Detlef Ehlert and Hans-R. Langner, Potsdam

Mobile Platform for Acquiring Information

Utilising information for management decisions can conserve natural resources and improve farm competitiveness The acquisition of relevant agronomic parameters and low cost solutions are the prerequisites for effective information management. High labour costs in the developed countries can be significantly offset through employing semiautonomous data acquisition. A simple chassis for a field scout is presented and discussed.

Dr.-Ing. Detlef Ehlert is the head and Dr.-Ing. Hans-R. Langner is a member of the department Engineering for Crop Production at the Institute of Agricultural Engineering Bornim e.V., Max-Eyth-Allee 100, 14469 Potsdam; e-mail: *dehlert@atb-potsdam.de*

Keywords

Land cultivation, information acquisition, mobile platform

An approach to fulfil the need for a sustainable and competitive agriculture is the use of information in order to reduce the input of resources. The information-guided crop production looks at site-specific parameters, e.g. differences in soil properties, weather, mesoclimate and in the crop biomass. These parameters have to be recorded site-specifically, they can be used as control parameters for the information-guided crop production [1]. But before the information can be used, the appropriate data must be collected. There are several well-known possibilities to acquire information such as manual measurements, different types of remote sensing and the use of vehicle based sensors.

Because farms will have increased competition in the future, the process of information acquisition has to be performed very effective. In order to achieve a high efficiency, two major conditions have to be fulfilled. Firstly, the information has to be relevant for the method design, since irrelevant information only causes expenses and is without any benefit. Secondly, costs for acquiring the information have to be low. This implies that the use of manpower has to be minimised due to high labour costs.

Data acquisition with a remote-controlled, semiautonomous platform is a promising solution to meet the above requirements.

System for acquiring information

The presented concept of a complete system for gathering and applying information in agriculture consists of the following main components: satellite techniques, mobile platform, farm machinery and control station. The realisation of this concept will include the features:

- Installation of sensor techniques on the mobile platform and the possibility to shift tasks from the farm machinery to the mobile platform
- Remote controlled and semiautonomous data acquisition with the platform
- Transfer of data from the platform to the control station in real time
- Work out of tasks for the farm machinery by using external and internal databases
- Wireless transmission of the tasks to the farm machinery and
- Confirmation signal from the farm machinery when the task has been completed.

The following discussion focuses on potential design variations for the mobile platform, which could also be specified by the international term „Field Scout".

Fig. 1: Field Scout during a test ride

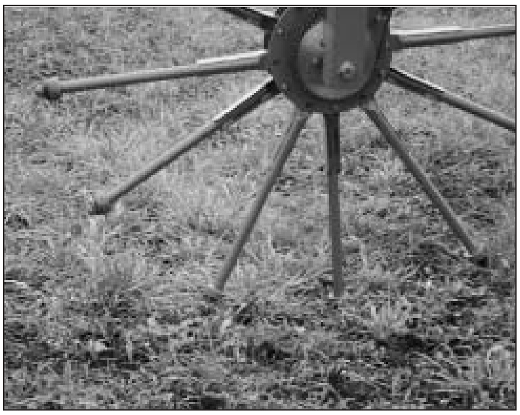

Fig. 2 : Spoke wheels of the Field Scout

Design variations for mobile platforms

In the first section it was pointed out that low costs are a decisive prerequisite for the effectiveness of information acquisition. Therefore, design concepts for mobile platforms have to concentrate on simple solutions, which will nevertheless have to meet the specific requirements.

Platforms working without drivers need to have all-terrain properties that are comparable to tractors or cross-country vehicles. That is why platforms with small dimensions are not adequate. When mobile platforms with tractor-like dimensions are to be used, fields covered by an established plant population are not passable at all or only in tram-lines. For driving along the tram-lines the driverless mobile platforms require a perfectly working navigation system based on data of the respective lines, as e.g. was presented for the first time at the fair Agritech-

