VIVA-Tech International Journal for Research and Innovation
ISSN(Online): 2581-7280

Volume 1, Issue 7 (2024)
Article No. COMP_19
PP 01-13

VIVA-TECH IJRI
ANNUAL RESEARCH JOURNAL

VIVA-TECH INTERNATIONAL JOURNAL FOR RESEARCH AND INNOVATION
ANNUAL RESEARCH JOURNAL
ISSN(ONLINE): 2581-7280

Smart Eyes on the Horizon : A survey of Real-Time CCTV Innovations

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Abstract : *The "Smart Eyes on the Horizon: A Survey of Real-Time CCTV Innovations", revolutionizing law enforcement, is a pivotal tool that embodies cutting-edge innovation through its advanced image deblurring technology. This state-of-the-art solution plays a central role in elevating the clarity of surveillance footage, thereby not only significantly enhancing facial recognition accuracy but also streamlining the matching of images with extensive databases. Operating seamlessly in real-time, Smart Eyes on the Horizon serves as a cornerstone in proactive crime prevention, empowering law enforcement with the ability to anticipate and swiftly respond to emerging threats, ensuring they remain one step ahead in the ever-evolving landscape of criminal activities. The system's intuitive user-friendly interface, combined with its scalability and customizable features, fosters widespread adoption among law enforcement agencies. Beyond addressing the critical need for improved image quality, It excels in accurate suspect identification, especially in the intricate scenarios of violence detection. This multifaceted tool is not merely a technological asset; it is a strategic ally that reinforces the capabilities of law enforcement in safeguarding communities. Moreover, Smart Eyes on the Horizon signifies a quantum leap in law enforcement technology, dynamically responding to the escalating demands for enhanced capabilities. Its commitment to prioritizing privacy and maintaining cost-effectiveness underscores its holistic approach to addressing the ethical considerations inherent in modern surveillance systems. By providing officers with unparalleled image deblurring capabilities, It equips them to respond more effectively to incidents, contributing significantly to the overarching goal of creating safer communities. In essence, Smart Eyes on the Horizon transcends being just a tool; it symbolizes the continuous evolution of law enforcement technology, ushering in an era where precision and efficiency are seamlessly intertwined for the greater good of society. This groundbreaking system not only exemplifies technological prowess but also exemplifies a commitment to a safer and more secure future.*

Keywords - *Databases, Facial recognition, Law enforcement, Privacy, Proactive crime prevention, Rapid responses, Real-time operation, Safer communities, Scalability, "Smart Eyes on the Horizon: A Survey of Real-Time CCTV Innovations", Surveillance footage, Suspect identification, User-friendly interface, Violence detection.*

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I. INTRODUCTION

In an era where public safety and security are paramount concerns, technological advancements have become instrumental in assisting law enforcement agencies in their mission to prevent and respond to violent incidents. Among these advancements, the development of a violence detection system with integrated image deblurring and database matching capabilities stands as a significant leap forward in the field of surveillance and law enforcement. This report explores the multifaceted nature of this innovative system, which not only addresses the challenges of identifying acts of violence but also enhances the process of suspect identification through advanced image enhancement and database integration. Violent incidents, ranging from physical altercations to acts of terrorism, pose a constant threat to society. Surveillance cameras have become a ubiquitous presence in public spaces, providing a means to monitor and record potential security threats. However, the effectiveness of these systems has often been hampered by the limitations of image quality. Challenges abound for law enforcement agencies when it comes to identifying and responding to violent incidents due to a myriad of factors. These include the presence of movement distortion, suboptimal light conditions, and poor camera stability, all of which can render footage unclear and unusable. Such impediments not only hamper the swift and accurate identification of individuals involved but also pose significant hurdles in formulating timely responses to mitigate potential threats. To overcome these limitations, the system introduced in this report incorporates state-of-the-art image deblurring technology. By mitigating the effects of motion blur and enhancing image clarity, this system empowers law enforcement agencies with the critical ability to extract valuable information from surveillance footage. This, in turn, facilitates a more precise assessment of violent incidents, aiding in the deployment of timely and targeted responses. Moreover, the system extends its capabilities beyond mere image enhancement. It integrates seamlessly with law enforcement databases, allowing for the rapid and accurate matching of captured images with existing records. This integrated approach revolutionizes the process of suspect identification, increasing the likelihood of apprehending individuals involved in violent incidents. The combination of image deblurring and database matching ensures a comprehensive solution to the complex challenges faced by law enforcement when investigating acts of violence.

