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Missing Person & Criminal Identification Using Image Processing

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A B S T R A C T

Every day, across the globe, a multitude of individuals—ranging from children to the elderly, including those with mental challenges—go missing. Their absence casts a shadow of uncertainty, leaving families and guardians in distress. In response to this pressing issue, we propose an innovative system that harnesses the power of web camera technology. This system operates on a simple yet profound principle: compare each person encountered through web video streaming with an extensive database of images. By doing so, we aim to locate missing individuals swiftly and efficiently. Following are the vital elements of this approach: Web Camera Technology, Database Comparison, Real-Time Alerts, Administrative Role. In summary, our system stands at the intersection of technology, compassion, and urgency. It strives to alleviate the anguish of families awaiting news of their loved ones. By harnessing the capabilities of web cameras and sophisticated algorithms, we hope to reunite missing individuals with their families and contribute to a safer society.

Keywords: Missing persons, finding, face recognition, web camera.

1. Introduction

Criminal and missing person identification is a crucial aspect of law enforcement and investigative work. It involves the use of various techniques and technologies to identify individuals who may be involved in criminal activities or have disappeared under suspicious circumstances.The process of criminal identification often starts with the collection and analysis of evidence, such as surveillance footage. These pieces of evidence are then compared to databases and records to find matches or potential leads. In some cases, specialized teams may be deployed to reconstruct facial features or use advanced forensic methods to identify unknown individuals.Similarly, missing person identification focuses on locating and identifying individuals who have gone missing and may be in danger. It involves gathering information about the missing person, including physical descriptions, photographs, and personal details. This information is shared with law enforcement agencies, the public, and other relevant organizations to aid in the search and identification process.Both criminal and missing person identification require close collaboration between various law enforcement agencies, forensic experts, and the public. By leveraging modern techniques and technologies, investigators strive to provide justice, closure, and peace of mind to victims, their families, and communities affected by these crimes or disappearances.

1.1 Motivation

The purpose of criminal and missing person identification is to accurately and systematically identify individuals who have been involved in criminal activities or have gone missing. This identification process is crucial for law enforcement agencies and authorities.Identification plays a critical role in capturing and bringing criminals to justice. By accurately identifying individuals involved in criminal activities, law enforcement agencies can initiate investigations, obtain warrants, and make arrests.Identifying criminals helps in protecting the public from potential harm. By tracking and apprehending individuals with criminal records, law enforcement agencies can reduce the risk of repeat offenses and maintain a safer environment for the community.Identifying criminals in cases of violent crimes or heinous acts provides a sense of closure to the victims and their families. It allows them to have some form of justice and provides them with the opportunity to move forward and heal.Identifying missing persons helps in locating and reuniting them with their families. By accurately identifying missing individuals, law enforcement agencies can effectively launch search operations, spread awareness, and enlist the public's help in finding them.Identification systems also help in preventing identity theft. By maintaining comprehensive records of individuals, authorities can verify identities and detect fraudulent activities in cases where criminals attempt to assume someone else's identity. Criminal and missing person identification plays a vital role in maintaining public safety, ensuring justice, providing closure, and reuniting families.

2. Literature Survey

(1) Aniruddha Dey, "A Contour based Procedure for Face Detection and Tracking from Video" 3rd Int'I Conf. on Recent Advances in Information Technology I RAIT-20161.

Recent advancements have highlighted the importance of face detection and tracking in videos. This technology has widespread applications in various commercial and security sectors. However, video-based face recognition remains a significant challenge due to factors like changing lighting conditions, noise interference, and variations in facial pose and location across different frames. This paper proposes a novel method for detecting and tracking faces within video databases. The primary objective is to accurately pinpoint the location of faces in each individual video frame. Furthermore, tracking facial movement plays a crucial role in building a comprehensive face recognition system. To track the movement of the human face within the video, the system calculates both the distance (magnitude and direction) between the corresponding corner points of two consecutive frames. Significant changes in these distances indicate a shift in the position and location of the face in the subsequent frame. The effectiveness of this method has been evaluated through experiments using the Honda/UCSD video database. The results demonstrate the method's efficiency in accurately detecting and tracking human faces within video recordings.

(2) Andreas Ess, Bastian Leibe, Konrad Schindler, Luc Van Gool, "A Mobile Vision System for Robust Multi-Person Tracking.

