ISOBUS DEMONSTRATOR AND WORKING ENVIRONMENT FOR AGRICULTURAL ENGINEERING EDUCATION

D. Bosse, T. Kinder , A. Ruckelshausen

University of Applied Sciences Osnabrück
Faculty of Engineering and Computer Science
Osnabrück, Germany

Competence Center ISOBUS e.V.
Wallenhorst, Germany

T. Dzinaj

Competence Center ISOBUS e.V.
Wallenhorst, Germany

R. Klose

University of Applied Sciences Osnabrück
Faculty of Engineering and Computer Science
Osnabrück, Germany

ABSTRACT

ISOBUS is the international accepted standard for the communication on agricultural equipment. The world´s first multi-manufacturer initiative developed an ISO-compatible terminal that is in combination with a sensor system the key component of the demonstrator. A state-of-the-art 3D Time-of-Flight camera has been chosen as a sensor system for ISOBUS integration. This camera provides a single sensor output of the projected volume in relation to a predefined surface. The sensor signal then is transferred and visualized in the ISO-Terminal. This ISO-compatible development of the software and system integration serves as an example for an ISOBUS working environment for education at University level. The system can be adopted to interdisciplinary groups of students, ranging from agriculture to electronics and computer science. Moreover, applying the integration of standard ISOBUS interfaces in research, field tests can be performed more easily using compatible machinery of farmers. Thus the working environment has a high potential for education as well as research.

Keywords: ISOBUS, 3D-ToF cameras, education

STANDARDIZATION OF THE COMMUNICATION BETWEEN AGRICULTURAL MACHINERY – THE ISOBUS

The number of electronic components in agricultural machinery has strongly increased during the last decades. As a consequence of this development farmers were confronted with a high number of different and complex handlings for their machinery caused by the diverse concepts of the agricultural machinery manufacturers.

In order to standardize the handling of the machinery a project in Germany was started that was called “Landwirtschaftliches Bussystem” (LBS). Its focus was concentrated on the development of a communication between a terminal and the agricultural machine. Using the terminal the farmer was able to handle the machine. This (national) standard could not be enforced in practice because of several reasons.

The operations on the LBS finally lead into the development of the international standard ISO 11783 that is also called ISOBUS (ISO 11783 Parts 1, 2009). The main aspect of the ISOBUS is the use of only one terminal for all compatible devices. First machines using this system were disposed at the beginning of this century. In spite of this standardized system problems arose, if i.e. a machine is handled with a terminal from a manufacturer that is not the manufacturer of the machine. Affected by these problems farmers were frustrated and started to accept this standard no longer. Until today this is still a problem (Hieronymus and Henninger, 2009), however, initiatives such as the "Agricultural Industry Electronics Foundation (AEF)” are working to improve the situation.

First multi-manufacturer initiative

Well know of these deficits in the compatibility of ISOBUS machines six agricultural machinery manufactures (AMAZONE, GRIMME, KRONE, KUHN, LEMKEN and RAUCH) decided to work together in order to turn ISOBUS into practice. The companies founded an association named “Competence Center ISOBUS e.V.” (CCI). The work of this association – as one initiative within AEF - concentres on the following issues (Dzinaj, 2009):

- Improvement of usability of ISOBUS technology
- Common development of an ISOBUS-Terminal
- Implementation of unique and multi-manufacturer menu navigation
- Development of a driver-software for electronic control units (ECUs)
- Ensuring the compatibility by hard- and software-tests

By realizing these issues, the CCI wants to increase the acceptance of the ISOBUS standard in the agriculture.

As a first result of this cooperation the companies (including competitors) have developed a multi-manufacturer usability concept for different applications, such as fertilizers or potato harvesting. In order to realize the concept, a new state-of-the art ISOBUS terminal has been developed to demonstrate the usability concept. Figure 1 shows a first presentation of this concept in 2009. Meanwhile more machinery manufacturers, such as PÖTTINGER or BERGMANN have joined the association. First field experiences with the new concepts and terminals will be available in 2010.

Fig. 1. Presentation of the multi-manufacturer ISOBUS terminal in 2009.

