Development of advanced seam tracking laser welding system with real-time process monitoring

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Laser welds are attractive for fabrications, being narrow, penetrating, made at high welding speed and introducing minimal distortion. Nevertheless, to guarantee consistent joint fusion, welding heads with seam tracking may sometimes be used, often with one or more non-contact optical devices (e.g. line/stripe diodes). These however can also be used for pre-weld seam examination and post-weld bead geometry inspection.

In the work described, a new type of seam tracking tool has been developed, which also uses the same hardware and software for real-time process monitoring. The seam being welded is fully illuminated, using a coaxial array of high intensity LEDs. Seam tracking is then driven by real-time analysis of the images recorded by a coaxial camera, equipped with an appropriate narrow bandpass filter. The images are logged and, simultaneously, analysed, to identify the joint position, and guide the welding head to it.

The quality of these images is such that they can also be used for in-process monitoring. Geometric features of the weld zone itself are extracted during welding, and through comparison to known, user-input, acceptable values, the welding taking place can then be flagged as OK or NOK to the operator. This can then help to target any post-weld NDI and, if needed, repair.

The same software can also log photoemissions during welding (e.g. back-reflected laser radiation from the process zone, and/or any visible light generated), as a second source of monitoring data.

Through industrially-guided trials, correlations have been identified between certain combinations of features in all this data and welding process deviations (causing weld defects). In particular, the example of monitoring developed can be used to detect and flag during welding characteristic changes in key recorded datasets when weld penetration reduces, when welding over materials of changing thickness.