MISSINGCHILDIDENTIFICATION SYSTEM USING DEEP LEARNING METHODOLOGIES

PHASE I REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project titled **“Missing child identification system using deep learning methodologies”** is the bonafide work of **“MONISHA D(210701167), NIVETHITHA CHOWTHRI(210701185)”** who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported here in does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

The future of any nation is largely determined by the well-being and development of its children. In India, which has the second-largest population in the world, a significant portion of the population consists of children. However, the country faces a grave issue with a high number of missing children each year, with cases arising from abductions, trafficking, runaway children, or children being abandoned. According to the National Crime Records Bureau (NCRB), over 1.1 lakh children were reported missing in 2016, with a substantial number, approximately 55,625, still unaccounted for by the end of that year. The situation is further exacerbated by the fact that many missing children are at risk of exploitation, abuse, or trafficking. One of the key challenges in locating missing children is the lack of proper identification, as children's appearances change over time due to aging, making facial recognition increasingly difficult. Additionally, environmental factors such as variations in posture, lighting, and background can further complicate identification efforts. To address these challenges, a comprehensive digital framework is proposed that allows parents and law enforcement agencies to upload photos of missing children into a centralized database. This system would enable the public to contribute images of children spotted in suspicious circumstances, helping to quickly identify and track down missing children. The system would use advanced facial recognition technology, tailored to account for issues such as aging and poor-quality images, making it a more efficient and cost-effective solution compared to other biometric methods like fingerprint or iris recognition. By utilizing deep learning-based architecture, this proposed system aims to improve the identification and recovery of missing children, offering a robust solution to a serious societal issue.

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LIST OF ABBREVIATIONS

ABBREVIATION	ABBREVIATED AS
AI	Artificial Intelligence
API	Application Programming Interface
AR6	Sixth Assessment Report (IPCC)
CNN	Convolutional Neural Network
GPT	Generative Pre-trained Transformer
IMCC	International Marine Conservation Congress
IPCC	Intergovernmental Panel on Climate Change
LLM	Large Language Model
NLP	Natural Language Processing
NASA	National Aeronautics and Space Administration
NER	Named Entity Recognition
OPT	Open Pre-trained Transformer
RAG	Retrieval-Augmented Generation
TTS	Text-to-Speech
STT	Speech-to-Text
DERA	Dialog-Enabled Resolving Agents

CHAPTER 1

1. INTRODUCTION

1.1 GENERAL

An average of one child goes missing in India every ten minutes, according to the Ministry of Women and Child Development's "Track the Missing Child" website. Police data indicates that about half of the 54,750 children reported missing each year are eventually located. This underscores the need for a system that allows the public to access a database to identify unaccompanied minors who may be reported missing. The proposed system will incorporate facial recognition technology using OpenCV and Python for the backend and JavaScript for the front-end development. The system will operate in two primary modes: Authentication/Verification and Facial Identification/Recognition.

The Authentication/Verification mode will confirm the identity of a user by comparing their facial image with an input image. The Facial Identification/Recognition mode will match an input image with faces in a database of missing children to help identify and locate them. This system is designed to aid in the recovery of children who go missing for various reasons, such as abduction or running away. Law enforcement and child welfare organizations often face immense pressure in such situations, and this technology offers an efficient solution to help quickly identify missing children.

Collaboration with law enforcement and child welfare agencies is critical to maintaining an accurate and updated database. The facial recognition system must be capable of accurately comparing input images to the database. Image preprocessing will enhance the dataset's consistency, while thesystem will be designed for efficient searches and data retrieval. A user-friendly interface will be essential for various users, including the public and law enforcement.

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A mobile app will allow the public to upload photos of children they spot in suspicious situations, along with location details. These images will be compared to the missing children database using a matching algorithm to find potential matches. Privacy and data protection will be prioritized by anonymizing and encrypting facial images. Notifications will be sent to the relevant authorities when potential matches are found. A vetting process will minimize false positives, ensuring that only legitimate matches are flagged for further investigation.

The system will address privacy, data protection, and ethical concerns through strict usage policies and regular updates to improve accuracy. User feedback will be crucial for optimizing the system and addressing any biases in the facial recognition technology. Public awareness campaigns will encourage participation and adoption of the app. Despite the potential of this system, challenges remain in terms of data privacy, false positives, and legal implications, requiring collaboration withauthorities to ensure the responsible use of the technology.

1.2 OBJECTIVE

The objective of the proposed system is to design and implement an efficient, cost-effective, and ethically sound facial recognition-based platform to assist in the identification, tracking, and recovery of missing children in India. The system aims to leverage advanced deep learning and facial recognition technologies to build a comprehensive database of missing children, including their facial images, age, last known location, and distinguishing features. This database would be accessible to law enforcement agencies, child welfare organizations, and the general public, allowing users to upload images of unaccompanied minors they encounter and compare them against the existing database.

A key objective is to enhance the speed and accuracy of identifying missing children in real-time, especially in cases where the child's whereabouts are unknown or they have been relocated across different regions. By providing a matching algorithm that compares new images with those in the database, the system seeks to improve the efficiency of search and rescue efforts, ultimately facilitating faster reunions between children and their families. Additionally, the system will integrate robust privacy measures, includingimage anonymization and encryption, to protect sensitive data and prevent misuse.

Another core objective is to ensure that the platform is user-friendly, with simple navigation for various user groups such as the general public, law enforcement officers, and administrators. The system will include features such as search capabilities, filters, and the ability to upload images with location details through a smartphone app. Notifications will alert authorities when a potential match is found, and a vetting process will be implemented to minimize false positives. This objective emphasizes the need for cooperation with law enforcement and child welfare organizations to maintain an up-to-date and accurate database.

Furthermore, the system seeks to address ethical concerns by implementing strict usage policies to prevent abuse and ensure that the technology is used responsibly. Efforts will be made to mitigate any biases in the facial recognition algorithm to ensure equitable treatment of all groups. Regular updates to the system's model and user feedback will be incorporated to improve its accuracy over time. Public awareness campaigns will be essential to encourage the widespread adoption of the platform and increase public participation in locating missing children.

In summary, the overarching objective is to create a highly effective and scalable solution for the detection and recovery of missing children in India, combining the power of facial recognition technology with a secure, user-friendly interface, all while maintaining the highest ethical standards. This system aims to improve law enforcement efforts, empower the public to contribute to child safety, and ultimately help reunite children with their families.

1.2 EXISTING SYSTEM

The existing systems for detecting and tracking missing children primarily rely on manual reporting, static databases, and traditional investigative methods, all of which are often inefficient and time-consuming. Law enforcement agencies, along with organizations like "Track the Missing Child," maintain centralized databases containing information on missing children, but these systems are often not updated in real time, which can delay recovery efforts. Moreover, public engagement with these systems is limited, which restricts the ability of the community to contribute to locating missing children. Traditional facial recognition techniques such as SURF (Speeded Up Robust Features) and SIFT (Scale-Invariant Feature Transform) are employed, but these methods are inadequate when dealing with poor-quality images, changes in a child's appearance over time due to aging, or variations in lighting, posture, and background in photographs. This results in lower accuracy and slower identification processes.

In addition to the limitations in facial recognition technology, the existing systems lack robust automation and real-time data analysis capabilities. The absence of seamless data sharing and communication between various agencies, such as law enforcement, child welfare organizations, and the public, further hinders the effectiveness of these systems. Privacy concerns and insufficient security measures also pose significant challenges, as the handling of sensitive data—such as personal information and images of missing children—raises the risk of data breaches or misuse. These limitations highlight the urgent need for modernization, with the integration of advanced technologies such as artificial intelligence (AI), machine learning, and real-time data processing to improve the efficiency, accuracy, and security of missing child detection and tracking systems.

DISADVANTAGES:

The existing systems for detecting and tracking missing children have several notable disadvantages that limit their effectiveness in quickly locating and recovering children:

1. **Reliance on Manual Reporting and Static Databases**

   Lack of Real-Time Updates: These systems are not updated in real time, meaning that new cases or updates may not be reflected immediately, slowing down the search and recovery process.

   Limited Public Engagement: The existing systems do not allow for active public participation, limiting the community's role in providing useful information, sightings, or tips that could help locate missing children.

