ROLE OF INFOCOMMUNICATION SYSTEMS IN PRECISION FARMING

A. LÁGYMÁNYOSI- I. SZABÓ – T. TÍMÁR

Szent István University, Faculty of Mechanical Engineering
2100, Gödöllő, Páter K. u. 1., e-mail: lagymanyosi.attila@gek.szie.hu

Abstract. *Installation of up-to-date sensors and controllers to an agricultural implement that is beginning to date is a quite complicated issue. Solving this kind of problem for an anachronistic tractor is simpler as a lot of complete controlling systems can be found on the market. These systems are compatible to each other and they are also ISOBUS conform. Adapting an adequate controlling system results a modern tractor that is able to operate a smart machine. In this article we review some useable controlling systems that our experimental tractor could be equipped with and evaluate that we could utilise the precision functions.*

Keywords: *Precision agricultural machinery, controller network, ISOBUS*

INTRODUCTION

The Precision Farming aim to managing variations in the field accurately to grow more food, using fewer resources and reducing production costs.

The most common technologies applied to Precision Farming practices, the next.

High precision positioning systems (like GPS) are the key technology to achieve accuracy when driving in the field, providing navigation and positioning capability. **Automated steering systems** enable to take over specific driving tasks like auto-steering, overhead turning, following field edges and overlapping of rows etc. **Geomapping** used to produce maps including soil type, nutrients levels etc. in layers and assign that information to the particular field location. **Sensors and remote sensing** collect data from a distance to evaluating soil and crop health (moisture, nutrients, compaction, crop diseases, etc). Data sensors can be mounted on moving machines and /or stand alone stations on field. **Integrated electronic communications** could happen between components in a system for example, tractor and tractor, tractor and farm office, tractor and dealer, tractor and fertiliser machine or any other apparatus. These are using cable or telemetric communications. **Variable rate technology (VRT)** has the possibility to adapt parameters on a machine to apply, for instance, seed or fertiliser according to the exact variations in plant growth, or soil nutrients and type etc. These technologies are the main cause of the newer and newer **Computer-based applications.** These applications can be used to create precise farm plans, field maps, crop scouting and yield maps. This, in turn, allows for the more precise application of inputs such as pesticides, herbicides, and fertilizers, thus helping to reduce expenses, produce higher yields and create a more environmentally-friendly operations.

The smart machines and tractors are the most important basis of the mentioned technologies. Nowadays the widely applied older tractors does not have smart features therefore these tractors are not suitable to precision farming.

One way to handling this problem is replacing the tractor to smarter one, or an other way to setting up the additional electronic and informatics function to the old apparatus.

Installing sensors and controllers on traditional machinery in order to operate it as an intelligent piece of equipment is a difficult task. On the other hand, numerous producers offer solutions for retrofitting traditional tractors with intelligent controlling systems. These are, in some extent, compatible with each other by providing ISOBUS conformity. By using these retrofitted systems such an automotive machine can be created that is able to control intelligent agricultural machinery.

In this article we discuss the systems suitable for controlling a precision machine and describe the structure and function of a selected system.

In case of developments related to the ISOBUS system a reference network shall be established to which the self-developed equipment can be connected for testing their functions. At the early phase of the development a network with suitable parameters can be built even in a laboratory environment. However, in case of testing prototypes under realistic conditions field examinations and measurements are necessary; therefore, it is recommended to install the reference network in an automotive machine.

High-priced machines equipped with an ISOBUS system are obviously eligible for testing the performance of such prototypes, but these are not always available and the warranty does not cover this kind of utilisation.

Lower valued tractors can also be retrofitted with the ISOBUS system; producers offer different solutions for achieving this result. Hardware elements of these retrofit ISOBUS systems are joined to the original system of the tractor by only a few connection points, unlike the above-mentioned high-priced machines into which the ISOBUS is being integrated together with other systems.

Clearly distinguishable hardware elements of retrofitted systems provide the possibility of implementing such modifications during the test phase that can minimise the potential damaging of machines caused by the failure of tested equipment. For example, an emergency stop device can be built in so that the entire ISOBUS system could be disconnected by the push of a button.

Based on the above considerations we decided to acquire a retrofit ISOBUS system. Among the major producers Ag Leader, ANEDO, Kverneland, Müller Elektronik, Reichhardt and Topcon offer this kind of solutions.

After comparing the systems available on the market we chose the ANEDO open_system providing basic ISOBUS functions. This system has been installed on our Claas Ares 576 ATZ tractor.

MATERIAL AND METHODS

Hereby we introduce and describe the elements of the system as well as their functions and structure. First of all we give an overview of the wire harness representing the backbone of the entire system as well as the hardware elements responsible for power supply and electricity (Figure 1).

