Bosse, Dominik; Kinder, Thomas; Dzinaj, Timur; Klose, Ralph and Ruckelshausen, Arno

ISOBUS-demonstrator for research and education

ISOBUS as an international standard for agricultural machinery has gained in significance. However, access is time-consuming and hence ISOBUS technology is still underrepresented in both education and research. Thus at the University of Applied Sciences Osnabrück an ISOBUS demonstrator has been developed, consisting of an ISOBUS terminal, a sensor system (3D-Time-of-Flight camera) and a microcontroller-based ECU (Electronic Control Unit). One aim is, the interdisciplinary application of the demonstrator in University level education. On the other hand the demonstrator has a high potential for research, since the integration strongly increases options in field trials and can reduce transfer time to prototype development.

Keywords
ISOBUS, education, research, 3-D-ToF camera

Abstract
Landtechnik 65 (2010), no. 4, pp. 261-263, 3 figures, 4 references

Economical, ecological and juridical conditions have led to an increased use of electronics and software in agricultural engineering over the last years. The number of innovations at the world´s largest exhibition for agricultural machinery and equipment, the Agritechnica, reflect this development. The extensive use of cross-linked electronic components on implements and on tractors shows that electronics, sensor and software have become a core competence in innovative agricultural engineering. The ISOBUS provides these electronic components with a standardized platform for information exchange and occupies a central position in mobile systems. In order to meet the resulting demand of the agricultural industry for skilled personnel and ISOBUS compatible innovations, an increased integration of ISOBUS-technology in research and education is imperative.

ISOBUS in research and education

Despite its relevance for the agricultural industry, ISOBUS is not adequately represented in the field of education. The slow progress of the integration process of the ISOBUS-technology in education has already been identified in a comprehensive research project about precision farming in Germany [1].

Target group specific access to the ISOBUS-technology has to be provided for students in fields of studies relevant to agricultural engineering (engineering, computer sciences and agricultural sciences). Both the technical aspects and the application are of a big importance. Examples are the analytical examination of the quality of data or the development of action guidelines based upon sensor data and other information.

The transfer of innovation into the agricultural practice is inhibited by the fact, that access to the ISOBUS-platform is possible only with a high degree of expertise. The ISOSBUS-demonstrator presented here can help to simplify research scenarios and shorten development cycles. Existing or innovative technology can be applied to the field of agricultural engineering without massive overhead and their relevance and suitability for the application in that field investigated. Also, in many instances only the synthesis of existing or novel information with freely accessible and standardized data (e.g. GPS, speed, slip, PTO-pitch) adds to the value of an application. Thus the focus of cross-linking agricultural data is to utilize potential synergies.

Field tests can be executed on any ISOBUS-compatible tractor, since there is no need to resort to proprietary host systems, which normally are only available in pilot plants.

The modular structure of a sensor system based upon the demonstrator, will allow the users to focus on their core competence by decoupling them from the intricacies of the ISOBUS communication layers.

ISOBUS-Demonstrator

The central component of the demonstrator [2] is a modular built-on electronic control unit (ECU). The ECU manages the connection to the ISOBUS and in addition is a flexible interface for sensors and actors of all kind by providing analog and digital in- and outputs. The access of the microcontroller-based ECU to the ISOBUS is realized by an ISOBUS driver-software, whose API has been built in a way that it can be used without specific knowledge about the ISOBUS standard. The sensor application, which is realized on the ECU, reads out the inputs in configurable cycle and switches the outputs depending on the entries of the user. The inputs are shown on the ISOBUS terminal. The graphical user interface provides access to the digital outputs of the ECU.

In the next stage of extension the ECU will be upgraded with additional interfaces for microcontroller-based sensors and actors. ISOBUS data in a appropriate format will also be provided on these interfaces. Another important addition is the projected integration into the demonstrator of a so called ISOBUS Task-Controller client. This allows transfer to the ISOBUS and logging of sensor and actor data in correlation e.g. with the geo-position.

The CCI ISOBUS-terminal that has been used was developed in a cross-manufacturer effort. Specific characteristics are the common and intuitive usability, and the fact that the hardware configuration is identical for all implement manufacturers [3].

As an example of application an innovative sensor system (3D Time-of-Flight camera) has been chosen that delivers agricultural relevant data. The ifm 3D Fime-of-Flight (ToF) provides information about the distance without an external image processing („intelligent camera“). Furthermore the projected volume in relation to a predefined surface can be read out at a single sensor output. The camera determines the distance to an object on a per pixel basis utilizing the time-of-flight principle. With the help of this information a 3D-information of an object is provided in „real time“. Since the distance to a predefined surface is known, the camera calculates the projected volume of the object in the measurement range. The projected volume of e.g. agricultural material (potatoes, grass or wheat) can be determined on this way.

Naturally, other types of sensors could have been used in the demonstrator context. However, Klose et al. [4] have already described the qualification of this new type of camera for the phenotyping of plants as agricultural application in a study about the use of 3D ToF cameras in the outside. The setup of the demonstrator in the laboratory environment is shown in **figure 1**.

The analog sensor output of the camera is directly connected with the microcontroller-based ECU. The input signal is transmitted by the ECU in a converted type via the ISOBUS. The necessary conversion to standardized message is performed by the implemented ISOBUS-driver and is absolute transparent for the user. For the illustration of the sensor information on the terminal the before described graphical user interface is used.

Experimental results

The functionality of the demonstrator was verified during an experiment under real-world conditions. The setup of the test of the demonstrator is depicted in **figure 2**.

