**Machine Problem No. 1**

**Topic: Topic 1.1: Introduction to Computer Vision and Image Processing**

**Week No.** 1-2

**Course Code: CSST106 Term:** 1st

Semester

**Course Title: Perception and Computer Vision Academic Year:** 2024-2025

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**Due date September 06, 2024 Points**

**Machine Problem No. 1: Exploring the Role of Computer Vision and Image Processing in AI**

**Objective:**

Understand the importance of computer vision and image processing in Artificial Intelligence (AI) and explore how these technologies enable AI systems to analyze and interpret visual data.

**Instructions:**

**Research and Comprehend:**

• **Introduction to Computer Vision:**

* Start by researching the basic concepts of Computer Vision, focusing on how AI systems process visual information.
* According to my research, Computer vision is a field of artificial intelligence (AI) that uses machine learning and neural networks to teach computers and systems to derive meaningful information from digital images, videos and other visual inputs—and to make recommendations or take actions when they see defects or issues.
* According to the website of <https://www.ibm.com/topics/computer-vision#:~:text=Computer%20vision%20is%20a%20field,they%20see%20defects%20or%20issues>. If AI allows computers to think, computer vision allows them see, observe, and understand. This process requires a lot of data. Through this data Computer vision systems learn to distinguish and recognize images. For instance, to train a computer to identify automobile tires, it must process a large number of tire images and related items to understand and identify a defect-free tire.
* There are two key technologies used in these process including deep learning and convolutional neural networks (CNNs).
* Machine learning involves algorithmic models that help a computer understand the context of visual data. By feeding enough data through these models, the computer learns to differentiate between images on its own.
* A CNN assists a machine learning or deep learning model by breaking images into pixels, assigning tags or labels to these pixels. It uses these labels to perform convolutions—a mathematical operation combining two functions to produce a third function—and makes predictions about the image content. The neural network iteratively runs convolutions, refining its predictions until they are accurate. This process allows the model to recognize and see images similarly to how humans do.

Reference: <https://www.ibm.com/topics/computer-vision#:~:text=Computer%20vision%20is%20a%20field,they%20see%20defects%20or%20issues>

* Understand the role of image processing in AI, including why it is crucial for AI systems to enhance, manipulate, and analyze images effectively.
* According to the website of <https://www.v7labs.com/blog/image-processing-guide> image processing involves manipulating digital images through the use of computer algorithms. This technique is crucial in many applications, such as face recognition, object detection, and image compression. Image processing is performed to enhance an existing image or to extract important information from it.
* Image processing is crucial for AI systems because it improves image quality, extracts important features, and enhances model accuracy. Image processing ensures that AI can accurately interpret and analyze visual data, leading to better performance.

• **Overview of Image Processing Techniques:**

* Explore the key techniques used in image processing, such as filtering, edge detection, and segmentation.
* According to the website of <https://www.v7labs.com/blog/image-processing-guide> there are 8 image processing techniques such as:

1. **Image enhancement**: Image enhancement improves the visual quality of an image by adjusting its features, such as brightness, contrast, and sharpness. This process makes important details more visible and easier to analyze, often by reducing noise or emphasizing certain elements.
2. **Image restoration:** Image restoration recovers an image that has been degraded by removing distortions or defects, such as blurriness, noise, or other imperfections. It tries to restore the original quality of the image as closely as possible, often using algorithms to reverse the damage and recover lost details.
3. **Image segmentation:** is the process of dividing an image into distinct regions or segments based on specific criteria, such as color, intensity, or texture. This technique helps isolate and identify objects or areas of interest within the image, making it easier to analyze and process individual components.
4. **Object detection:** Object detection identifies and locates objects within an image. It involves recognizing objects and drawing bounding boxes around them, often using algorithms to classify the objects and determine their positions. This technique is used in various applications, such as autonomous driving and facial recognition.
5. **Image compression:** Image compression reduces the file size of an image while maintaining as much quality as possible. It helps in saving storage space and reducing transmission time. Compression can reduced image quality.
6. **Image manipulation:** Image manipulation involves altering an image to achieve a desired effect or to correct imperfections. This can include adjustments to brightness, contrast, color balance, cropping, resizing, and applying filters or effects. It's used for enhancing images, creating artistic effects, or preparing images for various applications.
7. **Image generation**: Image generation refers to creating new images from scratch using algorithms or models.
8. **Image-to-Image translation:** Image-to-image translation involves converting an image from one domain or style to another while preserving the original content.