ISOBUS AS A FACILITY OF EDUCATING STUDENTS

The ISO-compatible development of software offers the opportunity of integrating components such as sensors into the ISOBUS system. Signals of the sensor are transferred via the ISOBUS to the terminal. The received information is displayed on the screen of the terminal and can either activate other processes via ISOBUS or log sensor information together with GPS data.

Since many parts of this development are standardized by the ISO 11783 a chance is given to educate students in agricultural engineering. The students may be involved in laboratory experiments or projects. Dependent on the courses (engineering, computer science or agriculture) the level of complexity can be adopted. Furthermore the integration of standard ISOBUS components in research, field test can be performed more easily using the high amount of compatible machinery. This results in a reduction of development steps. The lack of integration of ISOBUS technologies into education was an important result of a large research project in precision farming technologies in Germany (Werner et al., 2008).

This way of using the ISOBUS technology has a high potential for the education of students and for research. The considerations of the authors how to move this in to practice led into the development of an ISOBUS demonstrator that is described in the following.

THE ISOBUS DEMONSTRATOR

The multi-manufacturer terminal from CCI and a sensor system are the key components of the developed ISOBUS demonstrator. An innovative 3D Time-of-Flight (ToF) camera has been chosen as sensor system for the integration. These elements are named as demonstrator components and are described in the following.

ISOBUS terminal

The development of the terminal from CCI (see fig. 2) was focussed on the facets usability, user-friendliness and interoperability. Furthermore the multi-manufacturer concept guarantees the user a handling that is independent from the machine. The following aspects are of importance (Dzinaj T. et al, 2009):

- Manufacturer-comprehensive menu navigation and input of values
- A high recognition value by the use of equal pictograms
- Adaptation of the user interface
- Overall identically hardware equipment of the terminal
- Compatibility by the use of uniform driver software
- Ergonomic design of the terminal

Fig. 2. CCI ISOBUS terminal.

3D Time-of-Flight camera

The 3D ToF camera (fig. 3, right) from ifm provides the direct distance information. Moreover, a single sensor output of the projected volume in relation to a predefined surface is available. The opportunity of receiving this calculated information directly from the sensor is the reason for integrating this sensor into the demonstrator. The functional principle of the camera is described according to the left side of Fig. 3.

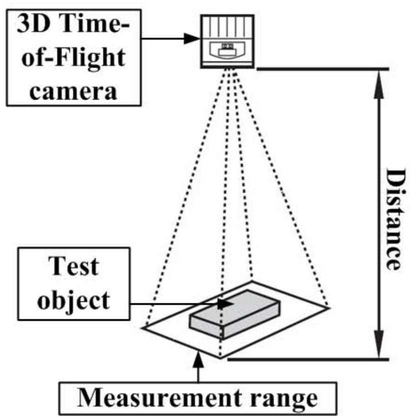


Fig. 3. Functional principle (left) and 3D- Time-of-Flight camera (right).

The camera determines the distance to the object by the time-of-flight principle. Therefore the time for each pixel is measured that is needed for the distance from the camera to the object and back. With the help of this information a 3D information of the test object is given directly. Since the distance to a predefined surface is known the camera calculates the projected volume of the object in the measurement range. Thus volumes of – for example - agricultural material (such as potatoes, grass or wheat) can be estimated.

A further reason of having a 3D ToF camera in the demonstrator is the importance of these cameras in agricultural applications. Klose et al. (2009) have performed a usability study for 3D ToF cameras for phenotyping applications under outdoor conditions.

SYSTEM STRUCTURE OF THE ISOBUS DEMONSTRATOR

The system structure includes the demonstrator components and a microcontroller, which works as an ECU in this ISOBUS system. The controller is a standard XC167 microcontroller from Infineon. This assembly is shown in fig. 4.

