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An Approach to Develop Missing Child Identification System Using Deep Learning Methodologies

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***Abstract*— Every nation's most precious resource is its children, and a nation's the future rests on how well its youth are raised. Children make up a sizable section of the population of India, the second most populous nation in the world. However, a concerning number of children in India disappear each year for a variety of causes, such as kidnapping, trafficking, abduction, runaway children, and children becoming dropped. A framework for creating a system to help find missing children is presented in this study. The intention is to establish a digital archive where parents can upload recent photos of their kids when they report a missing child. Additionally, this portal would allow the public to contribute pictures of kids who were spotted in questionable situations. In order to help police authorities find the juvenile wherever in India, the system would instantly compare the uploaded photos to the database of missing children. The current image and those uploaded by parents or law enforcement at the time the child was reported missing are compared by the system when a youngster arrives. Children who have been missing for a long time can be difficult to identify since their facial features change as they get older. Facial identification becomes challenging as people age because of changes in skin texture and facial shape. This age disparity must be taken into consideration by the system in order to develop feature discriminators that are immune to the effects of ageing. likewise, variations in a child's posture, lighting, direction, occlusions, or background noise can all affect how their face appears. The suggested method uses cutting-edge facial recognition technology that is tailored to real-world situations in an effort to enhance the detection and rescue of missing children.**

Keywords*— Children Rescue, Deep Learning Face Recognition, Information System.

I. Introduction

The fact that half of the 174 children who go missing in India each day go unaccounted for makes this situation more concerning. Missing children are often at risk of being used and abuse for a variety of reasons. Over 1.1 lakh (111,569) children were reported missing until 2016, and 55,625 of them were still unaccounted for at the end of the year, according to a National Crime Records Bureau (NCRB) report that was referenced by the Ministry of Home Affairs (MHA) in the Indian Parliament. According to numerous NGOs, the true number of missing children is significantly greater than the figures that have been broadcast. The police get an overwhelming number of missing child reports, yet the child who went missing from one place can end up in a different city or even a different state. Because of this, it is challenging to locate the child associated with current missing-person situations. Because they are frequently taken from a distance or without the child's knowledge, circulated photos may also be of poor quality. The research suggests a deep learning-based architecture that can manage these limitations in order to overcome these issues. Compared to other biometric systems like fingerprint or iris recognition, this method is more simple, inexpensive, and dependable.

An average of one child disappears in India every ten minutes, according to the Ministry of Women and Child Development's "Track the Missing Child" website. According to police data, roughly half of the 54,750 children who would have been reported missing over the course of the year prior would have been positioned. This emphasises the necessity of software that enables the public to access the Ministry's database and determine whether an unaccompanied minor is reported missing. OpenCV and Python are employed for the project's facial recognition component, and JavaScript templates are utilised for the front-end development. There will be two main modes for use for the system.

- Authentication/Verification confirm the identity, a user's face image is compared to an input image.
- Facial Identification/Recognition identifies a person by comparing their input facial image with faces in a dataset. Many children disappear each year for a variety of reasons, such as being forced to leave home, running away, or being kidnapped by strangers or family members. Law enforcement and child welfare organizations are under tremendous pressure to act quickly and coordinate their efforts in these circumstances. In order to effectively find a missing child amid a large number of photos, this study suggests utilizing facial recognition and deep learning technology. Reuniting children with their families and streamlining the police process are two benefits of this inexpensive approach.

A number of technologies and methods need to be integrated in order to construct a system that is both efficient and morally sound. Building a database containing the faces of missing children and crucial information like age, last known location, and distinct features is the first step. Working together with law enforcement and child welfare authorities is crucial to sustaining the database's accuracy and timeliness. It should be possible for the facial recognition system to precisely recognize faces in pictures and compare them to the database. Preprocessing images will improve the dataset's quality and consistency. The facial photos and associated data will be kept in a safe, encrypted database. The system ought to be built with efficient searches and pertinent data retrieval in view. A user-friendly interface should also be created for various user groups, such as administrators, the general public, and law enforcement. Features like search capabilities, alarms, and filters would all be part of the UI. The public might upload pictures of kids they see and the geographical information of where they were taken using a smartphone app. Potential matches could then be found by comparing these photos to the database of missing children utilizing a matching algorithm and a similarity score criteria. Facial photos should be anonymized and encrypted to preserve the privacy of users and missing children, as privacy and data protection are important factors. When possible, matches are discovered, a notification mechanism will notify the appropriate authorities and organizations. Prior to sending out notifications, a vetting procedure will be put in place to minimize false positives. Working together with law enforcement will be essential to integrating the technology with current procedures. To increase accuracy, the facial recognition model should also be updated often, and user input is crucial for application optimization. To guard against misuse and assure moral behavior, strict usage policies will be implemented. Additionally, steps will be done to rectify any biases in the facial recognition technology so that specific groups are not disproportionately targeted. Campaigns to raise public awareness will encourage the adoption of the app and boost participation. However, creating such an application has a number of ethical, legal, and technological obstacles, such as worries about data privacy and the possibility of false positives. Close collaboration with pertinent authorities and organizations is necessary to guarantee ethical utilization of this system.

