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Facial Biometrics for Missing Child Detection: A Deep Learning and SVM-Based Framework

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ABSTRACT

In today's rapidly advancing technological landscape, the intersection of artificial intelligence and public safety is becoming increasingly vital. The publication titled "Missing Child Identification System Using Deep Learning and Multiclass SVM" presents a significant stride in leveraging deep learning techniques to address the critical issue of child abduction and identification. This research explores the application of multiclass Support Vector Machines (SVM) alongside deep learning methodologies, showcasing a novel system designed to enhance the accuracy and efficiency of identifying missing children. By harnessing vast datasets and advanced algorithms, the proposed system aims to create a robust framework that not only identifies potential cases but also assists law enforcement agencies in locating missing individuals more effectively. The implications of such technology are profound. In a world where every moment counts, having an automated system capable of analyzing images and patterns rapidly can lead to quicker resolutions in missing child cases, ultimately saving lives. Moreover, this work underscores the importance of interdisciplinary collaboration—merging technology with social responsibility—to create solutions that have a tangible impact on society. As we reflect on this significant advancement, it prompts us to consider the ethical dimensions of using AI in sensitive contexts. While the potential benefits are considerable, it is crucial to ensure that such systems are implemented with careful consideration for privacy and ethical standards. In conclusion, the "Missing Child Identification System Using Deep Learning and Multiclass SVM" serves not only as a technological innovation but as a reminder of our collective responsibility to leverage these advancements for the greater good. As we continue to explore the capabilities of AI, may we always prioritize humanity at the forefront of our endeavours.

1. INTRODUCTION

In today’s world, the safety and well-being of our children remain paramount concerns for families and communities alike. The heartbreaking reality of missing children underscores the urgent need

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for innovative solutions that can aid in their identification and recovery. In this context, we present a pioneering approach— the Missing Child Identification System utilizing Deep Learning and Multiclass Support Vector Machines (SVM).

This project aims to harness the power of advanced machine learning techniques to revolutionize how we approach the sensitive issue of child abduction and misplacement. By leveraging deep learning algorithms, we can analyze vast datasets of images and reports, identifying emotional patterns and characteristics that may lead to quicker identification.

The introduction of a multiclass SVM enhances our system's capability to categorize and recognize varied profiles efficiently. This dual-approach not only streamlines the identification process but also increases accuracy, thereby improving response times when a child goes missing.

As we delve deeper into this project, our goal is to collaborate with law enforcement agencies, child welfare organizations, and technology experts to ensure that this system is not only effective but also ethical and respectful of privacy concerns.

Ultimately, by combining cutting-edge technology with a compassionate mission, we aspire to create a safer environment for children everywhere. Through innovation and collaboration, we can turn the tide against this pressing issue and bring hope to countless families.

2. LITERATURE SURVEY

1. Face Recognition Using Histograms of Oriented Gradients

Authors: O. Deniz, G. Bueno, J. Salido, and F. D. la Torre

Face recognition remains a prominent challenge in computer vision. Recently, Histograms of Oriented Gradients (HOG) have emerged as effective descriptors for general object detection and face recognition. This paper introduces a straightforward yet robust method for utilizing HOG features in face recognition. The key contributions include: (1) extracting HOG descriptors from a regular grid to mitigate errors caused by occlusion, pose, and illumination changes; (2) fusing multi-scale HOG descriptors to better capture structural details; and (3) applying dimensionality reduction to filter noise and reduce over fitting, especially when HOG features are extracted from overlapping cells. Experiments on four benchmark datasets validate the effectiveness of the proposed approach.

2. Face Recognition Using SIFT Features

Authors: C. Geng and X. Jiang

The Scale-Invariant Feature Transform (SIFT) has demonstrated strong performance in general object detection tasks. In this study, two novel techniques—Volume-SIFT (VSIFT) and Partial-Descriptor-SIFT (PDSIFT)—are proposed for face recognition, extending the original SIFT algorithm. Comparative analysis is carried out between holistic approaches such as Fisher face (FLDA), Null Space Linear Discriminant Analysis (NLDA), and Eigen feature Regularization and Extraction (ERE), and feature-based methods like SIFT and PDSIFT. Experiments conducted on the ORL and AR datasets show that PDSIFT notably outperforms the standard SIFT method and delivers results comparable to ERE, significantly surpassing FLDA and NLDA.

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3. Missing Child Identification Using Face Recognition System

Rohit Satle, Vishnuprasad Poojary, John Abraham, and Shilpa Wakode

The human face is critical in social interaction, particularly for identity recognition. Face recognition is an intuitive task for humans and has become a vital biometric technology due to advancements in digital cameras, mobile devices, and increasing security requirements. This paper presents the development of a face recognition system using Principal Component Analysis (PCA). PCA reduces image dimensionality while preserving significant variation, projecting facial images into a feature space formed by major differences across known images. These features, termed "Eigenfaces," are eigenvectors of the face set and do not necessarily correspond to facial features like eyes or nose. Recognition is achieved by comparing the weight vectors representing individuals in this feature space.