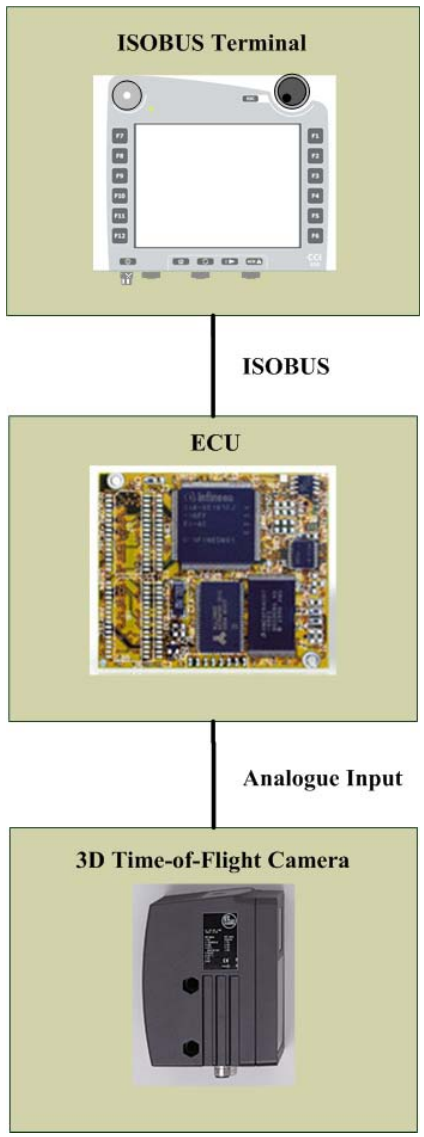
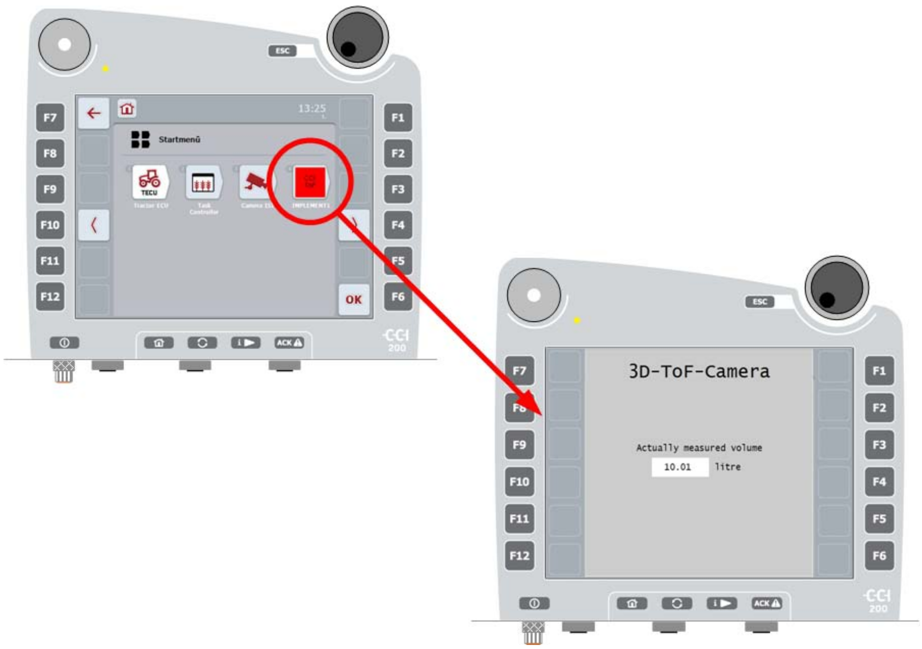


Fig. 4. System structure of the ISOBUS Demonstrator.

Information from the single sensor output is the analogue input of the ECU. The received data is transferred by the ECU to the terminal using the ISOBUS. The transmission of the sensor information via the bus system is handled by the CCI driver software that is implemented on the ECU. In order to display the



information from the sensor, which means the volume, a graphical user interface (GUI) for the terminal has been developed. This GUI can be seen in fig. 5.

Fig. 5. GUI of the ISOBUS demonstrator.

By selecting the encircled button in the start menu of the CCI terminal the user interface is opened. The actually measured volume is displayed in the white field in the centre of the screen.

Assembly in the laboratory environment

In order to arrange verification of the ISOBUS demonstrator, an assembly has been developed that enables the testing in the laboratory environment. The assembly in the laboratory even contains the demonstrator components as it can be seen in Fig. 6.

