Inline visualisation of spray impact pressure distribution via augmented reality: An approach to monitor cleaning processes

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Regular cleaning of food production equipment is essential to ensure food safety. Open plant cleaning is mainly done manually. Spray and foam lances are used by the cleaning staff to distribute the cleaning liquid or foam onto the surfaces to be cleaned. The human factor brings in necessary flexibility, but the reproducibility of the cleaning results depends on the skills of the personnel and is often low. An inline visualization of the cleaning results can help to strengthen the food safety management systems.
The poster shows a virtual cleaning assistant supported by augmented reality (AR). The system consists of three main components: i) spray lance with integrated tracking system for pose and position detection, ii) visualisation device (AR headset, smartphone) for displaying cleaning progress, iii) digital cleaning twin for data acquisition and simulation.
An innovative 3D tracking concept was developed for the tracking spray lance to record the position and orientation of the nozzle in space or in relation to the machine surfaces. 3D stereoscopic sensors with suitable VSLAM algorithms are used. Cleaning parameters such as water pressure are recorded via the CIP base station. The position and cleaning parameters are continuously sent via a remote connection to a server on which a digital 3D-image of the production environment is running. Here, the data is merged and used as input parameters in a quasi-real-time spray-cleaning simulation.
The simulation is based on nozzle data, in particular the impact pressure distribution. These parameters were measured as a function of nozzle distance, nozzle surface angle and pressure. The nozzle data is generated using an automated XYZ-linear table, which scans the full spray pattern.
During the cleaning process, based on the current position of the spray lance an impact pressure distribution of the applied cleaning liquid can be calculated and projected onto the 3D model of the machine to be cleaned. This visualization can be used by suitable AR devices to reflect the cleaning performance back to the cleaning specialist in almost real-time.
This feedback on the cleaning progress enables the cleaning personnel to avoid spray shadows or over-cleaned areas.