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Assistance system for loading of farm materials

The trend towards ever more powerful self-propelled harvesters with increasing working widths and growing throughput is easy to recognise. Especially where parallel loading takes place onto trailers there is a high demand on the machinery operators in order to achieve complete trailer filling with a loss-free operation.

For this reason investigations have been conducted towards a loading assistance system for filling trailers using a self-propelled silage harvester as an example of the loading machine at the TU Brunswick, Institute of Farm Machinery and Fluid Technology and the Institute for Regulation Technology.

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The focal point of the project reported upon lies in the development of loading strategies to allow complete filling of a trailer and its appropriate automatic application. On the one hand, the application is achieved through automated directing of the discharge spout. On the other, the correct positioning of the transport wagon has to be calculated which is then displayed to the driver via man-machine interface.

Required for realising this method is the achievement of the partial functions as demonstrated in *figure 1*.

Controlling the discharge spout involves both turning it and moving of the impact plate. The highest priority in its positioning is the sure targeting of the trailer interior so that harvest losses are avoided. Additionally, a loading strategy should be followed to ensure even and complete loading of the trailer through regular movement of the discharge equipment aimed at different target areas in the trailer.

A system is required to indicate the trailer is completely full with higher threshold values in the middle of the trailer compared with at the sides so that a heaped load is possible. The complete exploitation of transport capacity is reached when towards the end of the loading process a system recognises these different pre-set load thresholds.

The predetermining of a suitable trailer position for the loading is on the premise of as short a journey as possible for the cut material leaving the spout. This increases the chances of accuracy and also ensures that maximum available kinetic energy in the flow of harvested material is reserved for the compaction of the material already in the trailer. In that the trailer is driven as close to the harvester as possible, the position indications are limited only with regard to driving direction (forward/back).

Determining the vehicles' positions to one another is the basis for fulfilling the described system. Alongside the determination of

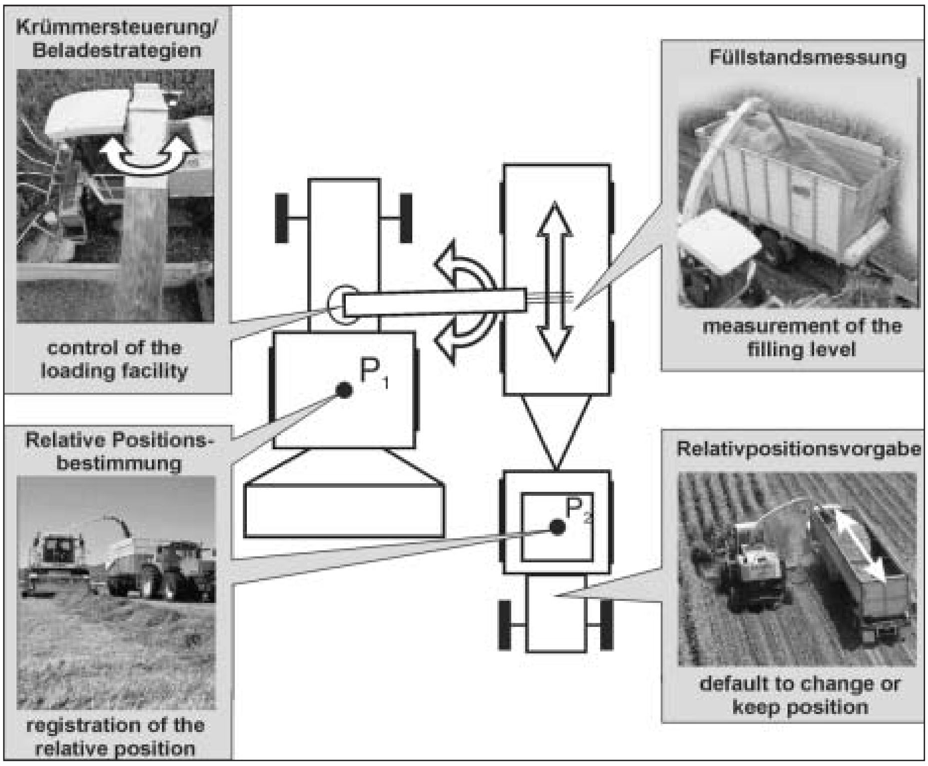

Fig. 1: Sub-functions of the assistence system (photos: Claas)

the distances in lateral and longitudinal directions the different driving directions have to be considered as well as the articulated angle between tractor and trainer.

Preliminary investigations

GPS receivers are being used more often in farm machinery too. The application in such cases extends from yield mapping to parallel tracking aids through to automatic vehicle steering [1, 2]. The latter case includes the use of high performance and therefore very expensive GPS receivers which enable an absolute location precision down to just a few centimetres [3].