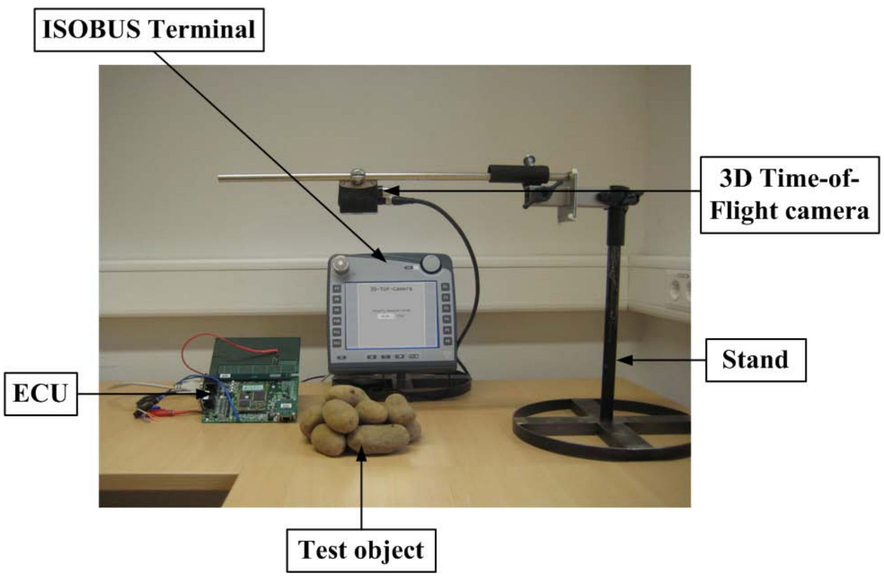


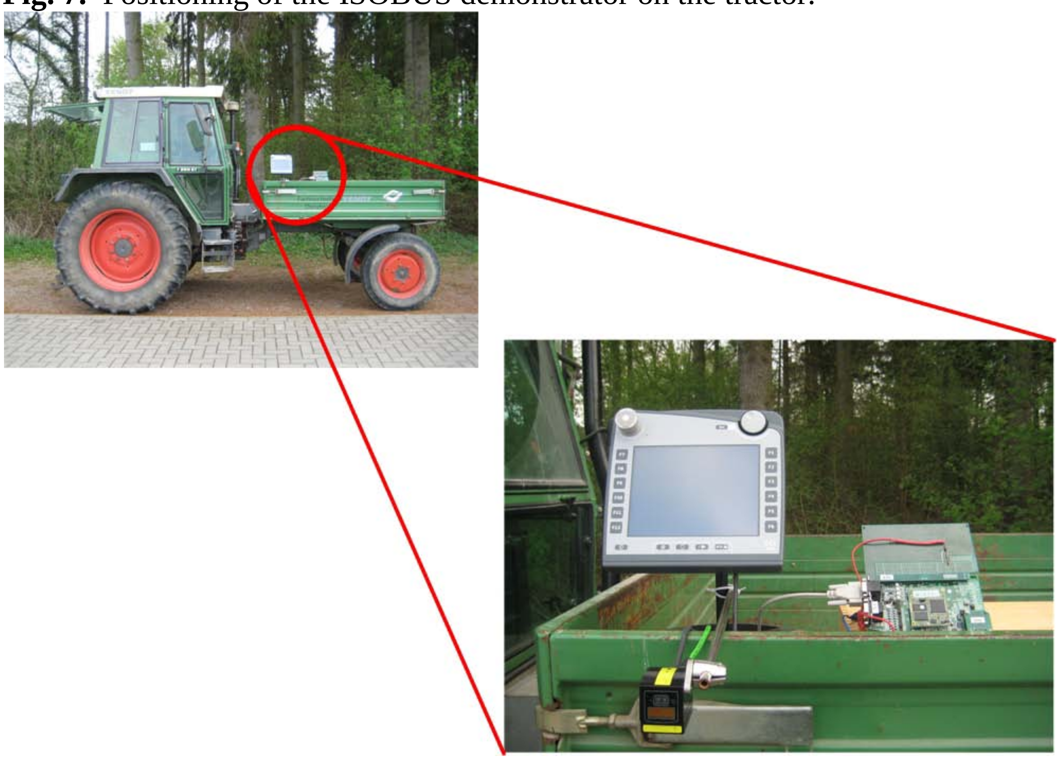
Fig. 6. Setup of the demonstrator in the laboratory environment.

