TECHNOLOGICAL INSTITUTE OF THE PHILIPPINES
COMPUTER ENGINEERING
QUEZON CITY

CPE DESIGN PROJECT

Testing, Evaluation and Risk Management (TERM) Plan

I. PROJECT DETAILS

Team Details

No.	25
Title	Design of a Flat Glass Inspection Device with Instance Segmentation-based Defect Detection
Members	Clarito, Vincent Carson D. Cordero, Edgardo Kenneth D. Detchosa, Ralph Christian D. Domondon, Mark Stefan P. Pineda, Julian Andre

Objectives (General & Specific)

The general objective of this project is to design and develop a flat glass inspection device that utilizes deep learning and computer vision techniques to accurately detect and classify surface defects in flat glass. The system uses instance-based segmentation to identify defects such as cracks, scratches, and bubbles in near real-time production environments. This solution aims to improve quality control, reduce reliance on manual inspection, minimize detection errors, and ensure compliance with industry standards for flat glass manufacturing.

Specifically, the project aims to:

1. Design a system that classifies defects in flat glass that are labeled as cracks, scratches, and bubbles in near real time.
2. Develop a web application that monitors detected glass defects with data analytics.
3. Test and evaluate the system's accuracy.

II. DETAILED TESTING PLAN

Objective 1: Bubble Detection Accuracy	
Test Case	Accuracy test for the detection of bubbles on a flat glass
Required Equipment	● Flat glass samples with bubble defects ● Camera ● Raspberry Pi 5 ● Web-based Application
Procedure	1. Place the bubble glass sample under the inspection device. 2. Capture images using the camera module. 3. Run YOLOv8m-seg inference. 4. Check detection logs. 5. Compare the detected defects with the defects identified through visual inspection conducted in accordance with ASTM C1036.
Schedule	January 1, 2026 until March 31, 2026
Standard(s)	**ISO 5725-1:2023 Accuracy (trueness and precision) of measurement methods and results:** Ensures the device delivers reliable detection performance by achieving a minimum detection accuracy of 95%, enabling consistent and effective feedback for training purposes. **ASTM C1036-25: Standard Specification for Flat Glass** This serves as the quality reference standard by defining the accepted types, sizes, and visibility criteria for flat glass defects. It provides standardized inspection conditions and defect classifications, ensuring that detected defects are validated.

Objective 1: Crack Detection Accuracy	
Test Case	Accuracy test for the detection of cracks on a flat glass
Required Equipment	● Flat glass samples with crack defects ● Camera ● Raspberry Pi 5 ● Web-based Application
Procedure	1. Place the cracked glass sample under the inspection device. 2. Capture images using the camera module. 3. Run YOLOv8m-seg inference. 4. Check detection logs. 5. Compare the detected defects with the defects identified through visual inspection conducted in accordance with ASTM C1036.
Schedule	January 1, 2026 until March 31, 2026
Standard(s)	**ISO 5725-1:2023 Accuracy (trueness and precision) of measurement methods and results:** Ensures the device delivers reliable detection performance by achieving a

	minimum detection accuracy of 95%, enabling consistent and effective feedback for training purposes. **ASTM C1036-25: Standard Specification for Flat Glass** This serves as the quality reference standard by defining the accepted types, sizes, and visibility criteria for flat glass defects. It provides standardized inspection conditions and defect classifications, ensuring that detected defects are validated.

Objective 1: Scratch Detection Accuracy	
Test Case	Accuracy test for the detection of scratches on a flat glass
Required Equipment	● Flat glass samples with scratch defects ● Camera ● Raspberry Pi 5 ● Web-based Application
Procedure	1. Place the scratch glass sample under the inspection device. 2. Capture images using the camera module. 3. Run YOLOv8m-seg inference. 4. Check detection logs. 5. Compare the detected defects with the defects identified through visual inspection conducted in accordance with ASTM C1036.
Schedule	January 1, 2026 until March 31, 2026
Standard(s)	**ISO 5725-1:2023 Accuracy (trueness and precision) of measurement methods and results:** Ensures the device delivers reliable detection performance by achieving a minimum detection accuracy of 95%, enabling consistent and effective feedback for training purposes. **ASTM C1036-25: Standard Specification for Flat Glass** This serves as the quality reference standard by defining the accepted types, sizes, and visibility criteria for flat glass defects. It provides standardized inspection conditions and defect classifications, ensuring that detected defects are validated.

