Nexus Photonics

Automated Defect Detection from Microscope Images

Overview

We are seeking developers or research collaborators to build an automated defect detection system for microscope images of fabricated test coupons. The goal is to replace manual inspection with a reliable and consistent algorithm capable of identifying, marking, and counting defects with high accuracy.

The image dataset currently includes over 70 microscope images showing micro-scale structures with various defects such as scratches, voids, surface particles, and irregular edges. These images are taken under controlled optical conditions and represent real-world manufacturing inspection challenges.

Project Objectives

1. Develop an automated inspection algorithm or application that can:
   - Detect and highlight all visible defects in microscope images.
   - Count the total number of defects per image.
   - Output both annotated images and a structured summary (e.g., CSV or JSON).
2. Ensure high reliability:
   - The system must not miss any visible defect (high recall).
   - Some tolerance for false positives is acceptable.
3. Design for usability and scalability:
   - The prototype can be a Python script or a lightweight application (e.g., PyQt or Streamlit interface).
   - It should allow easy testing with new images added in the future.

Technical Requirements

- Input: Folder of microscope images (JPEG/PNG/TIFF).
- Output:
  - Annotated image with highlighted defects (bounding boxes, masks, or contours).
  - Defect summary file listing defect count per image.
- Preferred tools: Python (OpenCV, scikit-image, NumPy, Pandas).
- Optional (for advanced prototypes): Machine learning approaches (e.g., CNN, YOLO, or segmentation models) trained on labeled data.

Deliverables

- Working prototype script or application.
- Example outputs (annotated images and reports).
- Short documentation on usage and methods.
- Optional: model training notebook and dataset annotation format (if ML is used).

Future Directions

If the initial phase is successful, the project may expand to:

- Defect classification by type and severity.
- Integration with automated inspection hardware or real-time image acquisition systems.
- Development of a data dashboard for tracking defect metrics across samples.

Key Challenge

The primary technical challenge is achieving robust defect detection—particularly for small or low-contrast defects—while maintaining precision across variable lighting and focus conditions.