Missing persons are a constant concern, especially for vulnerable populations like children and the elderly who may wander away unintentionally. Law enforcement heavily relies on CCTV footage to identify missing individuals, but the process can be time-consuming. This intelligent video surveillance system aims to improve missing person detection and tracking. The system allows users to register and create profiles for missing loved ones, including details and photos. It then continuously analyzes live feeds from CCTV cameras. Using advanced facial recognition algorithms, the system compares individuals in the footage against the missing person database. If a potential match is identified, an alert is triggered for user review. Upon confirmation, the system not only identifies the missing person but also tracks their movement within the camera's view, providing valuable location information. This crucial information is then automatically relayed via SMS alerts to both the registered user, likely a relative, and the police station, facilitating a swift response and hopefully a successful recovery. By leveraging intelligent video surveillance technology for faster identification, location tracking, and timely notification, this system offers a significant contribution to security and missing person cases.

(3). Rolf H. Baxter, Michael J. V. Leach, Sankha S. Mukherjee, and Neil M. Robertson, "An Adaptive Motion Model for Person Tracking with Instantaneous Head-Pose Features " IEEE SIGNAL PROCESSING LETTERS, VOL. 22, NO. 5, MAY 2015.

This research introduces a new method for tracking people in low-resolution videos using their behavior and head pose. It builds upon the Kalman Filter, a common tracking technique, but incorporates an additional element: where a person is looking can indicate where they're likely going next. This "intentional prior" is achieved by automatically analyzing head pose estimates within the video footage. While the research focuses on pedestrian surveillance, the concept is not limited to head pose and could be applicable to other behavioral cues. The researchers conducted a statistical analysis of pedestrian gazing behavior and then tested their tracking method on both simulated and real-world pedestrian observations. Their results demonstrate that using these "intentional priors" significantly improves tracking performance compared to a standard Kalman Filter.

(4) He Guohui, WangWanying, "An algorithm for fatigue driv- ing face detection and location" 2015 8th International Conference on Intelligent Computation Technology and Automation.

This paper proposes an improved face detection algorithm for a fatigue driving warning system. The goal is to achieve accurate face region detection, improve real-time performance, and enhance overall accuracy and reliability. Building on Yang's theory, the algorithm combines skin color segmentation with edge detection technology. It then takes a unique approach by merging a Gaussian Mixture Model and an Oval Clustering Model. This hybrid detection model aims to surpass the limitations of single detection methods and improve overall face detection accuracy. Experimental results demonstrate the effectiveness of this combined approach, achieving superior performance compared to relying solely on individual detection techniques.

(5) K. V. Arya, AbhinavAdarsh, "An Efficient Face Detection and Recognition Method for Surveillance" 2015 International Conference on Computational Intelligence and Communication Networks.

This research proposes a novel method for automatic face detection and recognition within surveillance systems. The system operates in a three-step process: First, it employs a skin color model to identify potential facial regions within the image. This model analyzes the image data in both YCbCr and HSV color spaces to effectively locate areas with skin-tone characteristics. Following skin detection, a height-to-width ratio filter is applied to further refine the identified skin regions. This step helps isolate areas with proportions consistent with human faces. Finally, the system utilizes a PCA (Principal Component Analysis) verification algorithm for accurate face recognition. A set of training images is used to establish a "face space," which essentially represents a collection of key facial characteristics. Test images are then projected onto subspaces within this face space. By measuring distances within this space, the system identifies the closest match from the training data, effectively recognizing the individual in the test image. The proposed method offers several advantages. It functions automatically, capable of detecting, extracting, and recognizing faces directly from camera or video footage. Additionally, the system exhibits resilience to various environmental conditions. By training on a limited set of characteristic faces, it can achieve recognition even under different lighting or background settings. The approach is also described as simple, efficient, and accurate, with a relative tolerance for minor variations in facial appearance. This combination of automation, environmental resilience, and accuracy makes this a promising method for face detection and recognition in surveillance applications.

(6) PrantiDutta, Dr. Nachamai M, Department of Computer Science, Christ University Bengaluru, India "Detection of Faces from Video Files with Different File Formats".

This research investigates the performance of a face detection system on single faces within pre-recorded videos. The system's effectiveness is evaluated across various video file formats. The study utilizes two datasets: a collection of raw, homemade videos and a set of ready-made videos. The research focuses on analyzing the detection rate achieved by the system for different video formats. In the first phase, the system is tested on raw homemade videos stored in .3gp, .avi, .mov, and .mp4 formats. In the second phase, it's tested on ready-made videos in .wmv, .m4v, .asf, and .mpg formats. The implementation of the system was done using MATLAB R2013a. The results indicate a detection accuracy of 72.79% for faces within the homemade video dataset and 82.78% for faces within the ready-made dataset. This suggests a potential influence of video source or format on the detection performance.

