Casting Defect Detection Using Deep Learning

1. Executive Summary:

This project aims to automate the quality inspection process in casting manufacturing by building a deep learning model to classify defective and non-defective submersible pump impeller images. By replacing manual inspection with an AI-based solution, the project seeks to reduce error rates, save time, and minimize financial losses due to undetected defects.

2. Problem Statement:

Background:
Casting defects such as blow holes, shrinkage, and metallurgical inconsistencies are common in manufacturing. Manual inspection is time-consuming and prone to human error, leading to potential rejection of entire orders and significant financial loss.

Objective:
Develop a deep learning classification model to automatically detect casting defects from grayscale images of impellers.
Ok casting and Defective casting

Scope:
Focus on binary classification (Defective vs. OK) using a real-life industrial dataset provided by PILOT TECHNOCAST. The model will be trained and evaluated on pre-split image data and deployed for real-time inference.

3. Data Sources:

Secondary Data:

- 6633 augmented grayscale images (300×300 pixels)
- 715 unaugmented grayscale images (512×512 pixels)
- Pre-split into training and testing folders with def_front and ok_front subfolders

4. Methodology:

Data Collection:
Use publicly available dataset from Kaggle: Casting Product Dataset

Data Preparation:

- Resize and normalize images
- Normalization (/255.0 scaling)
- Encode labels and split into training/validation sets(0 = OK, 1 = Defective)

Analysis Techniques:

- Convolutional Neural Networks (CNNs)
- Evaluation using accuracy, precision, recall, F1-score

Tools:
Python, TensorFlow/Keras, OpenCV, scikit-learn, Hugging face for deployment

5. Expected Outcomes:

- A robust image classification model with high accuracy on test data
- Automated defect detection system for industrial use
- Deployment of model via a user-friendly web interface
- Improved efficiency and reduced error rate in inspection
- Business insights on defect patterns and inspection efficiency

6. Dashboard Features:

- It will take image from user.
- Analyse and classify image whether it is ok or defective casting.
- model's **prediction confidence** for OK / Defective classes.
- Live graph showing total OK vs Defective predictions.
- Also shows defect type.

7. Risks and Challenges:

Technical Risks
Class imbalance may skew predictions
Limited lighting variations in dataset
Overfitting due to small unaugmented set

Deployment Risks
Real-world images may differ in brightness/angle
Need for GPU when scaling system in industry

8. Conclusion:

This project addresses a critical bottleneck in the casting industry by automating defect detection using deep learning. The deployed solution can significantly improve inspection accuracy, reduce operational costs, and enhance customer satisfaction. This project demonstrates both technical depth and real-world impact.

https://www.kaggle.com/datasets/ravirajsinh45/real-life-industrial-dataset-of-casting-product