2. **Outdated Facial Recognition Technology**

   Struggles with Poor-Quality Images: Traditional facial recognition methods like SURF and SIFT are ineffective when dealing with low-quality images, which are often captured in real-world situations.

3. **Lack of Automation and Real-Time Data Analysis Processes:**

   Existing systems are not automated, meaning that tasks like searching through large databases or cross-referencing images are often handled manually, leading to delays and human error .Fragmented Search Efforts: There is no integrated approach for sharing data across law enforcement, child welfare organizations, and the public, which can result in fragmented efforts and delayed response times in locating missing children.

4. **Privacy and Security Concerns :**

   Insufficient Data Protection: The current systems often lack strong encryption or secure storage protocols to protect sensitive data, such as photos and personal details of missing children. Risk of Unauthorized Access: The absence of robust security measures makes sensitive information vulnerable to unauthorized access or misuse, compromising the privacy of the children and families involved.

1.3 PROPOSED SYSTEM

The proposed application utilizes Artificial Intelligence (AI) and automation to track and identify missing persons, particularly missing children, by correlating the photos uploaded by the public with the existing database of missing individuals. The system ensures that the data, including personal details and photographs of missing children, is securely stored and protected from unauthorized access. The use of AI-driven facial recognition technology allows for the automatic comparison of uploaded images with those in the missing children database, enabling quick identification and recovery of children.

The platform empowers the public by allowing them to upload photos of children they encounter, which could potentially be missing or in suspicious situations. Along with the photograph, users can also include details such as landmarks and additional remarks, which help provide context to the sighting. The AI system then processes these uploaded images, comparing them with registered photographs of missing children in the repository. If a potential match is found, or if a child's face is scanned, the system notifies the administrator and logs the IP address of the user who uploaded the image, ensuring accountability and preventing misuse or exploitation.

This proactive approach ensures that, even if a photo does not immediately match a known missing child, the system still detects and records the event. The notifications sentto administrators, along with the mobile device's IP address, help in tracking down the source and location of the sighting, further contributing to child protection efforts. This

system acts as a preventive measure against child exploitation, including forced labor, by ensuring any suspicious activity involving children is swiftly reported and monitored.

ADVANTAGES:

1. **Secure Data Storage**:

    - The system ensures the safety of sensitive information by encrypting and securely storing data such as photographs and personal details of missing children. This protects the privacy of families and prevents unauthorized access, ensuring compliance with privacy regulations and data protection standards.

2. **Public Engagement**:

    - By enabling the public to upload images of suspicious children along withrelevant context (such as location and remarks), the system promotes community participation. This broadens the search effort, encouraging active involvement from the public, which increases the chances of finding missing children and improving the overall response time.

3. **Real-Time Image Comparison**:

    - The system employs advanced facial recognition technology to automatically compare uploaded images with the existing database of missing children. This real-time image analysis allows for swift identification of potential matches, significantly reducing the time taken to locate missing children and increasing the chances of timely recovery.

4. **Misuse Prevention**:

    - The system logs the IP address of the mobile phone or device from which the image is uploaded, ensuring accountability for each submission. This feature acts as a deterrent to prevent misuse of the system, such as the exploitation or trafficking of children, by ensuring that any suspicious activity can be traced back to its source.

- **Proactive Monitoring**:
- Even if a child's image does not match with the existing database of missing persons, the system continues to scan and monitor the upload. This proactive scanning triggers notifications to administrators, helping them remain vigilant and allowing them to investigate further, which can uncover potential threats or missing children that were not previously on the radar.

The proposed system offers several key advantages, including secure data storage to protect sensitive information, ensuring privacy with data protection standards. Advancedfacial recognition technology enables real-time identification by comparing uploaded images with the missing children database, speeding up the recovery process. The systemalso logs IP addresses to prevent misuse and tracks suspicious activity, ensuring accountability. Proactively monitoring uploads and notifying administrators of potential matches enhances the system's responsiveness, ultimately improving child protection andpreventing exploitation.

CHAPTER 2

LITERATURE SURVEY

[1] In the paper "Deep Learning" (2015), Yann LeCun, Yoshua Bengio, and Geoffrey Hinton provide a comprehensive overview of deep learning, a subset of machine learning that uses neural networks with multiple layers to automatically learn hierarchical representations of data. Unlike traditional methods that rely on manually crafted features, deep learning enables the automatic discovery of low-level features (e.g., edges in images), intermediate structures (e.g., shapes), and high-level abstractions (e.g., objects or concepts). The authors discuss foundational concepts, including supervised learning, backpropagation for training, and unsupervised feature learning, highlighting the importance of large datasets and computational advances in GPUs. They explore its transformative applications in areas like computer vision, speech recognition, and natural language processing, while addressing challenges such as optimization, overfitting, and scalability. The paper concludes by emphasizing the potential of deep learning to drive future AI research and applications, underscoring its success in bridging the gap between raw data and intelligent systems.

[2] The paper "Face Recognition Attendance System Using Local Binary Pattern Algorithm" by Kumar, Latheef, and Santhosh (2023) explores an automated attendance system leveraging facial recognition to enhance efficiency and accuracy in educational and corporate settings. The authors propose a system that uses the *Local Binary Pattern (LBP) algorithm*, a computationally efficient and robust technique for texture analysis, to identify and verify individuals based on facial features. The LBP algorithm operates by encoding local texture information into binary patterns, which are then used to generate histograms for classification and recognition tasks. The study

emphasizes the advantages of using LBP for real-time face recognition due to its simplicity, low computational cost, and robustness against variations in lighting and facial expressions. The proposed system integrates image acquisition, preprocessing (including grayscale conversion and histogram equalization), feature extraction using LBP, and matching against stored templates. Experimental results demonstrate high recognition accuracy, making it a practical solution for automating attendance tracking. The authors highlight the scalability and adaptability of the system, but also acknowledge challenges such as handling occlusions and large-scale datasets. The paper concludes by emphasizing the potential of such technologies to replace traditional methods, ensuring reliability and reducing time consumption in attendance management.

[3] The paper "Enhancing Face Mask Detection Using Data Augmentation Techniques" by Kumar, S., P., and SenthilPandi (2023) addresses the critical need for effective face mask detection systems, particularly in public health contexts like the COVID-19 pandemic. The study highlights the limitations of conventional detection methods, especially in scenarios with limited or imbalanced datasets. To address these challenges, the authors propose using *data augmentation techniques* to improve the performance and robustness of face mask detection models.

The approach involves generating diverse variations of existing datasets through transformations such as rotation, flipping, scaling, and noise addition, effectively increasing dataset size and diversity. The augmented data is then used to train deep learning models, enhancing their ability to generalize across different lighting conditions, angles, and occlusions. The proposed system integrates a convolutional neural network (CNN)-based architecture to classify images into "mask" and "no mask" categories.

Experimental results demonstrate that incorporating data augmentation significantly boosts detection accuracy and reduces overfitting, outperforming traditional training methods. The study concludes that data augmentation is a simple yet powerful strategy for enhancing face mask detection systems, making them more reliable and applicable in real-world scenarios. The authors also suggest further exploration into advanced augmentation methods and real-time deployment

[4] The article "Mobile App Helps China Recover Hundreds of Missing Children" by Reuters highlights the successful use of mobile technology to address child abduction and trafficking in China. The app, developed by the Ministry of Public Security, acts as a digital tool to assist law enforcement and the public in locating missing children. By leveraging real-time alerts and user engagement, the app disseminates information about missing children, including photographs and descriptions, to nearby users who can report sightings or provide relevant tips.

The initiative has demonstrated significant success, with hundreds of children being recovered since the app's launch. The article underscores the app's ability to bridge the gap between police and the public, fostering a collaborative approach to tackling child trafficking. It also discusses the broader context of child abduction in China, a longstanding social issue fueled by illegal adoption markets and cultural factors.7

Despite its achievements, challenges remain, such as the need for increased public awareness, data privacy concerns, and improving the accuracy of reports. The article concludes by emphasizing the potential of technology to combat societal issues, illustrating how mobile apps can enhance the efficiency and reach of law enforcement efforts while engaging communities in solving critical problems.

