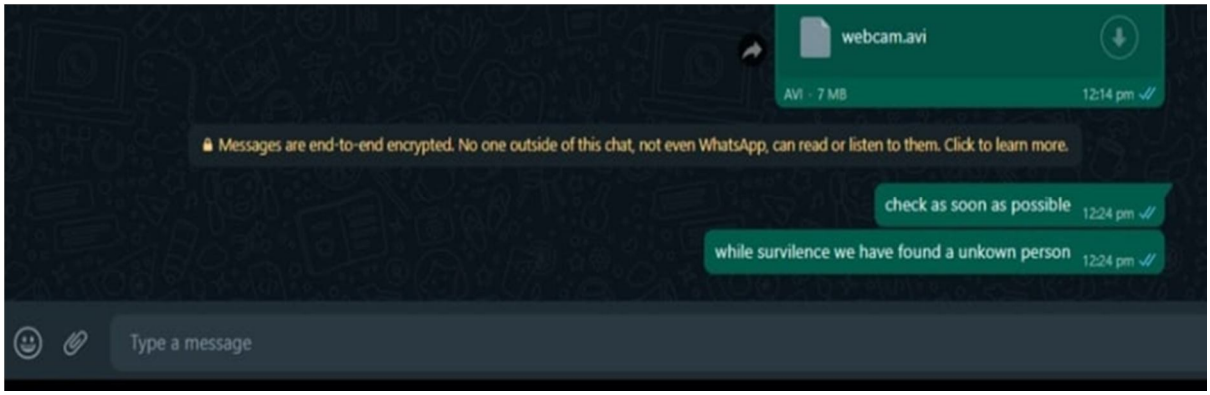


Figure 8: System send the alert message of presence of the intruder through Media

VIII. CONCLUSION

The surveillance environment is often of very poor quality. Furthermore, because of how the cameras work, uncontrolled recording situations might lead to ambient changes such changes in lighting, facial expressions, light shadowing, and body or face motion blur. Consequently, the performance and efficiency of video-based face recognition systems might be impacted by the quality of facial captures made by security cameras. We have suggested a HOG feature-based and FFNN classifier-based video surveillance system, which takes into account the security requirements of today. However, owing to changes in face movement in a different film sequence, the feature pattern may vary.

In the future, the system may be enhanced using convolutional neural networks and other deep learning approaches on larger datasets. Only those with permission are permitted in the allotted area, which is monitored by the system. In the database are all of the permitted person's faces. The technology flags any unauthorized individuals who enter the monitored area as intruders and notifies the authorised person via alert message. The area's observed sights are captured and kept in a database.

IX. FUTURE SCOPE

This technology has several applications in a variety of industries, including the military, finance, forensics, etc. This system's high degree of compactness, facial identification functionality, and ability to deliver immediate media notice make it quite helpful. Face recognition can potentially be tested in the future in addition to this.

The core of every security system is recognition. For the greatest recognition system, we typically need a well-trained database that can serve as the foundation for our recognition. In order to construct a smart surveillance system that we can use in our daily life at home, we include face detection and identification.

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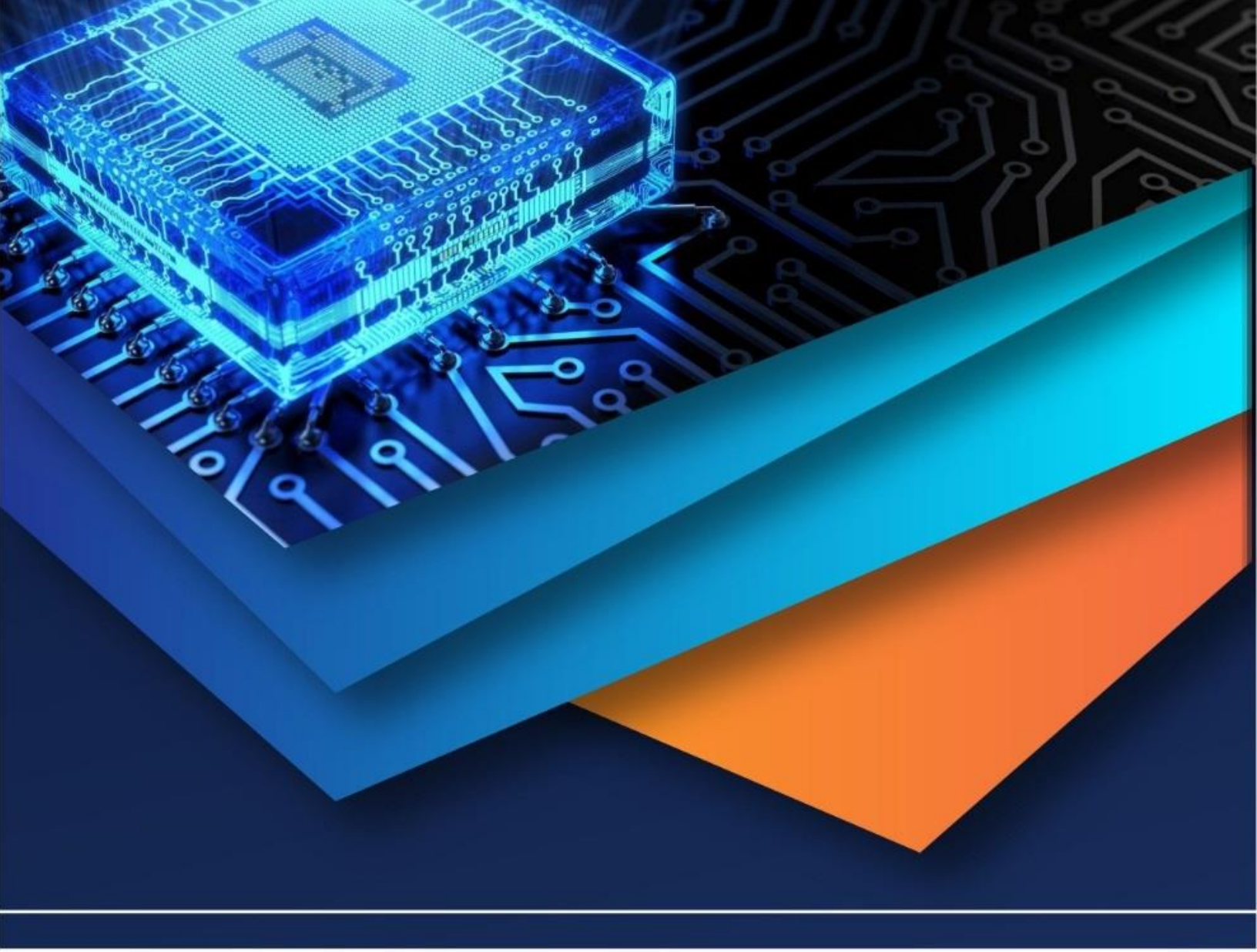
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