4. Very Deep Convolution Networks for Large-Scale Image Recognition

Authors: Karen Simonyan and Andrew Zisserman Thispaper explores how increasing the depth of convolutional neural networks affects their performance on large-scale image recognition tasks. A key contribution is the use of an architecture with very small (3×3) convolution filters, demonstrating that deeper networks—ranging from 16 to 19 layers—can significantly outperform previous models. This architecture formed the basis of the authors' submission to the Image Net Challenge 2014, where they achieved top rankings in localization and classification tracks. Moreover, their models showed excellent generalization to other datasets, achieving state-of-the-art results. The authors have made their top-performing ConvNet models publicly available to support further research in deep visual representation.

3. PROPOSED SYSTEM:

This paper proposes a child identification mechanism based on public participation and machine learning. The system is composed of the following modules:

Image Upload: The public uploads images of children via a portal.

Face Detection and Preprocessing: Algorithms such as MTCNN or Dlib extract the facial region.

Feature Extraction: VGG-Face CNN generates embeddings from the input face.

Classification: A multiclass SVM classifier identifies the individual by comparing embeddings against known records.

Feedback: The portal returns a "match" or "not found" response, which authorities can later review.

4. SYSTEM ARCHITECTURE:

Images of reported missing children are saved in a repository and the face area is selected for cropping to obtain input face images. Learned features from a Convolutional

Neural Network (CNN), a specific type of deep learning algorithm, are used for training a multi class SVM classifier. This machine learning approach is used to correctly label the child using the name

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indicated in the database provided by the concerned authority. In the following sections the paper details the work flow for child matching methodology. The flow chart of the automatic child face identification methodology is as shown in Figure 2

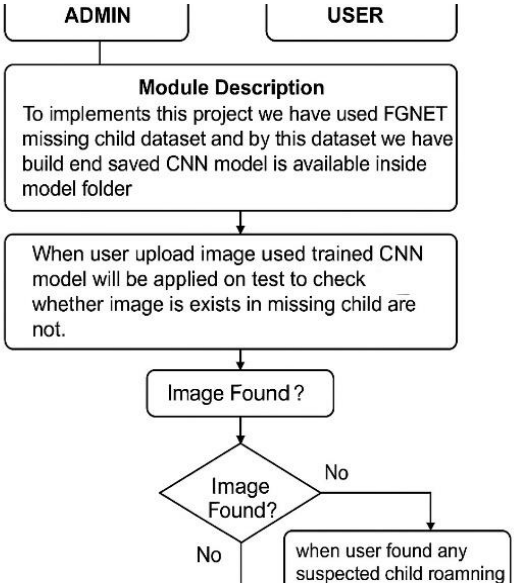

Figure1: Shows the Flowchart of Proposed Methodology

Modules

1. Admin
2. User

Module Description

1. To implements this project, we have used FGNET missing child dataset and by this dataset we have built and saved CNN model is available inside model folder.

2. When user upload image used trained CNN model will be applied on test to check whether image is exists in missing child are not.

3. When user found any suspected child roaming on road then user will take image and upload here and then CNN trained model will apply to get missing result. if unidentified image also uplod then application say not found.

5. METHODOLOGY

1) Using public dataset of missing children's called FGNET is used to train deep learning CNN prediction model. After training model whenever public upload any suspected child image then this model will check in trained model to detect whether this child is in missing database or not. This detected result will store in data baseband whenever want official persons will login and see that detection result. 2) SVM Multiclass classifier use to extract face features from images based on age

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and other facial features and then this detected face will input to CNN model to predict whether this face child exists in image database or not.

Algorithms

Face Recognition Pipeline Components

1. Face Detection Algorithm

Purpose: Detect and localize faces in images or video frames.
Common Methods:

- Haar Cascade Classifier (OpenCV)
- MTCNN (Multi-task Cascaded Convolutional Neural Network)
- Dlib's HOG + SVM face detector
  Role in the System: Provides accurate face region extraction as input for further processing.

2. Convolution Neural Network (CNN) for Feature Extraction

Purpose: Extract deep, high-level features that uniquely represent each face.
Popular Pre-trained Models:

- VGGFace
- ResNet50
- MobileNetV2
  How It Works:
- The CNN processes the cropped face image.
- Outputs a **feature vector (embedding)** — a compact numerical representation of facial characteristics.

3. Multi-class Support Vector Machine (SVM) for Classification

Purpose: Classify face embeddings into one of the known classes (e.g., each class represents a missing child).
Why SVM?

- Performs well with small-to-medium datasets.
- Handles high-dimensional feature vectors effectively.
  Implementation Strategy:
- Multi-class SVM using **One-vs-One** or **One-vs-Rest** approaches.