II. REVIEW OF LITERATURE SURVEY

The following chapter is a literature survey of the previous research papers and research which gives the detailed information about the previous system along with its advantages and disadvantages.

Deisy Chaves, Eduardo Fidalgo, Enrique Alegre, Rocío Alaiz-Rodríguez, Francisco Jáñez- Martino, George Azzopardi [1]**.** Face recognition serves as a crucial forensic asset aiding criminal investigators in identifying individuals involved in illicit activities, including refugees or victims of sexual exploitation. However, its efficacy is challenged by the need to operate with low-quality images from real-world scenarios while meeting stringent time constraints, presenting a formidable task. Despite the effectiveness demonstrated by deep learning methods in face detection, their computational demands are substantial, consuming significant processing time and power. In this research endeavor, we delve into the intricate balance between speed and accuracy exhibited by three leading deep-learning-driven facial recognition systems, scrutinizing their performance across the comprehensive WIDER Face and UFDD datasets while harnessing the computational capabilities of a diverse array of CPUs and GPUs. Furthermore, we develop a regression model capable of predicting performance metrics such as processing speed and precision. This predictive tool is envisioned to greatly assist end-users in forensic laboratories in evaluating the effectiveness of various face detection methodologies. Our experimental results indicate that resizing images to 25% and 50% of their original sizes on CPUs and GPUs, respectively, yields the optimal balance between speed and accuracy. Moreover, the development of multiple linear regression models enables performance assessment with a Mean Absolute Error (MAE) of 0.113, offering promising prospects for adoption within the forensic industry.

Sujy Han, Tae Bok Lee, Yong Seok Heo [2]. The majority of current face deblurring techniques make use of generative adversarial networks' (GANs') distribution modeling capabilities to enforce the restriction that the deblurred image must follow the distribution of sharp ground- truth images. Within the realm of Generative Adversarial Networks (GANs), the quest persists to generate crisp facial images imbued with remarkable fidelity and lifelike attributes from initially obscured or hazy facial representations. To tackle this challenge head-on, the

focus shifts towards intricately modeling the collective distribution of clear facial images alongside segmentation label maps. This innovative approach within the GAN framework aims to master the art of facial image deblurring, ensuring unprecedented clarity and realism in the final output. The researchers propose an innovative approach called the Semantic-Aware Pixel-wise Projection discriminator, designed to meticulously capture pixel-label correlations by integrating semantic label map information. This discriminator not only evaluates the authenticity of an image on a per-image basis but also generates a detailed map of probability pixel-wise, accurately depicting the realism of individual pixels within the input image. Furthermore, they introduce a novel concept known as prediction-weighted (PW) loss, aimed at fine-tuning the decoder's performance by emphasizing misclassified pixels. This technique leverages pixel-level authenticity assessment map,to dynamically adjust the contribution of each pixel, enhancing the overall fidelity and coherence of the generated output. These method beats other methods in terms of perceptual image quality both numerically and qualitatively, according to extensive experimental results.

Dilnoza Mamieva, Akmalbek Bobomirzaevich Abdusalomov, Mukhriddin Mukhiddinov, Taeg Keun Whangbo [3]. The focus of this study is on improving facial detection in difficult settings using deep learning techniques. Traditional approaches, which rely on hand-crafted features, struggle to handle photos in uncontrolled environments. To solve these issues, the study introduces RetinaNet baseline, a single-stage face identification framework. It improves both speed and accuracy through network advancements. Experiments on datasets such as WIDER FACE and FDDB yield outstanding results, with an average precision (AP) of 41.0 at 11.8 FPS for single-scale inference and 44.2 for multi-scale inference on the WIDER FACE benchmark. The model, which was built with PyTorch, detects faces with a high accuracy rate of 95%. Future directions are also discussed in the research, such as dealing with fuzzy photos in low- light circumstances and improving the approach for real-time facial emotion recognition utilizing deep learning techniques such as 3D CNN, 3D U-Net, and YOLOv. Overall, the proposed approach improves face detection accuracy and efficiency significantly, making it a promising solution for difficult real-world settings.