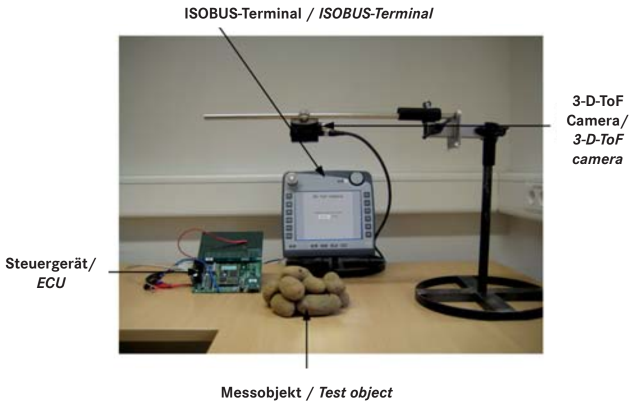
The distance of the 3D ToF camera to the ground in this assembly is nearly 1.40 m. The camera was mounted on a bar in order to guarantee a minimum distance to the tractor chassis. The volume of the test objects (here: potatoes), which were placed on the ground, can be detected without having parts of the tractor in the measuring range.

The tractor drives along a line of test objects - three clusters of potatoes were placed on the ground. The first cluster has a volume of ten liters, the second cluster has a volume of 20 liters and the third one has a volume of 26 liters. The clusters are positioned starting with the smallest volume and ending with the biggest volume. At the beginning of the test the tractor is positioned at the yellow pylon on the left. The tractor then drives with a constant speed toward the direction of the right pylon. During this time the volume in the measurement range of the camera is detected and recorded. The test stops when the camera on the tractor has crossed the right pylon. The recorded values of this test are visualized in the diagram in **figure 3**. The diagram shows that the recorded volumes are close to the values measured previous to the test (10l, 20l and 26l); the deviation is less than 5 %.

Conclusions

There will be a further increase in technical complexity of agricultural machinery, particularly in the areas of electronics and informatics. The ISOBUS provides a standardized platform for

Fig. 1

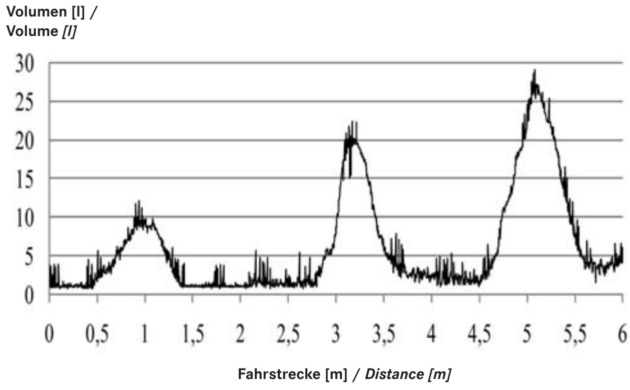


Setup of the demonstrator in the laboratory environment

Fig. 2

Test of the demonstrator

Fig. 3



Results of measurement of volume

the integration of diverse applications. In sync with this development easy access to the ISOBUS for research and education gains importance.

The ISOBUS demonstrator, a joint development of the CCI and the University of Applied Sciences Osnabrück, makes the ISOBUS technology accessible and provides direct access to the ISOBUS platform, due to its modular concept. As a result, both the integration of the technology in education and the options for the improved implementation of research work in products are greatly enhanced.

At this point the model character and the potential of the developed system have to be stressed. In addition to further hardware extensions especially the enlargement of the range of available software is contemplated. Public "Research-Apps" for ISOBUS-applications might be a viable option.

Literature

[1] Werner, A.; Dreger F.; Schwarz, J. (Hg.) (2008): Informationsgeleitete Pflanzenproduktion mit Precision Farming als zentrale inhaltliche und technische Voraussetzung für eine nachhaltige Entwicklung der landwirtschaftlichen Landnutzung. Forschungsprojekte pre agro II, Abschlussbericht

[2] Bosse, D.; Kinder, T.; Dzinaj, T.; Klose, R.; Ruckelshausen, A. (2010): ISOBUS Demonstrator and Working Environment for Agricultural Engineering Education, 10th International Conference on Precision Agriculture (ICPA), to be published

[3] Dzinaj, T.; Lebars, J.-M.; Möller, A.; Nagel, M.; Ruckelshausen, A.; Schniederbruns, B.; Stöcklin, V.; van den Boom M. (2009): ISOBUS meets the farmer: Multi-manufacturer ISO-Terminal. Proceedings 67th International Conference Agricultural Engineering / AgEng 2009, pp. 463-468

[4] Klose, R.; Penlington, J.; Ruckelshausen, A. (2009): Usability study of 3D Time-of-Flight cameras for automatic plant phenotyping. Proceedings CIGR-Workshop Image Analysis for Agricultural Products and Processes, pp. 17-93

Authors

Dominik Bosse and **Thomas Kinder** are project engineers with the Competence Center ISOBUS e.V., Zum Gruthügel 8, 49134 Wallenhorst, E-Mails: dominik.bosse@cc-isobus.com and thomas.kinder@cc-isobus.com

Timur Dzinaj is managing director of the Competence Center ISOBUS e.V., E-Mail: timur.dzinaj@cc-isobus.com

Ralph Klose is a research assistant with the „BoniRob" project (autonomous field robots) at the faculty of Engineering and Informatics; University of Applied Sciences Osnabrück, Albrechtstr. 30, 49076 Osnabrück, E-Mail: ralph.klose@gmx.de

Arno Ruckelshausen is lecturer at the faculty of Engineering and Informatics, University of Applied Sciences Osnabrück and head of research at the CCI e.V., Albrechtstr. 30, 49076 Osnabrück, E-Mail: a.ruckelshausen@fhos.de

Remark

The authors cooperate within the COALA (Competence in Applied Agricultural Engineering) project.