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Self-configuring Mobile Networks for Agriculture

Based on a mobile, electronic satellite system designed to position and transfer security and operation data of mobile working machines, the Technische Universität Berlin developed an instrument to independently connect net different devices and machines for the collection of process data, control and diagnoses purposes. In addition to the technical details of the modules, this paper gives an overview of possible applications of such systems in agriculture.

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Keywords

GPS, agriculture, self-configuring mobile networks, ZigBee

The centre of this unit is a PAN module controlled by a micro controller (PAN = private area network). Based on the wireless standard of ZigBee, the network is able to independently establish networks even over huge distances, via multi-hopping. The modules act independently, having analogous inlets, e.g. for temperature control as well as digital inlets and outlets, an integrated CAN interface, a GPS receiver and, if required, they are additionally fitted with a GPRS port for data transfer via internet. The cluster is composed of autonomously working modules, so-called ESOboxes, constantly being in radio contact to one another (*Fig. 1*).

The radio standard ZigBee has been chosen as internet infrastructure. On the one hand, this stack is based on the IEEE 802.15.4 standard, on the other hand it bases on the ZigBee protocol of the ZigBee alliance. The collected data are buffered in each box on a SD card. As all data packages have a time stamp, it is always possible to dispose of the latest data. The data are decoded and compared. In fixed intervals, the server then sends the data of the entire cluster to the headquarter. The common data format is XML.

Agricultural Applications

Agricultural engineering processes have to carry out ecological and economical demands. Especially the tracing of food is important for consumer protection. At the same time cost reduction is necesarry for farmers being competitive. This demand is independent of farming type – conventional or organic.

Figure 2 shows the agricultural production process with different sub-processes like tillage, sowing and so on. Each sub-process consists of further sub-processes which can be very different. The self-configurating network described above using ESOboxes facilitates multiple application varieties in the field of agriculture.

Control of mobile agricultural machines

With a machine being equipped with an ESObox and CAN interface, it is possible to realize communication between the machine and the headquarter. This helps to establish services like remote maintenance and diagnosis, remote operation and manipulation as well as process and machine modelling. By using teleservice technologies, it is possible e.g. to cyclically store and send data regarding load, environment conditions and wear characteristics to a central databank within the operation process. Thanks to the increased number of measured data per machine type, manufacturers are in the position to set up highly reliable analyses even after a short period of time. Furthermore, they can more

