RIT

DSCI 601 Project Proposal

Generative AI in Computer Vision for Sustainability in Machining

Professor: Abu Islam

Presented by: Srujan Vaddiparthi

Background and Key Research Questions

Background:

The project aims to explore the application of Generative AI, specifically GANs (Generative Adversarial Networks), to improve computer vision applications in sustainability. With sustainability-focused industrial processes, AI can enhance efficiency in recycling, defect detection, and manufacturing.

Key Research Questions:

- How can Generative AI improve object detection accuracy for sustainability-related applications?
- What is the potential of GANs in anomaly and defect detection for materials?
- How can synthetic data generation address the challenge of data scarcity in sustainability-focused AI models?

Data Source and Type:

- Real-world datasets are challenging to collect due to the niche applications in sustainability. Therefore, this project focuses on generating synthetic data with GANs to supplement real-world data where it is limited.

- Possible datasets may include:
  - Industrial images for object detection and defect detection.
    - Use cases like machined part images can highlight surface defects such as scratches or dents.
  - Simulated data generated by GANs to address the scarcity of annotated data.
    - Generating images to simulate defects or anomalies on smooth surfaces, which are often difficult to capture in bulk.

Scientific Merit:

- **Improved Defect Detection:**
  - Using GANs to recognize subtle defects across multiple manufacturing sectors.
  - Example: Detecting micro-cracks on metal surfaces in automotive or aerospace parts, where failure detection is critical.
- **Addressing Data Scarcity in Sustainability-Driven Applications:**
  - By generating synthetic data, this project aims to reduce bias and enhance model performance, making models more adaptable to real-world sustainability applications.
  - Example: Synthetic data for recycled material sorting (e.g., differentiating between types of plastics or metals), addressing challenges in recycling.
- **Reduced Dependence on Labeled Data:**
  - GANs reduce the need for large labeled datasets, speeding up model deployment.
  - Example: Generating synthetic images to pre-train models, easing the labeling burden.

Broader Impacts:

Environmental and Technological Impact:

- **Reduced Industrial Waste:**
  - Real-time defect detection leads to fewer discarded parts, supporting circular economy efforts.
  - Example: Detecting defects early in the production line reduces waste in industries like automotive and consumer electronics.
- **Energy and Resource Efficiency:**
  - AI-driven predictive maintenance optimizes equipment usage, extending machine lifespan.
  - Example: Predicting tool wear in CNC machining to prevent unexpected breakdowns, saving both energy and material costs.
- **Cross-Industry Applications:**
  - The research outcomes can extend beyond sustainability-focused industries to broader fields like aerospace, healthcare, and precision manufacturing.
  - Example: Using GAN-based image analysis for quality control in pharmaceuticals, ensuring consistency in production batches.