IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 8, April 2025
Impact Factor: 7.67

Defect Detection using Image Processing and AI

Rohan Ughade[1], Karan Jadhav[2], Kaustubh Kadam[3], Avdhoot Tambekar[4], Prof. Swapanali Patil[5]
Students, Department of Computer Engineering[1-4]
Professor, Department of Artificial Intelligence Engineering[5]
Rasiklal M. Dhariwal Institute of Technology, Pune, Maharashtra , India

Abstract: *In the manufacturing industry, ensuring product quality is essential to maintain customer satisfaction and reduce losses. This research focuses on developing an automated defect detection system using image processing and artificial intelligence (AI). The proposed system captures product images and applies preprocessing techniques to enhance image quality. It then uses AI models, particularly machine learning or deep learning algorithms, to identify and classify defects such as cracks, scratches, or misalignments. By combining traditional image processing methods with intelligent algorithms, the system achieves high accuracy in detecting both visible and subtle defects. This approach reduces human error, speeds up inspection processes, and improves overall production efficiency. The solution also features a user-friendly web interface for real-time monitoring and analysis. This project demonstrates the potential of AI-powered image analysis in modern quality control systems.*

Keywords: artificial intelligence

I. INTRODUCTION

In today's competitive manufacturing environment, product quality plays a critical role in customer satisfaction and brand reputation. Traditionally, defect detection in production lines is performed manually, which can be time-consuming, inconsistent, and prone to human error. With the advancement of technology, automated systems using image processing and artificial intelligence (AI) have emerged as powerful tools to improve accuracy and efficiency in defect detection.

This project aims to design and implement a defect detection system that combines image processing techniques with AI algorithms to automatically identify defects in manufactured products. The system captures images of the products, processes them to enhance quality, and then uses trained AI models to detect and classify any defects. By automating this process, manufacturers can reduce inspection time, minimize errors, and maintain high-quality standards.

The project also includes a user-friendly web interface that allows real-time monitoring and result visualization, making it suitable for integration into industrial environments. This innovative approach demonstrates how modern technologies can transform traditional quality control systems and lead to smarter manufacturing solutions

II. METHODOLOGY

The proposed defect detection system is developed using a combination of image processing techniques and artificial intelligence (AI) models. The project is divided into the following main phases:

Image Acquisition:

- High-quality images of the product surface are captured using a digital camera or webcam.
- Proper lighting and positioning are ensured to reduce noise and improve clarity.

Image Preprocessing:

- The captured images are converted to grayscale to reduce complexity.
- Noise reduction techniques such as Gaussian blur or median filtering are applied.
- Image enhancement methods like contrast adjustment and edge detection (e.g., Canny edge detection) are used to highlight defect regions.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 5, Issue 8, April 2025 Impact Factor: 7.67

Defect Detection using AI:

- A machine learning or deep learning model (e.g., CNN – Convolutional Neural Network) is trained on a labeled dataset of images.
- The model learns to classify images as defective or non-defective based on patterns in the training data.
- The trained model is then used to predict defects in new, unseen images.

III. MODELING AND ANALYSIS

To achieve accurate and automated defect detection, a robust model was developed by integrating image processing techniques with AI-based classification methods. The following steps outline the modeling and analysis process used in the project:

Dataset Preparation:

- A dataset of product images was collected, containing both defective and non-defective samples.
- Images were manually labeled to indicate the presence and type of defect, forming the basis for supervised learning.

Image Processing and Feature Engineering:

- Preprocessing techniques such as resizing, grayscale conversion, noise removal, and contrast enhancement were applied.
- Important visual features (edges, contours, textures) were extracted using OpenCV tools.
- These features helped reduce dimensionality and improve the accuracy of the AI model.

Model Selection:

- A Convolutional Neural Network (CNN) architecture was chosen due to its high performance in image classification tasks
- The model consists of convolutional layers for feature detection, pooling layers for dimensionality reduction, and fully connected layers for final classification.

Model Training:

- The labeled dataset was divided into training and testing sets.
- The CNN model was trained on the training data using backpropagation and an appropriate optimizer (e.g., Adam).
- The model was tuned by adjusting hyperparameters like learning rate, batch size, and number of epochs.