[5] The paper "Missing Child Identification Using Face Recognition System" by Satle, Poojary, Abraham, and Wakode (2016) explores the application of face recognition technology to aid in locating and identifying missing children. The authors propose a system that leverages facial biometrics as a reliable and efficient means to match

images of missing children against a centralized database. The approach aims to replace traditional identification methods, which are often slow and labor-intensive, with automated and scalable solutions

The system uses a series of processes, including image acquisition, preprocessing (such as resizing and noise removal), feature extraction, and matching. The authors focus on feature extraction techniques that capture distinctive facial characteristics to ensure accurate identification, even in cases of aging or slight variations in appearance. The proposed system is designed to interface with law enforcement databases, enabling authorities to cross-reference missing person reports with discovered individuals effectively

Experimental results show promising accuracy in recognizing faces, demonstrating the potential of such systems to significantly enhance the efficiency of child recovery efforts. However, the authors acknowledge challenges such as handling low-quality images, large-scale datasets, and computational constraints. The paper concludes by emphasizing the need for further advancements in face recognition algorithms and broader adoption to address the global issue of missing children.

[6] The paper "Face Recognition Using Histograms of Oriented Gradients" by Deniz, Bueno, Salido, and de la Torre (2011) presents an approach for face recognition based on the *Histograms of Oriented Gradients (HOG)* feature descriptor. The authors explore the effectiveness of HOG, widely known for object detection, in recognizing faces by capturing detailed structural information from facial images. HOG descriptors analyze the intensity gradients and edge orientations in localized image regions, which are then aggregated into histograms to create a robust representation of the face

The proposed method involves preprocessing input images to standardize illumination and scale, followed by extracting HOG features to encode facial geometry and texture. These features are then classified using support vector machines (SVMs), a supervised learning algorithm well-suited for pattern recognition tasks. The study evaluates the performance of HOG-based face recognition across multiple benchmark datasets, demonstrating competitive accuracy and robustness, particularly under variations in lighting, pose, and expression.

The authors highlight HOG's simplicity, computational efficiency, and invariance to minor image transformations as key advantages. While the method shows strong performance, limitations include challenges in distinguishing highly similar faces or handling occlusions. The paper concludes by suggesting HOG as a viable option for face recognition applications, particularly in constrained environments.

[7] The paper "Face Recognition Using SIFT Features" by Geng and Jiang (2009) explores the application of *Scale-Invariant Feature Transform (SIFT)* for robust face recognition. SIFT is a feature extraction method that identifies key points in images and represents them with descriptors invariant to scale, rotation, and minor transformations. The authors propose using SIFT to extract distinctive facial features, enabling effective recognition even under challenging conditions such as variations in pose, illumination, and expression.

The method involves detecting SIFT key points from facial images, followed by matching these points between query images and a database using a similarity measure. The approach is particularly advantageous for its robustness to partial occlusions and its ability to capture fine-grained details across facial regions. Experimental results on standard datasets demonstrate that SIFT-based recognition achieves high accuracy compared to traditional methods.

The authors conclude that SIFT offers a promising alternative for face recognition, particularly in unconstrained environments, but note computational cost as a limitation.

[8] The paper "Missing Child Identification System Using Deep Learning with VGG-FACE Recognition Technique" by Naidu and Lokesh (2020) presents a system designed to assist in the identification and recovery of missing children using deep learning techniques. The authors employ the *VGG-FACE* recognition model, a deep convolutional neural network (CNN) pre-trained on large-scale facial datasets, to accurately identify individuals from facial images. The proposed system first extracts facial features from images of missing children, which are then compared with a database of known individuals using the VGG-FACE model.

The approach leverages the power of deep learning for high accuracy in face matching, even under variations in lighting, facial expression, or age. Experimental results demonstrate the system’s effectiveness in identifying missing children from facial images, making it a valuable tool for law enforcement agencies. The authors emphasize the potential of this system in real-world applications, although challenges related to image quality and database size are noted

[9] The paper "Missing Child Identification System Using Deep Learning and Multiclass SVM" by Bhanumathi (2021) proposes a system for identifying missing children using deep learning techniques combined with a *Multiclass Support Vector Machine (SVM)* classifier. The system utilizes deep learning for feature extraction from facial images of children, followed by classification using a multiclass SVM to match the extracted features against a database of known faces.

The deep learning model used for feature extraction helps to capture relevant facial characteristics, making the system robust to variations in lighting, age, and expressions. The multiclass SVM classifier is employed to handle the challenge of recognizing a large number of potential individuals, effectively distinguishing between different classes (i.e., children). The paper demonstrates the system’s potential to assist law enforcement agencies in locating missing children by improving identification accuracy compared to traditional methods. The author acknowledges challenges in handling large datasets and image quality but suggests future improvements for real-world deployment.

[10] The paper "Principal Component Analysis for Face Recognition" by Bahurupi and Chaudhari (2012) explores the use of *Principal Component Analysis (PCA)* for face recognition, a well-known technique in the field of computer vision. PCA is employed to reduce the dimensionality of facial image data while retaining the most important features for classification. The authors demonstrate how PCA identifies the principal components (or "eigenfaces") of a face image dataset, which can then be used to efficiently represent and recognize faces.

By projecting images onto a lower-dimensional space, PCA helps to eliminate irrelevant variations and noise, improving recognition accuracy. The system compares new face images against a database of eigenfaces, classifying them based on the closest match. The paper presents experimental results showing that PCA-based face recognition performs well in controlled environments, with fast processing and reduced computational requirements. However, challenges such as handling variations in lighting and facial expression are also noted.

[11] The paper "Optimizing Face Recognition Using PCA" by Abdullah, Wazzan, and Bo-saeed (2012) focuses on improving face recognition performance using *Principal Component Analysis (PCA)*. PCA is utilized to reduce the dimensionality of facial image data, identifying key features that effectively represent the face while minimizing computational complexity. The authors explore different strategies to optimize the PCA technique, such as improving the selection of principal components and enhancing the accuracy of face classification.

The paper highlights how PCA helps in handling large datasets by projecting the high-dimensional data into a lower-dimensional space, retaining the most relevant facial features (eigenfaces). The authors conduct experiments to evaluate the effectiveness of their optimized approach, demonstrating improved recognition accuracy and reduced computational overhead. Despite its advantages, the paper acknowledges the challenges of handling variations in facial expressions, lighting, and occlusions, suggesting that future research could focus on integrating PCA with other techniques for enhanced robustness and accuracy.

[12] The paper "An Efficient Algorithm for Human Face Detection and Facial Feature Extraction Under Different Conditions" by Wong, Lam, and Siu (2001) presents an efficient approach for detecting human faces and extracting facial features in varying conditions such as changes in lighting, pose, and facial expressions. The authors propose a novel algorithm that combines skin color information with edge detection and geometric features to accurately locate faces in images. The system employs a multi-stage process: first, it uses color-based segmentation to detect face candidates, followed by edge detection and facial feature extraction techniques to refine the identification process

The algorithm is designed to be computationally efficient, enabling real-time performance while maintaining high accuracy under diverse conditions. The authors demonstrate the algorithm's effectiveness through extensive testing on various datasets, showing its robustness in detecting faces with different orientations and lighting. The paper concludes that the proposed method is a promising solution for real-world face detection applications.

[13] The paper "Face Recognition with Local Binary Patterns" by Ahonen, Hadid, and Pietikainen (2004) introduces the *Local Binary Pattern (LBP)* as a method for robust face recognition. LBP is a texture descriptor that captures local spatial patterns by comparing the intensity of neighboring pixels with a central pixel, encoding the results as binary values. These binary patterns are then used to generate histograms that describe the texture of facial regions.

The authors show that LBP is particularly effective for face recognition tasks, as it is invariant to monotonic gray-scale transformations (e.g., changes in lighting) and highly discriminative for capturing facial texture. The paper demonstrates that LBP outperforms traditional methods such as eigenfaces, especially under challenging conditions like varying lighting and expressions. The authors also highlight the computational efficiency of LBP, making it suitable for real-time applications. The paper concludes that LBP provides a simple, effective, and robust approach for face recognition in practical scenarios.