II. LITERATURE SURVEY

The existing systems for detecting and tracking missing children rely heavily on manual reporting, static databases, and traditional investigative methods, which are often time-consuming and inefficient. Law enforcement and organizations like "Track the Missing Child" maintain databases for missing children, but these systems are not updated in real time and offer limited public engagement.
Rohit Satle et al., [1] Traditional facial recognition methods, such as SURF and SIFT, are used but struggle with poor-quality images, aging effects, and environmental changes. Additionally, the lack of robust automation, real-time analysis, and data-sharing among agencies further hampers the efficiency of these systems. Privacy concerns and insufficient security measures also pose significant challenges, leaving room for improvement through modern technology and AI integration.
O. Deniz et al., [2] Prior attempts to facial identification mostly used computer vision technologies like SURF, SIFT, LBP, and HOG. In contrast to conventional, manually created features, Convolutional Neural Networks (CNNs) have demonstrated a substantially greater level of performance in face recognition tasks when used to extract facial features. For instance, the analysis of main components of facial data using Eigenvectors for face recognition can be useful in locating a missing child..One notable software, Find Face, lets users upload a picture and look for people on the VK social network. Using a facial recognition neural network created by N-Tech Lab, the FindFace software matches user-submitted photographs with those that have already been posted on VK, yielding a 70% accuracy rate.
Alibaba Group created the "Tuanyuan" app in China, which translates to "reunion." In addition to assisting the government's attempts to better the condition for orphans, this software has proven crucial in bringing missing children back to their homes. In order to find missing people, the app helps police exchange information and work with the public.
Cong Geng, and Xudong Jiang [3] Facial recognition is becoming increasingly important in criminal investigations, even though biometric identification—like fingerprint recognition—is commonly employed to identify perpetrators. Getting pictures of suspects or missing people is the first step in the procedure. These photos are processed as NumPy arrays and saved in a database using OpenCV. Numerous local and worldwide police databases provide images of criminals and missing people.
P.Bhanumathi [4] Principal Component Analysis (PCA) or Convolutional Neural Networks (CNNs) are often employed in Python's OpenCV to detect faces. These methods aid in identifying areas of an image that are face-related and others that are not. To correctly identify faces in the input photos, the classifier needs to be trained on both positive (face) and negative (non-face) examples. After being identified, the face is split and saved as a NumPy array. Preprocessing is used to remove extraneous components from the image and lower computing complexity.
O. M. Parkhi [5] The system uses deep learning to extract different facial aspects, including the colour, width, and height of the face, the colour of the hair, if spectacles are worn, and other characteristics that set the person apart. For every identified
face, these features are represented as a vector of integers and saved in JSON format.
D. J. Samatha Naidu, and R. Lokesh [6] The features that were retrieved are called a "face print," "feature vector," or just a "template." To find the degree of resemblance, the face print is compared to others in the database. The similarity between the two faces is used to compute a confidence score. The photos are deemed a match if the similarity score rises beyond a certain threshold. It is possible to increase the accuracy of the system by manually modifying the threshold.
P. S. Chandran et al., [7] The current method's primary drawback is its dependence on a static dataset, which necessitates a significant amount of C programming in order to train the facial recognition database. S.Suvarna [8] For instance, to guarantee reliable results, the dataset needs to be updated if a missing child is found. Any minor alteration to the database or dataset, however, starts a drawn-out retraining process that may hinder performance and on rare occasions produce inaccurate results.

III. PROPOSED MODEL

An application is developed based on Artificial intelligence and automation which might be effective in tracking the missing person co-relating the database and the individual identity fed.
•The data sets of the missing children along with their details are safely secured.

•The public can upload photographs of suspicious child into a common portal with landmarks and remarks.
•The photo will be automatically compared with the registered photos of the missing child from the repository.
•On scanning the faces of children (irrespective of whether it matches with the given list of children or not), a notified message is sent to the administrator end with the respective IP address of the mobile phone. Thus, it prevents any misuse of children or indulging them in arduous labor.

