

zPasteurAlzer: AI-enabled quality control in tunnel pasteurizers

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Project Details and Motivation

In the food and beverage industry many foods, beers, and soft drinks need to be pasteurized to minimise the effect of microorganisms on the physical stability and flavour of products. In tunnel pasteurization, the filled cans or bottles travel through a tunnel with several thermal zones where water is sprayed onto the packages to control their temperature. To monitor the pasteurization of a product, the temperature of the product in the can or bottle should be measured across the entire process, but it is not feasible and in practice, the operators pass periodically a thermograph for sampling, to assure that the process operates into the quality standards.



Figure 1: Tunnel pasteurizer in a beer bottle packaging line

zPasteurAlzer is an AI-enabled quality control solution for virtual measuring and live monitoring the temperature of the products during their pasteurization in tunnel pasteurizers. zPasteurAlzer (a) collects measurements for the temperature of sprayed water from the machine's sensors and the process' states from the machines' PLCs, (b) estimates the temperature at the cold point of the products during the intermediate steps of the process with virtual sensing techniques based on ML algorithms, (c) calculates the PUs (product quality) added to pasteurized products via AI-enabled models, and (d) monitors in real-time the key pasteurization process parameters and assures the quality standards.

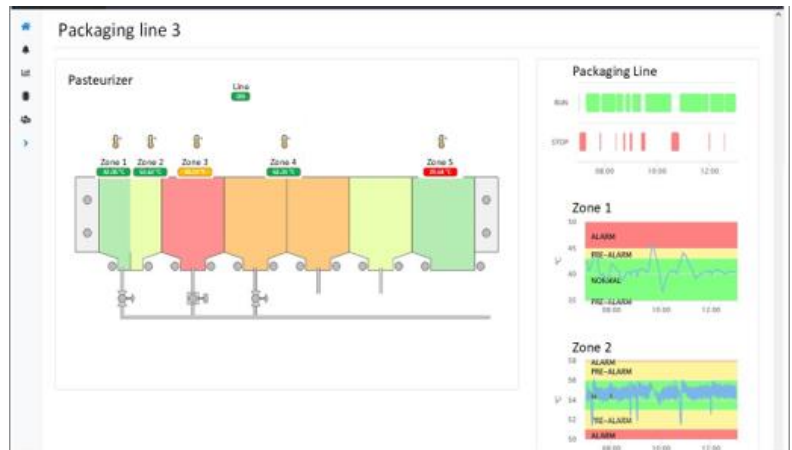


Figure 2: Live monitoring of pasteurizer's temperatures

In collaboration with a large brewing factory in Patras, Greece, the shop floor employees provided all the necessary information to define the requirements specifications of a predictive quality tool for the pasteurization process. For the validation of the zApp in a real use case, INDUST's IIoT controllers were deployed in the production line of the factory for data acquisition from sensors and PLCs of the pasteurizer and evaluation of the results in real conditions of industrial production.

ZDMP Fit

zPasteurAlzer is a zApp for the ZDMP platform that addresses zero-defect manufacturing (ZDM) aspects in the large food and beverage industry, through digitalising legacy pasteurizers over the use of AI/ML, IIoT, and virtual sensing technologies. It is an AI-enabled predictive quality solution adapted to industrial environments' needs and addressing to shop floor operators for live quality monitoring, early detection of process malfunctions, the prevention of producing defected products, and the assurance of quality in the pasteurization process. The open and generic approach followed makes the zApp applicable to any tunnel pasteurizer used in packaging production lines independent to the legacy of systems and the produced product.

The sub-project aims to tackle the lack of continuous quality monitoring in legacy pasteurizers. Shop-floor workers operating these legacy machines do not have a consistent, real-time view of the product quality (PUs), except when they manually use thermographs (PU recorders), which is time-consuming and occurs only a few times per working shift. Consequently, several products end up being discarded before entering the supply chain due to quality issues. The proposed zPasteurAlzer application intends to provide a solution through AI/ML and IoT technologies and ZDMPs components that continuously inform the operators about the quality of every batch of pasteurized products and thus give the chance for immediate reprocessing of bad quality products. This will eventually contribute to the reduction of those later rejected products (before supply chain quality controls) and as a result the reduction of by-products and raw materials that would be used if those products would proceed in the following stages of the production line.

