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INTELLIGENT SURVEILLANCE SUPPORT SYSTEM USING MACHINE LEARNING

Kujala Rupesh Kumar, Mr. Asif

[1]B.tech Student, Department Of Electronics and Computer Engineering, J.B Institute of Engineering and Technology

[2]Associate Professor, Department Of Electronics and Computer Engineering, J.B Institute of Engineering and Technology

Abstract: In past few decades we have seen an increase in the usage of surveillance systems such as CCTVs and portable monitoring devices. These are static but not intelligent. With the advent of Artificial Intelligence, frameworks like Computer Vision have increased the scope of including additional functionalities. This Intelligent Surveillance Support System adds to the conventional monitoring system with advanced real time features such as face recognition, alarm on theft/cheating detection, visitors in/out detection and motion detection. Emphasis is on doing the tasks mentioned above in real time. This is achieved by using optimized algorithms available in OpenCV Library which improves the usage of machine perception.

I. INTRODUCTION

Existing surveillance systems encompass a wide range of technologies and techniques used to monitor and record activities in various environments, such as public spaces, workplaces, and residential areas. These systems have significantly evolved over the years, incorporating advanced sensors, cameras, analytics software, and networking capabilities. However, despite their progress, they still face several limitations when compared to OpenCV (Open Source Computer Vision Library)

One of the primary limitations of existing surveillance systems is their dependence on specialized hardware and proprietary software. Many surveillance systems require the use of dedicated cameras and sensors that are designed specifically for them respective platforms. This can result in high costs, limited compatibility, and restricted scalability. On the other hand, OpenCV is an open-source library that can be used with a wide range of cameras, sensors, and computing platforms, offering greater flexibility and cost-effectiveness. Another limitation of existing surveillance systems is their reliance on preprogrammed rules and algorithms for video analysis and object detection. While these systems can be effective in detecting predefined events or patterns, they often struggle with complex scenarios or unexpected situations. OpenCV, on the other hand, provides a vast collection of computer vision algorithms and functions that can be customized and fine-tuned according to specific requirements. This flexibility allows for more accurate and adaptable video analysis, making it suitable for a broader range of surveillance applications.

Furthermore, existing surveillance systems often suffer from limited real-time capabilities and processing power. Due to the large amounts of data generated by cameras and sensors, the analysis and interpretation of video feeds can be a resource intensive task. Consequently, these systems may experience delays in detecting and responding to events, compromising their effectiveness in time-critical scenarios. OpenCV, being optimized

for efficient computer vision processing, can handle real-time video analysis with relatively lower computational overhead, enabling faster and more responsive surveillance applications.

In summary, while existing surveillance systems have made significant advancements in capturing and monitoring activities, they still have limitations when compared to OpenCV. The proprietary nature, limited flexibility, reliance on pre-programmed rules, and potential privacy concerns are some of the areas where OpenCV provides distinct advantages. OpenCV's open-source nature, compatibility with various hardware and platforms, customizable algorithms, real-time capabilities, and privacy considerations make it a powerful tool for developing advanced and adaptable surveillance solutions.

Proposed System:

The Intelligent Surveillance Support System (ISSS) is an innovative software solution that enables real-time monitoring and analysis of security footage to detect and identify potential threats. This system incorporates advanced features such as face recognition, alarm on theft detection, visitors in/out detection and motion detection, to provide a comprehensive and reliable security solution. The implementation of this software aims to improve the efficiency of surveillance systems, thereby enhancing the safety and security of public and private spaces. This work is emphasised on doing the tasks mentioned above in real time by using optimised algorithms available in OpenCV Library which improves the usage of machine perception. With the rapid advancements in technology and the increasing need for surveillance in today's world, the Intelligent Surveillance Support System holds immense potential in the field of security and surveillance.

The Intelligent Surveillance Support System (ISSS) is a sophisticated platform crafted to augment the surveillance infrastructure of public and private domains. ISSS integrates a host of features such as monitoring, recording, noise detection, motion detection, identification, and rectangle selection. The system's user interface is effortlessly navigable and is developed using the Python's Tkinter library. The software enables users to seamlessly interact with the graphical interface to conduct diverse surveillance operations, such as face recognition, alarm on theft detection, visitors in/out detection and motion detection. Library which improves the usage of machine perception.

