# Steering Method for Automatically Guided Tracked Vehicles

**Otto Lerke and Volker Schwieger (Germany)**

**Key words:** Engineering survey; Step-less drive; Kinematic model for tracked vehicles; Robot tachymeter; Guidance accuracy

## SUMMARY

The objective of this contribution is the design of an alternative steering method for a two-track crawler model, based on a scalable force transmission. Generally, the steering method of a two-track crawler chassis is based on a skid-steer concept (Beetz 2012). Thereby the curve drive is realized by adjusting different track velocities on the individual tracks. The resulting difference between the velocities of the right and left track has a direct influence on the curve radius. The bigger the difference, the smaller is the resulting curve radius. Such steering method is applied for bulldozers, track loaders and excavators (Beetz 2012). Generally, mechanically compounded drives are common for tracked vehicles (Gebhardt 2010). Among them, step-less drives or infinitely variable drives are most superior.

The Institute of Engineering Geodesy (IIGS), University of Stuttgart operates a crawler model, at scale 1:14, which is part of the construction machine simulator, that has been developed to test and evaluate different sensors, sensor combinations, as well as filter and control algorithms (Beetz 2012, Lerke and Schwieger 2015). Further components of the simulator are a robot tachymeter Leica TS30, a control computer, an analogue/ digital converter and a remote control. The crawler model, that has been used for the current investigation, has a two-stage continuous electric drive and thus complies with the requirements of the step-less drive functionality.

For the design of the new steering method a mechanical differential steering block has been used as a role model. The key part of such a block is the compensating gear, which balances different velocities of the inner and outer track during the curve drive. The approach is based on the kinematic model for tracked vehicles according to Le (1991), where the equation, which describes the relationship between the radius and the different velocities for the right and left track, has been modified and solved in a way, that a scaling factor n could be derived. This scaling factor

corresponds to the functionality of the compensating wheel of the differential steering block. The factor n scales the driving forces for the two tracks. Left and right track velocities are scaled by this factor and by its reciprocal respectively.

To evaluate the guidance quality of the new steering method, the model crawler, equipped with the new steering method, was guided automatically along different, predefined reference trajectories, using the simulator system of the IIGS. The guidance accuracy has been analysed by calculating the root mean square (RMS) between the reference and the real driven trajectory. The evaluation revealed an average RMS of 2,9 mm for the three driven trajectories.

The presented steering method satisfies the requirements of guidance accuracy. Comparable investigations on different steering methods, as e.g. Beetz (2012), showed a similar range of accuracy. The benefits of this system are the capacity to remain the set velocity during curve drives, no loss of driving forces at the tracks and simple calibration procedures.