Viktor Denes Huszar, Vamsi Kiram Adhikarla, (Member, IEEE), Imre Negyesi, Csaba Krasznay [4]. This research focuses on utilizing deep learning to improve the detection of harmful behavior in surveillance videos. Using 3D convolutions and pretrained action recognition models, the method improves accuracy by 2% with fewer parameters while being robust to common compression artifacts. The need of broad and representative datasets for violence detection, as well as the need for consistent dataset quality, is underlined. Cross-dataset analyses highlight differences in model performance, prompting efforts to build large-scale datasets, including real-world surveillance footage. The research also introduces a computationally lightweight system architecture for practical surveillance applications, with ambitions to improve managing scenarios involving occurrences spanning numerous video segments in the future. Overall, this work advances violence detection technologies for use in real-world surveillance circumstances.

Shivalila Hangaragi, Tripty Singh, Neelima N [5]. This study goes into the domains of face detection and recognition, two active disciplines within computer vision and deep learning that have a wide range of applications such as security, access control, and database identification. Face Mesh is used in the suggested model, allowing for robust performance in variable settings such as different lighting and backdrops, as well as supporting non-frontal photos across genders and age groups. The model is trained using a combination of images from the Labeled Wild Face (LWF) dataset and real-time captures, and when tested, it matches face landmarks to training images for recognition, designating unrecognized faces as "unknown." The model obtains an impressive 94.23% accuracy rate in facial recognition. The report also contains face reconstruction accuracy experiments using the BU3DFE dataset, highlighting the model's ability to recognize non-frontal faces of varied populations. A comparison with existing approaches demonstrates its usefulness, with a strong 94.23% accuracy in diverse test settings.

Raghda Awad Shaban Naseri, Ayça Kurnaz, Hameed Mutlag Farhan [6]. The authors provide an efficient and accurate deep learning-based face mask identification system designed for IoT applications in their article. The major goal is to enable real-time face mask recognition in IoT devices through the use of a resource-efficient, optimized face detection model. This real-time performance model exhibits promising accuracy and is evaluated using standard criteria. The study also tackles potential problems and limitations, while emphasizing the practical relevance of their IoT-compatible face mask detection technology in scenarios such as public safety and health compliance monitoring, underscoring its importance in modern contexts.

Nadia Mumtaz, Naveed Ejaz, Shabana Habib, Syed Muhammad Mohsin, Prayag Tiwari, Shahab S. Band, Neeraj Kumar [7].The study explores the issues posed by the vast volume of Big Video Data created in smart cities, especially via security cameras, emphasizing the difficulty of effectively automating its interpretation. It focuses on Violence Detection (VD) within the broader topic of Movement Recognition, highlighting the shift from manually created features to real-time deep learning-based models. Providing a comprehensive survey, it elucidates deep sequence learning approaches s and VD localization strategies, as well as early image processing and VD literature based on machine learning. It explores the advantages of simple

methods over sophisticated models in terms of efficiency. The study stresses the accomplishments and problems in the field of computer vision connected to VD, recommending a change from standard features to strong representations utilizing 2D CNNs and, ultimately, 3D CNNs. While testing results show that VD datasets have excellent accuracy and precision, the article raises concerns regarding the applicability of present models to real-world surveillance scenarios with abrupt changes. It underlines the importance of adapting deep models to non-stationary environments and relevant information extraction post-localization in order to accomplish successful VD.

Tao Wang, Kaihao Zhang, Xuanxi Chen, Wenhan Luo, Jiankang Deng, Tong Lu, Xiaochun Cao, Wei Liu, Hongdong Li, Stefanos Zafeiriou [8]. This work provides an in-depth examination of the evolution of Face Restoration (FR) techniques, from early methods based on probabilistic assumptions and models to modern deep learning-based approaches in the area of low-level computer vision. The study begins by presenting alternative problem formulations and the distinguishing features of face photos. It discusses the issues of face restoration before providing a full evaluation of FR methods that include both prior-based and deep learning-based methodologies. Deep learning approaches are evaluated in terms of network designs, loss functions, and benchmark datasets. In addition, the research performs a comprehensive benchmark evaluation of representative FR approaches. Finally, the research not only covers the subject of face restoration systematically, but it also identifies future approaches, such as network architecture, metrics, benchmark datasets, and potential applications in this domain.