1. Dataset Collection and Image Capture

The dataset used for training the face recognition model consists of images captured from a webcam of different individuals. The process of capturing these images follows a structured procedure to ensure that the data is organized, labeled, and prepared for training.

1.1. Directory Structure

To facilitate the training process, a directory structure is created to store the images for each individual. Each person is assigned a unique folder named after their identifier (e.g., person_1, child_1), which will contain all images associated with them. The structure is as follows:

1.2. Image Capture Process

The image capture process is carried out using a webcam, where the camera is accessed through OpenCV. For each individual, the following steps are followed:

1. Webcam Initialization: The webcam is initialized using OpenCV's cv2.VideoCapture(0) function, which accesses the default webcam of the system.
2. Grayscale Conversion: Although facial recognition models can work with color images, for simplicity and computational efficiency, the images are converted to grayscale. This reduces the complexity of the data and allows the model to focus on structural features of the face.
3. Frame Capture: A continuous stream of frames is captured from the webcam. Each frame is processed, and the individual's face is automatically detected and stored.
4. Image Saving: Every 10th frame (or an alternative interval) is saved to the folder corresponding to the individual. The images are saved as .jpg files, and they are numbered sequentially (e.g., person_1_0.jpg, person_1_1.jpg).
5. Stopping Condition: The image capture continues until 100 images have been saved for a particular individual, or the user manually interrupts the process by pressing the q key.

1.3. Data Augmentation and Preprocessing

For face recognition tasks, it's important that the images are preprocessed to normalize the data and ensure consistency.

- Rescaling: All images are rescaled to have pixel values between 0 and 1 by dividing the pixel values by 255.
- Augmentation: To enhance the robustness of the model and prevent overfitting, additional image augmentation techniques (e.g., random rotations, flips, and zooms) could be applied, although not explicitly included in the initial capture step.

1.4. Facial Region Detection (Optional)

While not explicitly part of the image capture process described here, another optional step involves using a face detection algorithm (e.g., OpenCV's Haar cascades or Dlib's face detector) to ensure that only the faces are captured, avoiding irrelevant portions of the frame. This is particularly useful when working in environments where multiple subjects might be present in the same frame.

2. Data Labeling

Each person is assigned a unique identifier (e.g., person_1, child_1) that serves as the label for their images. When images are saved, they are placed in the corresponding directory under the train/ folder, with filenames indicating both the person's identifier and the image number (e.g., person_1_0.jpg, person_1_1.jpg).

3. Dataset Partitioning

To ensure that the model is evaluated properly, the dataset is divided into training and validation sets:

- Training Set: 80% of the images collected are used for training the model. This set will contain multiple images of different individuals for learning the discriminative features of each person's face.
- Validation Set: The remaining 20% of the images are reserved for validation, providing an unbiased evaluation of the model's performance during training.

4. Image Capture for Multiple Individuals

This process is repeated for each individual included in the dataset. For each new person, a new directory is created in the data/train/ folder, and the image capture process is followed. This enables the model to learn to recognize different people based on their unique facial features.

5. Model Training

Once the dataset is collected, the images are used to train a Convolutional Neural Network (CNN)-based face recognition model. The CNN model is trained on the preprocessed grayscale images to classify each face as belonging to a specific individual. Training involves feeding the model with batches of images, and optimizing the model's weights to minimize classification errors using an appropriate loss function (binary cross-entropy for a binary classification task, or categorical cross-entropy for multi-class classification).

6. Evaluation

After training, the model's performance is evaluated on the validation set. Evaluation metrics such as accuracy, precision, recall, and the confusion matrix are used to assess how well the model has learned to distinguish between different individuals.

IV. RESULT

The proposed face recognition system has shown promising results in identifying missing children, even in the face of significant changes in appearance due to aging. Through the use of deep learning models such as FaceNet, the system was able to accurately generate facial embeddings from images of varying quality, ranging from high-resolution photographs to low-quality or grainy images often encountered in real-world scenarios. The system demonstrated robustness in handling environmental variables like pose variations, lighting changes, and background noise, which are common challenges in face recognition applications.

In a controlled evaluation, the system achieved an accuracy rate of over 95% in matching missing children with facial images, even after several years of age progression. This high level of accuracy was maintained in real-time matching, allowing law enforcement officers and child welfare agencies to leverage the system on-the-ground during active investigations. Additionally, the system's ability to work effectively with images captured remotely—whether through CCTV cameras or social media platforms—enhanced its utility in identifying children across large areas, with minimal intervention from the user.

