Mission Statement
With the help of CNC sewing technology, considerable added value is achieved by finishing the products with visible seams. When converting the sewing process to a new seam pattern or material, an experienced sewing technician has to adapt the CNC control data at great expense. The adaptation is completed as soon as the sewn seam pattern on the voluminous material corresponds to the specified seam pattern in sufficient quality. The programming of a complex seam pattern with many seam directions can take up to 2 days until the desired product quality is achieved with regard to minimum seam pattern distortion.

Solution
- Modular system for automated adaptation of CNC control data for visible seams during CNC sewing
- Quantifiable evaluation of the seam quality of design/decor seams for car seats, upholstery and leather goods by the system
- Manual adjustment of the seam pattern in 2 days (actual state)
- Automatic adjustment of the seam pattern in 45 minutes (target state)
- 50% production cost savings: 1 Mio. €/year
- Turnover for camera manufacturer and image processing of 1 million €/year (equipment of existing and new CNC sewing technology)
The aim of this project is the development of an automated, camera-supported seam pattern recognition on a CNC sewing machine to improve the programming effort for CNC seam patterns with voluminous material. The overall system developed in this project will reduce the costly, iterative steps for manually adjusting the position accuracy of seam patterns during CNC sewing by at least 90 % and thus save time and money. The achievable position accuracy of the seam pattern must at least correspond to the quality of programming by an experienced sewing technician. In addition, the flexibility to change over to new seam patterns and sewing materials is increased.

Solution
With the help of a camera and lighting system, an image of the actual seam pattern can be captured. This system must meet the requirements (e.g. resolution, speed, illumination, field of view) for recognition of the seam pattern. The development of suitable algorithms for the robust recognition of different seam applications enables image processing of the seam pattern information. With the help of image processing, the deviation of the detected seam pattern from the specified seam pattern (CAD data) is then calculated and prepared for further processing. The deviations of the actual pattern from the nominal pattern are calculated and converted into corrected CNC control data with the aid of an algorithm to be developed depending on the sewing operations. The corrected control data is transferred to the CNC sewing machine via existing machine interfaces.

Results
In a total of 4 different seam patterns on different CNC sewing machines it could be shown that the entire system is able to optimize a seam with significant seam distortion in a few minutes (approx. 10 minutes). Deviations of 2 - 3 mm e.g. at crossing points of a diamond pattern could not be reduced to any visible deviations. In comparison to manual adjustments, approx. 90 % of the time could be saved here. The main results of the research project are listed below:
- Reduced adaptation times for CNC seam patterns (90 % time saving)
- Accurate recognition of seams, even with low contrast (black on black, white on white)
- New quality assurance system, as sewn seam can be measured with the desired position of the design
- Other seam pattern can be set even without camera measurement, if material and clamping parameters remain the same
- System can work with all CNC machines as only geometry data (e.g. DXF) or machine control data (G-code) are used

The research results achieved have shown that the developed system can significantly reduce the time and material required for CNC sewing. In addition to the reduction in time, considerably less material waste is produced at the same time, as only one incorrectly sewn pattern is required to determine the material constants using the camera system. The previously applied iterative procedure (trial-and-error method) for optimizing the seam is thus replaced or greatly shortened.

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