Zhengwei Zhu, Yushi Lei, Yilin Qin, Chenyang Zhu, Yangping Zhu [9]. Deep learning stands as a formidable approach, striving to distil intricate abstract features from data and unravel the underlying distribution patterns via multiple nonlinear transformations. Super-Resolution (SR), a technique rooted in deep learning, endeavours to elevate low-resolution (LR) images to high-resolution (HR) counterparts using specialized algorithms, mitigating issues such as blurriness or poor quality stemming from constraints in the image acquisition environment. An enhanced model based on Real-ESRGAN, as the images reconstructed by RealESRGAN were excessively smooth and conspicuously lacked texture features. Initially, the utilization of High-Dimensional Modelling (HDM) resulted in unwarranted image degradation, counterproductive to its intended rectification of real-world image imperfections. Evaluation using the NIQE (Natural Image Quality Evaluator) metric across five test datasets demonstrated significant improvements over Real-ESRGAN. The employment of the SmoothL1 loss function led to an overall enhancement of model accuracy under identical experimental conditions with a faster convergence rate. The proposed model diverged from convention in several ways: the transition from HDM to second-order degenerate modelling, utilization of SmoothL1 loss function instead of L1 loss, and the replacement of the channel attention block with the last two convolutional layers in the dense block within the generator. Additionally, the adoption of PatchGAN as a discriminator marked a departure from conventional strategies in Real-ESRGAN and its variants. Comparative experiments against five authoritative models, including BSRGAN and Real-ESRGAN, showcased the superiority of the proposed model across traditional metrics such as NIQE and PI, underscoring its capacity to generate images with enhanced texture detail and lower distortion metrics.

Tae Bok Lee, Sujy Han, Yong Seok Heo [10] . Facial motion deblurring for individual images constitutes a vital yet specialized domain within image deblurring, focusing on reinstating sharpness in motion-blurred facial images. Deep neural networks have emerged as pivotal tools in image restoration, particularly in single-image face deblurring, showcasing remarkable efficacy. However, many existing methods aim to recover only a single sharp image from a motion-blurred facial image, overlooking the broader context of capturing aggregated sharp moments during exposure. Our objective is to restore output images conditioned on continuous control factors, addressing this temporal ambiguity. Introducing the facial motion-based reordering (FMR) process, we mitigate temporal ambiguity by leveraging human facial information. We present CFMD-GAN, a pioneering framework for persistent facial motion deblurring,, achieved through a unified network and training process. By applying FMR, we ensure a stable learning process by incorporating domain-specific facial knowledge. We elucidate the key components of CFMD-GAN, designed to recover the continuous moment latent in a blurry facial image via a moment control factor. The dataset, comprising high-quality facial videos captured in real-world scenarios. Blurry images are synthesized by averaging various consecutive sharp frames, akin to recent motion deblurring studies. Performance metrics such as PSNR, SSIM, and facial identity distance measured via ArcFace are employed for evaluation. This work opens doors to a new frontier in image restoration, with ample opportunities for further refinement and innovation in incorporating diverse facial priors.

Archana Tomar, Harish Patidar [11]. In today's diverse landscape, the demand for high-quality imagery across medical imaging, satellite observation, and multimedia is growing. Image super-resolution is crucial for reconstructing high-resolution images from low-resolution ones. Deep Convolutional Neural Networks (DCNNs) excel in this task, learning intricate patterns and relationships. Our research focuses on developing a specialized DCNN architecture for image super-resolution. Through supervised learning, the network generates

high-resolution outputs from low-resolution inputs. Experimental findings illustrate the superior performance of our DCNN over existing methods, consistently improving metrics like PSNR and SSI. In conclusion, our DCNN offers significant advancements in image super-resolution, enhancing image quality and preserving details effectively.