The ISSS working in real time is quite a complicated task as the goal is to monitor the frame, identify the person, detect noises, detect the visitors in the frame of focus, in addition to general video recording in real time. This is achieved using different algorithms for each application. In this paper we have achieved an all-in-one light weighted solution for this, which can run in any type of python supporting devices with any basic camera setup.

II. LITERATURE SURVEY

This section presents a literature survey of previously done work in the same domain. A study has [1] depicted inferences which emphasised on OpenCV, an open source, computer vision library for identifying and transforming useful information from images. Another researcher [2] proved that processing's purpose is to help a computer understand the content of an image. The majority of image processing is done using a group of

libraries offered by OpenCV. This provides the de facto standard API for computer vision applications. We can manage several issues that pop up in real time by using image processing software. Real-time OpenCV applications for image processing are also presented, along with instructions and examples.

According to some researchers [3], The Local Binary Pattern Histogram (LBPH) technique has been offered as a simple solution to the face identification problem since it can recognise both the front and side faces. Yet, in the presence of varied lighting, changeable emotions, and deflected attitude, the LBPH algorithm's recognition rate decreases. This problem is addressed by a modified LBPH method based on pixel neighbourhood grey median (MLBPH). The grey value of the pixel is changed to the median value of its neighbourhood sampling value after the feature value is extracted by the sunblock's and the statistical histogram is established to create the MLBPH feature dictionary, which is used to recognise the identity of the human face in comparison to the test image.

It has been [4] stated that Internet of Things can be useful for facial recognition to improve the smart home facilities. Recognition will be done with LBPH technique to identify a person and that can be highly useful for home residents. Challenging areas are to secure, monitor and control real time automation. The required components for the same are web camera, speaker, a stepper motor and Raspberry Pi3 System.

Studies by some researchers [5] in 2021 illustrated how important a person's face is to who they are; in the real world, it is used to tell apart the personalities of two or more people. To ensure that only the right person has access to their particular accounts, both real and virtual, some biological components have recently been altered. Biometrics, which uses identification methods including fingerprints, palm veins, DNA, palm prints, and facial recognition, is one of the methods that has been developed. Their research will demonstrate how image processing can be used to use facial identification and recognition algorithms to create a tool that can recognise students' frontal faces in a classroom.

In 2021, a work [6] explained that since its debut, digitisation of images has played a substantial and crucial role in the computer science discipline. It encompasses the techniques and methods used when modifying a digital image using a computer. It is a form of signal processing where the input and output could either be a picture or characteristics of that picture. One such crucial area of image processing is image in painting. It is a type of picture preservation and restoration. Additionally selects the best efficient in painting algorithm based on runtime metrics.

The idea [7] of a facial identification system has been proposed to increase reliability by employing facial recognition for a variety of purposes, such as making it simpler for individuals to access with the right security measures during Covid-19 as well as security when trying to disguise their identity. The technique considers using models like Eigen Faces, Fisher Faces, and LBPH Faces as well as software like Python and OpenCV. The units of analysis are taken into account to be still images and clips from videos that capture facial expressions; facial recognition algorithms are then trained on their patterns. According to the results, the LBPH Faces were able to identify faces with a 95% certainty and in less time, which increased the accuracy of facial recognition.

Another work [8] presented a project whose goal was to use face recognition to track attendance in real time across all institutional domains. It is one of the main issues facing all businesses. The proposed approach used

machine learning for other biometric measurements like fingerprint, iris, hand, and retina scans, it was simpler to process. The LBPH method will identify the face after the Haar cascade classifier has detected it. Realtime face data creation is the experiment's focus.

According to the study [9], NumPy arrays, which are the Python language's standard representation for numerical data, enable the efficient implementation of numerical operations in a high-level language, shows how to vectorize calculations, eliminate memory data copies, and reduce operation counts as the ways to improve NumPy speed .It has been [10] stated that Tkinter programming is intended for Python users that need to create applications with graphical user interfaces (GUIs).

