IMPLEMENTING SECTION CONTROL SYSTEM FOR CONVENTIONAL PLANTERS

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Abstract. *This article introduces a method to improve a conventional planting machine capability to work by an ISOBUS system section control. Utilisation of the experimental planter can improve the effectiveness of the plant production and can make this precision technology more economic.*

Keywords: *ISOBUS, Rate Controller, section control*

INTRODUCTION

The technical improvement of agriculture recently involves two main areas: reaching the required power by stronger power engines and the optimal utilisation of existing power by using IT tools. The constant technical developments have made it possible to provide stable power needed for hauling and operating the working equipment. Physical dimensions limit the growth of machinery; the highest possible power must be derived from the finite volume. Agricultural machines become more and more complex mechatronic systems. One of the most intense fields of development is the replacement of hydraulic power transmission. Electrical cables and powerful electric engines fulfil the necessary tasks instead of high pressure and cumbersome pipes.

During the last decade information technology has been rapidly developed in the agriculture. Today the term precision agriculture (PA) covers all advanced technologies utilised in agricultural production. There are two fundamental technical pillars of PA:

- high accuracy geolocation: (GNSS1, RTK2)
- standardised infocommunication networks: computer systems of tractors and machinery can communicate on a standardised platform via an ISOBUS system.

The above-mentioned info-communication technologies provide the basis for precision machine operation. These precision methods mean location specific and specimen specific interventions in plant production and animal husbandry, respectively.

Today's most widely used precision machine applications are: **Automatic steering, Turn Automation in Headland, Section Control, Documentation Active and Passive Implement Guidance System, Variable Rate Technology (VRT).** One of the key solutions of precision machine operation resulting considerable savings is section control. In case of implementing section control the working range is divided into sections. The tractor controls the operation of the machinery by taking already cultivated areas and parcel boundaries into account. For example, in a given operating situation of a six-row planter the system does not switch all the six rows off, but only that the rows that become needless. In this way overlaps can be avoided, but seeds will be delivered to all utilisable areas. For completing these tasks high accuracy geolocation (in Hungary it means an accuracy of 2.5 centimetres with RTK networks) and machinery applied with ISOBUS system.

One hindrance to developing technology is the acquisition of necessary machinery. The cost of machines equipped with such advanced info-communication systems is high. There may be compatibility issues among the different machines. Generally agricultural holdings with an area larger that 300 hectares have the financial conditions for implementing such investments. Moreover, the parcels of smaller farms are often tiny and irregular. In these lands overlaps between sessions are much more frequent, especially when cultivating sides and the last row. In case of small parcels these situations arise in greater number than during large-scale production.

In our research covering the area of precision machining we examined how an outdated machine could be retrofitted with an ISOBUS network and in which way could this system be attached to an advanced tractor having micro-controller network. The aim was to create a complete unit suitable for implementing precision arable farming operations.

MATERIAL AND METHODS

The John Deere 6R Series tractor used for section control has everything that is needed for this task (i.e. RTK, ISOBUS and activated AMS application). Section control is provided by installing the John Deere Rate Controller 2000. The tractor accesses this controller via the ISOBUS connection. Sections of the Monosem NG4 Plus conventional planter can be electronically controlled by hand. The Rate Controller 2000 performs automatically the task of switching sections on and off according to the commands received through the ISOBUS. After the system configuration the tractor is able to identify the planter and recognises its parameters (i.e. type, number of sections, physical dimensions).

Figure 1. ISOBUS connection and wire harness

Figure 1 shows the ISOBUS connection of the tractor (right side) to which the "smartened up" machine can be connected. The controlling computers of the tractor and the planter maintain direct data flow via this connection. Based on the exact geographical coordinates the controller of the tractor can send commands on switching the sections on or off. The current installation of Rate Controller 2000 makes unidirectional information flow possible: the tractor sends commands to the machine.