Tong Han, Li Zhao, Chuang Wang [12]. The demand for high-quality imagery spans medical diagnostics, satellite surveillance, and multimedia. Super resolution technology aims to enhance image resolution, leveraging Deep Convolutional Neural Networks (DCNNs) to overcome traditional limitations. Our research develops a specialized DCNN architecture for image super-resolution, addressing challenges like blurred images and low quality. Different approaches, including SRGAN and PULSE, offer various advantages in improving image resolution. Future advancements may involve sophisticated loss functions and lightweight models. Optimizing video enhancement algorithms holds promise for enhancing video quality across diverse platforms. In conclusion, leveraging deep learning advances, researchers strive to push the boundaries of image enhancement for superior visual experiences. By harnessing the capabilities of deep learning and advancing algorithmic approaches, researchers aim to push the boundaries of image enhancement and provide users with unparalleled visual experiences across various applications and platforms.

Zhiwei Yang, Yunyan Wang [13]. Deep learning has revolutionized image reconstruction, with generative adversarial networks (GANs) pioneering image resolution enhancement. Hierarchical feature learning algorithms, combining recurrent neural networks (RNNs), GANs, and dense convolutional networks, excel in high-resolution image reconstruction. The modified SRGAN network proposed here employs stacked convolutions and activation functions to enhance remote sensing imagery. It outperforms the original structure by refining object judgment criteria and incorporating characteristic values, showcasing improvements in resolution and clarity. Training on the AID dataset and refining adversarial loss through discriminant network comparison further enhances results. This paper proposes a modified SRGAN network for reconstructing high-resolution remote sensing data, showcasing enhancements over the original structure. Replacing normalization layers with residual error, refining object judgment criteria, and incorporating characteristic values to enhance sensory loss contribute to improved results.

Leese, Matthias [14]. This paper examines the data collection and analysis practices within police departments, focusing on the intersection of technology, data-driven approaches, and crime prevention strategies. The research, conducted over multiple years, delves into how police departments gather, process, and utilize data to inform their operational decisions. Key findings from the study include the emergence of data-driven managerialism within police departments, characterized by a shift towards utilizing large quantities of data for crime analysis and prevention. The paper highlights the importance of understanding the socio-technical aspects of data practices, emphasizing that data are not neutral representations of reality but are socially constructed. The analysis reveals that predictive policing aims to anticipate future criminal activity and apply targeted prevention measures PRECOBS stands as a pioneering predictive policing tool, harnessing advanced algorithms and historical crime data to anticipate the occurrence of what experts term "near-repeat" crimes. An acronym derived from its full title, "Pre Crime Observation System," PRECOBS represents a leap forward in law enforcement technology, offering proactive insights into potential criminal activity based on past patterns and trends. The PRECOBS algorithm, for instance, identifies patterns in crime data to estimate spatio-temporal risk factors for burglary. The study underscores the significance of data quality control, as crime data undergo updates and corrections to ensure accuracy and completeness. It explores how digital interfaces streamline data collection processes and enforce completeness, crucial for effective predictive policing. Furthermore, the paper emphasizes a practice-oriented perspective, emphasizing the enactment of social reality through data practices. It argues against dystopian views of technology-driven policing, advocating for a nuanced understanding of the interplay between data, algorithms, and human agency. Overall, the paper contributes to the broader discourse on crime, data, and policing by offering insights into the complexities of contemporary data-driven approaches and their implications for law enforcement strategies.

Arjun Menon, Kumari Shivani Singh, Raushan Kumar, Ritvik Sethi, Abha Kiran Rajpoot [15]. This article addresses the challenges inherent in traditional criminal detection methods and proposes facial recognition technology as a solution. It highlights the limitations of traditional approaches, such as reliance on physical evidence, and emphasizes the potential of facial recognition to automate and enhance the identification process. Facial recognition technology utilizes automated techniques to extract and analyze facial characteristics, allowing for rapid and accurate identification of individuals. Unlike conventional methods that rely on physical traces left by criminals, facial recognition can promptly issue alerts even when individuals attempt to conceal their identities. Powered by artificial intelligence and deep learning algorithms, facial recognition technology can overcome obstacles such as disguises or obscured faces, providing law enforcement agencies with a powerful tool for crime detection. Its efficiency and speed make it increasingly appealing to police departments worldwide. The article underscores the significance of data integrity, security, and traceability in criminal identification systems, with facial recognition offering advancements in these areas. By

automating the process and leveraging AI capabilities, facial recognition technology presents a promising approach to addressing the persistent challenge of criminal detection. Overall, the article advocates for the adoption of facial recognition technology as a transformative tool in law enforcement, offering improved efficiency, accuracy, and adaptability in identifying and apprehending criminals.

