Virtual reality welding education based on numerical real-time simulation

Virtual Reality Training Systems are well known and well established in many different disciplines. One example are Flight Simulation Training Systems. In welding education such systems are state-of-the-art when it comes to learn the manual skills needed for proper welding.

2005 Fronius International GmbH together with FH JOANNEUM Gesellschaft mbH started developing a virtual welding training system (Fronius Virtual Welding) which has been available as a product since 2009 and has since then been further developed by adding additional welding processes and tasks.

In combination with computational numerical welding process simulation such systems can be enhanced to enable a trainee to visualize and learn the influence of different welding parameters in a fast and cost-efficient way.

To our knowledge there is no virtual welding training system available at the moment that combines the advantages of virtual environments and physically calculated welding results into one system.

Fig. 1: Fronius Virtual Welding (© Fronius)
The use of computational simulation methods based on physical models for the investigation of arc welding processes is an established engineering method. It is an efficient way to locate necessary welding parameters, especially for tasks that exceed usual or well-known requirements. But numerical welding process simulation has a trade-off between calculation time and result accuracy. The calculation of half a second of welding with high physical accuracy can easily take several weeks, even on a high-performance computing systems.

Since 2001 the simulation group of the Welding and Joining Institute of RWTH Aachen University (ISF) has been carrying out research on arc welding processes to formulate physical models that, after being implemented into software (SimWeld – Welding Process Simulation Software), allow to calculate weld seam geometry and heat input and distribution within a few minutes on a standard personal computer.

**Successful combination demonstrated**

A prototype that demonstrates a first integration of SimWeld’s current numerical simulation algorithms into the Fronius Virtual Welding training system has been developed. The calculation of the simulation algorithms is executed asynchronously but not in real-time at the moment and the results can be visualised after a training is finished. This already enables a user to investigate and develop an understanding of the influence of different welding parameters, as for example welding speed or torch angles, on close-to-reality welding results.

As the project progresses, the computational numerical welding process simulation algorithms will be optimised to enable real-time calculations to already allow a visualisation of the results during a training, thus leading to a faster feedback cycle for the user.

**Impact and effects**

The overall system, i.e. the combination of the numerical welding process simulation and the virtual welding training system, will enable a trainee to directly and intuitively experience and understand the effects that are caused by different welding parameters in real-time.

This will lead to faster, cheaper and more efficient welding education in the future and will thus help to supply the demands for well-trained welders in different sectors of the industry as for example in automotive or mechanical engineering.

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