"EMIL" Real-Time Detection of the Blade Sharpness of Agricultural Machines

Analysis of the blade sharpness of the cutting device of a self-driving forage harvester

Project period
05/2014 – 05/2017

Problem

Self-driven forage harvesters are used for harvesting different biomass. The primarily harvested products, such as maize, triticale and grass, are intended for diverse processing purposes, such as e.g. the production of silage. The quality of the silage depends on the degree of sharpness of the used blades of the cutting device of the forage harvester, among others. To optimise the process chain, it is possible to assess the blade condition by the use of Artificial Neural Networks. This provides the operator of the forage harvester with the option to estimate the condition of the blade during the harvesting process. This, in turn, allows for the targeted initialisation of a blade sharpening process. The thus achieved optimisation of the resources and supplies used can contribute to extending the scheduled maintenance intervals while reducing the successive costs for the farmer.

Solution approach

The piezo electrical vibration sensors integrated into the forage harvester not only permit setting the position of the blade drum in respect of the counter-blade, but also facilitate the use of this data for assessing the vibration pattern during the harvest. The difference in vibration between sharp and blunt blades is to be used as indicator of the blade condition. Additional blade impressions are produced during the harvesting process to provide a qualitative statement on the blade condition. These impressions are subsequently digitised and analysed in the laboratory by 3D acquisition.

Fig. 1: False colour representation of the wear surface of a knife blade

Fig. 2: Photograph of a chopping head with mounted blades

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Result

Using computer-enhanced image evaluation and statistical analyses of the acoustic signals, it is possible to use algorithms for calculating the blade condition. These calculations serve for determining the correct time of sharpening and permit an improved utilisation of the resources used. The use of the integrated vibration pick-ups has proved to be useful correlation signals for determining the wear of the blades. Differences in the vibration signals with regard to the used harvested product could be determined. Using a developed impression process, it was possible to measure the chopper blades used.

Technologies

- Machine learning
- 3D measurement
- Condition monitoring
- Vibration analysis
- Software development

Project partners

CLAAS Selbstfahrende Erntemaschinen GmbH, CSE Predevelopement

University of Kassel, Department of Agricultural Engineering

University of Göttingen (Georg August University), Institute of Crop Sciences, Department of Agricultural Engineering

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Landwirtschaftliche Rentenbank

Publications

[1] Schneider, M.; Schweigel, M.; Walther, C.; Merbach, L.; Hartwig, S.; Wenzel, A.; Beneke, F. und Huster, J.: Detection of the Real Knife Condition of Self-Propelled Forage Harvesters by Automated Image Analysis; 23rd Workshop Computerbildanalyse in der Landwirtschaft; April 2017.

[2] Walther, C.; Wenzel, A.; Beneke, F.; Hensel, O. and Huster, J.: ; Determination of working states of the rotating cutting assembly in forage harvesters by artificial neural networks, at – Automatisierungstechnik, P. 198-206, DOI: 10.1515/auto-2016-0082, März 2017

[3] Walther, C.; Beneke, F.; Merbach, L.; Siebald, H.; Hensel, O. and Huster, J.: Machine-specific Approach for Automatic Classification of Cutting Process Efficiency, Machine Learning for Cyber Physical Systems - Selected papers from the International Conference ML4CPS 2015, Springer Berlin Heidelberg, P. 95-102, 2016

[4] Merbach, L.; Beneke, F.; Walther, C.; Hartwig, S.; Haseney, M.; Siebald, H.; Hensel, O. und Huster, J.: Systematic analysis of the influences on the wear of cutting knives, LAND.TECHNIK AgEng 2015 – Innovations in Agricultural Engineering for Efficient Farming, Conference: Agricultural Enginnering, VDI-Berichte Nr. 2251, pp. 395-404, VDI Verlag GmbH Düsseldorf, ISBN: 978-3-18-092251-5, November 2015