



Introduction to Computer Vision and Image Processing



Presentation by Maxyne Nuela Ignacio





Overview of Computer Vision

- Computer vision helps AI systems understand and analyze visual data, allowing machines to recognize objects, track movements, and make predictions. This ability powers advances in areas like autonomous vehicles, healthcare, and security.
- Image processing refines visual data for AI by enhancing quality, reducing noise, and highlighting important features. It's a critical step that helps algorithms identify patterns accurately, making it essential for reliable computer vision.



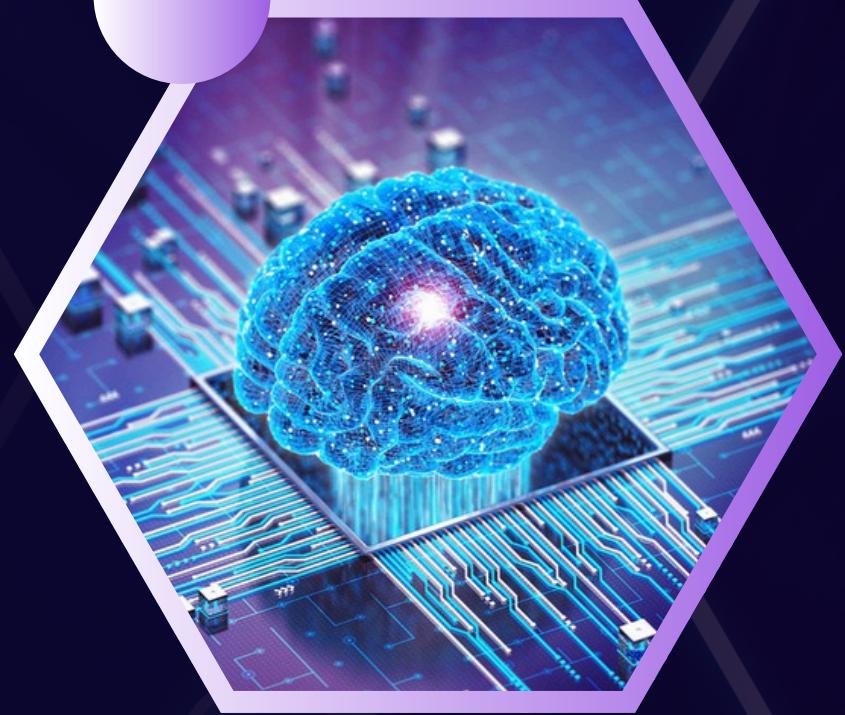


Image Processing Techniques



Filtering Techniques

such as Gaussian and median filters, are used to reduce noise and enhance image quality. By smoothing images, these filters help AI systems focus on significant features, improving the accuracy of analysis like object recognition and classification.



Edge Detection

Edge detection algorithms, like the Canny edge detector, identify boundaries within images. This technique allows AI systems to delineate object contours, enabling more effective identification and localization of objects within a scene, which is critical for applications such as autonomous driving and facial recognition.

