Missing Child Identification Using LBPH and OpenCV

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Abstract. India struggles with numerous missing children every year, and many children remain untraced. To address this issue, the proposed system would assist the police and the public by expediting the process of searching using face recognition. When a child goes missing, the parent login into portal and can upload the latest picture and details of the child. When the case is registered and he/she get stores in the database. The footage of the cameras be used to recognize the pre-trained missing child with the help of Local Binary Patterns Histogram (LBPH) face recognition. In this project, a web-based automated facial recognition system was developed, which is linked with backend machine learning technology to create a database for missing children. Furthermore, the system can detect both frontal and lateral faces in real-time. If matching is found, then it will send an alert email to the authorities.

Keywords: Missing child, LBPH, Face Recognition

INTRODUCTION

In recent times, biometric-driven methods [1] have surfaced as a notably auspicious approach to identifying individuals. Unlike traditional methods that rely on passwords, PINs smart cards, or other tangible items for authentication [2], biometric techniques involve assessing the biological features to authenticate their identity. Unlike passwords and PINs, which are vulnerable to theft or guessing [3] and objects such as cards, which are susceptible to being lost, forgotten, stolen, or copied. In contrast, an individual's biological attributes cannot be easily modified [4]. Its a challenging to alter an individual's biological characteristics [7]. These methods involve identification through physiological attributes [6] as well as behavioural features [9]. Facial recognition stands out as a particularly advantageous biometric method for several reasons [10]. Unlike many other technologies that require a user's voluntary action, such as fingerprint scanning or face-based identification these typically operates with minimal user involvement [5].

Historical Context and Evolution: The roots of facial recognition lie in the broader field of biometrics, which initially focused on fingerprints. This transitioned to facial recognition as technology advanced, recognizing the unique advantage of face-based identification [11].

Technological Milestones: Digital Image Processing Evolution [12]: The development of sophisticated digital image processing methods has been crucial. Techniques for detecting and isolating facial features in images have become more advanced, allowing for more accurate recognition [13]. Deep Learning Revolution: The integration of deep learning [14], particularly CNNs, marked a revolutionary shift in face recognition capabilities [15]. These networks can learn intricate patterns and distinguish between different faces with exceptional precision.

Current State-of-the-Art: Eigenfaces to Advanced Algorithms: The Eigenfaces approach [16] was foundational, but today's methods utilize more nuanced algorithms, including deep learning models that can handle diverse and non-standardized facial images. Enhancements for Real-world Application: Modern systems are designed to be robust against various real-world challenges like varying lighting conditions and different angles.

LITERATURE SURVEY

[17]. This paper explores the requirements and parameter configurations of an algorithm crucial to the field of person recognition in information technology. The goal is to establish a common framework accommodating both images of varying quality. The objective is to define input image requirements that ensure accurate identification across various images with different situations. The experimental research employs an algorithm at the core of recognizing a face in video streams. The algorithm integrates anisotropic diffusion as a preliminary processing techniques for images. Moreover, it employs Gabor wavelet transformation for image manipulation and utilizes Histogram of Oriented Gradients (HOG) along with local binary patterns in 1-dimensional space (1DLBP) for extracting features from images. The aim is to enhance the efficiency and reliability of person identification technology across a spectrum of image qualities.

[18]. In this paper the author uses Convolutional Neural Network (CNN)-based image recognition methods have demonstrated remarkable performance in enhancing the resolution of face images. Despite these achievements, challenges persist in the field of face recognition, especially in the context of recognizing faces with very low resolution scenarios where precision significantly decreases. To tackle this issue, the author introduces an innovative model for face hallucination and identification specifically crafted for face images in low resolution, leveraging feature representation. In the suggested model "identity-aware loss" function introduced. This function is combined with feature and image loss content, forming a holistic approach to jointly train the models. This combined methodology aims to address the challenges associated with low-resolution face recognition, offering a potential solution to enhance accuracy in challenging environments.