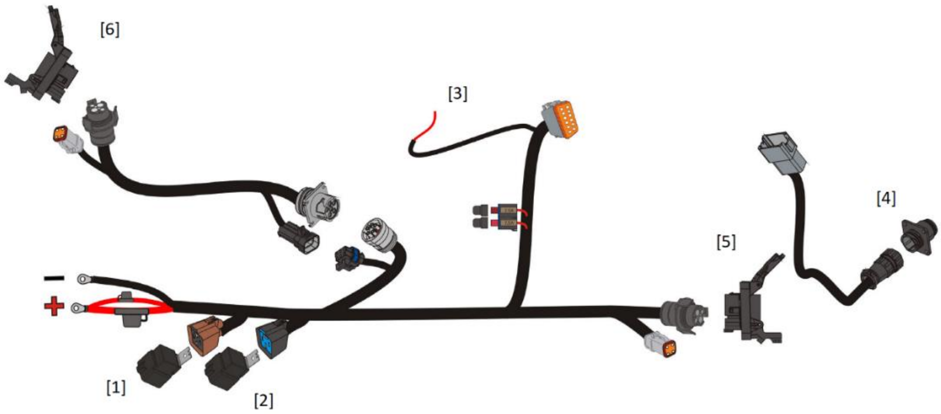

Figure 1. ISOBUS connectors and wire harness

The system receives power directly from the battery; it includes a 12V 30/40A relay [1] for ECU power and a 12V 70A relay [2] for main power. These relays are connected to checkpoint 15 of the tractor [3] that can be found beyond the ignition switch, thus when the ignition of the vehicle is switched off, the power supply of the ISOBUS system is ceased, too.

The system has one in-cab [4] and two breakaway connectors. These are standard connections; the primary (rear) breakaway connector (implement bus breakaway connector, IBBC) [5] has an active terminator (terminating bias circuit, TBC), while the secondary (front) one [6] is a passive terminator.

The tractor does not have a 3 point hitch top link, therefore the IBBC connector and its wire harness have not been installed. An active terminating element (TBC) was connected instead.

The Tractor Electronic Control Unit (TECU), the Universal Terminal (UT) and other accessories (AUX) are connected to the system via the in-cab connector. The installed system includes an ANEDO open_panel T50i terminal and an ANEDO open_ISOBUS box with switches (Figure 2). The minimal functionality of TECU is implemented by different components of the built-in terminal software.

Figure 2. ANEDO open panel T50i terminal and ANEDO open ISOBUS box with switches

This terminal offers one CAN, two RS232, five signal (digital/analogue input), one video and one USB interface. Out of them the CAN interface is currently used for ISOBUS communication, the USB port is necessary for down- and uploading data using pendrives, while a Garmin GPS 19x HVS GPS device using NMEA 0183 protocol is connected to one of the serial ports. An inductive sensor is attached to a digital input in order to measure distance by detecting wheel revolution.

Based on the data provided the above-mentioned devices the TECU application run on the terminal sends the speed values measured by wheel revolution (Wheel-Based Vehicle Speed) and GPS data (Navigation-Based Vehicle Speed).

RESULTS AND DICUSSIONS

The software allows to add further components that, after connecting them to the remaining free interfaces, can provide new sets of data. For example, signallers from power take-off (PTO) and from the 3 point hitch can be connected engaging one analogue interface each. They can give information on the Rear PTO output shaft speed and Rear hitch position.

Other applications available on the terminal are related to different functions of the UT. The currently used licence contains the precision functions of parallel tracking (Figure 3), TC-BAS

(Task-Controller Basic) and TC-GEO (Task-Controller Geo Based), but the licence can be extended in order to reach other functions such as TC-SC (Task-Controller Section Control).

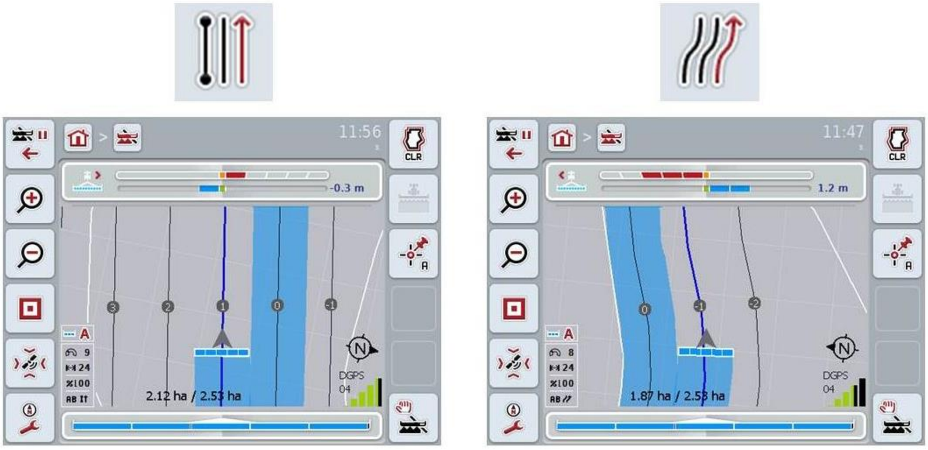

Figure 3 Parallel Tracking straight and curve mode

The box with switches has additional switches and buttons that can be programmed to manage different functions of the connected machinery. For instance, section control can be implemented via this device. Furthermore, it plays an important role in testing self-developed tools and equipment, since AUX control is a very complex part of the ISOBUS protocol.

CONCLUSIONS

With the help of the installed system the tractor is able to control and handle precision machinery. Moreover, it can be used for field examinations and measures as well as for testing self-developed devices.

The standard connectors ensure the plug and play connection for all machinery using ISOBUS system. Applications run by the terminal fulfil different precision functions such as row alignment, creation of parcel maps or the recording of completed works assigned to each plot in the field.

The system can be developed and improved. New and useful data can enter the network by installing additional sensors. These data can be used by the machinery for performing their precision functions. The number of these functions can also be increased by installing new applications. For example, the automatic section control of sprayers, fertiliser distributors and seeders can be accomplished.

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