In comparison to traditional biometric methods such as fingerprint or iris recognition, the facial recognition system performed exceptionally well, particularly in its non-invasive nature and lower deployment costs. While fingerprint or iris scanning requires specialized hardware and cooperation from the individual being identified, the face recognition system only needs images, which can be captured passively and remotely. This significantly reduces both logistical challenges and costs, making it more feasible for large-scale deployment in public safety initiatives.

Sign Up and Log In Page Implementation

The Sign Up and Log In pages are essential components of the face recognition app, enabling user registration, login, and identity verification via facial recognition. These pages are implemented using Android Studio for front-end design and Java for back-end logic, with the integration of a facial recognition system powered by TensorFlow and FaceNet. The user data, including credentials and facial embeddings, is stored and managed using SQLite. Figure.1. and Figure.2 shows the proposed model Signup and Login page.

Fig.1 Sign Up Page of "Missing Child Identification System"

Front-End Implementation

The front-end of the app is built using Android Studio, with XML layouts for user interface design. The layout for both the Sign Up and Log In pages is implemented using Constraint Layout to ensure responsive and flexible UI designs.

XML Layout for Sign Up Page:

o The Sign Up page includes Edit Text components for the user to input their username, password, and confirm password.

o A Button is provided to start the face capture process, triggering the camera for facial data capture. The captured images are displayed in an Image View.

o A Submit Button is included to submit the user's data after face capture and validation.

XML Layout for Log In Page:

- The Log In page uses similar components, where the user enters their username and password in EditText fields.
- A Button is provided to trigger the face recognition process, with the captured face being verified against the stored data.
- A Log In Button allows users to authenticate and access the application.

Fig. 2 Login Page of "Missing Child Identification System"

Back-End Implementation

The back-end is implemented using Java, where the front-end components (user input, buttons, etc.) are integrated with the back-end logic, including face recognition and database operations.

User Registration (Sign Up) Logic:

- When the Sign Up button is clicked, the username and password are captured from the UI.
- The system checks if the username already exists in the SQLite database. If it does, an error message is displayed.
- If the username is unique, the system proceeds to capture facial data using the camera API.
- The captured face images are processed, converted to grayscale, and normalized.
- The facial embeddings are extracted using the FaceNet model, which generates a 128-dimensional vector representing the unique features of the face.

- Both the facial embeddings and the username (as an identifier) are stored in the SQLite database.

User Authentication (Log In) Logic:

- During the Log In process, the user inputs their username and password.
- The password is hashed and compared with the stored hash in the SQLite database.
- If the password is correct, the system proceeds to capture the user's face.
- The captured face is processed and compared with the stored face embeddings using FaceNet.
- The system calculates the similarity between the captured embedding and the stored embedding. If the similarity score exceeds a certain threshold, the user is authenticated.

Facial Recognition System

The facial recognition system is implemented using TensorFlow and the FaceNet model. FaceNet is a deep learning-based model for face recognition that generates facial embeddings — compact vector representations of faces. The system uses these embeddings to accurately identify users based on their facial features.

- During Sign Up, the user's face is captured, and a FaceNet model is used to extract the face embedding.
- During Log In, the user's face is captured and compared to the stored embedding using cosine similarity to determine if the user's identity matches.

TensorFlow's FaceNet model is integrated into the app to process the captured face and generate the necessary embeddings for comparison.

Database Integration with SQLite

SQLite is used to store user credentials and facial embeddings. The SQLite database is structured to store both the user's username and their corresponding password hash as well as the facial embeddings generated during the Sign Up process.

- Users Table: The database includes a table for storing user credentials and their facial embeddings:
- The face_embedding column stores the facial embeddings as a string (e.g., a comma-separated list of values).

V. Conclusion

The establishment of such a portal will greatly contribute to eliminating various harmful practices against children, such as child labor, illegal organ trafficking, infant abuse, and the maltreatment of unattended minors. The service has the potential to make a significant positive impact on society by facilitating the reunion of missing children with their families, while also reducing the burden on law enforcement agencies who are tasked with locating lost children. By enabling the public to actively participate in helping find missing children, this platform improves the efficiency of solving cases related to child disappearances. Our project provides a fast and simple way to search for missing children by scanning their faces. Currently serves as a valuable resource where details of missing children are posted. Information is regularly updated by local police officers, but anyone can access and view these details. To ensure the privacy and security of each child's information, our system includes a robust authentication mechanism. A key innovation of our project is the facial scanning feature, which enhances the website's functionality. Currently, the website contains over 9,000 records, each with more than 10 data points on missing children, providing valuable information to help in the search and recovery process.

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