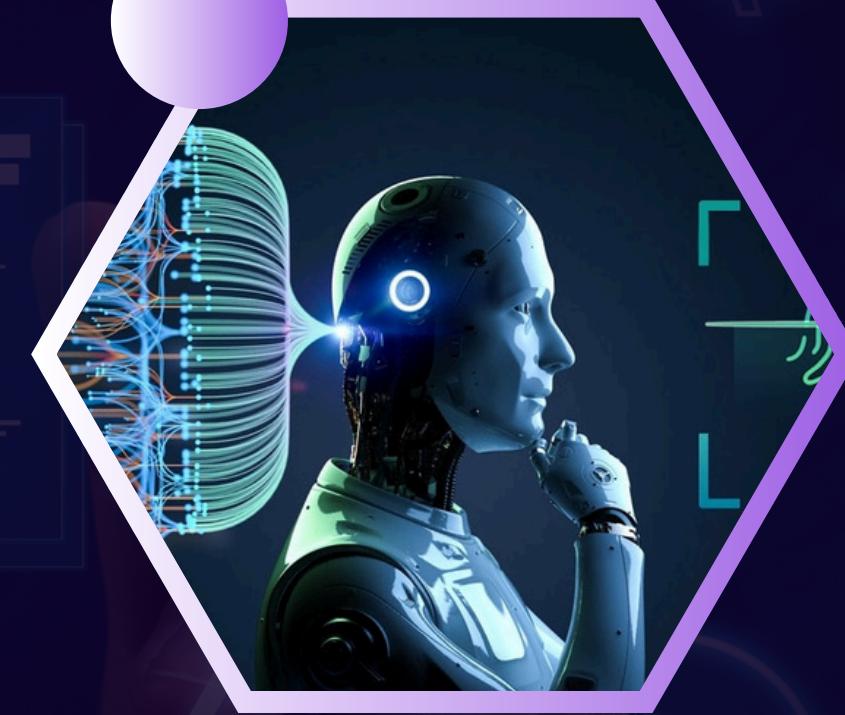


Image Segmentation

Image segmentation techniques partition an image into distinct regions or objects based on characteristics such as color, intensity, or texture.



Case Study Overview

- Face recognition identifies or verifies a person's identity by analyzing facial features from an image or video.
- Image processing enhances facial data by detecting faces, adjusting for lighting, and extracting features like the eyes, nose, and mouth.
- These processes address challenges such as varying lighting conditions, different poses, and complex backgrounds that could reduce accuracy.
- By refining image quality, image processing ensures that face recognition systems remain reliable and accurate across diverse settings.