Objective 1: Near Real-Time Detection Accuracy	
Test Case	Accuracy test for defect detection in near real-time on defined evaluation parameters
Required Equipment	● Flat glass samples with known defects ● Camera ● Raspberry Pi 5 ● Web-based Application

Procedure	1. Place a flat glass sample with a known defect under the inspection device. 2. Capture images using the camera module. 3. Run YOLOv11n-seg inference on the captured image. 4. Record the start and end time of the inference process to determine system response time. 5. Compute the inference latency in milliseconds. 6. In accordance with **ISO/IEC/IEEE 24765**, which defines real-time system correctness as dependent on meeting specified time constraints, verify that the measured response time satisfies the defined operational timing requirement. 7. Based on **ISO 22400**, which defines cycle time as the time interval between consecutive production units, compare the measured latency against the established operational inspection interval serving as the system's timing constraint. 8. Repeat the procedure for multiple samples and compute the average and maximum latency to ensure consistency of near real-time performance.
Schedule	January 1, 2026, until March 31, 2026
Standard(s)	**ISO/IEC/IEEE 24765:** In accordance with ISO/IEC/IEEE 24765, which defines a real-time system as one whose correctness depends on meeting specified time constraints, the proposed defect detection system includes response time verification as part of its validation procedure. **ISO 22400:** Based on ISO 22400, which defines cycle time as the time interval between consecutive production units, an operational inspection interval was established to serve as the timing constraint against which system latency was evaluated.

<table>
<tr><th colspan="2">Objective 2: Monitor the Defect Detection and Logs</th></tr>
<tr><td>Test Case</td><td>Accuracy test for the correct display of defect results and logs.</td></tr>
<tr><td>Required Equipment</td><td>Flat glass samples with known defects
Camera
Raspberry Pi 5
Web-based Application</td></tr>
<tr><td>Procedure</td><td>Prepare flat glass samples with predefined and documented defect types.
Place a glass sample under the inspection device.
Capture the image using the camera module connected to the Raspberry Pi
Run YOLOv8m-seg inference to detect and classify defects.
Transmit the detection results to the web-based application.
Open the web application dashboard and verify that:
The detected defect type is correctly displayed.
The defect status is correctly shown.
The associated confidence score is displayed.
Verify that the inspection result is logged with:
Camera
Correct defect classification.
Unique inspection identifier.
Timestamp formatted according to ISO 8601
Refresh or reload the web application to confirm that the logged inspection data persists and remains retrievable.
Repeat the procedure for multiple samples and compare displayed results against known ground truth labels to compute display and logging accuracy.</td></tr>
<tr><td>Schedule</td><td>January 1, 2026 until March 31, 2026</td></tr>
<tr><td>Standard(s)</td><td>ISO 8601 - Date and Time Format
This standard defines the requirements for representing date and time information in a consistent and unambiguous format to ensure the accurate exchange of temporal data across systems and processes. It establishes a universally recognized date and time notation to ensure reliable and consistent logging and traceability across all phases.

VDI/VDE/VDMA 2632 Part 4.1 - Stability Testing of Vision Systems
In accordance with VDI/VDE/VDMA 2632 Part 4.1, which provides a framework for the stability testing of automated surface inspection systems, the monitoring system implements continuous performance audits to detect sensitivity drift. The system utilizes simulation in-feeds and reference pattern tracking to ensure that the instance segmentation masks remain precise and that the Intersection over Union (IoU) for detected glass defects does not degrade due to environmental factors such as lighting decay or camera sensor aging.</td></tr>
</table>

	ISO 9001:2015 Clause 7.1.5 - Monitoring and Measuring Resources In accordance with ISO 9001:2015 Clause 7.1.5, which requires organizations to ensure that monitoring and measuring resources are suitable and properly controlled, the defect detection system verifies that the camera, processing unit, and software components are capable of producing valid and reliable inspection results. Calibration of imaging parameters, validation of inference performance, and periodic verification of system accuracy are conducted to ensure consistent monitoring of glass defects and reliable measurement outputs throughout operation. **ISO 9001:2015 (Clause 8.5.2) - Identification and Traceability** This standard defines the requirements for identifying process outputs to ensure the conformity of products and services. It provides best practices for uniquely identifying items and maintaining traceability throughout a process, as sequentially tagging each detected flaw ensures accurate quality control monitoring and reliable data logging during the inspection phase.

