POKAIOK: A Standalone AI-Powered Assistant for Enhanced Visual Inspection in Production Lines

A. Leclerc[1,2], O. Gibaru[1], C. Gout[2], C. Le Guyader[2], C. Miranda[1]

[1]: BUAWEI, 59350 Saint-André-lez-Lille, France

[2]: LMI, INSA Rouen Normandie, Normandie Univ., France

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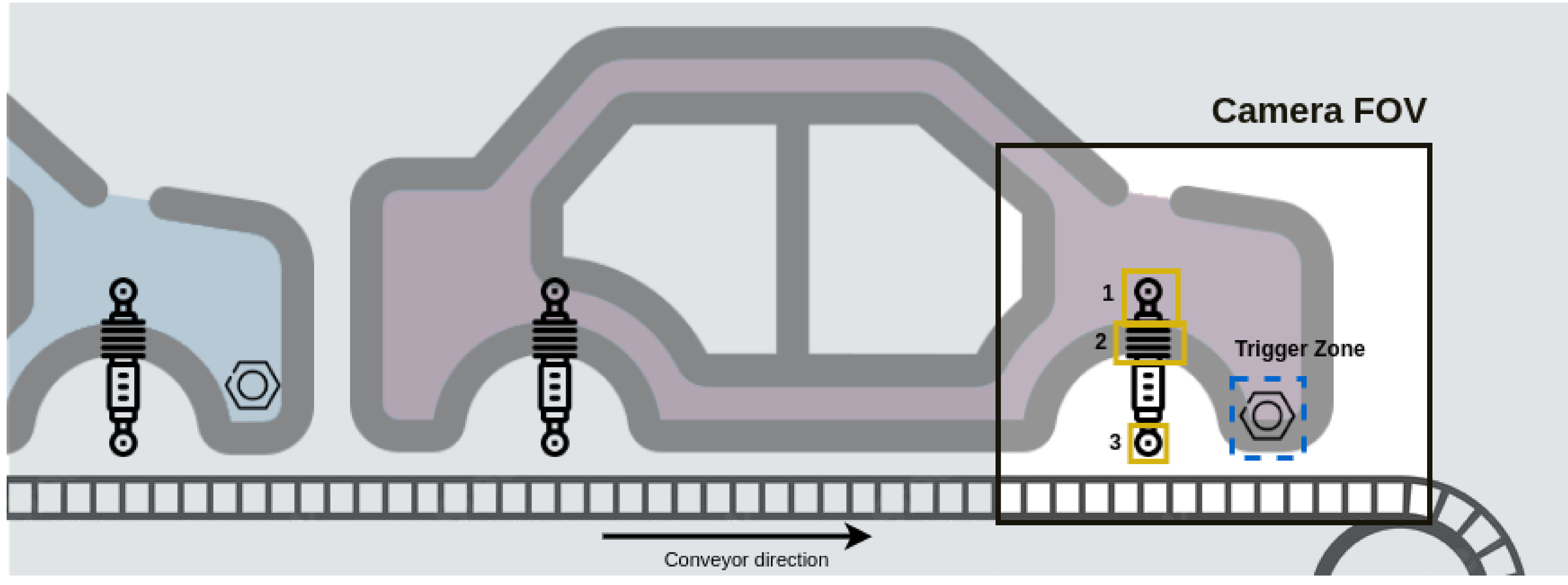
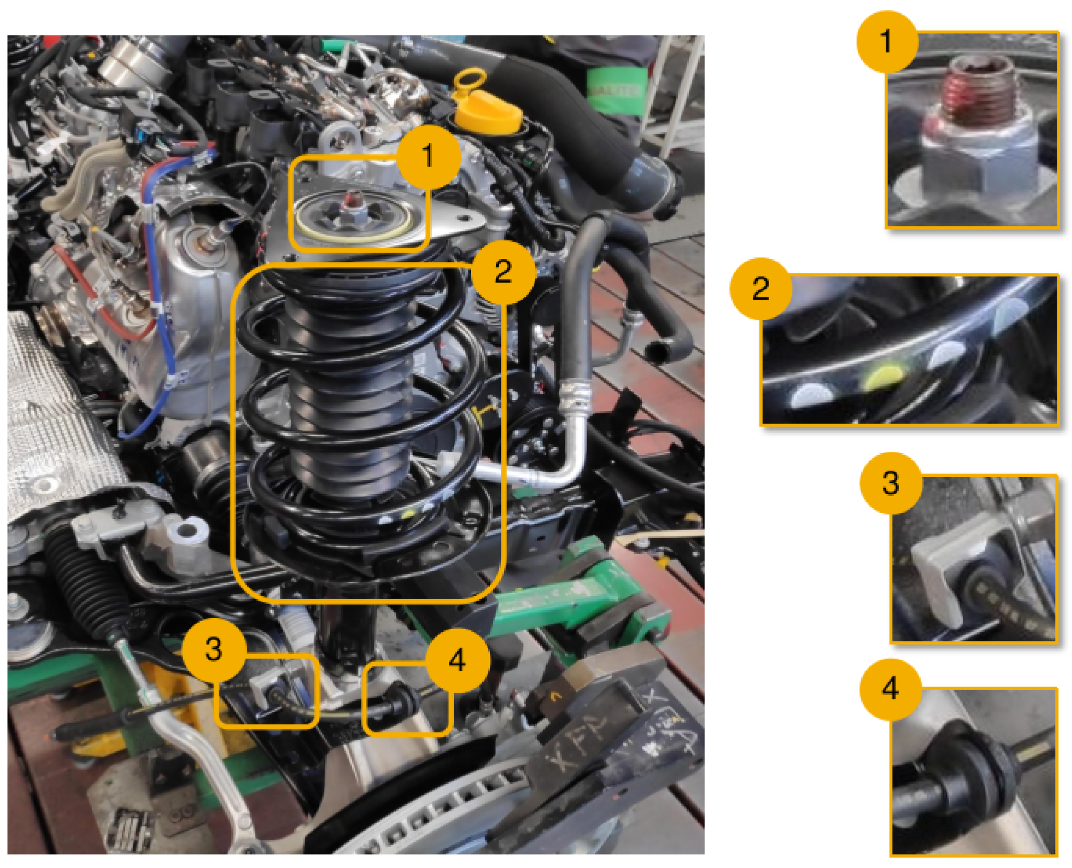
1. POKAIOK

