TECHNICAL REPORT

Design and implement a smart, automated system for product labeling and traceability

TEAM NAME : TechNova

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Abstract

The Smart Product Labeling and Traceability System is an intelligent solution designed to streamline product inspection, labeling, and data traceability within manufacturing units. This system automates the generation of QR labels, simulates product quality tests using virtual test machines, and enables label verification through OCR or QR decoding. By capturing machine data and administrator feedback, the solution ensures traceability and provides detailed PDF reports for record-keeping and audits. The system is built using Python and deployed via Streamlit, aiming to improve quality control, minimize human errors, and enhance transparency in production lines.

Introduction

With modern manufacturing shifting toward smart factories and Industry 4.0 standards, traceability and quality assurance have become crucial. Our project addresses this need by offering a lightweight, efficient, and scalable application that digitizes and automates product labeling and tracking. Products undergo three stages of virtual testing, each emulating typical quality control machines. After evaluation, a QR label is generated containing product-specific data, which can be verified later using OCR/QR-based scanning.

This system is useful for factories, testing centers, and R&D environments where frequent testing, monitoring, and labeling are essential. It reduces manual logging and integrates end-to-end traceability for each item.

Motivation Behind the Project

In traditional manufacturing setups, maintaining records of product testing, labeling, and traceability is labor-intensive and error-prone. Our team recognized the need to create a digital, automated pipeline where:

- Each device receives a unique ID and label.
- All test data (pass/fail, issues, comments) is recorded.
- The label can be validated post-manufacture using OCR or QR scan.
- Admins can download official PDF reports for individual products.

This system is especially helpful in high-volume production settings, ensuring quality checks are documented and traceable from assembly to delivery.

Data Source

All data is logged automatically into an Excel spreadsheet (`inspection_log.xlsx`) created and updated by the application. It records:

- Device ID and Batch ID
- RoHS compliance
- QR code path
- Entry mode (Admin/Sensor)
- Test results for TM1, TM2, TM3 (Status, Time, Issue)
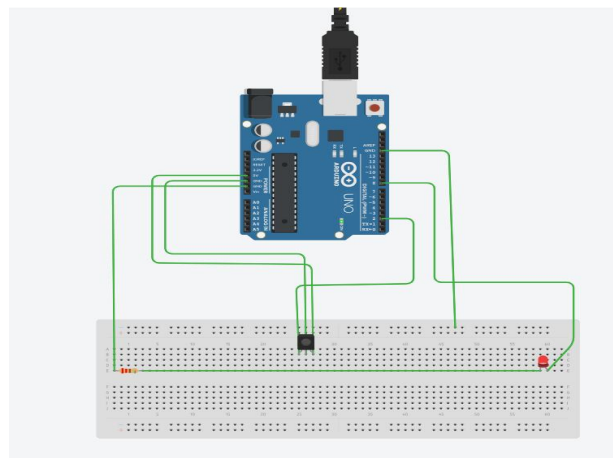- Admin comments

This log acts as the central repository for traceability, analytics, and reporting.

Work

The system includes the following modules:

- Entry Module: For both Admin (manual) and Sensor (automated) entries.
- QR Code Generator: Generates a QR label with device and batch data.
- Simulated Testing: The product goes through three test stages, and the result is stored along with issues.
- Traceability Panel: Allows admins to search for a device, view logs, visualize failure stats, and download a PDF report.
- Label Validation (OCR): Admins can upload a scanned label image to verify that the printed QR matches log records.
- Analytics: Failure counts for TM1, TM2, and TM3 are displayed in a bar graph using Plotly.

CIRCUITRY:

Circuit Design For Product Detection

Output Screens :

Product Entry System

Entry Mode
- Admin
- Sensor

Admin-Controlled Product Entry

Device ID

D1005

Batch ID

B1005

Manufacturing Date

2025/07/12

RoHS Compliant?
- Yes
- No

TM1 Issue Comment

e.g., Barcode scanner delay

TM2 Issue Comment

e.g., Label smudged

TM3 Issue Comment

e.g., Sensor glitch

Admin Comment (optional)

Submit

Product tested and recorded with issue comments.

Generated QR Code

Admin Entry module

Entry Module   Admin - Traceability

Product Entry System

Entry Mode
- Admin
- Sensor

Simulated Sensor Entry

Auto-Generate Sensor Entry

Sensor entry submitted: D1006 | B1006

Generated QR Code

Sensor based Entry module

Admin Access

Enter Admin Password

········   👁

Access Granted

Search Device ID

Validate Printed Label (via OCR)

Upload Scanned QR Label Image

☁ Drag and drop file here
   Limit 200MB per file • PNG, JPG, JPEG   Browse files

📄 D1006.png 0.8KB   ✕

▦ Uploaded QR Label

Extracted > Device ID: D1006, Batch ID: B1006

Time Taken: 0.0s

QR Decode Status: PASS

Issue: No issue

Device ID: D1006
Batch ID: B1006   ● Explain ⚙
Date: 2025-07-12
RoHS: Yes

Matched Log Entry:

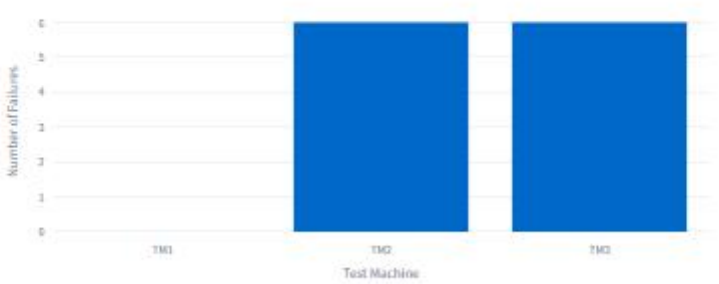| Device ID	Batch ID	RoHS	QR Code Path	Entry Mode	Admin Comment	TM1 Status	TM
D1006	B1006	Yes	qr_codes/D1006.png	Sensor	None	PASS	

Download Traceability PDF from QR Match

Generate PDF from QR

Traceability module

TM Failure Analytics

Failure Count per Test Machine

Testing Machine Analysis

Entry Module   Admin - Traceability

Admin Access

Enter Admin Password

....   👁

Access Granted

Search Device ID

Validate Printed Label (via OCR)

Upload Scanned QR Label Image

Drag and drop file here
Limit 200MB per file • PNG, JPG, JPEG   Browse files

OCR validation module

Links of the result:

Github link :

https://github.com/Shadowmk-cell/SmartLabellingAndTraceability