Project Proposal

Image Classification for Manufacturing

Introduction

Manufacturing quality control is a critical aspect of modern industrial processes. Visual inspection has traditionally been performed by human operators, which can be time-consuming, subjective, and prone to errors due to fatigue. Automated image classification using deep learning presents an opportunity to enhance quality control processes by providing consistent, rapid, and accurate defect detection in manufacturing lines.

Need of the Project

Manufacturing defects can lead to significant financial losses, customer dissatisfaction, and potential safety issues. While manual inspection remains common in many industries, it faces several challenges including;

- Inconsistency in quality assessment across different inspectors
- Human fatigue affecting detection accuracy during long shifts
- Increasing production speeds requiring faster inspection
- Subtle defects that may be difficult for human eyes to detect consistently

An automated image classification system using deep learning can address these challenges by providing the following;

- Consistent quality assessment criteria
- Real-time detection capabilities
- High accuracy in identifying subtle defects
- Scalable solution for high-volume production lines

Objective

To develop a deep learning-based image classification system that can accurately classify manufacturing products as defective or non-defective.

Methodology

i) Understanding Previous Research

- Review of published literature on deep learning applications in manufacturing
- Analysis of current state-of-the-art methods in industrial image classification
- Study of various deep learning architectures suitable for defect detection

ii) Data Collection and Preprocessing

- Utilize the MVTec AD dataset, which contains comprehensive industrial images
- Implement data augmentation techniques to enhance model robustness
- Perform image preprocessing including normalization and standardization

iii) Model Development and Implementation

- Implementation of a CNN-based architecture (ResNet50 or EfficientNet)
- Benchmark comparison with traditional machine learning approaches (SVM with HOG features)
- Feature extraction and transfer learning from pre-trained models
- Fine-tuning of model parameters for optimal performance

iv) Evaluation Strategy

- Implement k-fold cross-validation (k=5)
- Utilize metrics including:
  - Accuracy
  - Precision
  - Recall
  - F1-score
  - Confusion matrix
- Compare results with traditional machine learning benchmarks

v) Experimental Design

- Split dataset into 70% training, 15% validation, and 15% testing
- Implement early stopping to prevent overfitting
- Perform hyperparameter optimization using grid search
- Conduct multiple training runs to ensure result consistency

References

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2. Wang, T., Chen, Y., Qiao, M., & Snoussi, H. (2017). A fast and robust convolutional neural network-based defect detection model in product quality control. The International Journal of Advanced Manufacturing Technology, 94(9), 3465-3471.
3. MVTec Software GmbH. (2019). MVTec Anomaly Detection Dataset. https://www.mvtec.com/company/research/datasets/mvtec-ad