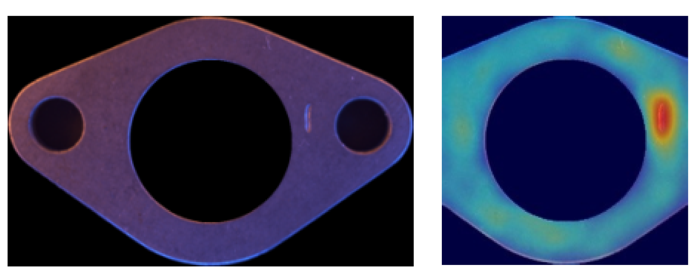
We propose an **AI-driven solution to streamline visual inspections in factory production lines**, particularly in automotive manufacturing, where numerous quality checkpoints must be managed continuously.

Our objective is to create a **system capable of autonomously inspecting moving items and assemblies on conveyors and production lines, verifying specific part conformity for each assembly**. In order to address the challenges of prior knowledge deficit and the changing nature of industrial use cases, the system must be quickly adaptable and uncertainty-aware.

The proposed AI assistant aims to reduce the difficulty, tedium, and unreliability of human visual checks on production lines while meeting specific industrial constraints of rapid setup (< 1 hour), limited computing power, and short analysis time (< 100 ms).







Sample use cases : car spring and flange quality control

The system is composed of two parts : the trigger, embodying the picture taking decision, and the analyser, performing quality or traceability controls.

2. Contributions

The current system may deliver suboptimal results in challenging conditions such as changes in illumination or occlusion of the field of view. Our aim is to reduce the error rate to 1 in a million.

The key contributions are as follows:

- Improving the existing system features by upgrading the model and enhancing dataset curation methods
- Introducing trajectory tracking to refine trigger performance in complex and ambiguous scenarios.

3. Improving the existing trigger system

Triggering is a crucial step since it is the source of information transmitted to the classification system.

The first work consisted of updating the object detection model used by the system (Faster-RCNN) by adopting a recent version of YOLO [2].

This improvement in terms of raw performance and inference time allows us to work with higher-resolution images and better localize the triggering object as it passes in front of the camera.

Inspired by the Track Anything approach [3], we have implemented a new semi-supervised annotation system which gives better results.

In this poster, we focus on strategies to leverage trajectory information to reduce false detections and non-detections.

