Harvesting process optimization for SPFH Operators

Zeynep Tuncer*, Oleg Rostanin*, Karlheinz Köller, Georg Kormann*

*John Deere GmbH & Co. KG
Straßburger Allee 3
67657 Kaiserslautern
{TuncerZeynep, RostaninOleg, KormannGeorg}@JohnDeere.com
Karlheinz.Koeller@uni-hohenheim.de

Abstract: As precision farming technologies are on the rise and witness a tremendous development, consequently, machine settings and harvesting machines themselves are getting more and more complex. Although the Ag contractor business is growing in whole, the number of fulltime employees is permanently reduced at the same time. As a consequence, farmers depend more and more on seasonal workers who are not as qualified and who are, particular with regard to machine operation, not trained and inexperienced. This paper introduces an overall concept for streamlining harvesting operations via a logical step-by-step guidance routine, which is started at the current job, navigates the operator to the correct field and provides support in the setup of the machine via a single application.

1 Introduction

Due to high personnel turnover and sinking numbers of fulltime employees [BP 14] agricultural contractor companies [SB 14] are forced to hire seasonal workers who are in most cases not as qualified as required. As a rule, contractors do not provide training to seasonal workers, which is why production is not as effective, rather time consuming and characterized by a low machine performance, which also results in a low product quality and a waste of fuel.

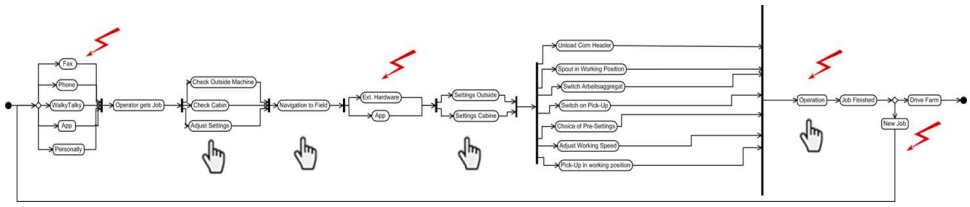

Figure 1: Harvesting process for the SPFH Operator

The current standard procedure for handing over agricultural job plans to the machine operator is via phone, fax or paper. Naturally, this procedure is error-prone and not optimized regarding efficiency. During the previous years, so-called Farm Management

Information Systems (FMIS) were introduced and are currently more and more in use for work scheduling, although these FMIS do not offer complete job execution procedures, nor do they provide navigation features or machine set up configuration tools. Generally speaking, there is no infrastructure or solution available which supports the operator so that he does not have to change hardware or faces physical or logical constraints.

The solution is should be an overall harvesting process optimization app for the operator, which supports the process.

As a consequence, a so-called overall harvesting machine app was developed to support inexperienced operators when setting up harvesting machines. In addition, on-road agricultural navigation is introduced as a new feature for optimizing Ag processes – which range from soil cultivation to harvesting and transport. This paper presents a concept to support the operator during the entire harvesting process with a single, logical step-by-step application, which does not require the operator to use different user interfaces which will finally overstrain him. The concept features a mobile app on a tablet which is integrated in the machine cab. The app logs into a cloud portal, from where it obtains the current job assignment data and job descriptions which contain all required data for forage harvesting operations, e.g., recommended length of cut, kernel processor-space or cutting height. Additional data regarding field location (optimal entry point) or obstacles in the field are also provided by the app. The operator is not any longer required to use the mobile phone or walky-talky to retrieve information, neither does he have to type in parameters into the machine display. The smoothly integrated and adjusted navigation app guides the operator automatically to the field entry point.

When arriving at the field entry point, the operator is provided with logical step-by-step instructions to enter the recommended machine settings.

This paper focuses on the SPFH operator and presents a conceptual study.

2 Related Work

In agriculture, task assignments are currently forwarded to the operator by phone, fax or paper. As previously explained, these types of task assignments are error-prone. The AgDNA mobile app [AD14] can be used for farm planning, record keeping, boundary mapping, worked area mapping, live equipment tracking and scouting observations. AO Lohnunternehmer by Land-Data Eurosoft [LDE14] provides a FMIS which is able to manage job information. The cloud portal also provides a wireless job data exchange feature.