The 3D ToF camera is mounted on a stand in order to measure the volume of the test objects that are placed underneath. In this assembly potatoes were chosen as test object.

VERIFICATION OF THE ISOBUS DEMONSTRATOR

Next to the verification of the developed demonstrator in the laboratory environment, the demonstrator has also been applied in a field test. In order to arrange this test, the demonstrator components were installed on a tractor. The positioning of the demonstrator itself and its components in detail can be seen in Fig. 7.

Fig. 7. Positioning of the ISOBUS demonstrator on the tractor.



The distance from the 3D ToF camera to the ground in this assembly is 1.43m. The camera has been mounted on a bar in order to have a higher distance to the tractor. The volume of objects, which are placed on the ground, can be detected on this way without having parts of the tractor in the measuring range.

Proceedings in the field test

In the realized procedure of the field test the tractor (with the mounted demonstrator) drives along a line of test objects. Therefore three clusters of potatoes were placed on the ground. The first cluster has a volume of ten litres, the second a volume of twenty litres and the third one 26 litres. The potatoes are then positioned starting with the smallest volume and ending with the biggest volume. This assembly can be seen in Fig. 8.

At the beginning of the test the tractor starts driving at the left (yellow) pylon. The tractor drives with a constant speed of 0.1 km/h towards 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 visualised in the diagram in Fig. 9.

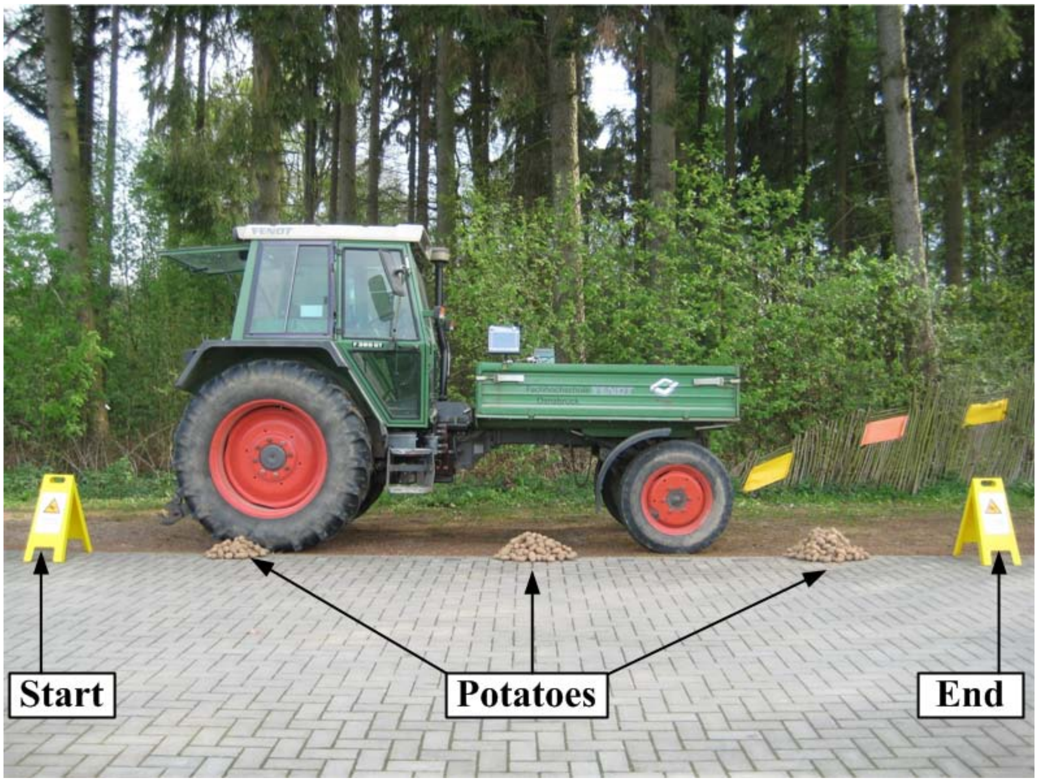


Fig. 8. Test of the demonstrator with a tractor and potatos.