* Identify at least three core techniques and investigate how these techniques help AI systems to extract meaningful information from images.
* Based on my research the three core techniques in image processing are Image segmentation, Image enhancement, and feature extraction.

1. **Image Segmentation:**

Divides an image into segments or regions based on specific criteria. It help AI systems by isolating objects or regions within an image making it easier to analyze each part separately. It also helps AI systems focus on regions of interest, such as separating foreground objects from the background.

1. **Image Enhancement:**

Improves the visual quality of an image by adjusting various attributes like brightness, contrast, and sharpness. This technique improves quality by enhancing important features and details in the image, making it easier for AI systems to identify and analyze objects. It also removes unwanted noise or distortions and Make subtle features more apparent, helping AI systems recognize patterns and details improving the performance of models in tasks like image recognition and analysis.

1. **Feature Extraction:**

This technique Identifies and extracts key features from an image, such as edges, textures, and shapes. Reduces complex images into a set of meaningful features, making it easier for AI systems to process and analyze. It also recognize patterns and characteristics, which is vital for tasks like face recognition, image classification, and object tracking.

**Hands-On Exploration:**

• **Case Study Selection:**

* Choose a real-world AI application that utilizes computer vision (e.g., facial recognition systems, autonomous vehicles, or medical imaging).
* **Chosen AI application: Facial Recognition**

Based on my researchA face recognition system is a computer application that automatically identifies or verifies a person from a digital image or video frame. It typically does this by comparing selected facial features from the image with those stored in a facial database.

* Investigate how image processing is used within this application. Focus on the specific techniques applied and their effectiveness in solving visual problems.

According to the website of <https://it.telkomuniversity.ac.id/en/the-workflow-of-the-face-recognition-process/>. Facial recognition undergo pre-processing to eliminate noise or irrelevant information. This stage is crucial in facial recognition as it prepares the facial image data by performing tasks such as cropping, face detection, resizing, and converting the RGB format to grayscale. The goal of pre-processing is to enhance the system's ability to accurately and quickly identify faces.

These are the stages of preprocessing:

**1. Cropping**

Cropping involves selecting the specific area of a facial image that contains the relevant object, allowing it to be isolated from any unwanted parts. This step ensures that only the necessary portion of the image proceeds to the next stage.

**2. Face Detection**

Face detection is the process of identifying and isolating the facial region within an image, resulting in a simpler output. Various methods are used for this, with the Viola-Jones method being one of the most common. This technique aims to discard areas not recognized as faces, improving the system’s performance in matching facial images.

**3. Resizing**

Resizing adjusts the pixel dimensions of a facial image. Since images obtained from face detection often vary in size, standardizing the image dimensions is essential for the system to efficiently recognize individuals and maintain a consistent database of facial images.

**4. RGB to Grayscale Conversion**

After resizing, the RGB image is converted to grayscale. Grayscale images have a simpler structure, which facilitates the computational process. This conversion is intended to make the facial matching process faster and more efficient compared to working with RGB images.

**5. Feature Extraction**

Feature extraction involves identifying and capturing the unique characteristics of a face that distinguish it from others in a dataset. This is achieved through face detection algorithms such as Local Binary Patterns (LBP), Principal Component Analysis (PCA), Eigenfaces, Histogram of Oriented Gradients (HOG), or Convolutional Neural Networks (CNN). These features are essential for accurate facial recognition.