Other Researchers Also a work [11] explains scikit- image, a collection of Python-based image processing methods made available by a thriving community of volunteers under the permissive BSD Open-Source license. Python's expanding popularity as a scientific programming language and the expanding accessibility of a sizeable eco- system of auxiliary tools make it an ideal environment for developing an image processing toolkit.

The summary of some other studies in this domain of our work are presented in table

III. DESIGN

This document approaches the aspects listed below, each require a particular set of algorithms and techniques to operate: Monitor, recognise the family member, listen for noises and look out for visitors in the room. We will go over the methodologies and algorithms used for each function.

First, the GUI has seven buttons, each with its own function:

- Monitor (Module 5): The function uses OpenCV to detect motion in a video stream by comparing successive frames and finding contours in the thresholder difference image and helps identify missing object.
- Rectangle (Module 2): This feature tracks motion in a user-selected region of interest in the camera frame by comparing consecutive frames of the video. It displays "MOTION" in green text if motion is detected and "NO- MOTION" in red text, otherwise and ends when the escape key is pressed.
- Noise (Module 1): This feature detects motion in a video captured by the default camera by comparing consecutive frames, applying thresholding and contour detection. It displays "MOTION" in green text if motion is detected and "NOMOTION" in red text if no motion is detected...
- Record (Module 4): This feature records a timestamped video using the default camera and saves it in AVI format with 640x480 resolution and 20 FPS, which can be stopped and saved by pressing the "Esc" key.
- In-Out (Module 3): This feature uses OpenCV and date-time libraries to detect motion and track the direction of movement of a visitor in front of the camera. It saves timestamped images in the "in" or "out" folder depending on whether the visitor is moving towards the left or right, respectively.
- Identify (Module 6): This feature defines three functions, "collect data()", "train()", and "identify()", which are used for face recognition with OpenCV, Haar cascades, and LBPH. The functions are

integrated with a Tkinter GUI for adding new faces and recognizing known faces in real-time from a webcam.

- Exit

4.1.1 System Architecture:

The Architecture of the proposed model is as follows:

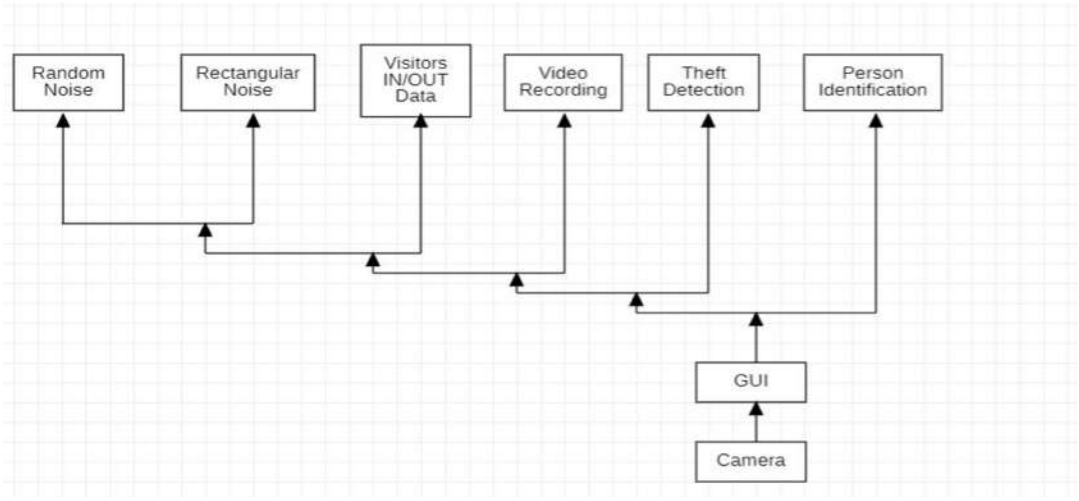

Figure-1: Architecture of the proposed model.

