PhD Research Proposal

Title:

Advanced Image Processing Techniques for Real-Time Data Analysis

1. Introduction

The exponential growth of visual data from sensors, cameras, and IoT devices has created a demand for efficient and accurate real-time image analysis systems. Real-time image processing is essential in applications such as autonomous vehicles, medical diagnostics, surveillance, and industrial automation. However, achieving both high accuracy and low latency remains a major challenge due to computational complexity, noise, and environmental variations. This research aims to develop advanced and optimized image processing algorithms capable of handling large-scale, dynamic data streams in real-time, integrating modern deep learning and classical methods to enhance efficiency and adaptability.

2. Research Problem

Existing image processing techniques offer strong performance but often require high computational power and are unsuitable for real-time or embedded systems. The challenge lies in balancing computational speed with analytical accuracy, particularly in resource-limited environments. This study addresses how hybrid, lightweight, and adaptive models can deliver high accuracy and low latency for real-time image data analysis.

3. Objectives

- To design novel real-time algorithms for image enhancement, segmentation, and feature extraction.
- To integrate deep learning and traditional processing methods for improved accuracy and robustness.
- To optimize algorithms for low-latency performance on edge and embedded systems.
- To develop and validate a framework for real-time image data analysis across multiple domains.

4. Methodology

- Data Collection & Preprocessing: Acquire datasets from domains like medical imaging, surveillance, and autonomous navigation.
- Algorithm Development: Develop hybrid models combining CNNs, transformers, and traditional filters.
- Optimization: Implement GPU acceleration, quantization, and edge-AI optimization for real-time performance.
- Evaluation: Compare proposed methods using benchmarks such as ImageNet and COCO with metrics like accuracy, latency, and throughput.

- Validation: Deploy models in live scenarios to assess performance in real-time environments.

5. Expected Outcomes

- A set of high-performance, real-time image processing algorithms.
- A unified, scalable framework for real-time data analysis.
- Publications in reputed journals and possible industrial applications in automation, healthcare, and smart systems.

6. Significance

The proposed research contributes to advancing real-time computer vision by merging AI-driven intelligence with efficient computational design, making it viable for practical, real-world use. It will strengthen Kalasalingam University's research presence in Artificial Intelligence, Image Processing, and Real-Time Systems, and support the development of next-generation intelligent imaging technologies.

7. References

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