[19]. As per statistics from NCRB presented by the Ministry of Home Affairs in parliament, a cumulative count of 111,569 missing children were reported until 2016, with 55,625 of them still unaccounted for by year-end. In this author uses AI technology to search for missing children intiative, a python based GUI application was developed to assist law enforcement in initiating new cases and conducting searches for missing children.

[20]. This paper focuses on a system comprising an autonomous drone equipped with facial identification techniques for real-time tracking of a specified individual. The automated process entails a drone managing video stream. The computer executes contemporary facial recognition techniques and transmits guidelines returns to the drone, guiding its movements to identify and track the designated person. In this FaceNet is implemented and tested to determine their efficacy in this system. The selection of these systems was based on a combination of effectiveness and visibility. Tests were carried out to evaluate how well each facial recognition system performed based on the distance between the drone and an individual, taking into account factors such as the angle of the individual's face. Furthermore, additional experiments were carried out to evaluate the processing speed of each facial recognition system.

PROBLEM STATEMENT

In India, to locate missing children, the police department uses manual searching processes that are time-consuming, inefficient, and resource-intensive, often stretching over extended periods and sometimes lasting for years. To expedite the process and improve efficiency, there is a pressing need for a more effective solution harnessing the power of technology. To overcome this, the proposed system offers a systematic and technological solution that leverages facial recognition algorithms, such as Local Binary Pattern Histograms (LBPH), and integrates them into a user-friendly platform. This system would facilitate the efficient identification of missing children by automating the recognition process and enabling real-time matching with a centralized database of facial images.

PROPOSED SYSTEM

The methodology for the "Missing Child Identification Using LBPH and Open CV" project using the Local Binary Patterns Histograms (LBPH) algorithm encompasses several critical stages, each contributing to the development of an efficient and reliable face recognition system. Initially, the process begins with data collection and preprocessing, where a diverse dataset of facial images, particularly of missing children, is gathered from various sources like public records and social media. These images are then preprocessed to ensure quality and consistency, involving steps like grayscale conversion, normalization, and resizing. The core of the methodology lies in feature extraction using LBPH. Each image undergoes a Local Binary Pattern transformation, where pixels are compared with their neighbors and converted into a binary pattern, effectively capturing the texture and structural details of the face. Subsequently, histograms of these binary patterns are calculated for different regions (cells) of the face to form a global histogram represents the entire face.

The next phase involves training the LBPH recognizer. This training associates each global histogram with a corresponding label, identifying each child. Following this, the system is integrated into a user-friendly software platform that connects to a database storing these histograms and their associated labels. For the recognition and matching process, when an input face is received from the live stream through a webcam, it undergoes the same pre-processing and feature extraction steps. The system then compares the input face histogram to those in the database using a similarity measure, typically the Euclidean distance, to find the closest match and retrieve the corresponding label. In case of successful matches, the system generates automatic alert email to the relevant authorities or parties.

To ensure the system's effectiveness, regular performance evaluations are conducted under various conditions such as different lightening, poses and facial expressions to guarantee robustness. Based on these evaluations, the system undergoes continuous improvements, which might include retraining the model with new data.

