Intelligent Sensor Networks in Farming Machines

Name of the Organisations Involved

- CLAAS Selbstfahrende Erntemaschinen GmbH, Germany
- Universität Bielefeld, Germany

Challenges Identified

Every harvesting process is a big challenge. The combine harvester must be continually adapted to the conditions of the field and the weather because the plants can vary greatly in their size, their spikes, the number of grains and grain size - due to soil influences, water points, shadow formation or different management of the field. This means there is no ‘standard’ setting for a combine harvester.

How can the harvesting process of a combine harvester be better monitored?
How can the person operating the machine be relieved?

These are valid questions related to the identified challenges and to be answered by the good practice example. Scientists from the Research Institute for Cognition and Robotics (CoR-Lab) at Bielefeld University and the agricultural machinery manufacturer CLAAS in Harsewinkel (Gütersloh district) addressed these questions in the innovation project 'Intelligent sensor network for determining process variables' (InSensEPro).

Goals and Solution

Machine learning and AI algorithms are used to detect and locate plant species from the composite drone. The goal of the InSensEPro project was to develop an intelligent sensor network for combine harvesters. The system is intended to precisely determine and interpret grain loss directly during harvest. This means it can recommend to the person operating the machine how to optimize the harvesting journey.

Actions taken

The first step was to find a sensor system that was actually able to determine the desired grain loss. The harvest throughput is immense – up to 120 tons per hour. Capturing this with sensors is a challenging task. In order to avoid blockages or other negative effects, the volume flow must not be hindered by the measurement. At the same time, there are harsh operating conditions during the harvesting process, which rule out classic optical processes such as the internal use of cameras, especially due to the massive amounts of dust. The mechanical stresses caused by vibrations and the transport of the crop are also an exclusion criterion for most processes. The project team found and implemented a suitable structure-borne sound-based sensor system that is able to reliably measure the grain flow and distinguish it from short straw and other transported material.

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However, this method cannot directly measure the complete grain loss, but only the crop flow for a specific position in the combine harvester's installation space. As a second step, in order to capture enough data to estimate grain loss, suitable mounting positions for the more than 100 sensors had to be found. In addition, to reduce the amount of wiring and the associated influence on the flow of goods, various wired and wireless transmission technologies were experimented with.

An energy-saving wireless transmission technology – Bluetooth Low Energy – has proven to be particularly suitable for this particular application. The sensor network records all relevant data and makes it available to a central control unit for further analysis. The number of data sources resulting from this is in the mid-three-digit range.

However, this large number of data streams that are continuous over time is neither manageable nor interpretable for a single person, the person driving the combine harvester. And here comes the third step. By using artificial intelligence methods, it has been possible to compress the large amount of data for the combine driver into one target variable, grain loss, and thus make it usable and easy manageable.

The result: In a total of 60 harvest days and 46 laboratory days, it was possible to develop an intelligent sensor network that monitors the processes in the agricultural machine and interprets its data using artificial intelligence.

Image: Networking sensors and equipment during the testing. Source: InSensEPro

Image: The combine harvestor at work. Source: InSensEPro

Benefits and Impact

- With the sensor network, grain losses can now be determined much more precisely, so that the driver can optimize the machine settings to better target grain losses.
- This makes it possible to increase the efficiency of the harvesting machine while at the same time optimizing the quality of the harvested crop. In addition, the person operating the machine is relieved.

Contact Information

Marvin Barther

Email: marvin.barther@claas.com

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CLAAS Selbstfahrende Erntemaschinen GmbH,
Website: https://www.claas.com
Other: https://www.its-owl.de/die-projekte-im-ueberblick/innovationsprojekte/innovationsprojekte-1/back-560/insensepro/

YouTube: https://www.youtube.com/watch?v=02G0r6N4nfs

Prepared by

Wolfgang Kniejski (INI-Novation GmbH)

Application Area
☒ Condition of Assets

Digital Technology in the Value Chain
☒ Agricultural Inputs and Services

Digital Technologies
☒ IoT ☒ Sensor Technology ☒ Artificial Intelligence (AI)

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