III. Analysis Table

Analysis table summarizes the research papers on the Smart Eyes on the Horizon: A Survey of Real-Time CCTV Innovations. Below is a detailed description of various algorithms used in research papers.

Table 1: Analysis Table

Title	Summary	Advantages	TechStack
Assessment and Estimation of Face Detection Performance Based on Deep Learning for Forensic Applications [1]	This study explores the use of face recognition in criminal investigations, focusing on challenges and benefits. It evaluates three deep-learning-based face detection models for speed and accuracy on various hardware setups. Also introduces a regression model to estimate performance with a low Mean Absolute Error (MAE) of 0.113.	By addressing the challenges of working with low- quality images from real-world scenarios, the research contributes to the development of more robust face recognition systems capable of handling difficult conditions.	MTCNN, PyramidBox, DSFD
Semantic-Aware Face Deblurring With Pixel-Wise Projection Discriminator [2]	The face deblurring advancements use GANs to enhance sharpness. A new approach combines sharp face images and segmentation labels in GANs. A semantic-aware SAPP discriminator for pixel-label matching and a prediction-weighted loss for pixel importance. Training starts coarse and goes fine for global and local focus. This method outperforms existing techniques	The method yields enhanced perceptual image quality, surpassing existing techniques. This means that the deblurred face images are more visually appealing and faithful to the original sharp images.	Generative adversarial networks (GANs) , Semantic-aware pixel-wise projection (SAPP)
Improved Face Detection Method via Learning Small Faces on Hard Images Based on a Deep Learning Approach [3]	The evolution of facial recognition from manual techniques to deep learning-based face detection. A single-stage face detector called RetinaNet baseline, which enhances detection speed and	The method leverages deep learning to achieve significantly improved accuracy in face detection, which is crucial for various applications, including facial recognition and analysis.	Retina net baseline, a single- stage face detector

	accuracy. The method achieves competitive results on benchmark datasets, particularly with multi- scale inference. Implemented in PyTorch, achieves a high accuracy of 95.6% in successfully detected faces, outperforming existing methods in both detection and recognition tasks.		
Toward Fast and Accurate Violence Detection for Automated Video Surveillance Applications [4]	The challenge of automated violence detection in CCTV videos, driven by the difficulty of analyzing the vast amount of video data in real-time Utilizing intelligent networks enhanced by 3D convolutions, the system adeptly assimilates spatial intricacies and temporal dynamics within the video footage. Utilized to enhance efficiency and accuracy. The approach is evaluated on diverse public datasets, outperforming existing methods by approximately 2% in accuracy with fewer model parameters. It also shows robustness in handling common compression artifacts.	Despite its improved accuracy, the approach requires fewer model parameters, making it more efficient in terms of computational resources and memory usage.	Anomaly detection, Anomaly localization, Automated video surveillance
Face Detection and Recognition Using Face Mesh and Deep Neural Network [5]	This survey paper presents a novel approach to detecting and recognizing faces by leveraging Face Mesh technology.. It has various practical applications, including identifying people in specific locations, checking against police databases, and controlling access to restricted areas. The model is robust, working well in different conditions and with various demographics. It's trained on diverse	The model demonstrates robust performance, functioning effectively under varying conditions, including changes in illumination and background. It can also handle non- frontal images of individuals of different genders, ages, and races.	Neural Network; Face mesh landmarks.