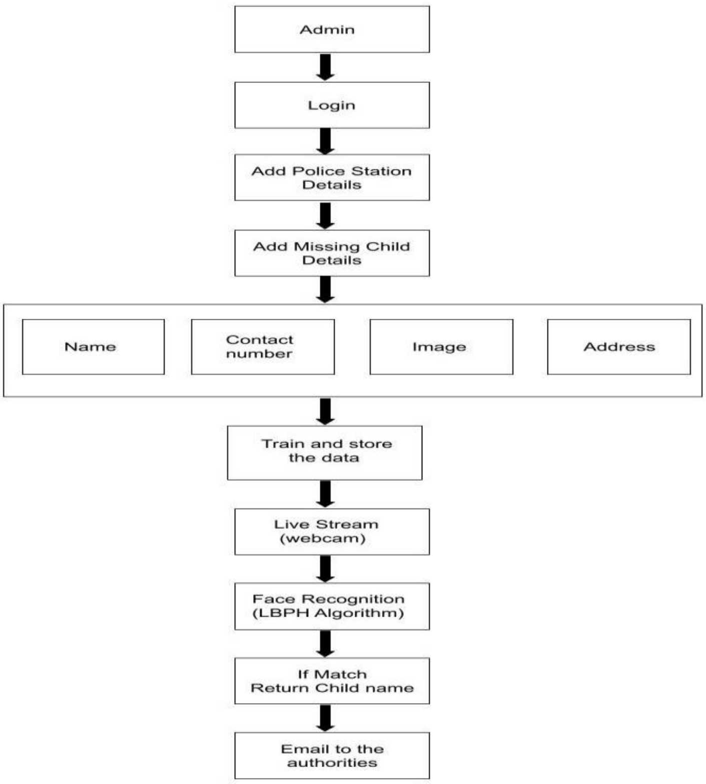

FIGURE 1. Block diagram of proposed system

Proposed Methodology Overview

Face Recognition Algorithm:

Local Binary Pattern Histogram: in the context of the "Missing Child Identification Using LBPH and Open CV". This method is grounded with principle of Local Binary Pattern.

Conceptual Foundation of LBPH: The LBPH face recognizer utilizes the Local Binary Patterns technique to analyze facial images. The fundamental concept behind Local Binary Pattern (LBP) aims to grasp the local arrangement within the picture by examining each pixel in connection with its neighboring pixels.

The process involves the following steps:

Local Binary Pattern Transformation: For each pixel in the grayscale image, its neighborhood is examined. Typically, a 3x3 window is used. The central pixel value is compared to that of its surrounding neighbours. If a central pixel value intensity is higher or equal, it is marked with 0; otherwise, it's marked with 1. During this process, every pixel in the image is converted into a binary number (its "local binary pattern").

$$f(x) = \begin{cases} 1, & x >= \text{cenval} \\ 0, & \text{Otherwise} \end{cases}$$

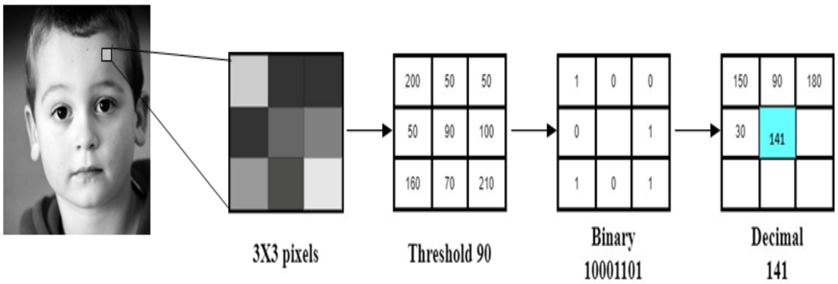

FIGURE 2. Local binary pattern operator

Histogram Computation: Following the LBP transformation, the image undergoes a process where it is partitioned into grids or cells. For each of these cells, a histogram of the binary patterns is calculated. These histograms provide a simple representation of the facial features within each cell.


```
opencv_lbphfaces:
   threshold: 1.7976931348623157e+308
   radius: 1
   neighbors: 8
   grid_x: 8
   grid_y: 8
   histograms:
      - !!opencv-matrix
         rows: 1
         cols: 16384
         dt: f
         data: [ 4.29687500e-02, 7.81250000e-03, 0., 0., 3.90625000e-03,
             0., 7.81250000e-03, 2.73437500e-02, 1.17187500e-02,
             3.90625000e-03, 0., 3.90625000e-03, 2.34375000e-02, 0.,
             7.81250000e-03, 1.17187500e-02, 2.73437500e-02,
             3.90625000e-03, 0., 0., 7.81250000e-03, 0., 0., 0.,
             3.51562500e-02, 0., 0., 3.90625000e-03, 5.07812500e-02, 0.,
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             0., 3.90625000e-03, 0., 0., 0., 4.68750000e-02, 0., 0., 0.,
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   labels: !!opencv-matrix
      rows: 151
      cols: 1
      dt: i
      data: [ 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
          0, 0, 0, 0, 0 ]
```


FIGURE 3. Representation of histograms

Concatenation of Histograms: The histogram values from each cells are amalgamated into a unified final histogram. This will encapsulates the characteristics of the face effectively.