4. Data Augmentation Algorithm

Purpose: Enrich the dataset by creating additional training samples.
Techniques Applied:

- Image rotation
- Horizontal flipping
- Zooming

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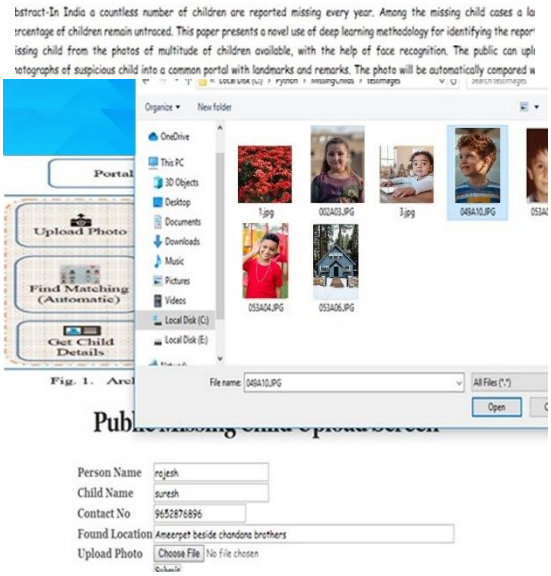
- Brightness adjustment
- Noise addition
  Benefit: Increases dataset diversity, improves generalization, and reduces overfitting during training.

5. Dimensionality Reduction (Optional)

Purpose: Simplify high-dimensional feature vectors before classification.
Advantage: Reduces computational cost and may improve accuracy.
Common Technique: Principal Component Analysis (PCA)

6. RESULTS

screen public can click on 'Public Upload Suspected Child' link to get below page and to add missing child details



screen public will enter suspected child details and then upload photo and then click on 'Submit' button and to get below result

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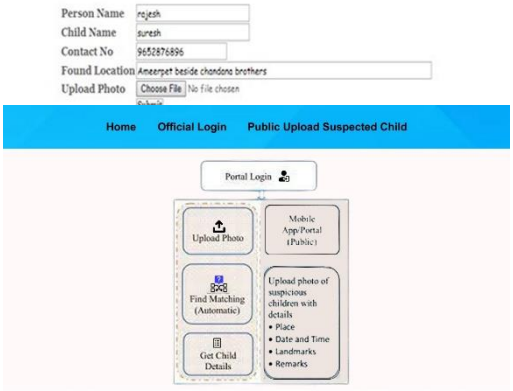
screen we can see child not found in missing DB and we can try with other image

is the result for new above child details



screen uploaded child found in database and now click on ‘Official Login’ link to get below login screen

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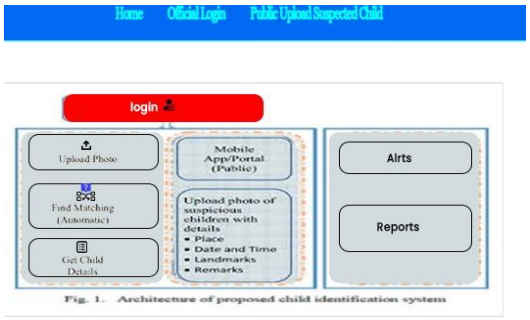

Fig. 1. Architecture of proposed child identification system

screen admin can login by entering username and password as 'admin' and 'admin' and after clicking on 'Login' button will get below screen

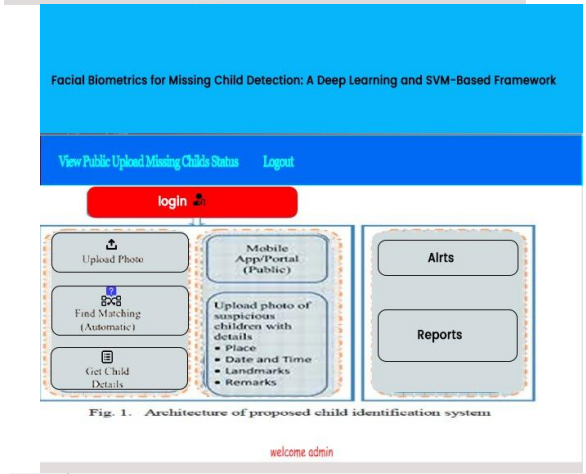

Fig. 1. Architecture of proposed child identification system

screen official can click on 'View Public Upload Missing Childs Status' link to view all uploads and its result done by public

Upload Person Name	Child Name	Contact No	Found Location	Child Image	Uploaded Date	Status
rajesh	suresh	9652876896	Ameerpet beside chandana brothers		2020-12-16 17:54:25	Child not found in missing database
john	fredde	1234543212	Ameerpet beside chandana brothers		2020-12-16 17:55:35	Child not found in missing database
johny	jojo	9652876896	Ameerpet beside chandana brothers		2020-12-16 17:56:06	Child found in missing database

officials can see all details and then take action to find that child

7.CONCLUSION

A missing child identification system is proposed, which combines the powerful CNN based deep learning approach for feature extraction and support vector machine classifier for classification of different child categories. This system is evaluated with the deep learning model which is trained

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with feature representations of children faces. By discarding the softmax of the VGG-Face model and extracting CNN image features to train a multi class SVM, it was possible to achieve superior performance. Performance of the proposed system is tested using the photographs of children with different lighting conditions, noises and also images at different ages of children. The classification achieved a higher accuracy of 99.41% which shows that the proposed methodology of face recognition could be used for reliable missing children identification.

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