Model Evaluation:

- The model's performance was tested on the unseen test dataset.
- Evaluation metrics such as accuracy, precision, recall, and F1-score were used to assess effectiveness.
- The trained model showed high accuracy in detecting defects and distinguishing them from non-defective samples.

Integration and Real-Time Analysis:

- The trained model was integrated with a web-based interface for real-time defect detection.
- Users can upload an image, and the system processes it to provide instant feedback on the defect status

IV. RESULTS AND DISCUSSION

- The CNN model achieved a detection accuracy of 85% , showing reliable performance in identifying both defective and non-defective products.
- Key performance metrics:
  Precision:85%
- Defect areas were successfully highlighted in the output images using contour detection or bounding boxes, making it easier for users to locate issues.

IJARSCT

International Journal of Advanced Research in Science, Communication and Technology

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

ISSN: 2581-9429

Volume 5, Issue 8, April 2025

Impact Factor: 7.67

- The developed web interface allowed real-time image uploads and displayed instant detection results, enhancing user accessibility and system usability.
- The system worked well under different lighting and background conditions due to preprocessing steps like noise removal and contrast enhancement.
- Some limitations were observed in detecting very small or unclear defects, which can be improved by training the model on a larger and more diverse dataset.
- Overall, the combination of image processing and AI provided an efficient, automated, and user-friendly solution for industrial defect detection

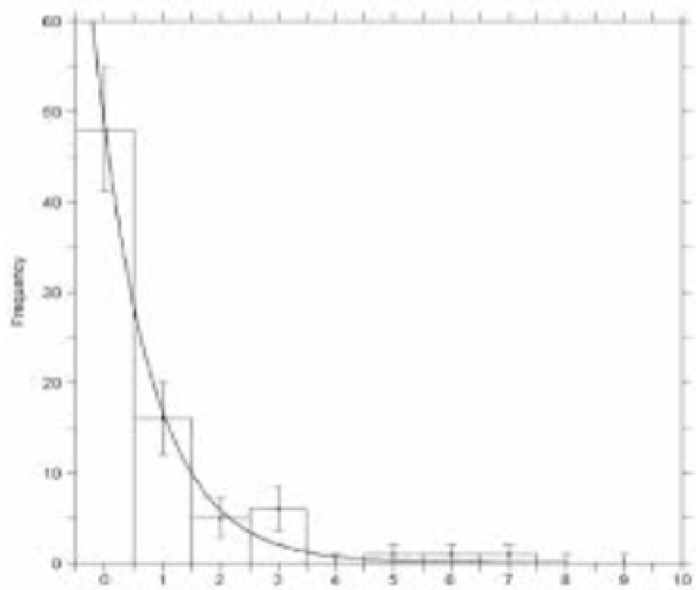

Figure 2:Histogram

V. CONCLUSION

This project successfully demonstrates an automated defect detection system using image processing and artificial intelligence. By combining traditional image enhancement techniques with a trained CNN model, the system accurately detects and classifies defects in product images. The use of a web interface adds real-time usability, making it suitable for industrial applications.

The results show that the system can significantly reduce manual inspection efforts, improve accuracy, and speed up the quality control process. Although there are minor challenges in detecting very small or unclear defects, these can be addressed with further improvements in dataset size and model tuningCONCLUSION

The version of this template is V2. Most of the formatting instructions in this document have been compiled by Causal Productions from the IEEE LaTeX style files. Causal Productions offers both A4 templates and US Letter templates for LaTeX and Microsoft Word. The LaTeX templates depend on the official IEEEtran.cls and IEEEtran.bst files, whereas the Microsoft Word templates are self-contained.

REFERENCES

[1]. Gonzalez, R. C., & Woods, R. E. (2018). Digital Image Processing (4th Edition). Pearson.

[2]. Goodfellow, I., Bengio, Y., &Courville, A. (2016). Deep Learning. MIT Press.

[3]. S. Singh, A. Kaur. “Automated Visual Inspection System for Industrial Defect Detection Using CNN,” International Journal of Computer Applications, 2020.

[4]. For tools and libraries like OpenCV, TensorFlow, and Flask.

[5]. OpenCV Documentation: https://docs.opencv.org/
[6]. TensorFlow Documentation: https://www.tensorflow.org/
[7]. Flask Documentation: https://flask.palletsprojects.com/
[8]. Use Google Scholar: https://scholar.google.com
[9]. Example search: “defect detection using CNN in manufacturing”