Face Recognition: When recognizing a face, the LBPH algorithm contrasts the histogram of the input image with the unified final histograms of training images. To finding out the accurate identification using a Euclidean distance metric.

Euclidean distance Formula:

$$d_{L2}(x, y) = \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2}$$

Where, x is a histogram1

y is a histogram2.

IMPLEMENTATION

User Module

Admin

Security and Access Control: The admin, typically a system administrator or authorized personnel, is required to log into the system for security reasons. This step ensures that only authorized individuals have access to sensitive data.

Authentication Process: The login process involves entering credentials such as a username and password. The system may also implement two-factor authentication for enhanced security.

User Interface: The admin is presented with a user-friendly interface upon successful login, allowing easy navigation and control of the system's functionalities.

Add Missing Child Details

Data Entry Interface: Once logged in, the admin has access to a form or interface where they can input details of missing children. This typically includes the child's name, contact number, image and address.

Uploading Images: A critical part of this step is uploading a recent photograph of the missing child. The system may allow multiple images to be uploaded to enhance recognition accuracy.

Data Verification and Storage: The admin reviews the entered data for accuracy before submission. Once submitted, the details are stored securely in the system's database, making them accessible for facial recognition processes and alerts.

Police Station

Access to Facial Recognition System: Police may have direct access to the facial recognition system, allowing them to use the uploaded images and details for field identification.

Automatic Alert Email

Generating Alert Email: The system can generate automatic alert email when there is a potential match found by the facial recognition. These alert email can be sent to the police station to take further actions.

System Module

User Authentication Module

Ensures secure access to the system, allowing only authorized users (e.g., admin, police personnel) to login and perform actions.

Functionality: Includes login screens, password verification, and potentially two-factor authentication mechanisms. It manages user credentials and access rights.

Data Management Module

Handles all data related activities, such as storing, retrieving, and updating information regarding missing children.

Functionality:

Child Information Entry: Allows admins to input detailed information about missing children, including name, contact number and address.

Image Upload and Storage: Facilitates uploading and storing photographs of missing children. It ensures that images are stored with ID securely and are easily retrievable for processing.

Face Recognition Module

Core of the system, responsible for processing and identifying faces from the live stream input of faces from a webcam.

Functionality: Face recognition system involves mainly following 3 steps:

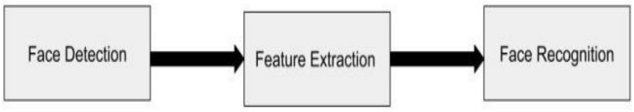

FIGURE 4. Face recognition System

Face Detection: In this step, if a face is detected in the frame, it will draw a rectangular box around it.

Feature Extraction: Utilizes algorithms like LBPH to extract and analyze facial features from the uploaded images.

Face Matching: Compares features from new or incoming faces detected in a live stream of a webcam with the database of missing children to identify potential matches.

Automatic Email Alert Generation and Management Module

Generates and manages alert emails related to potential matches or sightings of missing children.

Functionality: Sends notifications through email to relevant authorities (like police stations) when the system identifies a potential match.

RESULTS AND DISCUSSIONS

Results

The expected results would encompass several key performance indicators. Primarily, the system's accuracy in facial recognition would be a critical outcome, under varied conditions such as different lighting, angles, and facial expressions. The efficiency of the system would be gauged by a marked reduction in the time taken to identify and locate missing children compared to traditional methods, contributing to quicker and more effective responses.