4.1.3 Diagrams:

Module 1: Random Noise Event

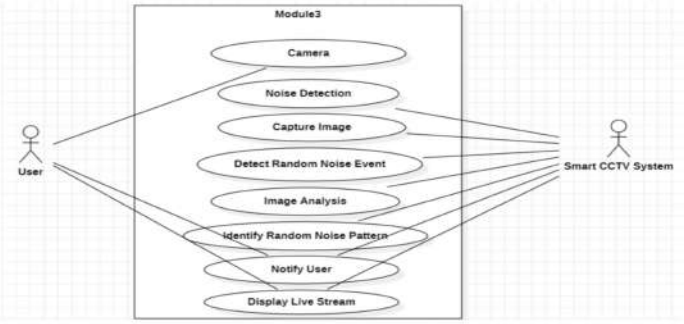

Figure-2: Module-1

Module 2: Rectangular Noise Event

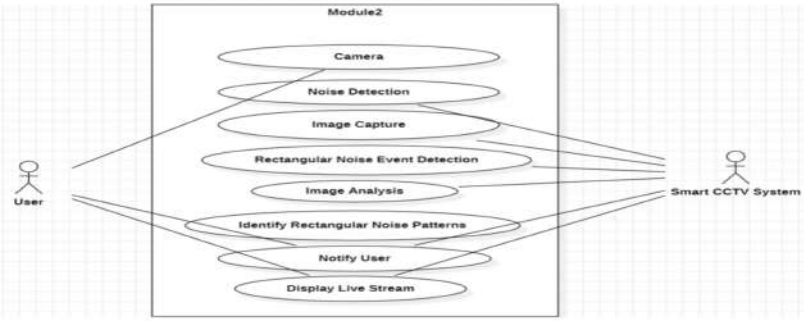

Figure-3: Module-2

Module 3: Visitors IN/OUT Data

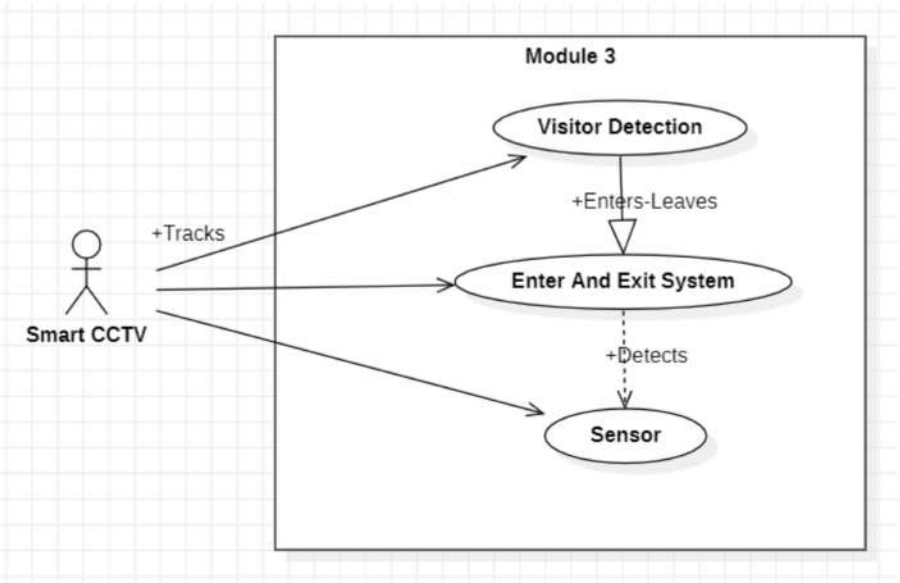

Figure-4: Module-3

Module 4: Video Recording

