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Methodology for Temporary Analysis of Production and Logistic Systems on the Basis of Distance Data

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Abstract : In small and medium-sized enterprises (SMEs), the challenge is to create a well-grounded and reliable basis for process analysis, optimization and planning due to a lack of data. SMEs have limited access to methods with which they can effectively and efficiently analyse processes and identify cause-and-effect relationships in order to generate the necessary database and derive optimization potential from it. The implementation of digitalization within the framework of Industry 4.0 thus becomes a particular necessity for SMEs. For these reasons, the abstract presents an analysis methodology that is subject to the objective of developing an SME-appropriate methodology for efficient, temporarily feasible data collection and evaluation in flexible production and logistics systems as a basis for process analysis and optimization. The overall methodology focuses on retrospective, event-based tracing and analysis of material flow objects. The technological basis consists of Bluetooth low energy (BLE)-based transmitters, so-called beacons, and smart mobile devices (SMD), e.g. smartphones as receivers, between which distance data can be measured and derived motion profiles. The distance is determined using the Received Signal Strength Indicator (RSSI), which is a measure of signal field strength between transmitter and receiver. The focus is the development of a software-based methodology for interpretation of relative movements of transmitters and receivers based on distance data. The main research is on selection and implementation of pattern recognition methods for automatic process recognition as well as methods for the visualization of relative distance data. Due to an existing categorization of the database regarding process types, classification methods (e.g. Support Vector Machine) from the field of supervised learning are used. The necessary data quality requires selection of suitable methods as well as filters for smoothing occurring signal variations of the RSSI, the integration of methods for determination of correction factors depending on possible signal interference sources (columns, pallets) as well as the configuration of the used technology. The parameter settings on which respective algorithms are based have a further significant influence on result quality of the classification methods, correction models and methods for visualizing the position profiles used. The accuracy of classification algorithms can be improved up to 30% by selected parameter variation; this has already been proven in studies. Similar potentials can be observed with parameter variation of methods and filters for signal smoothing. Thus, there is increased interest in obtaining detailed results on the influence of parameter and factor combinations on data quality in this area. The overall methodology is realized with a modular software architecture consisting of independently modules for data acquisition, data preparation and data storage. The demonstrator for initialization and data acquisition is available as mobile Java-based application. The data preparation, including methods for signal smoothing, are Python-based with the possibility to vary parameter settings and to store them in the database (SQLite). The evaluation is divided into two separate software modules with database connection: the achievement of an automated assignment of defined process classes to distance data using selected classification algorithms and the visualization as well as reporting in terms of a graphical user interface (GUI).

Keywords : event-based tracing, machine learning, process classification, parameter settings, RSSI, signal smoothing
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