Variations under Different Lightening conditions: The lightening parameter plays a vital role in recognizing a human face, It is easier to recognize the face in light, but it could be very difficult to recognize the face in low lightning. The following are the results obtained to recognize the human face under different lightning conditions.

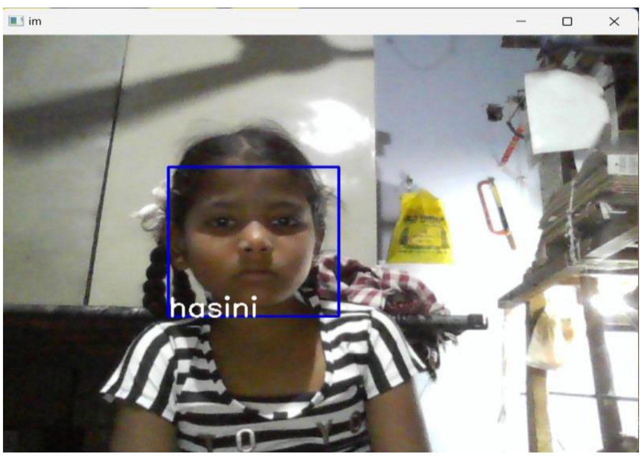

FIGURE 5. Recognizing child face in lightening

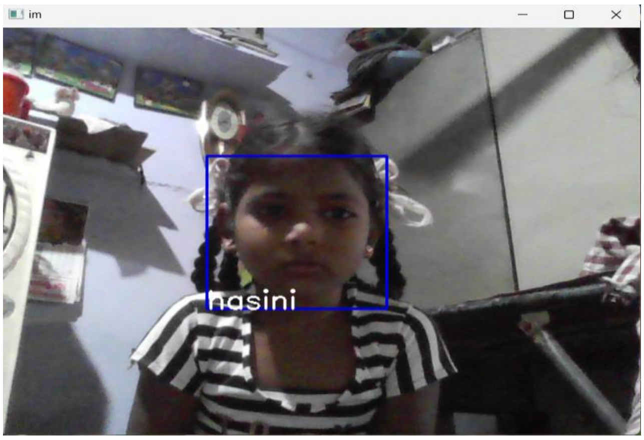

FIGURE 6. **Recognizing child face in poor lightening**

Variations with Different Facial Expressions: facial expression plays a vital role to identifying the person. The following are the results obtained to identifying the child under various facial expressions.

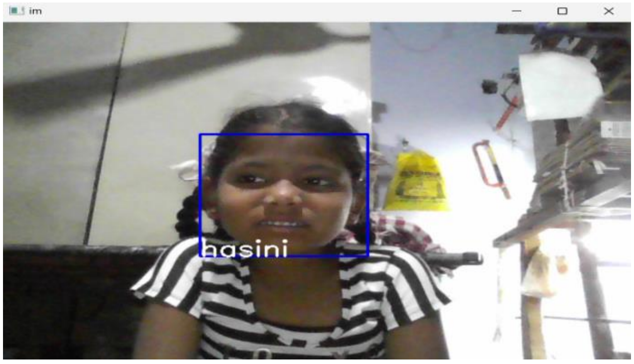

FIGURE 7. Recognizing the child face when facial expression is "happy"

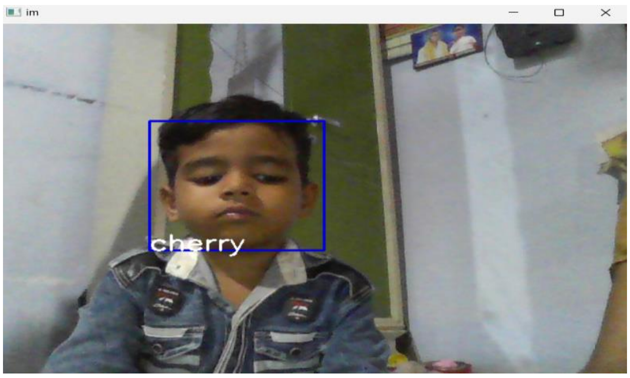

FIGURE 8. Recognizing the child face when facial expression is "sad"

Variations with Different Poses: Following are the results obtained under different poses in face recognition.