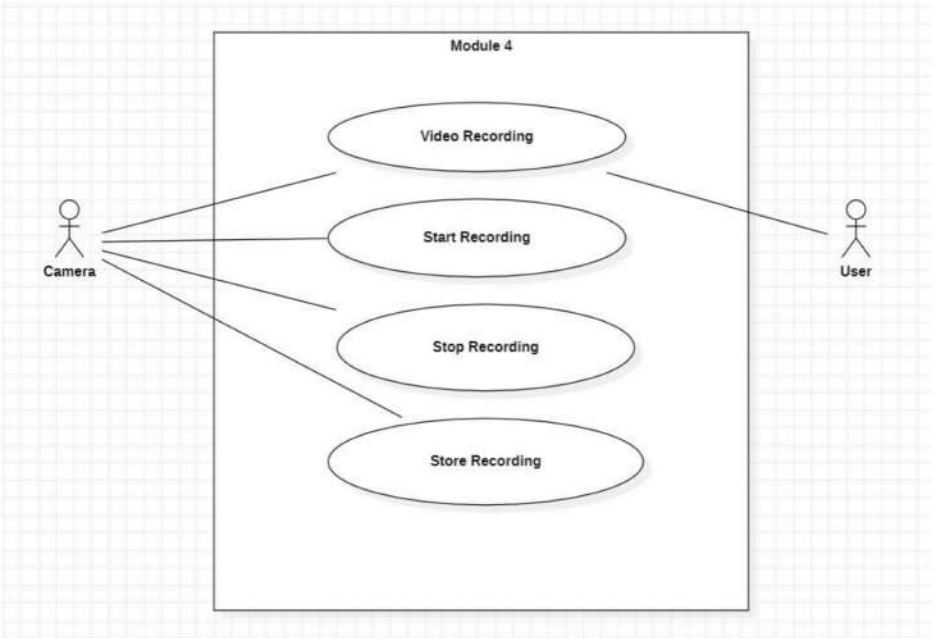

Figure-5: Module-4

Module 5: Theft Detection

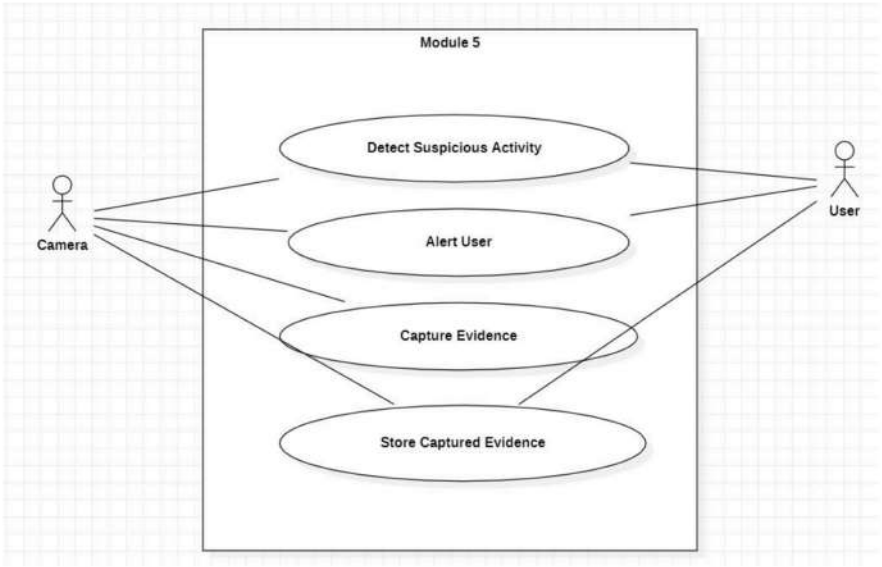

Figure-6: Module-5

Module 6: Person Identification

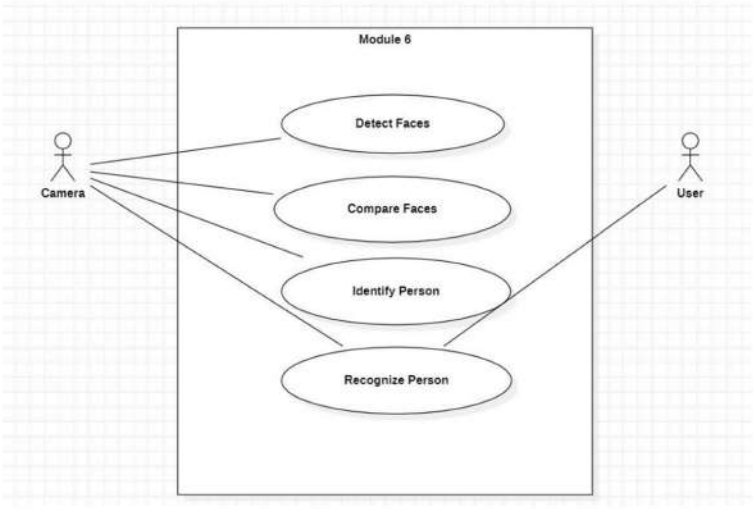

Figure-7: Module-6

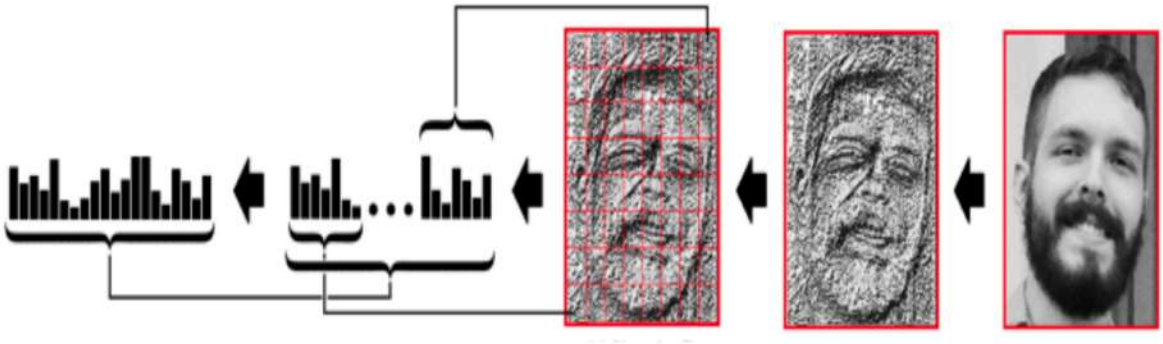

Figure 8 . Extraction of Features with histogram representation.