	datasets and achieves an impressive 94.23% accuracy in face recognition.		
Optimized face detector-based intelligent face mask detection model in IoT using deep learning approach [6]	This study introduces an advanced model using IoT for automated mask identification. It optimizes key parameters through a novel algorithm called ASMFO and achieves remarkable accuracy improvements in face detection and mask classification. Compared to conventional methods, it significantly outperforms with high effect for accurate mask detection, particularly in public health contexts.	By using SSD and a hybrid deep Learning approach, the model employs state-of-the-art technology for face detection and mask classification, ensuring accuracy and efficiency.	Single Shot Multi- box Detector (SSD).
An Overview of Violence Detection Techniques: Current Challenges and Future Directions [7]	The proliferation of surveillance cameras in smart cities led to a massive volume of video data, making automated analysis a challenging task. Violence Detection is essential for identifying unusual human actions in this data. Traditional VD relies on manual features, but deep learning-based models are gaining prominence. This paper provides an overview of deep sequence learning and localization strategies in VD, as well as earlier image processing and machine learning approaches	Deep learning- based models mentioned in the overview can facilitate real-time VD analysis, allowing swift detection of violent incidents, which is crucial for ensuring public safety.	Big Video data, Deep Learning for VD.
A Survey of Deep Face Restoration: Denoise, Super- Resolution, Deblur, Artifact Removal [8]	Face Restoration (FR), which enhances low-quality face images to high-quality ones. Traditional methods had limitations, but recent advances in deep learning have improved FR significantly. The paper provides a comprehensive survey of deep learning techniques for FR,	The shift from traditional methods to deep-learning based approaches addresses the limitations of FR for real-world applications, where the quality of input images can vary significantly	Face restoration, Deep learning, Face deblurring, Face denoising.

	covering problem formulations, challenges, methods, network architectures, loss functions, and benchmark evaluations. It also discusses future directions and offers an open-source repository for the discussed methods.		
IRE: Improved Image Super-Resolution Based on Real-ESRGAN [9]	It introduces an enhanced model of Real-ESRGAN, a deep learning technique for Image Super-Resolution, aiming to address issues of smoothness and texture lack in reconstructed images. It employs High-Dimensional Modeling initially but transitions to second-order degenerate modeling, utilizing SmoothL1 loss function and PatchGAN discriminator. The model, trained on 256x256-pixel input images with kernel size of 3, outperforms traditional metrics across five test datasets, demonstrating superior texture detail and lower distortion. The proposed method surpasses benchmarks like BSRGAN in both qualitative and quantitative assessments, showcasing its advancements in image quality.	Enhanced texture detail and reduced distortion in reconstructed images.	Deep Learning , Real-ESRGAN, High-Dimensional Modeling (HDM),SmoothL1 Loss Function, ZatchGAN Discriminator.
Continuous Facial Motion Deblurring [10]	The CFMD-GAN framework heralds a pioneering approach to address the challenge of continuous facial motion deblurring. Its primary objective is the revitalization of clarity within facial images marred by motion blur through the adept utilization of deep neural networks.. By	1. Restoration of continuous sharp moments from single motion-blurred facial images. 2. Mitigation of temporal ambiguity through facial motion-based reordering.	Deep Learning, Generative Adversarial Networks (GANs), Facial Motion-Based Reordering (FMR), Image Restoration Techniques, Python Programming Language, TensorFlow or PyTorch Frameworks.

	introducing the facial motion-based reordering (FMR) process, the model addresses temporal ambiguity and ensures stable learning through domain-specific facial knowledge. CFMD-GAN stands as the pioneering endeavor in single-to-video face deblurring, offering significant advancements in image restoration and paving the way for future research in continuous facial motion deblurring.		
Enhancing image super-resolution with deep convolutional neural networks [11]	This research introduces a specialized Deep Convolutional Neural Network (DCNN) architecture for image super-resolution, leveraging its ability to learn complex mappings between low and high-resolution image spaces. Through supervised learning on paired datasets, the DCNN consistently outperforms existing methods like SRCNN, ESRGAN, and SRGAN, showcasing significant improvements in metrics like PSNR and SSI. The proposed DCNN architecture demonstrates proficiency in preserving image fidelity and reducing reconstruction errors, marking substantial advancements in image super-resolution.	1. Specialized DCNN architecture tailored explicitly for image super-resolution. 2. Comprehensive evaluation across multiple datasets and evaluation metrics affirm the method's robustness and versatility.	Deep Convolutional Neural Networks (DCNN), Supervised Learning.
Research on Super-resolution Image Based on Deep Learning [12]	Exploring the domain of image super-resolution, utilizing Deep Convolutional Neural Networks (DCNNs) to enhance image resolution across various applications. By leveraging DCNNs' ability to learn intricate patterns, specialized architectures are developed to overcome	1. Utilizes Deep Convolutional Neural Networks (DCNNs) for image super-resolution, enabling the enhancement of image resolution across diverse domains. 2. Specialized DCNN architectures tailored explicitly for image super-resolution address	Deep Convolutional Neural Networks (DCNNs), Convolutional Neural Network (CNN) Models, Generative Adversarial Networks (GANs), Supervised and Self-supervised Learning.