4. Trajectory tracking

Gaussian Process Filtering approach. Key point: kernel choice:

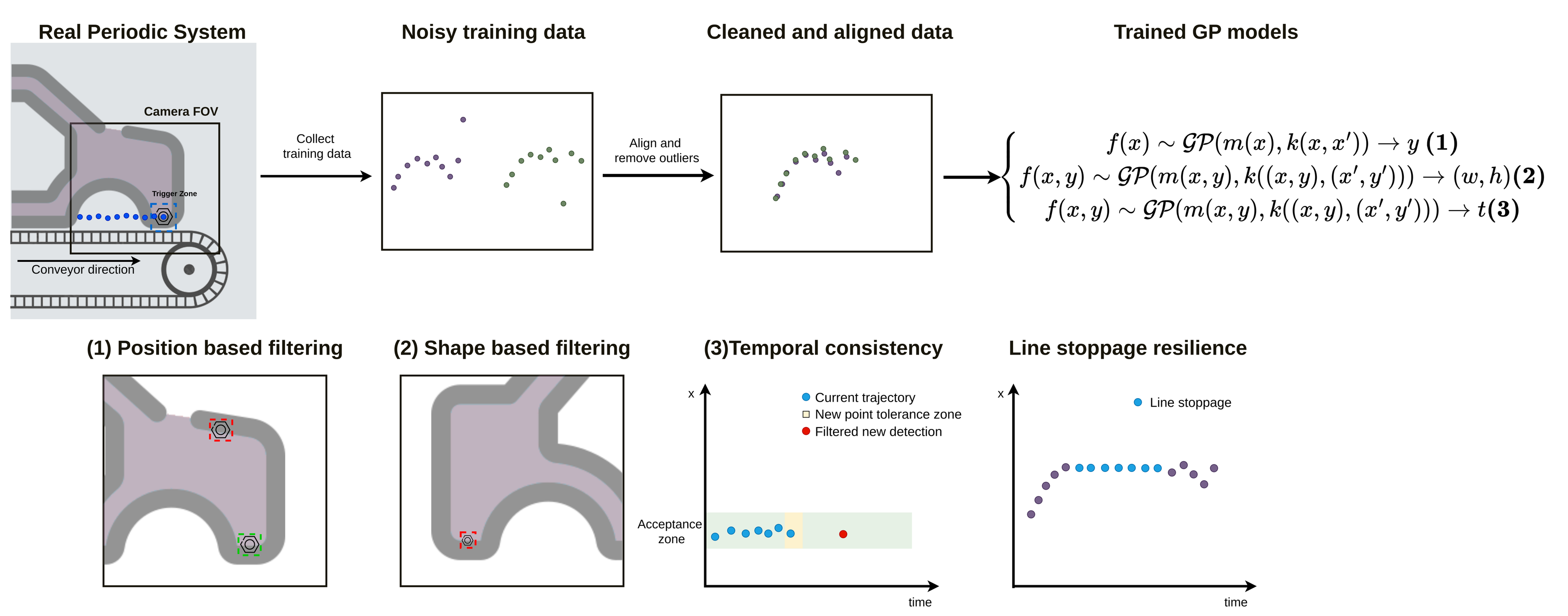
- linear kernel

$$k(x, x') = x^T x'$$

- Radial basis funtion kernel

$$k(x, x') = \exp\left(-\frac{\|x - x'\|^2}{2\sigma^2}\right).$$

Following ideas from [4], we proposed to use Gaussian processes to assign different scores to the detections of the object detection model. These scores enable the filtering of false positives by considering factors such as position, size, and temporal consistency.



5. Future work

In future work, we aim to develop a multi-view dataset using a circular conveyor system. The primary objective is to incorporate various types of anomalies, including those that require 3D scene reconstruction to solve them. This dataset will feature challenging examples from our industrial experience, such as complex lighting conditions, varying conveyor speeds, and precise anomaly classifications.

Conveyor to create artificial datasets (Labex AMIES.)
Work in progress.

References

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[2] A. Bochkovskiy, C.-Yao Wang, and H.-Y. Mark Liao. YOLOv4: Optimal speed and accuracy of object detection., 2020 (https://arxiv.org/abs/2004.10934)

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[4] J. Guérin, A. M. de Paula Canuto and L. M. Garcia Goncalves, "Robust Detection of Objects under Periodic Motion with Gaussian Process Filtering," 2020 19th IEEE International Conference on Machine Learning and Applications (ICMLA), Miami, FL, USA, 2020, pp. 685-692.