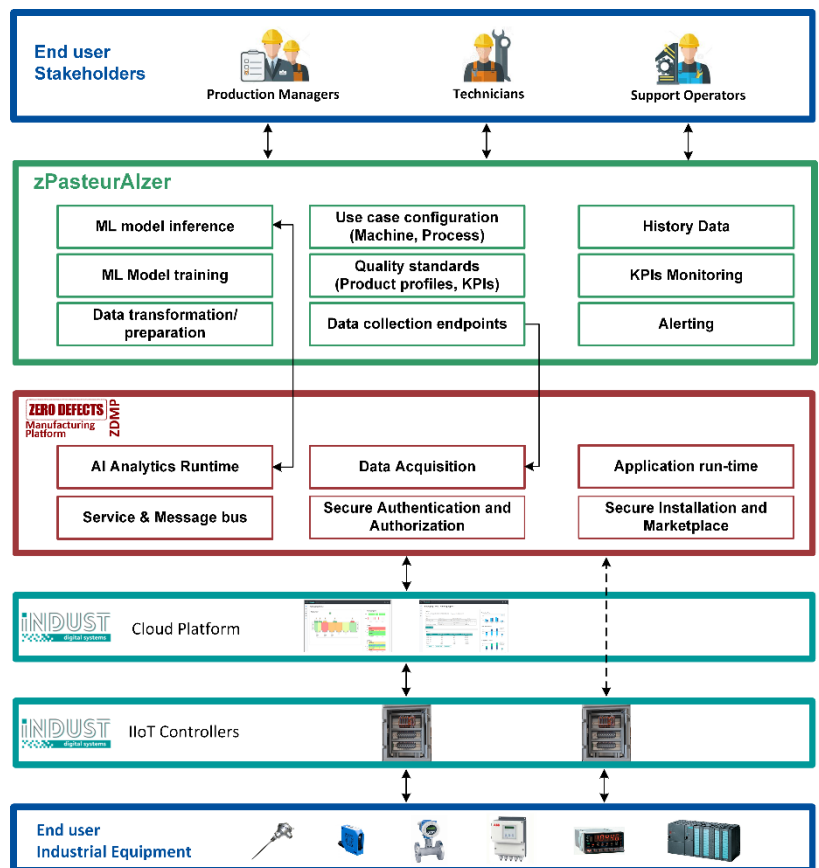


Figure 3: zPasteurAlzer high level architecture schema.

zPasteurAlzer is aligned with the ZDMP's objectives: (a) "To ensure the quality of the product along the value chain of the manufacturing process by deploying advanced modelling, detection, inspection, and predictive techniques", and (b) "To ensure outstanding process quality, through equipment, resource, energy efficiency, by deploying novel AI-based solutions". zPasteurAlzer is an App for the ZDMP ecosystem that:

- Monitors the key parameters of industrials systems of the pasteurization process
- Collects data from the connected sensors, IIoT controllers and production machines, and analyses them for anomaly detection
- Applies secure connections between INDUST IIoT controllers, INDUST cloud, and the ZDMP platform for data management
- Enables the interconnectivity through the whole loop from the sensors, the IIoT controllers, the cloud system, the ML models, the ZDMP platform, and the dashboard for the end-users
- Supports easy and safe connection establishments between the different layers of its architecture using the INDUST's and ZDMP's APIs
- Enables the integration of ML models and the interoperability with the INDUST cloud system and the INDUST IIoT controllers
- Provides quality assurance as-a-service (QAaaS) solutions for tunnel pasteurization processes, that automatically detect malfunctions and prevent the production of defective products

Results to Date

During the requirements specification phase, in collaboration with industrial end-users we collected all the important information according to the real needs of a pasteurization process, and we specified the requirements for the development of the ML algorithms and the zApp software. We studied the key parameters around the tunnel pasteurization process, the ways that industries in the food and beverage sector with modern and legacy pasteurizers deal with the challenges of this critical procedure and identified the issues that zPasteurAlzer is going to address according to the gaps of commonly used pasteurization machines in packaging lines. The high-level architecture of the proposed zApp is designed, including the interactions between the zComponents, the INDUST IIoT controllers, and the INDUST cloud platform.

During the setup phase, installed, deployed, and configured all the systems and tools for data acquisition, ML models development and software implementation. At the end user's factory, the temperature sensors were installed on the pasteurizer machine, the INDUST IIoT controllers were deployed at the production line, all the sensors and the signals from the pasteurizer's PLC were connected to the controllers, and all the required configurations on the INDUST IIoT controllers and the INDUST cloud platform were made for the data acquisition. The first datasets were prepared for the ML algorithms and extracted some preliminary results for the virtual sensing models. On our local server, were deployed in separate virtual machines all the zComponents of ZDMP that are required for the development of the zApp.

Participant Details

- **Organisation(S):** INDUST Systems
 - **Web:** www.indust.io,
 - **Contact:** gabriel.filiios@indust.io
 - **Profile:** INDUST is developing an industrial digitalisation system for monitoring critical parameters in production processes. It is an effective tool for shop floor employees to improve production efficiency and reduce costs. The system is installed on the production line, detects malfunctions and indicates to operators when and where to intervene to deal with problems immediately.
- **Organisation(S):** The Internet of things Lab
 - **Web:** <https://iotlab.ceid.upatras.gr>
 - **Contact:** nikole@cti.gr
 - **Profile:** The IoT-Lab is a research laboratory at the University of Patras. The Lab focuses on the design, analysis and implementation of AI/ML algorithms, systems, applications, and testbeds for the Internet of Things. The activity of the research team includes coordination and participation in R&D Projects, industrial research, and the development of innovative systems.



Environment

The ZDMP – Zero Defects Manufacturing Platform – is a project funded by the H2020 Framework Programme of the European Commission under Grant Agreement 825631 and conducted from January 2019 until December 2022. It engages 31 partners (Users, Technology Providers, Consultants and Research Institutes) with a mission to “Provide the platform, components, services, and marketplace to achieve the right product, at the right time, with the right conditions using the right resources.”. Further information can be found at www.zdmp.eu. ZDMP channels 3.2M€ of SME orientated funding to subprojects, such as this one to both facilitate SMEs with their innovations and increase the value of the ZDMP ecosystem.

Links

• Primary Partner:	gabriel.filiios@indust.io
• Secondary Partner:	nikole@cti.gr
• Sub project website/blog	https://www.indust.io/?page_id=8015&lang=en
• Architecture Component/App(s)	AI Analytics Runtime Data Acquisition Service & Message bus Application run-time Secure Authentication and Authorization Secure Installation Marketplace