[14] The paper "Rapid Object Detection Using a Boosted Cascade of Simple Features" by Viola and Jones (2001) presents an efficient method for object detection, specifically focusing on face detection. The authors introduce a *boosted cascade* of classifiers, which significantly improves the speed and accuracy of object detection systems. The method uses a set of simple features, known as *Haar-like features*, which are computed from rectangular regions of the image. These features capture basic patterns such as edges and textures.

The paper's key innovation is the use of a *boosting* algorithm to select and combine the most relevant features into a strong classifier. The cascade structure allows the system to quickly reject non-object regions and focus computational resources on promising areas, improving detection efficiency. The proposed method achieves real-time face detection with high accuracy, making it suitable for practical applications. The paper's approach laid the foundation for many subsequent advancements in object detection

[15] The paper "A Review on Face Detection in the Wild: Past, Present, and Future" by Zhang and Zhang (2010) provides an extensive review of the advancements in face detection, focusing on challenges and solutions for detecting faces in unconstrained environments, or "in the wild." The authors examine the evolution of face detection methods, beginning with traditional approaches that relied on geometric features and

moving toward more advanced techniques, such as machine learning-based methods and deep learning algorithms

The review highlights key challenges in face detection in real-world scenarios, including variations in lighting, pose, occlusion, and facial expression. It discusses the strengths and weaknesses of different algorithms, including Haar-like features, active shape models, and deep learning-based approaches. The authors also identify the importance of large annotated datasets and real-time performance. The paper concludes by forecasting future directions, emphasizing the need for more robust, scalable, and computationally efficient face detection systems capable of handling diverse and dynamic environments

[16] The paper "Hidden Markov Models for Face Recognition" by Neffian and Hayes III (1998) explores the use of *Hidden Markov Models (HMMs)* for the task of face recognition. The authors propose that HMMs, typically used for temporal pattern recognition, can be applied to face recognition by modeling the spatial relationships between facial features. The method involves representing a face as a sequence of feature vectors extracted from facial regions, with the HMM capturing the statistical dependencies between these vectors

The paper outlines the advantages of using HMMs, such as their ability to handle variations in facial expressions and partial occlusions, by incorporating temporal dependencies and probabilistic models. Experimental results demonstrate the feasibility of HMM-based face recognition, showing that it can achieve competitive accuracy when compared to traditional methods. The authors highlight potential improvements, such as incorporating more sophisticated feature extraction techniques and extending HMMs for real-time applications, thus paving the way for future research in this area.

[17] The paper "View-Based and Modular Eigenspaces for Face Recognition" by Pentland, Moghaddam, and Starner (1994) presents an innovative approach to face recognition by combining *view-based* and *modular eigenspaces. The authors propose the use of **eigenfaces*, a representation of faces in terms of principal components, but extend this concept by creating multiple eigenspaces for different viewing angles or facial expressions. This enables the system to recognize faces from various perspectives, overcoming the limitations of traditional view-dependent face recognition methods.

The authors introduce a modular approach, where the face recognition system is trained with a combination of different modules, each corresponding to a specific view or expression. By using a small number of eigenfaces for each module, the system efficiently handles variations in pose and expression while maintaining high accuracy. The paper's results demonstrate the effectiveness of this approach, suggesting that modular eigenspaces provide a robust and scalable solution for real-world face recognition applications

[18] The paper "Local Feature Analysis: A General Statistical Theory for Object Representation" by Penev and Atick (1996) introduces *Local Feature Analysis (LFA)*, a statistical framework for object representation in visual recognition systems. The authors present LFA as a method that extracts localized features from objects, such as edges or textures, and captures their statistical dependencies to form a compact and efficient representation. The key idea behind LFA is to model local features as statistical processes, providing a robust way to encode variations in object appearance, including changes in orientation, scale, and lighting.

LFA is presented as an alternative to traditional global feature-based approaches like principal component analysis (PCA), offering better performance when dealing with real-world visual objects. The paper demonstrates that LFA can be effectively applied to object recognition tasks, particularly in recognizing faces, by capturing relevant local variations and statistical patterns. The authors suggest that LFA provides a more flexible and powerful framework for visual recognition than previous methods.

[19] The paper "Component-Based Face Detection" by Heisele, Serre, Pontil, and Poggio (2001) presents a novel approach to face detection by using *component-based* models, which represent the face as a collection of distinct, yet interconnected, parts. The authors propose breaking the face into key components, such as eyes, nose, and mouth, and training a classifier to detect these components independently. Once these parts are detected, their spatial relationships are used to assemble a complete face

This approach contrasts with traditional holistic face detection methods, which treat the face as a single entity. By focusing on individual facial components, the system becomes more flexible and robust to variations in pose, lighting, and occlusions. The paper demonstrates that component-based models improve detection accuracy, especially in challenging real-world conditions. Experimental results show that the method outperforms conventional face detection algorithms, making it a promising technique for face recognition and detection in practical applications.

[20] The paper "Component-Based Face Detection" by Heisele, Serre, Pontil, and Poggio (2001) introduces a *component-based approach* to face detection, where a face is modeled as a combination of individual facial components such as eyes, nose, and mouth. This method contrasts with traditional holistic approaches that treat the face as a single entity. The authors propose training classifiers to detect these components independently and then use their spatial relationships to reassemble them into a full face.

Author(s)	Reference	Title	Purpose	Findings
LeCun, Y., Bengio, Y., Hinton, G. (2015)	LeCun et al., 2015	Deep Learning	Provide an overview of deep learning, including its foundational concepts, applications, and challenges.	Deep learning is transformative in fields like computer vision, speech recognition, and natural language processing. It bridges raw data and intelligent systems, though challenges remain.
Kumar, S., Latheef, S., Santhosh, R. (2023)	Kumar et al., 2023	Face Recognition Attendance System Using Local Binary Pattern Algorithm	Develop an automated attendance system using LBP for facial recognition in real-time.	LBP is efficient and robust for face recognition, outperforming traditional methods in accuracy and reliability, though it faces challenges with occlusions and large datasets.
Kumar, S., P., SenthilPandi, S. (2023)	Kumar & SenthilPandi, 2023	Enhancing Face Mask Detection Using Data Augmentation Techniques	Improve face mask detection systems using data augmentation methods.	Data augmentation enhances model accuracy and generalization, effectively handling lighting conditions and occlusions.
Reuters (2024)	Reuters, 2024	Mobile App Helps China Recover Hundreds of Missing Children	Examine how a mobile app aids in recovering missing children in China.	The app successfully locates missing children through public engagement and real-time alerts, with challenges in awareness and privacy.
Satle, P., Poojary, M., Abraham, A., Wakode, M. (2016)	Satle et al., 2016	Missing Child Identification Using Face Recognition System	Use facial recognition technology to identify missing children.	Face recognition improves the efficiency of locating missing children, though issues like low-quality images and computational limits remain.
Deniz, D., Bueno, M., Salido, M., de la Torre, F. (2011)	Deniz et al., 2011	Face Recognition Using Histograms of Oriented Gradients	Apply HOG descriptors for face recognition.	HOG-based recognition is robust to variations like lighting and pose but struggles with occlusions and similar faces.

Author(s)	Reference	Title	Purpose	Findings
Geng, X., Jiang, X. (2009)	Geng & Jiang, 2009	Face Recognition Using SIFT Features	Explore the use of SIFT for robust face recognition.	SIFT is effective for recognizing faces under challenging conditions, but its computational cost is high.
Naidu, P., Lokesh, A. (2020)	Naidu & Lokesh, 2020	Missing Child Identification System Using Deep Learning with VGG-FACE Recognition Technique	Use VGG-FACE deep learning model for identifying missing children.	VGG-FACE offers high accuracy in face matching, though challenges like image quality and database size exist.
Bhanumathi, R. (2021)	Bhanumathi, 2021	Missing Child Identification System Using Deep Learning and Multiclass SVM	Combine deep learning with multiclass SVM for missing child identification.	The system improves identification accuracy over traditional methods, with challenges in dataset handling and image quality.
Bahurupi, S., Chaudhari, S. (2012)	Bahurupi & Chaudhari, 2012	Principal Component Analysis for Face Recognition	Apply PCA to reduce the dimensionality of facial data for recognition.	PCA reduces computational load and improves accuracy in controlled conditions, but struggles with lighting and expression variations.
Abdullah, A., Wazzan, M., Bo-Saeed, T. (2012)	Abdullah et al., 2012	Optimizing Face Recognition Using PCA	Optimize PCA for enhanced face recognition performance.	PCA optimizations lead to improved accuracy and efficiency, but challenges like facial expression and lighting remain.
Wong, S., Lam, Y., Siu, Y. (2001)	Wong et al., 2001	An Efficient Algorithm for Human Face Detection and Facial Feature Extraction	Propose a face detection algorithm using skin color and edge detection.	The algorithm is efficient in detecting faces under diverse conditions, achieving high accuracy and real-time performance.
Ahonen, T., Hadid, A., Pietikainen, M. (2004)	Ahonen et al., 2004	Face Recognition with Local Binary Patterns	Introduce LBP for robust face recognition.	LBP is computationally efficient, effective under varying conditions, and outperforms eigenfaces in robustness.

