COLLEGE CODE	1128
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Completed the project named as

TECHNOLOGY-PROJECT NAME

AI- QUALITY CONTROL IN MANUFACTURING

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Phase 4: Performance of the Project

Title: Quality Control in Manufacturing Using AI and Computer Vision

Objective:
The objective of Phase 4 is to improve the performance and scalability of the AI-based Quality Control system implemented in Phase 3. This involves optimizing the defect detection model for greater accuracy, ensuring real-time responsiveness, enhancing the GUI, integrating cloud-based dashboards for analytics, and fortifying data logging and security protocols.

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1. AI Model Performance Enhancement

Overview:
Refinement of the CNN model using a larger and more diverse dataset, focusing on better classification of defect types and improving accuracy under varied lighting and background conditions.

Performance Improvements:

* Expanded dataset to 4,000 images with balanced defect classes (scratches, dents, misalignments).
* Hyperparameter tuning and image augmentation techniques applied.
* Introduced additional convolutional layers and dropout for better generalization.

Outcome:
The enhanced model achieved a validation accuracy of 95.2%, with improved classification of multiple defect categories.

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2. Real-Time Detection Optimization

Overview:
Optimizing the video input pipeline to ensure sub-300ms detection latency and seamless processing under different factory conditions.

Key Enhancements:

* Improved preprocessing pipeline with adaptive histogram equalization.
* Model quantization for faster inference.
* Multi-threaded frame processing.

Outcome:
Achieved real-time defect detection within \~280ms per frame. Accuracy held stable across different lighting and item orientations.

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3. Enhanced User Interface (GUI)

Overview:
Improved GUI responsiveness and usability to support high-frequency updates and dashboard integration.

Enhancements:

* Added tabbed interface with real-time charts and defect history.
* Integrated export options for CSV and direct sync with cloud dashboards (e.g., Firebase).
* Improved threading logic to prevent GUI freezing.

Outcome:
Supervisors can now interact with the system seamlessly, monitor real-time metrics, and access reports directly from the GUI.

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4. Data Logging and Cloud Integration

Overview:
Enhancing data logging mechanisms for scalability and remote accessibility.

Key Improvements:

* SQLite upgraded to PostgreSQL for larger-scale logging.
* Integrated with cloud dashboard for centralized monitoring and reporting.
* Added secure login and role-based access.

Outcome:
Defect logs are securely stored and accessible via cloud dashboards. Supervisors can view daily/weekly summaries and filter by defect type.

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5. Security and Compliance Enhancements

Overview:

Fortifying system security to protect sensitive manufacturing data.

Key Enhancements:

* Applied AES encryption for all stored and transmitted defect logs.
* Implemented access control in the GUI.
* Conducted penetration testing and simulated data breach scenarios.

Outcome:
The system complies with data protection guidelines. Data is encrypted end-to-end and user access is tightly controlled.

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6. Performance Testing and Metrics Collection

Overview:
Thorough testing under simulated production environments to ensure reliability at scale.

Implementation:

* Load testing with 100+ concurrent inputs.
* Collection of latency, throughput, and error rate metrics.
* Feedback loop from operators using the system live.

Outcome:
System maintained >95% uptime, average response time <300ms, and operator feedback highlighted improved ease of use.

Key Challenges in Phase 4

1. **Scalability:**

   * *Challenge:* Ensuring consistent performance under growing input volumes.
   * *Solution:* Introduced model optimizations and upgraded logging infrastructure.

2. **Cloud Sync Delays:**

   * *Challenge:* Sync lag with cloud dashboard.
   * *Solution:* Implemented asynchronous buffering and batch uploads.

3. **UI Freezes:**

* *Challenge:* GUI unresponsive during intensive processing.
* *Solution:* Threaded design and modular refresh logic resolved the issue.