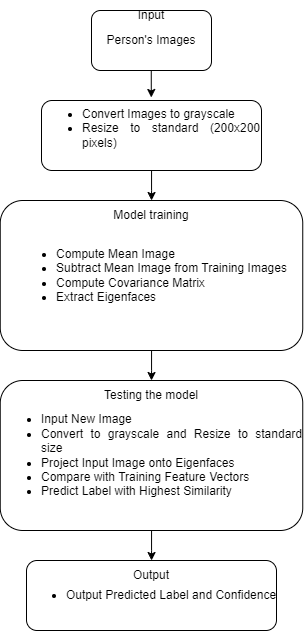
• **Implementation Creation:**

o Select a simple problem related to your chosen AI application.

**Problem:** Different individuals may have similar facial features and the same individual may look different in various images due to changes in expression, age, or appearance.

**Solution:** **Feature Extraction**, based on my research techniques like Eigenfaces and Fisherfaces, analyze the most significant features that differentiate one face from another, help address these issues. These methods reduce the likelihood of confusing similar-looking faces and improve the system's ability to recognize the same person despite variations.

o Create an image processing model (e.g., edge detection algorithm or image segmentation) to address this problem.

* Use diagrams or visual aids to illustrate how the image processing technique is applied and how the AI system would utilize it.

**Presentation Development:**

• **Slide 1: Introduction to Computer Vision and Image Processing**

o Provide an overview of Computer Vision and the critical role image processing plays in AI

systems.

• **Slide 2: Types of Image Processing Techniques**

o Describe the three core techniques you researched. Include examples of each and discuss their applications in AI.

• **Slide 3: Case Study Overview**

o Present the AI application you selected. Explain how image processing is used in this application and the challenges it addresses.

• **Slide 4: Your Image Processing Implementation**

o Present the model you created for the simple problem. Explain how the model works and how it helps the AI system solve the problem.

• **Slide 5: Conclusion**

o Summarize the importance of effective image processing in AI and reflect on what you learned from the activity.

**Extension Activity:**

• **Research an Emerging Form of Image Processing:**

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

o Prepare a brief report or additional slide discussing its potential impact on future AI systems.

**Submission Instruction:**

• **Create GitHub Repository:** Create a repository for the subject (e.g., CSST106-CS4D).

• **Sample Machine Problem** (Reference: [https://github.com/leeroyvincent/MIT-504-DEPATILLO)](https://github.com/leeroyvincent/MIT-504-DEPATILLO)

• **Submission Format:** Create a PowerPoint presentation based on the "Presentation Development" section and export it to a video with 5-10 seconds transition per slide. Include the content in GitHub using Markdown Language (.md).

• **Filename Format:** [SECTION-BERNARDINO-MP1] 4D-BERNARDINO-MP1

• **Penalties:** Inability to follow this instruction will result in a 5-point deduction for filename format and a 5-point deduction per day for late submission. Cheating and plagiarism will be penalized.

**Rubric for Machine Problem No. 1: Exploring the Role of Computer Vision and Image Processing in AI**

**Criteria Excellent (10 points) Good (8 points) Fair (5 points) Poor (2 points)**

**Research and understanding of AI**

Comprehensive understanding of AI and the role of image

processing.

Good understanding with minor gaps.

Basic understanding with some

inaccuracies.

Poor or incomplete understanding.

**Overview of**

Thorough exploration of Adequate

Limited

Minimal or incorrect

**Image Processing** three techniques with

exploration with

exploration with

exploration of

**Techniques**

**Case Study Selection and Analysis**

**Creation of**

**Image Processing**

**Model**

**Presentation**

clear examples. Well-chosen AI application with clear analysis of image

processing techniques

and their effectiveness. Clear, accurate, and well-illustrated model that effectively

addresses the problem.

Well-organized, visually appealing, and

professional

some examples.

Appropriate application chosen with some analysis.

Good model with minor inaccuracies or unclear illustrations.

Organized presentation with

minor issues in

unclear examples.

Basic application chosen with limited analysis.

Basic model with significant errors or poor illustrations.

Somewhat organized but

techniques.

Poorly chosen application with little to no analysis.

Inaccurate or poorly constructed model.

Disorganized presentation with

**Quality**

presentation with clear

visual appeal or

lacks visual appeal poor visuals and

explanations.

clarity.

or clarity.

unclear content.