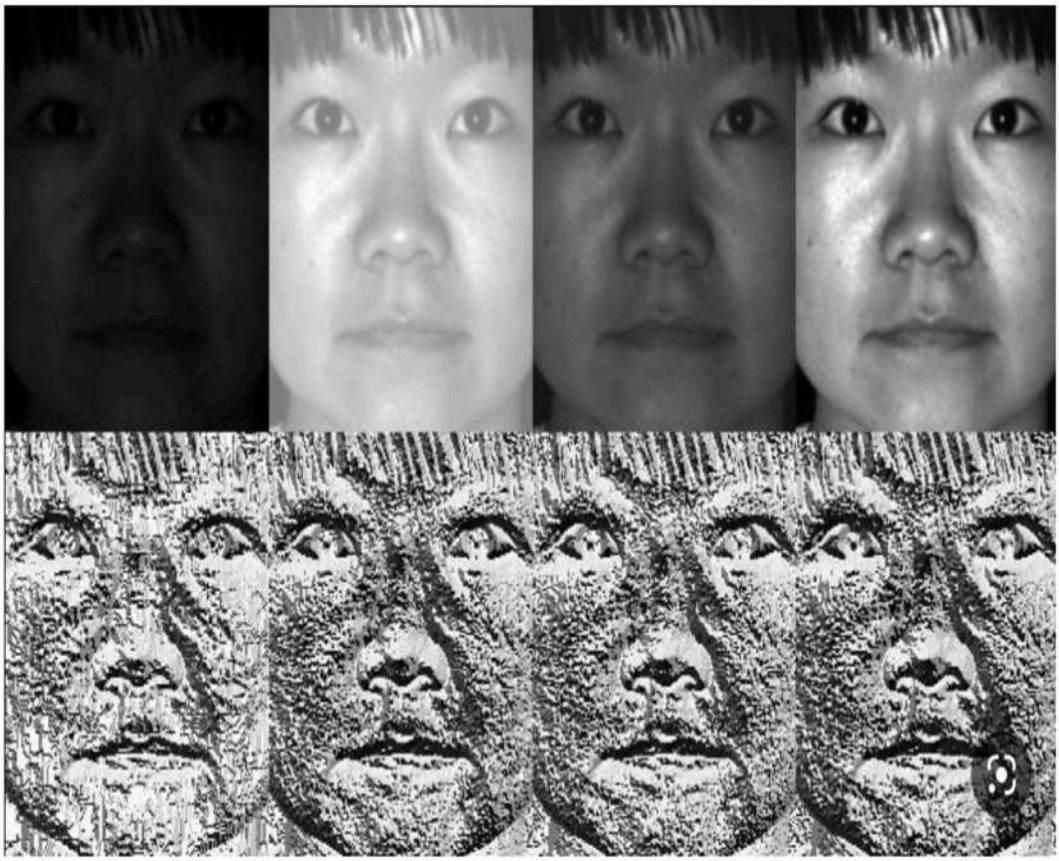

Figure 9. Identification of Related feature

IV. Result

Figure-10: GUI

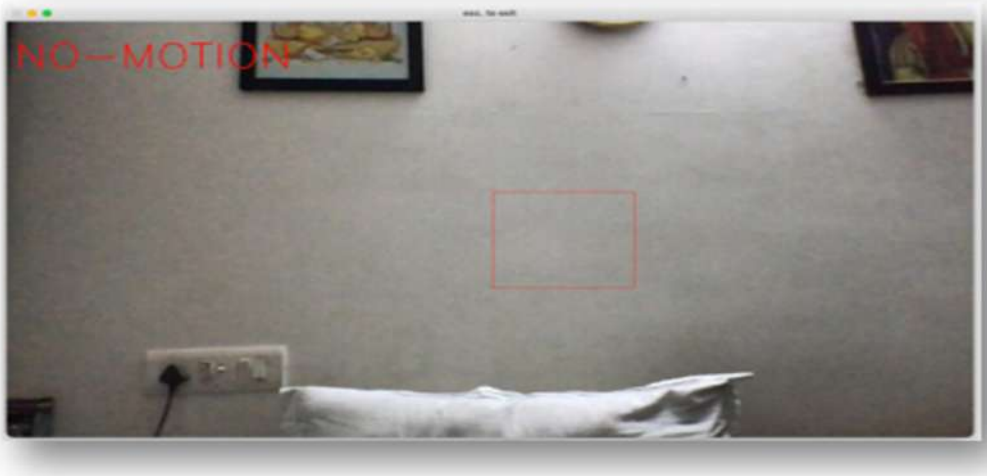

Figure-11 Rectangular Noise

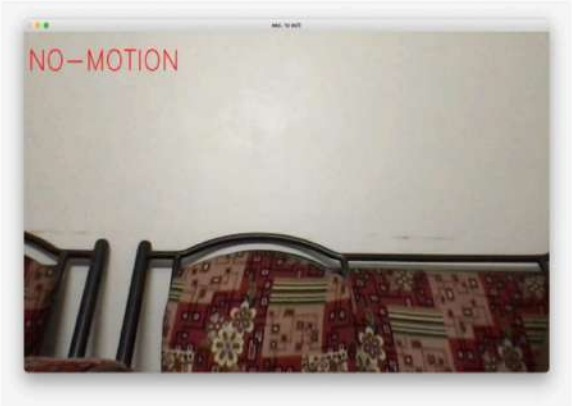

Figure-12: Noise Detection - NO MOTION

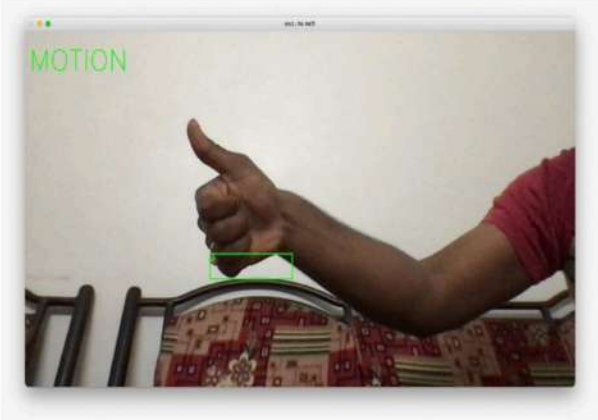

Figure-13: Noise Detection - MOTION

TESTING

This is an analysis of the main aspect. A machine learning approach known as haar cascading is used to identify the faces in a given frame. The research conducted by researchers [20] in their work of Facial identification using Haar cascade and LBP classifiers, justifies the adoption of the haar cascading algorithm over the LBP algorithm. With the help of their work, we are now able to evaluate the algorithm in the context of our use case, the Smart CCTV based Real time threat detection System. Haar Cascade classifier used in this system and accuracy measures are evaluated with respect to number of faces detected as shown in table 2.

