

# Vision-Based Arrow Direction Detection on Muffler for Automated Welding

## Industry

Automotive Manufacturing – Exhaust / Muffler Welding Line

## Problem Statement

In the muffler welding process, correct **orientation of the muffler** is critical.

Each muffler has a **directional arrow marking**, and welding must start **only if the arrow direction is correct**.

Earlier, this verification was:

- Manual
- Error-prone
- Causing incorrect welds and rework

The client required an **automated, reliable, and PLC-integrated vision solution** to ensure **zero welding on wrongly oriented parts**.

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## Project Objective

- Detect arrow marking on the muffler using a camera
  - Identify **arrow direction (Left / Right / Correct orientation)**
  - Send **OK / NOT OK signal to PLC**
  - Allow welding operation **only when orientation is correct**
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## Solution Overview

We implemented a **Vision-Based Arrow Detection System** with real-time PLC communication.

### System Flow:

1. Camera captures muffler image before welding
2. Vision algorithm detects arrow marking
3. Arrow direction is calculated
4. If direction matches reference:
  - PLC receives **OK signal**
  - Welding operation starts
5. If direction is wrong:

- PLC blocks welding
  - Operator intervention required
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## **Technical Approach**

- **Edge-based arrow detection**
- Direction vector analysis
- ROI-based processing for high speed
- Noise-resistant logic suitable for welding environment

### **Key Highlights:**

- Works under industrial lighting
  - Robust against dust and surface reflections
  - Fast decision-making suitable for cycle-time constraints
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## **System Architecture**

- **Industrial Camera** mounted near welding station
  - **Vision Processing System** (Industrial PC / Jetson)
  - **PLC Interface** via Digital I/O / Ethernet
  - **Welding Machine Interlock**
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## **Results & Benefits**

- ✓ 100% prevention of wrong-orientation welding
  - ✓ Zero manual inspection required
  - ✓ Improved weld quality and consistency
  - ✓ Reduced rework and scrap
  - ✓ Seamless PLC integration
  - ✓ Industry-ready and scalable solution
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## **Conclusion**

This project demonstrates how **Vision + PLC integration** can eliminate human error and enable **fully automated, decision-driven welding operations**.

The solution is **production-proven**, scalable, and adaptable to other orientation or marking-based inspection tasks.