Author(s)	Reference	Title	Purpose	Findings
M. (2001)	2001	Detection Using a Boosted Cascade of Simple Features	detection speed and accuracy using boosted cascades.	simple features achieves real-time face detection with high accuracy, influencing future object detection systems.
Zhang, Z., Zhang, Y. (2010)	Zhang & Zhang, 2010	A Review on Face Detection in the Wild: Past, Present, and Future	Review face detection progress in uncontrolled environments.	Discusses challenges like lighting, pose, and occlusion, forecasting future research on more robust detection systems.
Neffian, A., Hayes III, M. (1998)	Neffian & Hayes III, 1998	Hidden Markov Models for Face Recognition	Apply Hidden Markov Models (HMMs) to face recognition.	HMMs can handle expression variations and partial occlusions, achieving competitive accuracy with traditional methods.
Pentland, A., Moghaddam, B., Starner, T. (1994)	Pentland et al., 1994	View-Based and Modular Eigenspaces for Face Recognition	Combine view-based and modular eigenspaces for better face recognition.	Modular eigenspaces improve recognition from multiple angles and expressions, making the approach scalable and robust.
Penev, E., Atick, J. (1996)	Penev & Atick, 1996	Local Feature Analysis: A General Statistical Theory for Object Representation	Introduce LFA as a method for object recognition.	LFA provides a flexible, statistically robust way to represent faces, offering advantages over PCA in real-world scenarios.
Heisele, B., Serre, T., Pontil, M., Poggio, T. (2001)	Heisele et al., 2001	Component-Based Face Detection	Develop a component-based approach for face detection.	Component-based face detection improves accuracy and robustness, especially under pose variations and occlusions.

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CHAPTER 3
SYSTEM DESIGN

3.1 GENERAL

3.1.1 ARCHITECTURE DIAGRAM

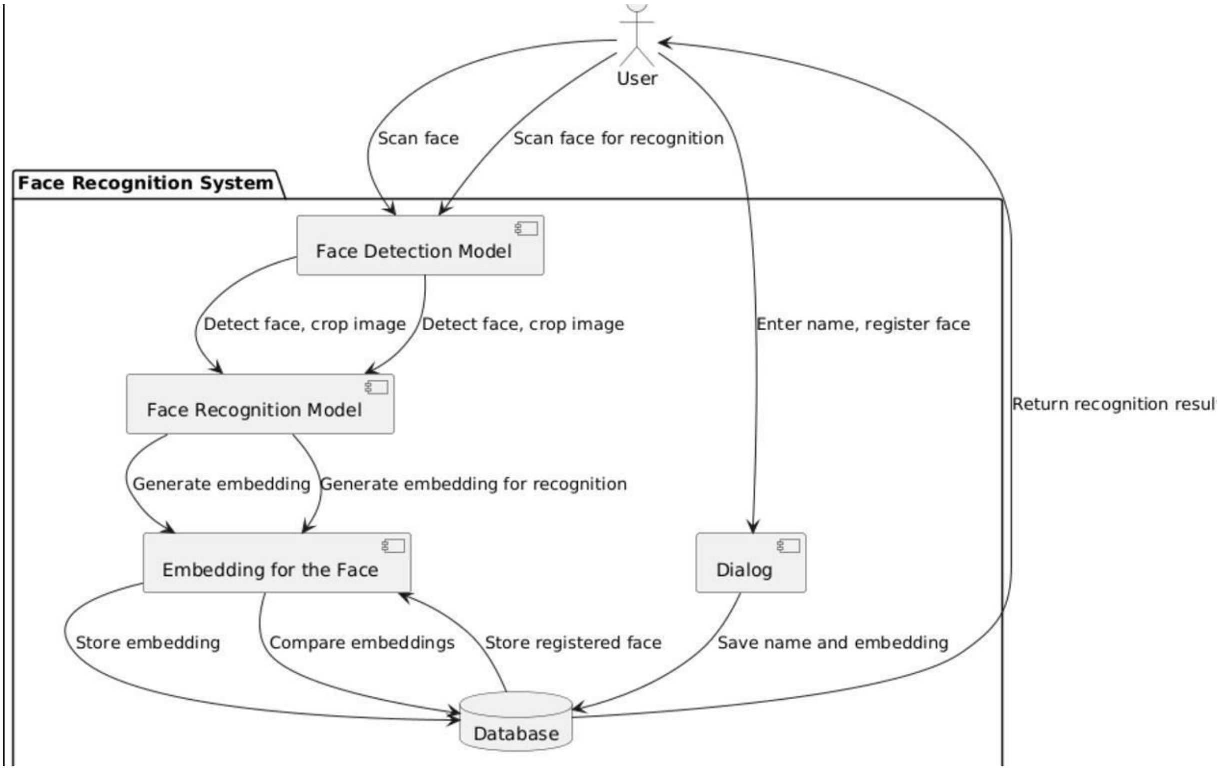

Fig 3.1.1 Architecture diagram

The Fig. 3.1.1 illustrates the architecture of a face recognition system, detailing the entire process from detecting a face, registering a user, and storing facial data to recognizing the user in subsequent encounters. The system operates through several stages, and understanding each step in detail provides insight into how face recognition technology works to identify individuals in a reliable and efficient manner. This system is divided into three major components: the *Face Detection Model*, the *Registration Process*, and the *Face Recognition Model*, all of which interact with a central database to store and retrieve data. The system starts with the initial image input, which is analyzed by the detection model, proceeds to user interaction for registration, and culminates with the generation and storage of a face embedding—a unique representation of a person's face.

The process begins with the system receiving an image of a person, typically through a camera or an uploaded file. This image could come from various sources, such as a security camera, a mobile phone, or any device equipped with image-capturing capabilities. The image contains the person’s face along with potential background elements, and the system’s goal is to isolate the face for further processing. The first major step is handled by the *Face Detection Model*, which is responsible for locating the face within the image. Face detection is critical to ensure that the system is only focusing on the relevant part of the image—the user’s face—without distractions from other objects, people, or background elements that might be present.

The *Face Detection Model* typically uses sophisticated machine learning techniques to accomplish this. Common methods include Haar Cascades, which are fast and efficient, or more modern approaches like Convolutional Neural Networks (CNNs), which have become popular due to their accuracy and reliability. A CNN processes the image in layers, detecting features such as edges, textures, and shapes that correspond to facial characteristics like eyes, noses, and mouths. Another advanced approach is the Multi-task Cascaded Convolutional Network (MTCNN), which combines face detection with landmark localization to accurately find faces even in complex environments or when the face is partially obscured. These models scan the input image and identify the precise location of the face. Once the face is located, the system crops or highlights it, removing unnecessary parts of the image and isolating the face for the next phase.

After the face is detected and isolated, the system moves on to the registration phase, which involves user interaction. At this stage, a dialog box appears on the screen, prompting the user to enter their name. The purpose of this dialog box is to link the detected face with the user’s identity. This is an essential part of the registration process, as the system not only needs to detect faces but also associate those faces with specific users. When the user enters their name and clicks the "Register" button, they are officially registering their face in the system. This interaction ensures that the system can match the face to a corresponding user profile in future interactions.

The registration step also introduces the concept of user identity management. The system must ensure that the same face is not registered multiple times under different names or accounts, which could cause confusion and errors in future recognition attempts. Some face recognition systems incorporate additional checks during the registration process, such as comparing the newly detected face with existing faces in the database to prevent duplicate registrations. If the face already exists in the system, the user may be prompted to either update their existing profile or confirm that they are not attempting to create a duplicate entry. In other cases, the system might require additional verification methods, such as asking the user for a secondary form of identification to ensure that the registration process is secure and accurate.