(7) Lihe Zhang, Huchuan Lu, Dandan Du, and Luning Liu, "Sparse Hashing Tracking" IEEE TRANSACTIONS ON IMAGE PROCESS-ING, VOL. 25, NO. 2, FEBRUARY 2016.

This research introduces a groundbreaking object tracking framework that utilizes a hashing method for efficient neighbor searching within video sequences. Unlike traditional approaches that view tracking as a complex classification problem, this method treats it as a simpler task of finding the closest neighbor in a binary space. This is achieved by employing hash functions to project both the target object (template) and candidate objects from each frame into a specialized digital space called the Hamming space. This space facilitates faster distance calculations, significantly improving overall tracking efficiency. Conventional tracking methods often overlook the relationships between different object classes. This new approach takes a more comprehensive approach, incorporating both the similarities within a class (intra-class) and the differences between classes (inter-class) during the training of multiple hash functions. This leads to more accurate classification and reduces tracking errors. The system introduces sparsity into the hash function coefficients. This essentially acts as a dynamic feature selection process, automatically identifying the most informative and stable features that best represent the target object. This is crucial for adapting to visual variations, such as changes in lighting or occlusions, that can occur throughout the tracking process. The research concludes by demonstrating the effectiveness of this new method through extensive testing on various challenging video sequences. The results confirm that this approach outperforms existing state-of-the-art object tracking algorithms.

(8) Dennis Mitzel, Esther Horbert, Andreas Ess, and Bastian Leibe, " Multi-person Tracking with Sparse Detection and Continuous segmentation".

This research proposes a novel framework for tracking multiple pedestrians on mobile platforms at street level. It departs from traditional "tracking-by-detection" methods by employing an efficient level-set tracker. This low-level tracker continuously follows individual pedestrians, initialized and updated by a pedestrian detector. A series of consistency checks are applied to ensure robustness. To handle situations like temporary occlusions or minor tracking errors (drift), the framework utilizes a high-level multi-hypothesis tracker. This tracker analyzes the outputs from the low-level tracker (tracklets) and performs longer-term data association. This two-tiered approach simplifies short-term data association, leading to more accurate and reliable tracking even when the pedestrian detector experiences limitations. An additional benefit of this design is its computational efficiency. Since the pedestrian detector only needs to be active periodically, the overall system requires less processing power. The research concludes by demonstrating the effectiveness of this approach through quantitative evaluation on various challenging video sequences. The results confirm that this framework achieves state-of-the-art performance in mobile, street-level multi-person tracking.

(9) Francesco Comaschi, Sander Stuijk, TwanBasten, HenkCorpo- raal, "ROBUST ONLINE FACE TRACKING-BY-DETECTION"

Accurate online face tracking in unconstrained videos remains a significant challenge. Factors like extreme variations in facial appearance and occlusions make it a complex problem. This research introduces RFTD (Robust Face Tracking-by-Detection), a system that merges tracking and detection into a unified framework for robust face tracking in unconstrained video environments. RFTD leverages the idea that by combining stable and adaptable algorithms, the system can achieve more robust tracking. It utilizes an online Structured Output Support Vector Machine (SO-SVM) alongside an offline-trained face detector. This breaks the cycle of self-learning often encountered in tracking algorithms. Additionally, a Deformable Part Model (DPM) landmark detector supervises the face detector, assessing the reliability of its output. Extensive evaluations demonstrate that RFTD consistently delivers strong tracking performance across various scenarios. It achieves a high mean success rate and boasts the lowest standard deviation across benchmark video datasets. This suggests that RFTD offers a significant improvement in online face tracking within unconstrained video settings.

(9) Xiaoming Liu and Tsuhan Chen, "Video-Based Face Recog- nition Using Adaptive Hidden Markov Models" Electrical and Computer Engineering, Carnegie Mellon University, Pittsburgh, PA, 15213, U.S.A.

Video-based face recognition has emerged as a promising alternative to traditional methods that rely on static images. This research proposes a novel approach utilizing adaptive Hidden Markov Models (HMMs) for recognizing faces within video sequences. The system employs HMMs during the training phase. During recognition, the system analyzes the temporal features extracted from the test video sequence. This analysis is performed by an HMM specifically trained for each subject in the database. The system then compares the likelihood scores generated by each HMM. The highest score indicates the most probable match between the test video and a known individual in the database. The proposed method incorporates unsupervised learning, allowing each HMM to continuously improve its model over time. This is achieved by incorporating information from the test video sequence itself during the recognition process. Extensive testing across various video databases demonstrates that this approach using adaptive HMMs surpasses a simpler method that relies on a majority vote of individual image-based recognition results. This signifies the effectiveness of the proposed method for video-based face recognition.