	challenges like blurred images and low quality. Different approaches, such as SRCNN, SRGAN, and PULSE, offer distinct advantages in enhancing image resolution, with future advancements focusing on sophisticated loss functions and lightweight models.	challenges like blurred images and low quality.	
Image Enhancement and Improvement Algorithm Based on Esrgan Singal Frame Remote Sensing Image [13]	Presenting advancements in high-resolution remote sensing image reconstruction using a modified SRGAN network. Leveraging generative adversarial networks (GANs) and hierarchical feature learning algorithms, the proposed model enhances resolution and clarity compared to the original structure. Key modifications include replacing normalization layers with residual error, refining object judgment criteria, and incorporating characteristic values to enhance sensory loss. Training on the AID dataset and calibrating adversarial loss through discriminant network comparison further refine the results, promising significant advancements in remote sensing image super-resolution.	1. Utilizes a modified SRGAN network for reconstructing high-resolution remote sensing data, showcasing enhancements over the original structure. 2. Incorporates generative adversarial networks (GANs) and hierarchical feature learning algorithms to improve resolution and clarity.	Generative Adversarial Networks (GANs), Recurrent Neural Networks (RNNs), Dense Convolutional Neural Networks.
Enacting criminal futures: data practices and crime prevention[14]	This paper investigates data practices in police departments, highlighting the shift towards data-driven managerialism and the emergence of predictive policing. Key findings include the socio-technical nature of data practices, emphasizing their social construction and importance in crime prevention. The study	1. Offers insights into data-driven approaches in law enforcement, enhancing crime analysis and prevention strategies. 2. Emphasizes the socio-technical aspects of data practices, highlighting their social construction and implications for policing.	Predictive policing software like PRECOBS (Pre Crime Observation System), Algorithms for crime data analysis, Digital interfaces for data collection and quality control.

	underscores the significance of data quality control and the role of digital interfaces in streamlining data collection for predictive policing. It advocates for a nuanced understanding of technology-driven policing and human agency.		
Leveraging Facial Recognition Technology in Criminal Identification [15]	This article promotes facial recognition technology as a solution to the challenges faced by traditional criminal detection methods. It highlights the speed, accuracy, and automation capabilities of facial recognition, enabled by artificial intelligence and deep learning algorithms. Advantages include rapid identification of individuals, even when disguises are used, and advancements in data integrity, security, and traceability.	1. Speed and accuracy: Facial recognition technology offers rapid and accurate identification of individuals, enhancing law enforcement efficiency. 2. Automation: Automated techniques extract and analyze facial characteristics, reducing reliance on physical evidence and manual processes.	Artificial intelligence, Deep learning algorithms, Facial recognition software and systems.

IV. Conclusion

In conclusion, the latest strides in deep learning technology showcase remarkable advancements, technology have transformed several fields, including forensic investigation, surveillance, and facial recognition, making them more effective and efficient. For instance, new techniques like deep learning-based face detection have greatly improved forensic investigations, while semantic-aware pixel-wise projection has enhanced facial recognition capabilities. Additionally, innovations like RetinaNet baseline have made remote sensing more accurate. These developments, along with techniques such as 3D convolutions for violence detection, are not only making our communities safer but also helping law enforcement agencies better to identify and apprehend criminals. In aggregate, the fusion of deep learning, computer vision, and forensic science is drawing us nearer to a society characterized by enhanced safety and security

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