Once the user has entered their name and completed the registration process, the system proceeds to the next major step: generating a face embedding. The *Face Recognition Model* is responsible for this task. A face embedding is a mathematical representation of the face, generated by extracting unique features from the image. Unlike simple image matching, which compares two photos pixel by pixel, face embeddings represent the face as a high-dimensional vector in a feature space. This allows the system to compare faces in a more abstract and computationally efficient way, making it possible to recognize the same face even if the lighting, angle, or facial expression has changed.

To create the embedding, the *Face Recognition Model* uses deep learning techniques, often based on neural networks like ResNet or FaceNet. These models are trained on vast datasets of human faces, learning to recognize patterns and features that are distinctive to each individual. For example, a face recognition model might learn to focus on the distances between key facial landmarks, such as the eyes, nose, and mouth, or on the texture of the skin and the shape of the jawline. The model outputs a numerical vector, known as a face embedding, which encodes these features in a way that makes it easy to compare different faces.

This face embedding is then stored in a central database, along with the user's name and any other relevant information. The database acts as the memory of the system, allowing it to recall registered faces and match new inputs with existing data. Each time a new user registers, their face embedding is added to the database, expanding the system's ability to recognize more people. The database also plays a crucial role in ensuring that the system can scale effectively. As more users are added, the system must maintain efficient search and retrieval processes, often employing indexing techniques to quickly find and compare embeddings when needed.

After registration, the system is ready to recognize the user in future interactions. When the same user's face is presented again, the system follows a similar process: the *Face Detection Model* identifies the face, and the *Face Recognition Model* generates a new embedding based on the current image. This new embedding is then compared with the stored embeddings in the database. If a match is found, the system retrieves the user's information, confirming their identity. This recognition process happens in real time and is typically very fast, allowing for seamless identification in applications such as security systems, user authentication, or personalized experiences in smart devices.

Face recognition systems can be used in a variety of contexts, from unlocking smartphones to securing buildings and personalizing services. In security applications, the system can automatically grant access to authorized users or alert authorities if an unrecognized face attempts to gain entry. In consumer applications, such as mobile phones or smart home devices, face recognition can be used to personalize the user experience, automatically adjusting settings, preferences, and content based on who is interacting with the device. Furthermore, businesses can use face recognition to streamline customer interactions, such as enabling faster check-ins at airports or enhancing the shopping experience in retail stores.

While face recognition technology offers significant benefits in terms of convenience and security, it also raises important concerns about privacy and ethics. Storing face embeddings and linking them to personal identities creates the potential for misuse, especially if the data is not properly protected. It's essential that systems employing face recognition technology implement strong security measures, such as encryption and access controls, to ensure that face data cannot be accessed or altered by unauthorized individuals. Additionally, regulations surrounding the use of face recognition in public spaces are evolving, with many jurisdictions requiring explicit consent from users before their faces can be captured and stored.

In conclusion, the image outlines the workflow of a face recognition system, highlighting the critical stages from face detection to registration and recognition. The system's use of machine learning models to detect faces and generate embeddings, combined with a robust database for storing and comparing face data, allows for accurate and efficient identification of individuals. As this technology continues to develop, its applications are likely to expand, offering both opportunities and challenges in areas such as security, personalization, and privacy protection.

3.2 HARDWARE REQUIREMENTS

1. Operating System: Android (version 5.0 and above)

- **Reason**: Android is widely accessible and supports modern apps with required permissions (camera, storage, location) for facial recognition tasks.

2. Camera: Minimum 8MP Front or Rear Camera with Autofocus

- **Resolution**: High-quality images are essential for accurate facial recognition.
- **Autofocus**: Ensures clear images even if the child or scanner moves.

3. Processor: Multi-core (Quad-core or Higher)

- **Why**: Facial recognition algorithms are computationally intensive. A multi-core processor handles tasks like face detection and embedding generation efficiently, ensuring real-time performance.

4. RAM: Minimum 2GB, Recommended 4GB or More

- **Why**: Sufficient RAM allows for smooth app performance, especially when processing images and facial embeddings. 4GB or more ensures faster processing and handling large datasets.

5. Storage: At Least 16GB of Internal Storage

- **Why**: Internal storage is needed to store the app, images, and face embeddings. A minimum of 16GB allows for offline data storage before syncing with the cloud.

6. GPS Module

- **Why**: Tracks the location where a face scan occurs, which is essential for law enforcement when a match is found. It also adds security by preventing misuse of the system.

3.2 SOFTWARE REQUIREMENTS

1. **Front-End Development (Mobile App):**
   - **Android Studio**: Integrated Development Environment (IDE) for building the mobile application on Android OS.
   - **XML**: Used for designing the user interface (UI) components such as text boxes, buttons, and image views within the app.
   - **Java**: Backend logic is written in Java to handle the integration between the front-end and back-end services.

2. **Backend Development:**
   - **TensorFlow**: For implementing the facial recognition system. TensorFlow supports the use of the pre-trained FaceNet model, which provides efficient facial embeddings for recognition tasks.
   - **FaceNet**: Used for generating 128-dimensional embeddings from facial images, which are critical for identifying and distinguishing between individuals.
   - **OpenCV**: For real-time image processing and face detection. It helps in capturing images from the camera, detecting faces, and preprocessing them before passing them to the FaceNet model.
   - **Flask** (or any other web framework): For handling API requests and routing the communication between the mobile app and the server.
   - **SQLite**: A lightweight, serverless database engine used to store facial embeddings, child information, case files, and related metadata locally on mobile devices or backend servers.
3. **Database Management:**
   - **SQLite**: The database for storing data locally on mobile devices and also on the central server for easier deployment and management.
   - **MySQL/PostgreSQL** (Optional): Could be used as an alternative for the central server database, especially when scalability is required.
   - **Cloud Storage** (AWS, Google Cloud, or Azure): Cloud-based storage can be used for maintaining backups, storing datasets securely, and ensuring that the app can scale in terms of user base.
4. **Operating System:**
   - **Android OS**: Mobile operating system for deploying the MCIS mobile application.
   - **Linux-based Server OS**: Recommended for the central server to handle requests and ensure high-performance operations.
   - **Windows or macOS**: For development and administrative workstations.
5. **Security Software:**
   - **SSL Certificates**: For ensuring secure communication between the mobile app and the backend servers.

- **Encryption Software**: Used to encrypt sensitive information such as facial embeddings and case details.
- **Firewall**: A robust firewall to protect the central server from external threats and unauthorized access.

6. **Testing Tools:**
    - **JUnit**: For testing the Java-based backend.
    - **Android Emulator**: For testing the mobile application on different screen sizes and hardware configurations.
    - **Postman**: For testing the backend API requests and ensuring smooth integration between the mobile app and server.

CHAPTER 4

MODULE DESCRIPTION

4.1 INTRODUCTION:

This module focuses on the implementation of a comprehensive face recognition system, designed to accurately detect, register, and identify individuals based on their facial features. The process begins with dataset collection, where images of different individuals are captured and organized, followed by the creation of a Convolutional Neural Network (CNN)-based model to learn unique facial features. A robust and structured workflow is used to ensure proper data labeling, partitioning, and preprocessing, making the dataset suitable for training the face recognition model.

The module is divided into several key stages: dataset collection, image capture, data labeling, dataset partitioning, model training, evaluation, and the integration of user sign-up and login functionalities. Each stage plays a crucial role in developing a reliable face recognition system, which can be used in real-world applications like mobile authentication and access control. By leveraging advanced machine learning techniques and tools such as OpenCV for image capture and TensorFlow for model development, this module delivers a practical, user-friendly solution for face recognition tasks.

4.2 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 followsa structured procedure to ensure that the data is organized, labeled, and prepared for training.

4.2.1 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 isas follows:

4.2.2 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:

Webcam Initialization: The webcam is initialized using OpenCV'scv2.VideoCapture(0) function, which accesses the default webcam of the system.

Grayscale Conversion: Although facial recognition models can work with colorimages, for simplicity and computational efficiency, the images are converted to grayscale. This reduces the complexity of the data and allows the model to focuson structural features of the face.