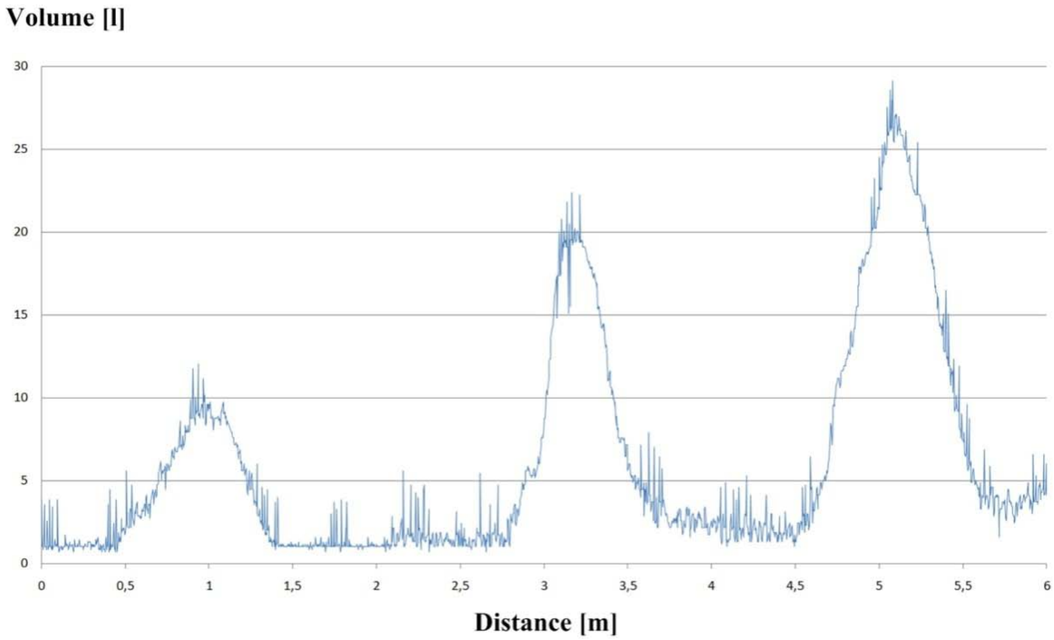


Fig. 9. Measured volume of the 3D-ToF camera for the test shown in fig. 8.

The diagram shows that the recorded volumes are close to the values measured previous to the test (10 l, 20 l and 26 l), the accuracy is about 5 %.

CONCLUSION

The technical complexity of agricultural machinery will rise in the future so that it gets more important to learn and apply technologies such as the ISOBUS. This standard enables the development of machines that are compatible to other ISOBUS machines. This is of high value for the farmer in his daily work.

Since this technology gets more important in the agriculture it is necessary to educate students in agricultural engineering. The developed demonstrator serves as an example for the integration of ISOBUS standard into laboratory experiments of projects. The students learn the ISO-compatible development of the software and the system integration.

Another advantage of the ISOBUS is highlighted by the demonstrator: the integration of further components like sensors into the system of a machine is performed more easily by this standard. With the use of standard components this results in a reduction of development steps.

BIBLIOGRAPHY

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 Inernational Conferenc Agricultural Engineering / AgEng 2009, pp 463-468.

Hieronymus, P. and Henninger,G. 2009. ISOBUS – Current Status and Challenges in Development, Implementation and Practical Application, Yearbook Agricultural Engineering, DLG-Verlag, Editors H.-H.Harms, F.Meier, pp 34-40.

ISO 11783 Parts 1 2009. 14 Tractors and machinery for agriculture and forestry – Serial control and communications data network, Beuth-Verlag, 2009 (and earlier).

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", ISSN 0947-7314, pp. 93-17.

Werner, A., Dreger F., Schwarz, J. (editors) 2008. Informationsgeleitete Pflanzenproduktion mit Precision Farming als zentrale inhaltliche und technische Voraussetzung für eine nachhaltige Entwicklung der landwirtschaftlichen Landnutzung Research projekte "pre agro II", final report.