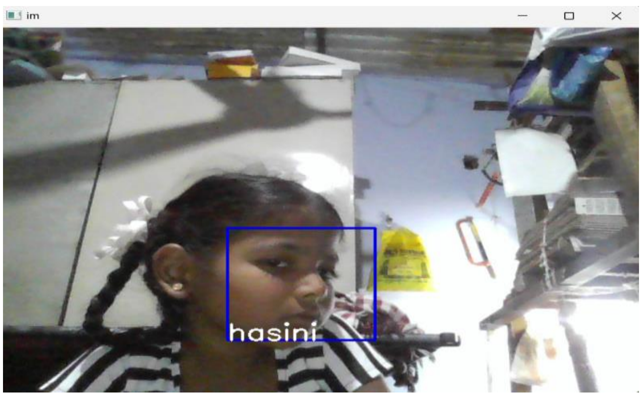

FIGURE 9. Recognizing the child face in side view

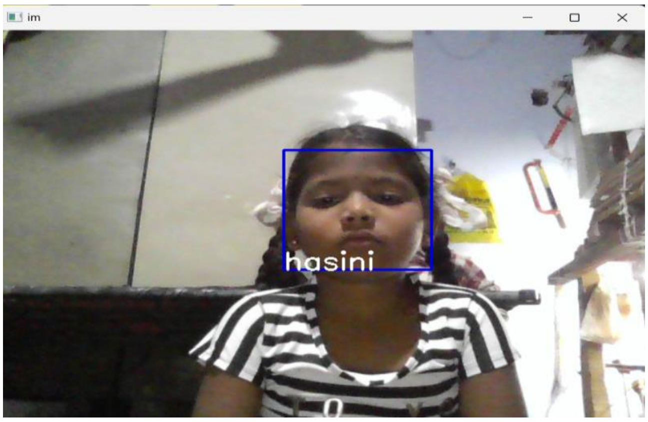

FIGURE 10. Recognizing the child when face is up

Discussions

Comparison with Traditional Methods:

Speed and Efficiency: Unlike traditional methods, which are often labour-intensive and time-consuming, facial recognition algorithms provide rapid identification, saving critical time in situations like finding missing children.

Accuracy: While traditional methods like manual photo comparisons are prone to human error, facial recognition offers a higher level of accuracy, especially over large datasets.

Scalability: Traditional methods become increasingly impractical as the volume of data increases, whereas facial recognition algorithms maintain their efficacy even with large databases.

Non-Intrusiveness: Traditional biometric methods like fingerprinting require physical contact or cooperation from individuals, whereas facial recognition can be done passively, without needing active participation from the subject.