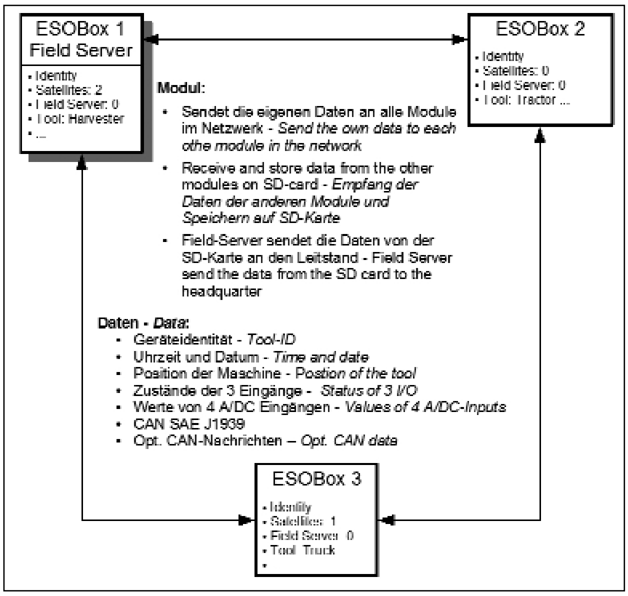

Fig. 1: System self configuration process

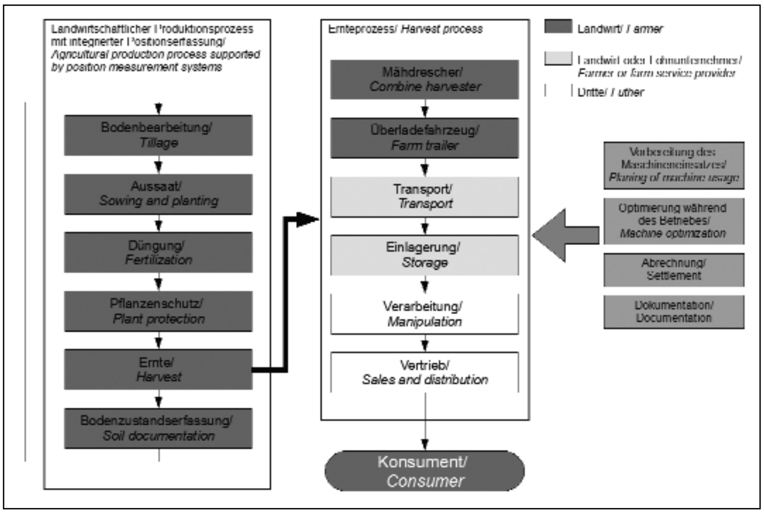

Fig. 2: Agricultural production process and the harvest process

precisely develop utilisation and damage profiles for the individual machines and, thus, offer useful new services to the operators, such as individual adjustment hints and maintenance measures.

Teleservice applications exist for a great number of products. In the field of mobile working machines there is only little use of teleservice systems. The reasons are high costs, the missing data infra structure, and the need for special customer service [1, 2]. Göres presented an actual telesesevice research project called DAMIT [3]. They want to develop a data management system for a teleservice application on mobile working machines. They define four major objectives of their project: Development of new maintenance strategies for exemplary sub-assemblies, methods to reduce the amount of data to transfer, methods to optimise communication and data storage and methods of process modelling of a sugar beet harvesting chain and a service workshop.

The ESOB-system can be a useful part of such management systems.

Flexible, self-configurating and dynamical data transfer between different mobile agricultural machines

Automated wireless communication between the individual agricultural machines, e.g. crop harvester and shuttle, facilitates data transfer, e.g. in order to improve the loading of the transport vehicle by adjusting the driving speeds. At the same time, it is possible to transfer the data the harvester stored (such as harvest data depending on the position) to the shuttle, which then leads to the next application.

Constituent of a universal agricultural process and quality documentation system

Due to the wireless data transfer, the network can turn into the basis of a universal agricultural documentation system, shown by the example of the harvester. Harvest data depending on the position as well as other crop data can be transmitted from the harvester's ESObox to the ESObox of the transport vehicle while transferring the crop. The transport vehicle thus disposes of all information about the crop, e.g. place of harvest, harvest condition, harvest time, etc. These data can then be transferred to the following crop stages, setting up a complete information chain up to the consumer. It is an advantage that the crop need not be fitted with data media in the harvesting process, which would have to be removed later with difficulty. However, a problem might be the sizes of the considered crop charges and potential commingling with different charges, impeding clear retracement.

The communication system needs standardized data formats and protocols. In the area of mobile machine communication the usage of CAN systems is standard. Typical standards are SAE J 1939 and ISOBUS ISO 11783. These standards allow the communication between machine and diagnostic tools. Actual USB storage sticks and SD cards are used to transfer data from the machine to the farm office's personal computer and the farm management information system (FIMS) [4]. Systems which use GRPS breed costs. This is a barrier for market penetration. Non-open communication systems are another barrier, i. e. systems which allow only the communication between machines of one manufacturer. Special sensor systems are necessary for the quality determination. Regarding grain quality determination in the combine, near infrared spectroscopy (NIRS) can be employed. The gathered machine data can be imported into FIMS. Farmers or farm service providers will thus have detailed information on which machines are used in what way on which field.

In order to provide other partners with these FIMS information set up these, e. g. production and process chains, the agroXML standard is used [5]. This standard facilitates easy importing and exporting data into different software applications as all process data and variables are standardized. It will be reasonable here to implement an interface via agroXML as this will be the interface between lifestock farming and plant production in future.

Conclusions

The usage of modern information and communication systems helps to optimize agricultural engineering processes. The collected data can be used for machine control, diagnosis and documentation. Especially the documentation of harvesting processes is necessary for general quality documentation of food. The presented system using the ZigBee-Standard fulfills the demands on mobile communication systems for mobile working machines. Further investigations at the Technische Universität Berlin will improve the practical use in harvesting machines and the data security

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