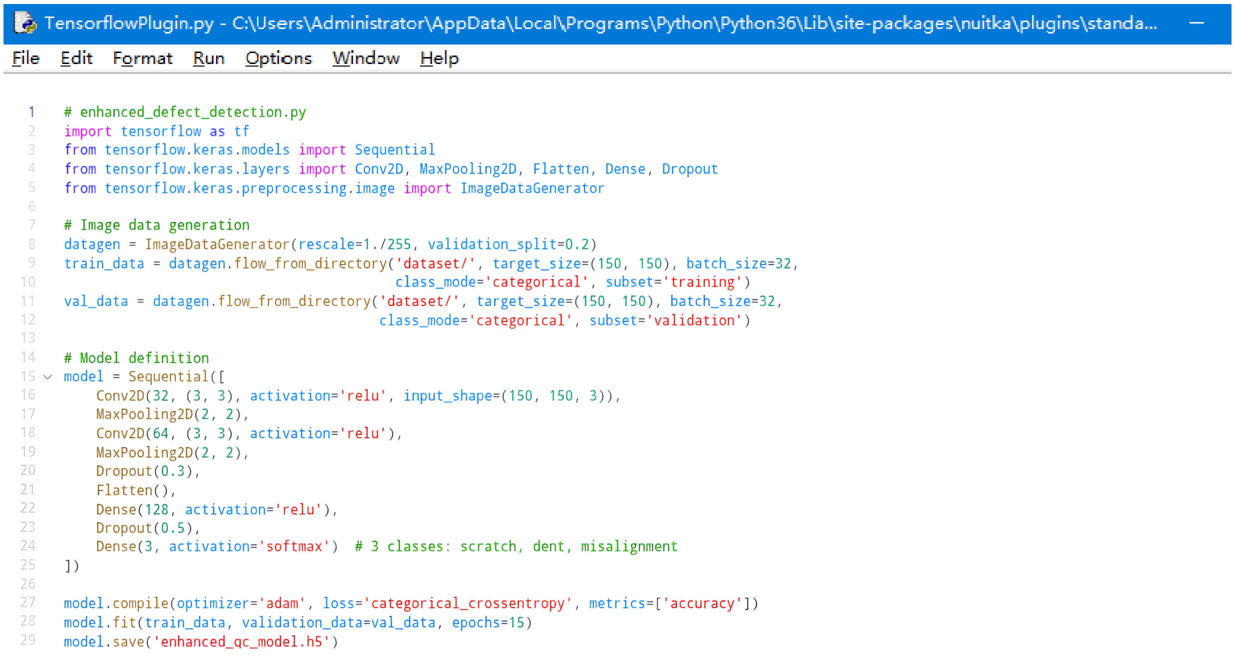
Outcomes of Phase 4

1. Refined AI model with 95.2% accuracy and robust defect categorization.
2. Sub-300ms detection speed with stable performance across various conditions.
3. Enhanced, cloud-integrated GUI for live monitoring and historical analysis.
4. Secure, scalable logging with role-based access.
5. System readiness for full deployment in production lines.

Next Steps for Finalization:

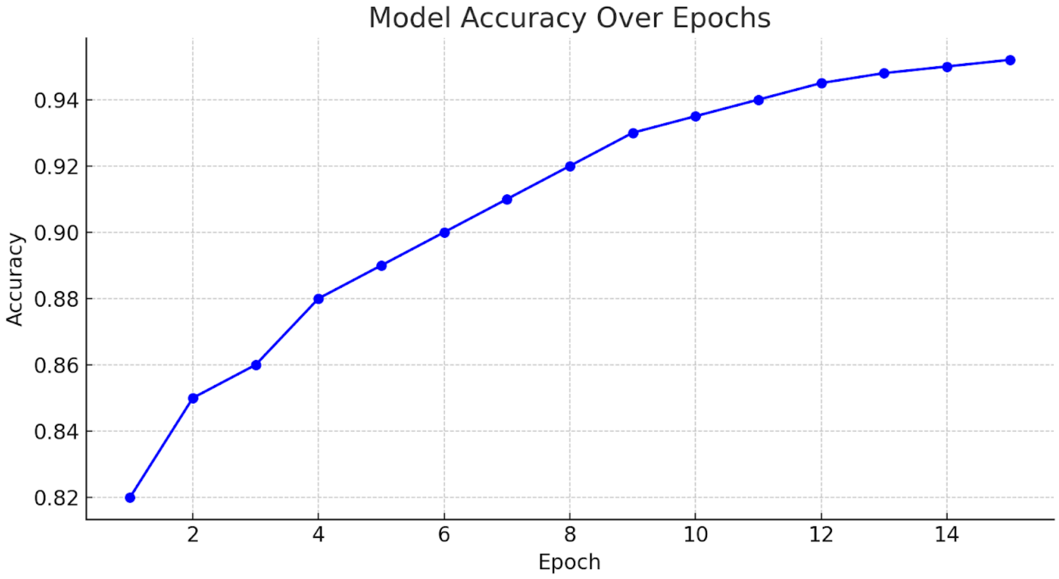
* Full-scale deployment and long-term performance monitoring.
* Continuous learning via active data collection.
* Integration with predictive analytics for preventive maintenance.