At the ILF preliminary investigations were carried out with the aim of determining the precision possible for relative positioning using a simple GPS receiver. The basic thoughts behind this work were that through correlation of measurement errors of two similar GPS receiver models a greater precision could be achieved in relative positioning to one another compared with absolute position determination. Applied in the trials were two Garmin GPS 35 DGPS receivers loaded with correction data from the DGPS service SAPOSEPS to increase their measuring precision. *Figure 2* demonstrates an approximate 900 m long trail drive at a constant 9 km/h with two receivers on one vehicle.

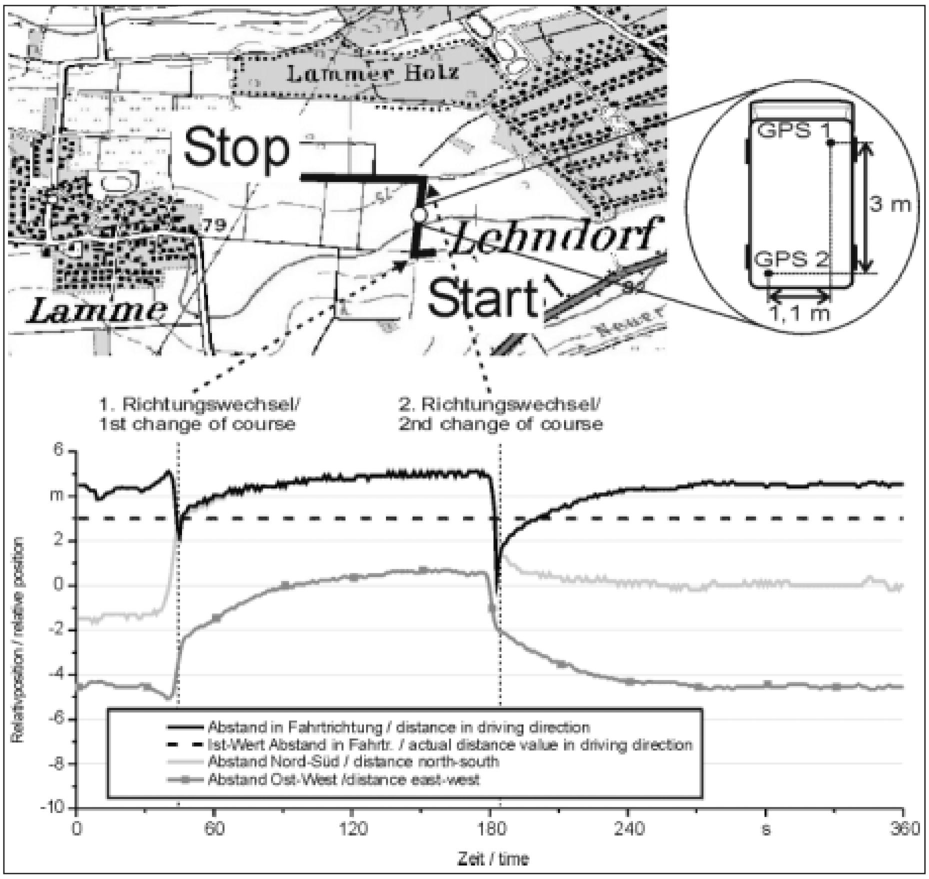

Fig. 2: Registration of relative position by DGPS

It was shown that the measured distance in the direction of travel deviated up to several metres from the 1st value. Especially following a change in direction, the measured relative positions altered considerably over a period of ~ 60 seconds, although remaining constant according to the fix positions of the receivers on the vehicle and the constant course.

The trials showed that correlating error influences does not lead to a great increase in precision for determination of relative position. Measurement errors of sometimes over 2 m mean this simple method for determining relative position is not acceptable.

Further procedures

For the development of assistance systems, the construction is planned of two trial vehicles equipped with high-precision carrier phase corrected DGPS systems for determining relative position. Relative positions of the vehicles will be decided via DGPS determined driving course as well as from the steering angles which have to be additionally recorded.

Hereby a vehicle will be fitted with an appropriately designed silage harvester discharge spout and the second vehicle will serve as draught machine pulling a trailer fitted with sensors to determine aim reliability.

Three development stages are foreseen:

1. Orientation on pre-determined target areas during parallel driving
2. Automatic conducting of loading procedures according to relative position instructions
3. Integration of full-position measurement towards the end of the loading.

The application of the third development step can only occur through a transfer onto real harvesting situations in that only under loading during real conditions does the required change in filling status take place.

Along with the technical aspects described the economic aspects of the assistance system are also to be investigated. By comparing achievable savings through reduced harvested material losses and better exploitation of transporting capacity with the expected costs for the described system a prognosis on its economic practicality should then be reached.

Summary

The development of a loading assistance system for farm material from self-propelled harvesters to transport trailers in the field has proved a multiple aspectual challenge with research input required.

Cheap DGPS receivers are not suitable for determining the required relative positions. Here, the application of high-quality sensors is required.

Literature

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