Objective 2: Data Analytics	
Test Case	Accuracy Test for Data Analytics
Required Equipment	● Flat glass samples with known defects ● Camera ● Raspberry Pi 5 ● Web-based Application
Procedure	1. Prepare a controlled set of flat glass samples with predefined and documented defect types (crack, scratch, bubble). 2. Perform a series of inspections using the inspection device. 3. Allow the system to detect defects and automatically log all inspection results into the database. 4. Manually record the ground truth results for each inspected sample for validation purposes. 5. Open the web-based application analytics dashboard. 6. Verify that the following computed metrics are correctly displayed: ○ Total number of defective samples ○ Per-class defect counts (crack, scratch, bubble) ○ Defect rate (%) 7. Manually compute the expected statistics using the recorded ground truth data. 8. Compare the manually calculated values with the analytics dashboard outputs to verify mathematical accuracy and consistency in accordance with ISO/IEC 25012 (Data Quality). 9. Cross-check that all inspection entries are complete, non-duplicated, and sequentially logged, ensuring proper monitoring and evaluation in

	accordance with ISO 9001:2015 Clause 9.1.
Schedule	January 1, 2026 until March 31, 2026
Standard(s)	**ISO/IEC 25012 – Data Quality Model** In accordance with ISO/IEC 25012, which defines data quality characteristics such as accuracy, completeness, consistency, and traceability, the analytics module of the system ensures that computed defect statistics are mathematically correct and derived from complete and non-duplicated inspection records. The dashboard outputs are validated against manually verified ground truth data to ensure reliable aggregation and accurate representation of inspection results. **ISO 9001:2015 Clause 9.1 – Monitoring, Measurement, Analysis, and Evaluation** In accordance with ISO 9001:2015 Clause 9.1, which requires organizations to analyze and evaluate monitoring data to ensure process performance and conformity, the system implements structured verification of analytical outputs. Defect trends, counts, and performance metrics displayed in the web-based application are cross-checked against stored inspection logs to confirm correctness, supporting evidence-based evaluation of inspection accuracy and system performance.

III. SUCCESS CRITERIA / METRICS

TEST CASE	METRIC
Crack Detection	Crack Detection Accuracy (%)
Scratch Detection	Scratch Detection Accuracy (%)
Bubble Detection	Bubble Detection Accuracy (%)
Near-Real Time Detection	Near-Real Time Detection Accuracy (%)
Defect Monitoring and Logging	Defect Monitoring and Logging Accuracy (%)
Correct Data Analytics Output	Data Analytics Accuracy (%)

IV. RISK MANAGEMENT PLAN

TEST CASE	RISK	ACTION PLAN
Crack Detection	Misclassification of cracks as scratches	The risk will be mitigated by including depth-varying crack samples in the training dataset and enhancing lighting angles to emphasize depth-based shadows.
Scratch Detection	Missed thin scratches	Increase resolution and enhance preprocessing
Bubble Detection	Bias toward large bubbles	Balance the dataset and define size thresholds
Near-Real Time	Inference Time Exceeds Near	This will be mitigated through model

Detection	Real-Time Threshold	optimization, resolution adjustment, hardware acceleration verification, and controlled performance benchmarking to ensure compliance with the specified operational timing constraint.
Analytics	Incorrect computation of defect statistics, such as inaccurate defect rate, incorrect per-class counts, duplicate or missing data affecting analytical outputs.	Mitigate the risk by validating dashboard metrics against raw database records using controlled test datasets. Implement database integrity constraints, enforce unique inspection identifiers, apply automated verification of aggregation functions, and perform periodic cross-checking between manually computed results and system-generated analytics to ensure data accuracy, completeness, and consistency.
Defect Monitoring and Logging	Incomplete, delayed, or incorrect logging of detected defects	Implement automatic refresh mechanisms and real-time data synchronization between the inference engine and the web interface. Validate database write operations, implement error handling and confirmation checks for each logging process, and perform periodic cross-verification between detected defects and stored records to ensure logging accuracy.

Endorsed by: **Reviewed by:**

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