FIGURE 11. Home page

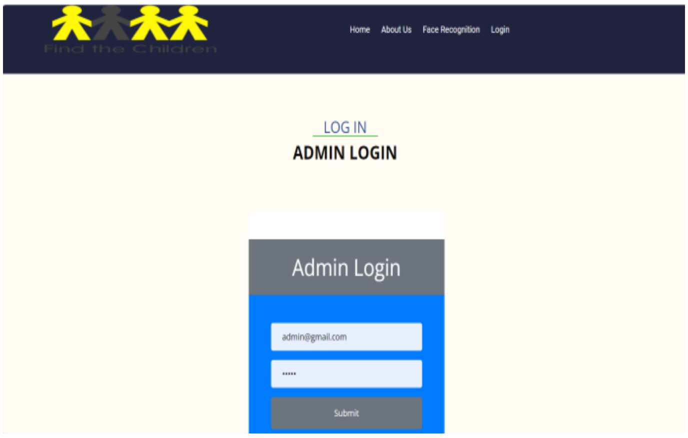

FIGURE 12. Admin login page

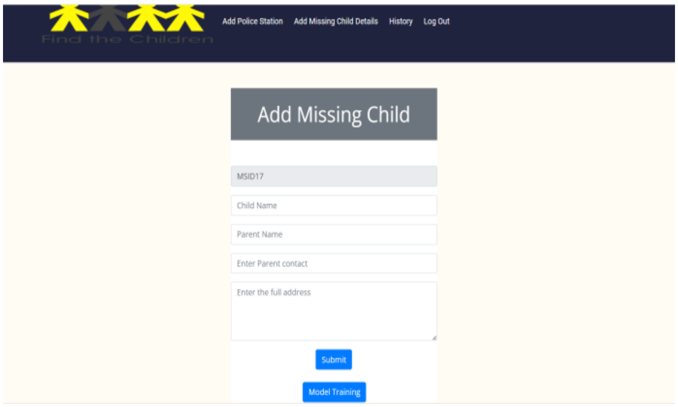

FIGURE 13. Add and train the missing child details

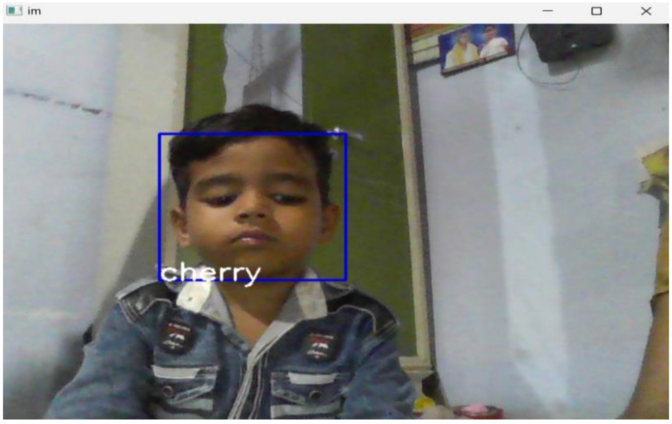

FIGURE 14. Facial recognition and matching the missing child

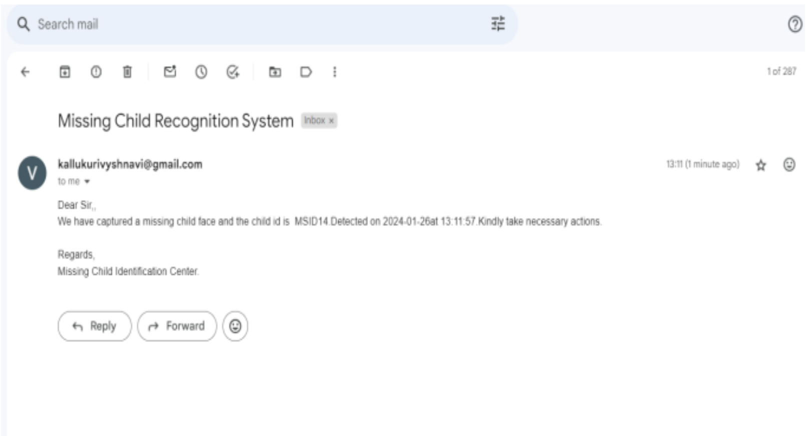

FIGURE 15. Alert email notification

CONCLUSION

The project aims to address the issue of missing children by utilizing facial recognition technologies, specifically Local Binary Pattern Histograms (LBPH). The system, which combines image processing techniques and deep learning, has shown potential for enhancing the speed and accuracy of identifying missing children. Its success in accurately matching children's faces under different conditions demonstrates in tackling real-world challenges. The project also emphasizes the importance of ethical considerations and privacy in the deployment of facial recognition technology. The collaborative approach, involving authorities like police departments and administrative personnel, ensures the system is adaptable and user-friendly. This project represents hope for child safety and welfare, highlighting the potential of facial recognition technology for societal impact.

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