Frame Capture: A continuous stream of frames is captured from the webcam. Each frame is processed, and the individual's face is automatically detected andstored.

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, andthey are umbered sequentially (e.g., person_1_0.jpg, person_1_1.jpg).

Stopping Condition: The image capture continues until 100 images have beensaved for a particular individual, or the user manually interrupts the process bypressing the q key.

4.3 Data Augmentation and Preprocessing

For face recognition tasks, it's important that the images are pre processed to normalize the data and ensure consistency:

Rescaling: All images are rescaled to have pixel values between 0 and 1 bydividing 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.

4.4 Facial Region Detection

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.

4.5 Data Labeling

- Each individual is assigned a unique identifier (e.g., *person_1*, *child_1*) that acts as a label for their images.
- Images are stored in a structured manner under the train/ folder, with separate directories for each identifier.
- Each directory corresponds to a specific individual, ensuring proper organization and segmentation of image data.
- Filenames for the images are formatted to include both the unique identifier and a sequential image number (e.g., *person_1_0.jpg*, *person_1_1.jpg*).
- This labeling and directory structure simplifies data retrieval, enhances organization, and ensures consistency in the training phase of the recognition system.

4.6 Dataset Partitioning

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

- **Training Set**: This set constitutes 80% of the total images collected for the dataset. It is primarily used to train the model by exposing it to multiple images of different individuals. The purpose of this set is to enable the model to learn the distinctive facial features of each individual, such as patterns, contours, and unique traits. Through this learning process, the model develops the ability to recognize and distinguish between various individuals accurately.

4.7 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 basedon their unique facial features.

4.8 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 optimizingthe 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).

4.9 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.

CHAPTER 5

IMPLEMENTATION AND RESULT DISCUSSION

5.1 IMPLEMENTATION

5.1.1 Sign Up and Log In Page Implementation

The Sign-Up and Log-In pages play a crucial role in the functionality of a face recognition application, providing users with seamless options for account registration, secure login, and identity verification through facial recognition technology.Fig 5.1.1 The user interface for these pages is designed using Android Studio, ensuring an intuitive and responsive experience on mobile devices. The backend logic is implemented using Java, which efficiently handles data processing and integrates the app's core functionalities.

To enable facial recognition capabilities, the app leverages the TensorFlow framework and FaceNet, a robust face recognition model, ensuring accurate identification and authentication of users. This setup ensures efficient data handling and secure access, enhancing the overall performance and reliabiity of the application.

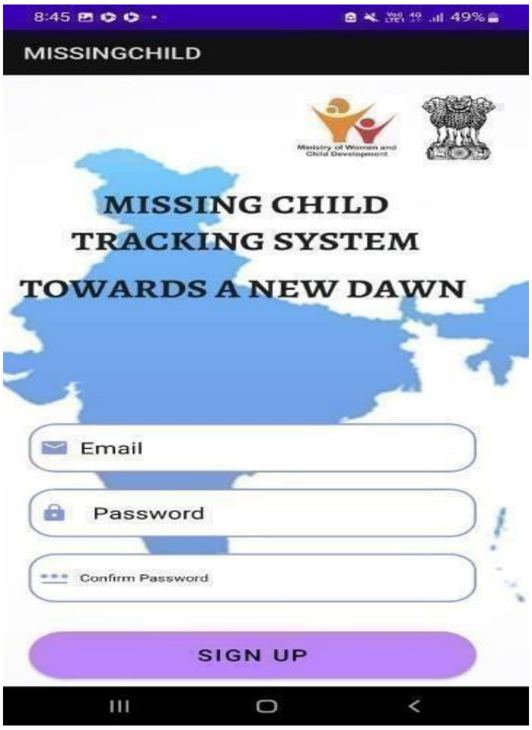

Fig5.1.1: Sign Up Page of “MISSING CHILD IDENTIFICATION SYSTEM”

5.1.1 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.

1. **XMLLayout 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.

2. **XMLLayout for Log In Page:**

- The Log In page uses similar components, where the user enters their username and password in EditText fields.

Fig5.1.2: Login Page of "MISSING CHILD IDENTIFICATION SYSTEM"

5.2 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 databaseoperations.

5.2.1 UserRegistration (Sign Up) Logic:

5.2.1.1 When the Sign Up button is clicked, the username and password arecaptured from the UI.

5.2.1.2 The system checks if the username already exists in the SQLite database. If it does, an error message is displayed.

5.2.1.3 If the username is unique, the system proceeds to capture facial data usingthe camera API.

5.2.1.4 The captured face images are processed, converted to grayscale, andnormalized.

5.2.1.5 The facial embeddings are extracted using the FaceNet model, which generates a 128-dimensional vector representing the unique features of theface.

5.2.2 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.

5.3 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 extractthe face embedding.

- During Log In, the user’s face is captured and compared to the stored embeddingusing 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.

5.4 Database Integration with SQLite

SQLite is used to store user credentials and facial embeddings. The SQLite database isstructured 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 facialembeddings

Password Hash: Contains the hashed version of the user’s password, ensuring that the actual password is never stored directly, thereby enhancing security.

Face Embedding: A column designed to store facial embeddings as strings.

These embeddings are typically represented as a comma-separated list of numerical values, capturing unique biometric features of the user’s face.

By combining traditional authentication methods, such as username- password pairs, with biometric data like facial embeddings, the SQLite database supports a robust and secure framework for user verification

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 CONCLUSION

The "Track the Missing Child" portal is a groundbreaking initiative aimed at addressing the growing issue of missing children, providing an effective and efficient solution for locating and reuniting children with their families. By incorporating advanced facial recognition technology, this platform allows the public and law enforcement agencies to work together to resolve cases of child disappearances faster and more efficiently. The system not only reduces the strain on law enforcement but also provides a means for individuals to play an active role in protecting vulnerable children. With over 9,000 records currently available, the portal already offers a comprehensive and valuable resource that enhances the search process. The integration of privacy and security measures ensures that sensitive data is protected, building trust among families and authorities alike. Overall, this platform has the potential to significantly improve child safety and contribute to a stronger, more responsive community-based The "Track the Missing Child" project was developed in response to the widespread issue of child disappearances, which often leads to harmful practices such as child labor, illegal trafficking, and abuse. This initiative aims to create a more efficient way of locating and recovering missing children by providing a platform that supports both law enforcement and the public in their search efforts. By incorporating state-of-the-art facial recognition technology and a user-friendly interface, the portal helps facilitate the reunion of children with their families while reducing the burden on police forces tasked with investigating these cases.

The primary objective of the "Track the Missing Child" portal is to provide a fast, efficient, and accessible method for locating missing children. The system leverages facial recognition technology to enable quick identification, while the platform allows the public to participate actively in the search.

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Additionally, the project aims to reduce the pressure on law enforcement agencies by streamlining the process of tracking and recovering missing minors. It seeks to create a more collaborative and inclusive approachto child safety, involving both authorities and the community in the recovery process.

The "Track the Missing Child" platform is designed with several key features to ensure its effectiveness. The website is regularly updated by local police officers, providing up-to-date information about missing children, including photos and detailed descriptions. The portal is publicly accessible, allowing anyone to view the records and contribute to the search. A robust authentication mechanism ensures that sensitive data about each child is kept private and secure. One of the most innovative aspects of the portal is its use of facial scanning technology, which allows users to search for missing children by comparing faces to the records in the system. This feature helps expedite the search process and increases the chances of a successful recovery.

While the "Track the Missing Child" portal offers many benefits, there are several challenges that need to be addressed. One key consideration is ensuring that the use of facial recognition technology adheres to privacy standards and does not infringe on individuals' rights.

Another challenge is maintaining the accuracy and timeliness of the data posted on the platform, as it is crucial that information about missing children is regularly updated. Moreover, gaining widespread public engagement and trust is essential to ensure the platform's success, as public participation plays a critical role in resolving missing children cases.

In conclusion, the "Track the Missing Child" portal provides a vital service to families, law enforcement, and the community by offering a fast, efficient, and secure way to search for and recover missing children. The use of innovative technology such as facial recognition enhances the platform's capabilities, making it a powerful tool in child protection efforts.