3. Methodology.

This research proposes a system utilizing facial recognition technology to identify missing persons and criminals. For missing person identification, the system continuously analyzes live webcam footage. It extracts facial features from any individuals captured on camera and compares them to a database of known missing people. If a match is identified, the system automatically triggers an email alert to the designated police officer, including the location where the potential match was detected. This can significantly reduce response times and aid in locating missing individuals. The system also features a secure login for authorized administrators. Administrators can manage the database of registered police officers, granting them access to the system for real-time monitoring. Police officers can log in to the system to view live camera feeds. The system employs advanced algorithms to detect faces within the footage and extract facial features. If a match is found against the missing person database, a notification and email alert are generated, informing the officer of the potential match's location. Even in cases where no match is found, the system provides a notification. Technically, the system is built using Python and relies on the OpenCV library for computer vision tasks. Facial detection is achieved through a combination of the Haar cascade algorithm and the frontal face detection algorithm. A MySQL database stores all relevant data. The system requires a webcam to function effectively, allowing for real-time face detection and potential missing person identification. Overall, this system offers a valuable tool for law enforcement by streamlining missing person identification and potentially aiding in **criminal investigations.**

3.1 Haar Feature Selection

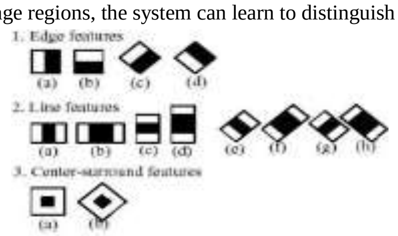
This passage describes a method for object classification that utilizes features specifically designed for fast processing. These features, known as Haar features, offer a simpler alternative to analyzing every pixel in an image. Similar to Haar filters used in image processing, these features capture specific patterns within the image. An example of a Haar feature is a "2-rectangle feature." This feature essentially calculates the difference between the sum of pixel intensities within two rectangular areas. These rectangles can be positioned and scaled at various locations within the original image. Additionally, the method can incorporate more complex features like "3-rectangle features" and "4-rectangle features" to capture a wider range of patterns. The object classification process involves three key steps:

Data Collection: The first step involves gathering a set of images that represent the object of interest (positive images) and images that do not contain the object (negative images).

Feature Generation: Haar features are then extracted from these images. This is achieved by applying a sliding window approach across the image, essentially analyzing small rectangular regions at different positions and scales.

3. Feature Calculation: For each Haar feature applied at a specific location, the system calculates a value by subtracting the sum of pixel intensities within one rectangle from the sum of intensities within another. This value essentially captures the contrast between the two rectangular areas.

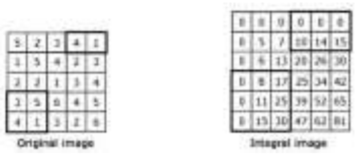
By analyzing these Haar features across different image regions, the system can learn to distinguish between objects and non-objects, achieving fast and efficient classification.



Haar Features

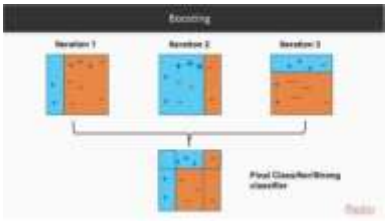
3.2.Integral Image Representation

This concept describes a technique known as an integral image. It essentially pre-computes the sum of pixel values within rectangular areas in an image. This calculation can be done efficiently in a single pass over the entire image. The core principle is that the value stored at any point within the integral image represents the sum of all the pixel intensities located above and to the left of that specific point in the original image. This pre-calculated data structure allows for rapid computations involving rectangular image regions.