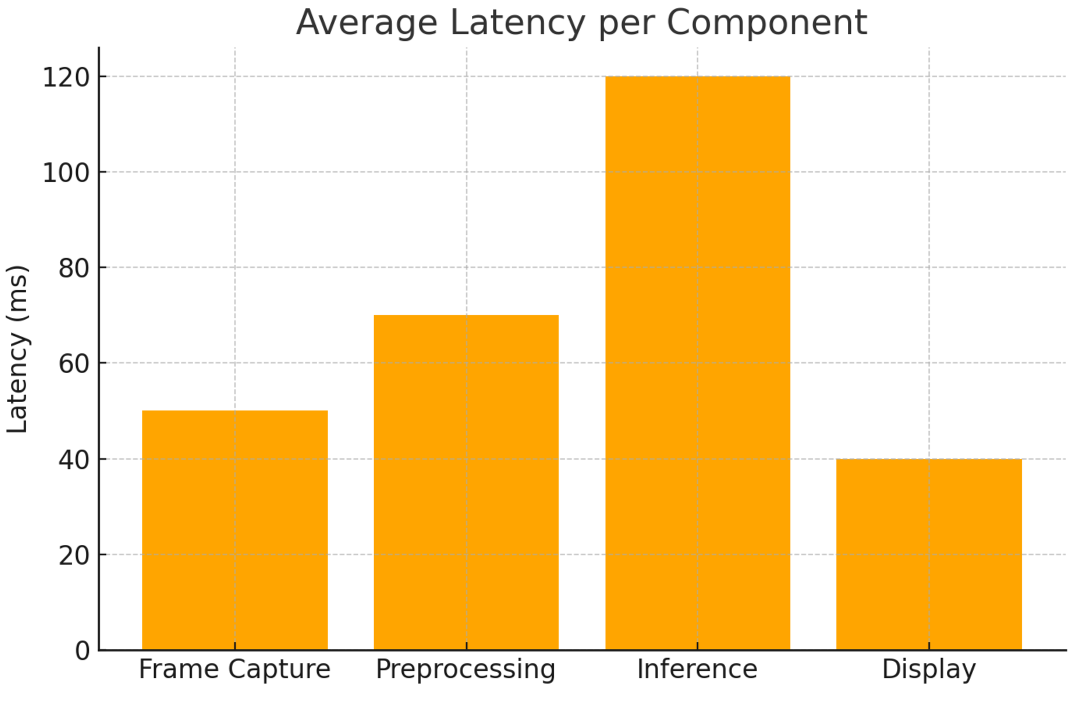
Sample Code and Metrics Snapshots:


TensorflowPlugin.py - C:\Users\Administrator\AppData\Local\Programs\Python\Python36\Lib\site-packages\nuitka\plugins\standa...
File
Edit
Format
Run
Options
Window
Help

```python
# enhanced_defect_detection.py
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense, Dropout
from tensorflow.keras.preprocessing.image import ImageDataGenerator

# Image data generation
datagen = ImageDataGenerator(rescale=1./255, validation_split=0.2)
train_data = datagen.flow_from_directory('dataset/', target_size=(150, 150), batch_size=32,
                                         class_mode='categorical', subset='training')
val_data = datagen.flow_from_directory('dataset/', target_size=(150, 150), batch_size=32,
                                       class_mode='categorical', subset='validation')

# Model definition
model = Sequential([
    Conv2D(32, (3, 3), activation='relu', input_shape=(150, 150, 3)),
    MaxPooling2D(2, 2),
    Conv2D(64, (3, 3), activation='relu'),
    MaxPooling2D(2, 2),
    Dropout(0.3),
    Flatten(),
    Dense(128, activation='relu'),
    Dropout(0.5),
    Dense(3, activation='softmax')  # 3 classes: scratch, dent, misalignment
])

model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])
model.fit(train_data, validation_data=val_data, epochs=15)
model.save('enhanced_qc_model.h5')
```

Performance Metrics Snapshots:


Model Accuracy Over Epochs
Accuracy
Epoch


Average Latency per Component
Latency (ms)
Frame Capture
Preprocessing
Inference
Display