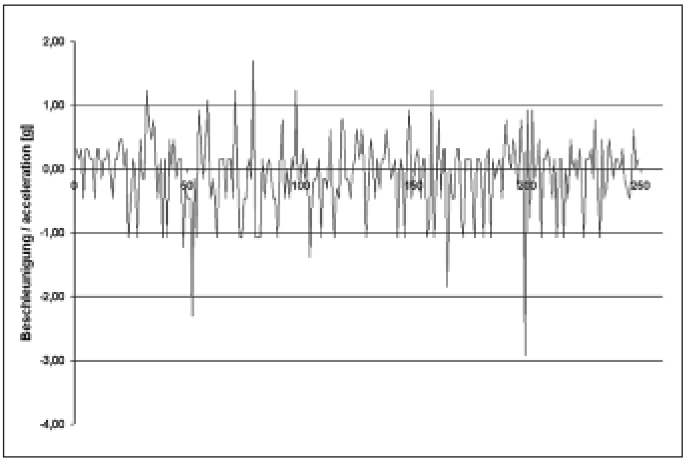

Fig. 3: Result of an acceleration measurement with the Field Scout

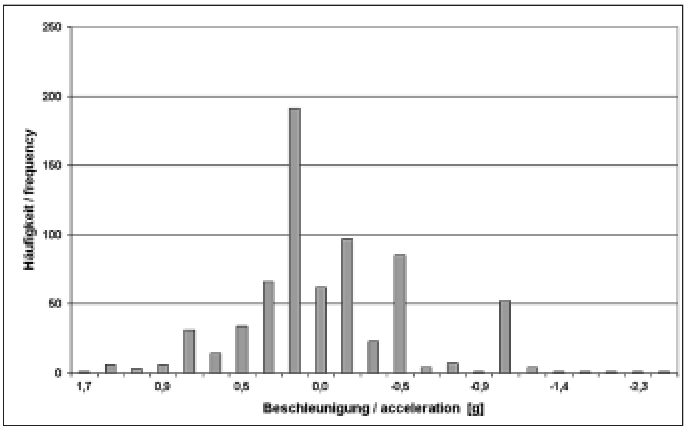

Fig. 4: Histogram of the acceleration values of the Field Scout measurements

nica 1997 by GEO-TEC, or they will need appropriate image recognition systems [2]. Both methods of navigation are still under research and development [3, 4, 5].

Another approach for a platform solution is the use of a chassis that has only little influence on crops when driving outside the tram-lines.

A chassis with three open spoke wheels was designed and developed for the platform „Field Scout“ with special consideration on limiting costs. Field tests revealed that the small points where the spokes contact the ground cause only little damage to the crops (*Fig.1 and 2*). A ground clearance of 1.6 m for the frame in the platform is realised in order to allow driving through established cereal fields. With a wheel diameter of 1.40 m and 12 spokes the desired all-terrain properties and platform running quality could be achieved.

At the current stage of development, the „Field Scout“ drives without a combustion engine. Two 12 V batteries with a capacity of 260 Ah supply power to a direct current motor with 430 W nominal power. The torque is 1,0 Nm by nominal power at 3000 rpm. The chassis of the Field Scout has a total weight of 259 kg including 80 kg battery weight. By using light materials like aluminium or carbon fibre, an optimised design and by using modern drive concepts (e.g. fuel cells) the total mass could be highly reduced. Yet at the moment, the possibilities to reduce the total mass are not used because the surplus mass is taken into consideration as potential payload. Only the front wheel drives the actual version of the Field Scout. Other constructional solutions would be the drive by the two rear wheels.

Driving tests with 1,5 m/s speed on soils with different consistency showed that the spoke wheels cave into ground if the soil is too wet. To counteract this effect, the spoke wheels are equipped with additional thrust rings (*Fig. 2*). The implementation of the thrust rings limits the unwanted sinking of the spokes to an acceptable level.

Spoke wheels and their contact areas form a dodecagon and not a circle. That is why on solid ground the spoke wheels introduce a vertical movement and the amplitude Δh can be calculated according to the following equation

$$\Delta h = \frac{1{,}40\,m}{2}\left(1-\cos\frac{360°}{2\cdot 12}\right) = 0{,}024\,m$$

For the present geometrical relations of the Field Scout the amplitude Δh is 0,024 m. The value Δh is reduced on compliant drive lanes. Due to the inherent vertical amplitude movement the components on the chassis like batteries, devices and sensors, are exposed to acceleration load, depending on drive speed and lane properties. This is especially difficult when using shock sensitive devices or sensors that need smooth guiding for exact functioning (e.g. video monitoring cameras). The problem can be partly evaded by short stops of the platform.

The driving dynamics of the Field Scout was investigated by using an acceleration sensor with a measuring range of 10 g, mounted above the driven wheel. Acceleration measurements where done on a grassland with medium ground moisture. Data were collected with an acceleration sensor by Mikrotechnik+Sensorik, Jena, and converted analogue-to-digital every second via a peak detector. The gradients (*Fig. 3*) show acceleration values up to 1,7 g (upward) and negative values of up to -2,9 g (downward). The frequency of the acceleration values is shown in *Fig. 4*. The curve results from the interaction between spoke wheel and ground. The time dependent course of the acceleration gives indications on the force impacts on devices and sensors, caused by the comparatively low number of 12 spokes.

Another constructional version remains in open spoke wheels (*Fig. 2*) equipped with wheel rims, leading to a rolling motion of the closed wheel form similar to conventional wheels. The application of very narrow wheel rims will moreover minimise the contact areas and reduce the effects on the crop population. Further test runs will be carried out.

Literature

Books are identified by •

[1] • *Werner und Jarfe*: Precision Agriculture - Herausforderung an integrative Forschung, Entwicklung und Anwendung in der Praxis. KTBL-Sonderveröffentlichung 038 , Darmstadt, 2002

[2] *Steckmann, K., O. Wulf und B. Wagner*: 3D Laserscanner zur Bereichsüberwachung und Lagebestimmung. Robotik 2004, 17./18.Juni 2004, München, VDI-Berichte Nr. 1841, S. 469-476

[3] *Keicher, R., und H. Seufert*: Automatic guidance for agricultural vehicles in Europe. Journal Computer and Electronics in Agriculture 35 (2000), S. 169-194

[4] • *Schraut, M.*: Umgebungserfassung auf Basis lernender digitaler Karten zur vorausschauenden Konditionierung von Fahrerassistenzsystemen. Dissertation, Lehrstuhl für Realzeit-Computersysteme der TU München, 2000

[5] *Blackmore, B. S., H. Have and S. A. Fountas*: Specification of behavioural requirements for an autonomous tractor. Proceedings of 6th International Symposium on Fruit, Nut andVegetable Production Engineering Conference , 2001. Potsdam - Bornim, Germany, Institut für Agrartechnik Bornim e.V., pp. 25-36