Figure 2. Planter on the Virtual Terminal

Figure 2 shows the display of the tractor's virtual terminal. The controller identifies the parameters of the machine that are shared through the ISOBUS connection. It can be seen that the JDRC2000 controller can deal with six sections – six rows. The number of seeds to be sown is also indicated. In this configuration the controller cannot adjust this value. The data is included for the documentation.

The controller shall be connected to the ISOBUS network. ISOBUS is a type of CAN network: beside the feed line it includes two signal lines and the grounding. The controller shall be connected to the sections one by one. In this article we used a six-row planter, although the controller can manage more than six sections. This controller in this configuration can only switch the sections on or off. Section control can be implemented for several workflow processes (e.g. administering chemicals during sowing).

Figure 3 shows the connectors of Rate Controller that includes both the signal cables heading toward to the ISOBUS connector, power supply, CAN terminator and the controlling outputs of the sections. Connections were established based on the manuals of Rate Controller and on the implemented measures.

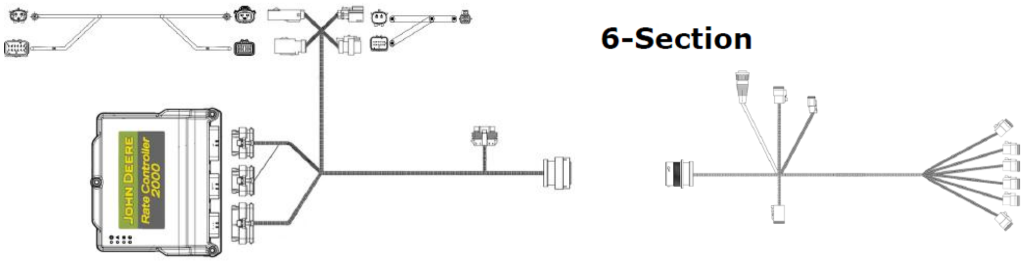

Figure 3. Connection of the Rate Controller

After establishing the connection the tractor identifies the planter and its sections. The tractor can, via the ISOBUS connector, control the sections by using the preset cultivation data. As a result overlaps and the amount of input material is decreased.

RESULTS AND DICUSSIONS

Without applying section control the six-row planter used, in each case, more seeds than the product of the area and the number of seeds would have justified. The increased amount of seeds did not result higher yield. Avoiding overlaps requires extra labour input so that plants can have ideal area for their development. Under section control exactly the necessary amount of seeds can be sown calculated by the area and the number of seeds. Input material is saved by using this method. Without section control seeds are sown in surplus that leads to denser plant cover. If all these plants were left in the field they would compete each other for nutrients, thus less yield will be available by using more seeds. Removing the redundant plants requires extra labour, therefore it leads to increased workforce and energy consumption – beside the larger use of input material.

Figure 4. Section control in working

Figure 4 shows how section control is implemented in practice. The tractor and the machine can be seen in the middle of the picture. The pink line indicates the preset parcel boundaries. The blue area is already planted where the machine has already been to. It is obvious where overlaps occur on row level. In case a whole row would be overlapped, the controller switches it off. At the bottom of the screen it can be read that the tractor is currently using the following systems: documentation, automatic steering, automatic turning and section control.

Another great advantage of precision agriculture, beside control section, is the ability of changing the amount of seeds sown. Based on a preset covering map section control always administer the amount assigned to the certain coordinates. Redundant rows are switched off according to the completed work (covered areas) and the boundaries. A covering map is also needed for implementing varied intensity sowing. The tractor possesses this ability, however the planter is currently not able to perform this feature. Such machinery would be needed for which the amount of sown seeds ran be electronically regulated. The number of seeds is indicated, but it serves only documentation purposes. The preset number of seeds will be recorded for the completed work, although it is not necessarily the same as the number set for the planter. Later on, we would like to examine the feasibility of varying amounts (VRT) of application on this conventional Planter with the JDRC control unit.

CONCLUSIONS

By using the control system described in this article traditional seeders can be engaged in precision farming. The same quantity and quality of products can be achieved by decreased use of labour and input material in case of applying section control.

Figure 5. Result of section control

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