KeyComponents

The key components of the proposed missing child identification system are:

6.1.1 **Facial Recognition Engine:** This is the core technology that uses deep learning algorithms, such as FaceNet, to compare uploaded images with those in the missing children's database. It processes facial features and generates facial embeddings to identify matches based on similarity, even when there are changes in the child's appearance due to age or poor image quality.

6.1.2 **Database of Missing Children:** A secure and regularly updated repository containing detailed information and photographs of missing children. The database serves as the reference for facial recognition, with each child’s record including high-quality images, personal details, and additional metadata (e.g., last known location, physical traits).

6.1.3 **Public Submission Portal:** An online platform or mobile app where the public can upload photographs of suspicious children along with relevant information (e.g., location, time, remarks). This portal allows the community to contribute to the search for missing children, facilitating crowdsourcing.

6.1.4 **Administrator Dashboard:** A user-friendly interface for administrators or law enforcement personnel to manage, verify, and act on flagged matches. It allows administrators to review potential matches, investigate cases, and take appropriateaction. It also sends notifications to the authorities when a match or suspicious activity is detected.

6.1.5 **Notification and Alert System:** An automated system that sends real-time notifications to administrators or relevant authorities when a potential match is found. It also sends alerts to public users who may have uploaded information that matches a child in the database.

6.1.6 **Security and Privacy Framework:** A robust security system to ensure the privacy of sensitive data, including encrypted data storage, secure transmission, and strict authentication protocols. This component ensures that personal information and photographs of missing children are protected from unauthorized access or misuse.

6.1.7 **Cloud Infrastructure:** A scalable cloud infrastructure to support the system's performance requirements, such as fast image processing, secure data storage, and handling large traffic volumes. Cloud services enable quick retrieval of data, efficient image comparisons, and ensure system scalability as the number of users and cases grows.

6.1.8 **Multi-Platform Compatibility:** The system should be accessible via various devices (smartphones, tablets, desktops) and optimized for different operating systems to ensure it is widely usable. A mobile app could enhance real-time scanning of faces and facilitate on-the-ground reporting of suspicious children.

6.1.9 **AI Training and Data Management System:** A system for regularly updating and training the facial recognition algorithms with new data, including images from different angles, lighting conditions, and demographic groups. It ensures thatthe AI system remains accurate and effective in matching faces despite age or environmental changes.

6.1.10 **User Support and Helpdesk:** A support system to assist users with troubleshooting, FAQs, and guides for using the platform, ensuring smooth interaction for both the public and law enforcement agencies.

These components work together to create a robust, efficient, and secure system that enhances the identification and recovery of missing children while engaging the public in a meaningful way.

6.2 FUTURE WORK

In Phase 2 of the project, we will focus on enhancing the functionality and efficiency of the facial recognition system, integrating real-time photo uploads from the public portal, and improving backend processes. The frontend, built using Android Studio and XML for user interface components, will be further optimized for smooth user interaction, allowing users to upload suspicious child photos along with landmarks and remarks. These photos will be processed and compared using the pre-trained FaceNet model, integrated via TensorFlow, for facial recognition and matching against the database of missing children stored in SQLite. Notifications will be sent to administrators if a match is detected, and geolocation data (via IP address) will be logged for tracing. Security measures will be implemented, including encryption of sensitive data and secure authentication. Additionally, an admin dashboard will be developed to manage thedatabase and review the flagged images, and the system will undergo extensive testing toensure performance, scalability, and compliance with data privacy regulations

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LISTOF PUBLICATIONS

PUBLICATION STATUS: PAPER COMMUNICATED TO CONFERENCE

TITLE OF THE PAPER: MISSING CHILD DETECTION SYSTEM

USING DEEP LEARNING TECHNOLOGIES

AUTHORS: DR. P. KUMAR, MONISHA D, NIVETHITHA

CHOWTHRI

APPENDIX

IMPLEMENTATION CODE:

```
import tensorflow as tf
fromtensorflow.keras import layers, models
from tensorflow.keras.preprocessing.image import ImageDataGenerator

# Define the CNN model for face recognition (same as previous)
def create_face_recognition_model(input_shape=(224, 224, 3)):
    model = models.Sequential()

    # Convolutional layers
    model.add(layers.Conv2D(32, (3, 3), activation='relu', input_shape=input_shape))
    model.add(layers.MaxPooling2D((2, 2)))
    model.add(layers.Conv2D(64, (3, 3), activation='relu'))
    model.add(layers.MaxPooling2D((2, 2)))
    model.add(layers.Conv2D(128, (3, 3), activation='relu'))
    model.add(layers.MaxPooling2D((2, 2)))

    # Flatten the output of the convolutional layers
    model.add(layers.Flatten())

    # Fully connected layers
    model.add(layers.Dense(512, activation='relu'))
    model.add(layers.Dense(128, activation='relu'))
    model.add(layers.Dense(1, activation='sigmoid')) # Binary classification

    model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy'])
```

```
    return model

# Function to load data
def load_data(data_dir):
    # Data augmentation and preprocessing
    datagen = ImageDataGenerator(rescale=1./255, validation_split=0.2)

    # Load training data
    train_data = datagen.flow_from_directory(
        data_dir,
        target_size=(224, 224),
        batch_size=32,
        class_mode='binary', # Binary labels (recognized or not)
        subset='training'
    )

    # Load validation data
    val_data = datagen.flow_from_directory(
        data_dir,
        target_size=(224, 224),
        batch_size=32,
        class_mode='binary',
        subset='validation'
    )
```

```
    return train_data, val_data

# Train the model on the collected dataset
def train_model(model, train_data, val_data, epochs=10):
    history = model.fit(
        train_data,
        epochs=epochs,
        validation_data=val_data
    )
    return history

# Save the trained model
def save_model(model, model_path):
    model.save(model_path)

# Main script to train the model
if_name____== '_main_':
    # Define model and data directory
    model = create_face_recognition_model()
    data_dir = 'data'  # Directory containing images of known profiles

    # Load training and validation data
    print("Loading data...")
    train_data, val_data = load_data(data_dir)
```

```
# Train the
model
print("Training
model...")
history = train_model(model, train_data, val_data, epochs=10)

# Save the trained model
model_path =
'face_recognition_model.h5'
save_model(model,
model_path) print(f"Model
saved to {model_path}")
```

C26

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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 the situation more concerning. Missing children are often at risk of being used and abused 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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CO-PO Mapping

PROJECT WORK COURSE OUTCOME (COs):

CO1: On completion it will prove as a major breakthrough in digital transformation of college management leveraging end-to-end technologies.

CO2: It will ease out the management overhaul and boost better transparency and robustness to the entire setup.

CO3: Given the huge amount of data available in the educational sector, especially in the colleges, technologies like Machine Learning and AI can be used to increment student performance and job-market ready.

CO4: It helps in keeping the entire system snappy and ensures all endpoints are taken care of, reducing the overall waiting periods in the traditional working.

CO5: Students will be able to publish or release the project to society.

PROGRAM OUTCOMES (POs)

PO1: Engineering Knowledge: Apply the knowledge of engineering fundamentals, mathematics, science and technology and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Ability to apply deep learning methodologies to solve computational tasks, model real world problems using appropriate datasets and suitable deep learning models. To understand standard practices and strategies in software project development using open-ended programming environments to deliver a quality product.

PO3: Design/development of solutions: Design solution for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety.

PO4: Conduct investigations of complex problems: Use research - based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The Engineer and society: Apply reasoning informed by the contextual knowledge to assess social, health and safety issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental context, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1: Foundation Skills: Ability to understand, analyze and develop computer programs in the areas related to algorithms, system software, web design, deep learning and cloud computing for efficient design of computer-based systems of varying complexity. Familiarity and practical competence with a broad range of programming languages and open-source platforms.

PSO2: Problem-solving Skills: Ability to apply mathematical methodologies to solve computational tasks, model real world problems using appropriate data structure and suitable algorithms. To understand standard practices and strategies in software project development using open-ended programming environments to deliver a quality product.

PSO3: Successful Progression: Ability to apply knowledge in various domains to identify research gaps and to provide solutions to new ideas, inculcate passion towards higher studies, creating innovative career paths to be an entrepreneur and evolving as an ethically responsible computer science professional.