Image Processing Implementation

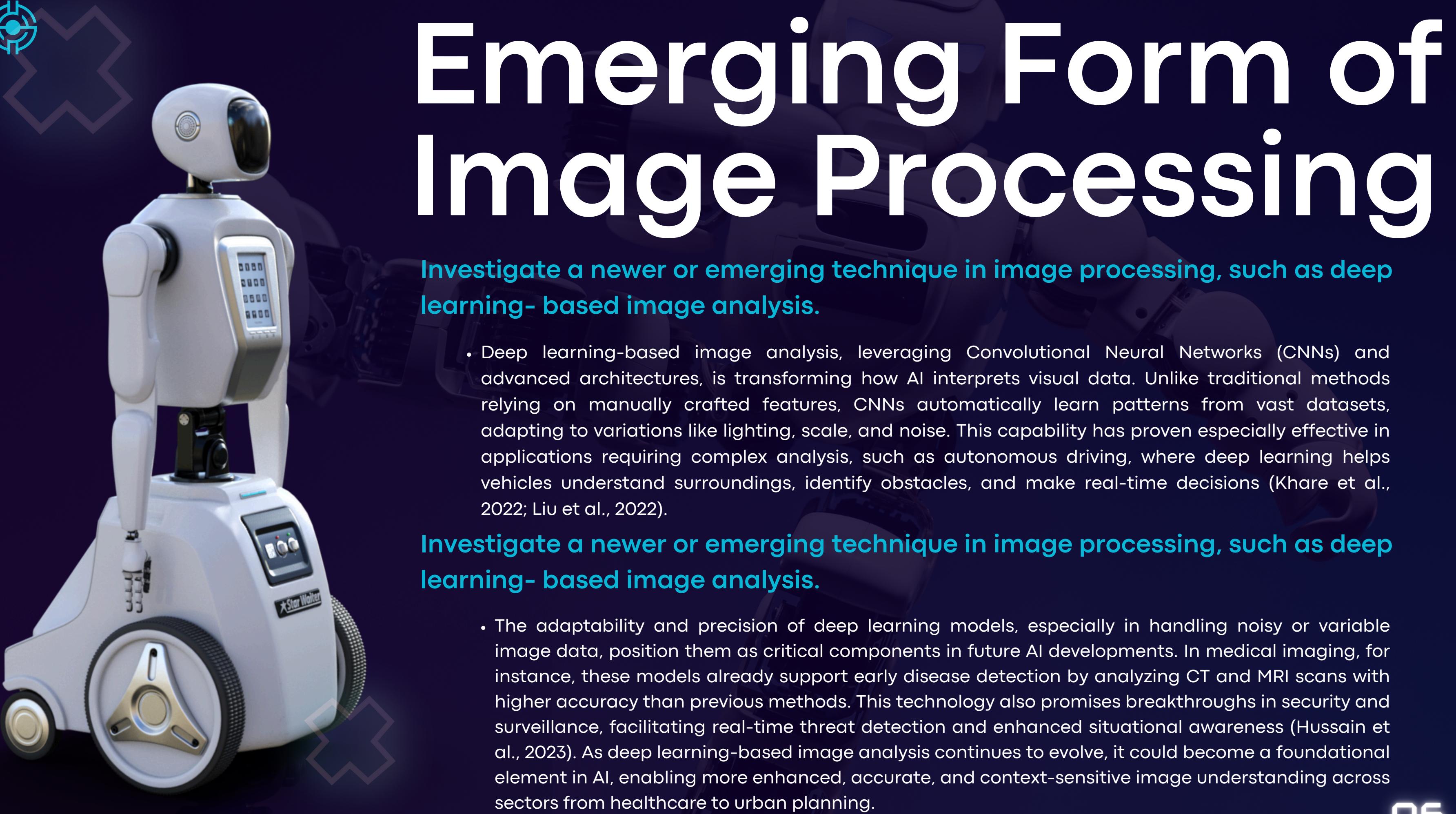
- The model processes images using several key steps to enhance facial data for reliable recognition and solve the **Problem in inaccurate detection under poor lighting conditions**. First, it converts images to **grayscale**, simplifying the data by reducing color complexity.
- **Gaussian blur** is applied to smooth out noise, while **edge detection** highlights important facial boundaries, making it easier to identify key features.
- **Histogram equalization** improves contrast, helping the model work better under different lighting conditions. For additional robustness, an illumination-invariant color space minimizes the effect of varying light intensities on the face.
- Finally, **face detection with Haar cascades** identifies the location of faces, ensuring the model focuses only on relevant areas for recognition. This combination of steps prepares facial images effectively, enhancing accuracy in face recognition by ensuring quality and consistency in the input data.





CONCLUSION

Effective image processing is essential in AI, as it optimizes raw data for analysis, enabling more accurate and reliable performance in applications like face recognition. It enhances image quality, reduces noise, and highlights key features, addressing challenges such as lighting variations and background complexity. From this activity, I learned how critical preprocessing is to ensure that AI systems interpret visual data accurately, as well as how specific techniques like grayscale conversion, Gaussian blur, and histogram equalization contribute to improved recognition in complex, real-world conditions.



Emerging Form of Image Processing

Investigate a newer or emerging technique in image processing, such as deep learning- based image analysis.

- Deep learning-based image analysis, leveraging Convolutional Neural Networks (CNNs) and advanced architectures, is transforming how AI interprets visual data. Unlike traditional methods relying on manually crafted features, CNNs automatically learn patterns from vast datasets, adapting to variations like lighting, scale, and noise. This capability has proven especially effective in applications requiring complex analysis, such as autonomous driving, where deep learning helps vehicles understand surroundings, identify obstacles, and make real-time decisions (Khare et al., 2022; Liu et al., 2022).

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- The adaptability and precision of deep learning models, especially in handling noisy or variable image data, position them as critical components in future AI developments. In medical imaging, for instance, these models already support early disease detection by analyzing CT and MRI scans with higher accuracy than previous methods. This technology also promises breakthroughs in security and surveillance, facilitating real-time threat detection and enhanced situational awareness (Hussain et al., 2023). As deep learning-based image analysis continues to evolve, it could become a foundational element in AI, enabling more enhanced, accurate, and context-sensitive image understanding across sectors from healthcare to urban planning.