3.3.Adaboost Training

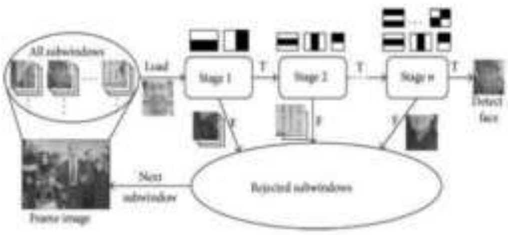
While millions of potential features can be extracted from an image, directly evaluating all of them can be computationally expensive. This research addresses this challenge by employing a technique known as AdaBoost (short for Adaptive Boosting). AdaBoost acts as a training algorithm for classifiers, strategically selecting only the most informative features from the vast pool of possibilities. The core idea behind AdaBoost involves assigning weights to individual data points. These weights essentially reflect the level of difficulty the classifier has in correctly classifying each data point. Initially, all data points are assigned equal weights. As the training process progresses, the weights are dynamically adjusted. Data points that the classifier consistently misclassifies receive increased weights, essentially forcing the classifier to focus its attention on these challenging examples. Conversely, correctly classified points see their weights decrease, reflecting their lower importance in the learning process. Through this iterative process of weight adjustment and feature selection, AdaBoost guides the classifier towards the most informative features, ultimately leading to a more robust and efficient classification model.



3.4.Cascade Classifier Architecture

Cascade classifiers are a unique type of classifier structure designed for efficient object detection.

They function by chaining together multiple, weaker classifiers in a sequential order. Each classifier makes a simple decision – is this a potential object or not? By combining the results of these successive "mini-decisions," the cascade classifier progressively refines its evaluation. The structure of a cascade classifier resembles a simplified decision tree, where each stage acts as a decision point. This multi-stage approach offers a key advantage: it allows for the quick elimination of non-object regions in an image, significantly reducing the overall processing time. The training process for a cascade classifier involves several steps:



Architecture

1.Data Collection: A large collection of images containing the target object (positive images) and images without the object (negative images) is assembled.

2.Negative Image Preparation: The negative images may require specific arrangements to ensure effective training.

3.Positive Image Cropping: The positive images might undergo cropping to isolate specific object regions of interest.

4.Positive Image Vector Creation: The positive image data is transformed into a format suitable for training the classifier.

5.Haar Feature Training: The system utilizes Haar features (explained previously) to train the individual classifiers within the cascade.

6.XML File Generation: Finally, the trained cascade classifier is saved in a specific file format (XML) for future use in object detection tasks.

By leveraging this cascade structure and efficient training process, cascade classifiers achieve fast and accurate object detection in real-world applications.

3.5 Modified Algorithm

This system identifies whether individuals within a video sequence are wearing masks. It accomplishes this task in two key phases:

Face and Mouth Detection: In the first stage, the system locates human faces and mouths within each frame of the video.

Mask Detection: Once a face and mouth are identified, the system analyzes the region around the mouth to determine if a mask is present. This analysis likely involves factors such as color contrast and the presence of multiple rectangular areas (potentially representing the mask and the face beneath it).

By combining these two stages, the system can effectively detect mask usage within the video footage.

Following truth table will provide correct condition of with mask/ without mask:

Face Detected (Gray)	Face Detected (Black & White)	Mouth Detected	Output
len(faces) == 0	len(faces_bw) == 0	NA	No Face Found
len(faces) == 0	len(faces_bw) == 1	NA	Mask Found (White)
len(faces) > 0	len(faces_bw) == 0 OR len(faces_bw) > 1	len(mouth_rects) == 0	Mask Found
len(faces) > 0	len(faces_bw) == 0 OR len(faces_bw) > 1	len(mouth_rects) > 0 AND y < my < y + h	No Mask Found

Conditions for with mask/ without mask

4. Conclusions

This research introduces a novel system designed for missing person and criminal identification. The system has been rigorously tested and demonstrated to effectively identify missing individuals, including children and senior citizens. One of the key strengths of this system lies in its resource efficiency. It requires minimal hardware components, leading to lower power consumption and a cost-effective implementation. This makes it a practical solution for wider deployment in various settings. The system excels at identifying vulnerable populations who are more susceptible to getting lost or wandering off, such as young children, senior citizens, or individuals with physical limitations. By leveraging facial recognition technology, the system can potentially reunite missing individuals with their families through collaboration with law enforcement. This technology has the potential to significantly improve public safety by aiding in the swift identification and recovery of missing persons, particularly those belonging to vulnerable groups. It can be a valuable tool for authorities and communities working to safeguard children, senior citizens, and individuals with physical challenges. By expediting the identification process, the system can minimize the search time and potentially lead to more successful recoveries. Overall, this missing person and criminal identification system presents a promising solution for enhancing public safety and reuniting missing individuals with their loved ones. Its efficient design and focus on vulnerable populations make it a valuable tool for law enforcement and communities alike.

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