We propose a new computer vision based technique that does not use data collected from real images to teach a decision-making algorithm. It uses CAD-Models which is already available from the product planning phase to check all product variants on the assembly line for misplaced or wrong components. This solution can hence be used already in the ramp-up phase of new models in which problems are more frequent. Our method can also easily adapt to changes of production, where existing methods need to redo the whole teach-in process, we just need to set the new nominal position of the part in the reference coordinate system, which can even be done semi automatically upfront the changes are initiated in the assembly line.

Abstract

We propose a new computer vision based technique that does not use data collected from real images to teach a decision-making algorithm. It uses CAD-Models which is already available from the product planning phase to check all product variants on the assembly line for misplaced or wrong components. This solution can hence be used already in the ramp-up phase of new models in which problems are more frequent. Our method can also easily adapt to changes of production, where existing methods need to redo the whole teach-in process, we just need to set the new nominal position of the part in the reference coordinate system, which can even be done semi automatically upfront the changes are initiated in the assembly line.

Keywords: Quality assurance; Mixed model assembly lines; Computer Vision; CAD-based; Augmented-Reality

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1. Introduction

Mixed model assembly lines are subject to increasing complexity due to increasing model variety per assembly line, short product life cycles and increased product complexity. Especially in the automotive production the integration of new variants and segregation of discontinued variants in short frequencies leads to a constant change. The trend of dynamic markets with demanding clients, forces manufacturers to invest in flexible production strategies. Following this idea, the rise of variants and thus the production of small series fills out niche markets and increases the sales volume. [1]

The integration of new models means high effort. New processes and production systems must be tested and optimized during production ramp-up phases. These optimizations are usually made to reach time targets (e.g. slow assembly processes), cost targets (e.g. more workers are needed than planned) and quality targets (e.g. agglomeration of quality deviations). In order to make a declaration about the produced quality, quality assurance must be carried out. Thus, in these early stages it is important to be able to use a functional and flexible quality assurance method. On the mixed model assembly line, several products are produced in different variations. The product ramp-ups take place as shown in fig. 1. The illustrated scenario describes the models A and B, which are integrated into the assembly line. After a successful production testing, model A is brought to peak production in the ramp-up phase. During the ramp-up phase, new processes have to be improved and the quality of the product must be brought to a required level. Due to the strategy of assembling several variants per assembly line and at the same time striving for a low product life cycle, model B is integrated into the mixed model assembly line after the successful integration of model A. Fig. 1 shows that there is a constant change in the production of a mixed model assembly line [3]. At the same time, the desired quality must be ensured with increased product complexity. Since a low level of automation isstrived for in the final assembly of the automotive industry in order to be able to respond flexibly to changes, many tasks are performed manually by a worker [4]. Due to constant changes, the workers only have a small learning curve in order to master the assembly processes. A backup of assembled quality is therefore indispensable.

Regarding to [1], the growth of flexibility usually does not correlate with adapted quality assurance strategies. The demand for high-quality products compels the quality assurance to provide methods which can meet the changing requirements. To overcome the challenges presented in [1] and [3] the main aim of this work is to provide a flexible quality assuring system, which is ready to use for the first product being produced. The method relies on CAD-Model based optical tracking to compare real objects to their virtual counterpart. So, the quality assurance system can be planned and developed upfront and, once installed, used from the very first assembled product.

2. State of the art

Existing methods of quality assurance in the assembly line answer the questions to completeness, correct component variants and correct position of mounted components. One method is the use of trained workers, who carry out an optical test based on variant and equipment instructions. Information about the variants or equipment and thus which tests the employees have to perform can be transferred via a product information paper carried along on the product. The decision which test characteristics are to be assured is made by the worker based on training courses. This also means, that the worker has to keep every possible variant and its indicator in mind. The number of verifiable variants can be increased by displaying the inspection characteristics on a handheld to the worker [5].

This kind of quality assurance can be quickly used, be available at ramp-up phases and the worker can easily be trained to new product variants, which makes the method changeable. However, there is no automatic documentation on the quality assurance. Furthermore, the employee is subject to a period of fatigue, whereby the number of overlooked errors can increase as the working time progresses. This means decreasing reliability and robustness.

A further method is the self-service test, in which the respective assembling worker has to check his work himself and confirm by stamp or signature. However, the worker does not recognize errors due to ignorance or confusion. Such errors are not recognized until after the next steps in the assembly, and thus involve a chain of follow-up work and a cause analysis to the origin of the quality deviation. [6], [7]
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