The combination of a FMIS, wireless task transfer and general purpose navigation software (e.g., [TE14] combined with Google Maps App under Android) is a unsophisticated solution which tends to lead to poor navigation experiences if applied in the Ag domain. Existing car navigation solutions do not meet the requirements in the Ag sector because oversized machine dimensions, weight, connected implements, trailers, hazardous chemicals etc. have to be taken into consideration. In this respect, Ag

navigation is similar to navigation solutions for trucks (e.g.,[CG14]). However, the road network which is available for Ag vehicle differs considerably from the public road network for cars and trucks: most of Ag vehicles are prohibited on freeways whereas they have to travel on smaller field and forest roads that are mostly ignored by commercial map suppliers because of the relatively small number of potential users as compared to those in automotive areas. Lacos[LC14] is a pioneer in providing Ag specific navigation solutions which take vehicle weight and height into account. The software monitors assigned jobs and navigates the operator to the field entry. However, there are no features for entering machine settings available. Various solutions for integrated machine displays which assist the user during machine setup do exist. Nevertheless, there is no integrated solution, which combines job assignment, navigation to the field and step-by-step machine setup support currently available.

3 Material and Methodology

Questionnaire
In an poll in 2014, twenty-one experts regarding field choppers and operators rated by 66% rapid configuration, fast menu navigation, easy interaction, clear usage concepts, error messages in text form as the most important settings , if they could optimize Forage Harvester/Self-Propelled Forage Harvesters.
In order to receive feedback from experts or advanced drivers, a concept has to be developed which will support the operator during the completion of the assigned jobs in the best and easiest possible way.

Prototype
Based on interview results, a generic workflow for assisting a SPFH operator was designed which is illustrated in **Fehler! Verweisquelle konnte nicht gefunden werden.**. A mobile app for an Android tablet which is integrated in the machine cab and is based on the Sokolova, K Architecture Model for Android Application Development, was developed. [SA et al]. After login into the cloud portal, the operator receives the job information including field location and machine setup.
The app has to feature also a simple and intuitive user interface supporting forage harvesting operation. A logical step-by-step wizard guides the operator through the harvesting process (Figure 2).

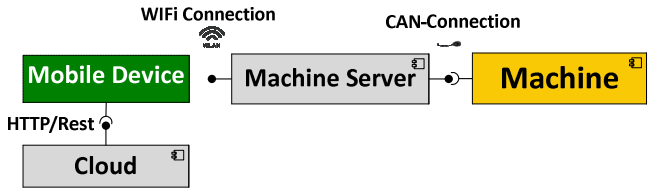

Figure 2: System Overview

The described concept is illustrated in this architecture, where a cloud portal is able to provide the job data. The tablet application retrieves the data from the cloud. Thus, the

application displays the job data on the tablet user interface. The tablet directly retrieves the machine data from server or from the cloud to set up the machine. The figure shows the interface connections which have logical step-by-step and smooth interfaces.

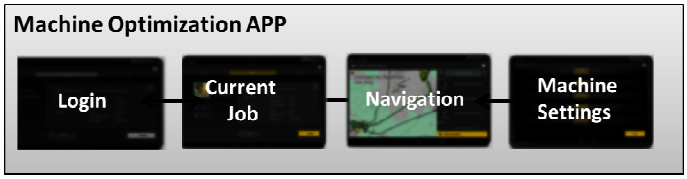

Figure 3: Screen flow of the Machine Optimization App

The concept of this app contains the entire user interface logic.

4 Conclusions

The study showed that there is a high demand for an overall single application solution as described, but further verification and validation is to be done.
First evaluations regarding the interface were positively rated by the users. The next step is to develop a concept validation in a long term user study. Additional to that, the implementation of the communication between the mobile devices and other applications such as navigation application will be verified as well as the communication via the machine CAN-Bus.

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