No.of faces in the image	5	10	15	20
No.faces detected	5	9	12	19
Accuracy (%)	100	90	80	95

Table 2. Accuracy measures for no. of faces detected.

Metrics	AT&T	5_Celebrity	LUDB
Accuracy (%)	98% ± 1.24%	40% ± 6.8%	95% ± 1.96%
Precision	0.97 ± 0.015	0.36 ± 0.07	0.925 ± 0.024
Recall	0.98 ± 0.012	0.4 ± 0.068	0.95 ± 0.02
F1 Score	0.97 ± 0.015	0.358 ± 0.07	0.934 ± 0.023

Table 3: On the AT&T dataset, 5_Celebrity and LUDB [19] evaluation measures:

Refer to their study as shown in table 3 to learn more about how this method, compares under various weather situations. LBPH accuracy graph for the datasets. Figure 9 presents precision and recall measures

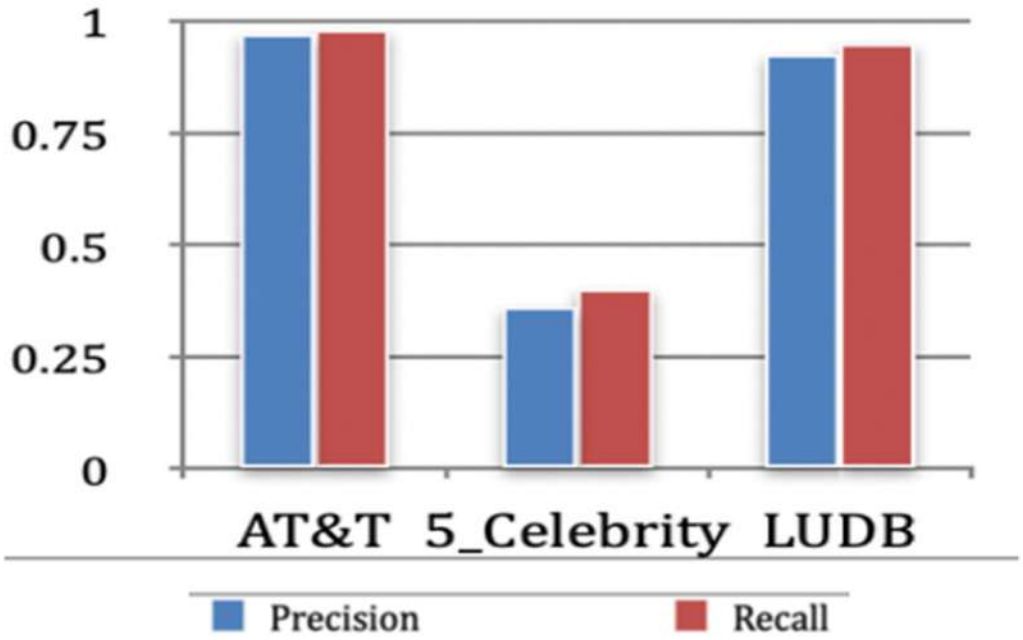

Figure-16: Precision and Recall graph for the datasets

V. CONCLUSION & FUTURE SCOPE

This ISSS is a innovative solution for advanced video surveillance. Leveraging the power of computer vision using OpenCV, it offers unparalleled capabilities that far those of traditional systems. With its advanced motion detection, theft detection, facial recognition, and in- out movement tracking, this system provides a highly sophisticated level of security that can keep any environment safe and secure.

Furthermore, this system has a wide range of future extensions that will further enhance its capabilities. For instance, the system can be integrated with mobile CCTV and used to monitor offline centre-based examinations without the need for human intervention. The addition of built-in night vision will make it ideal for use in low-light environments, while the incorporation of deep learning technology will enable it to identify deadly weapons and detect accidental fires.

This system can also be developed as a standalone device that requires no external support, making it an ideal solution for deployment in remote locations or areas with limited connectivity. Moreover, the creation of a standalone program that does not require any prerequisites, such as Python, will make it more accessible to users who may not have the technical expertise to operate traditional security systems. In summary, ISSS represents modern video surveillance technology, and its advanced features, extensive functionality, and flexible deployment options make it an asset for a broad range of application

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