INTELLIGENT SOIL TILLAGE USING IMAGE SENSORS

Farming needs to be efficient from an economical and environmental point of view, hence optimal use of tools is essential in all processes. In the majority of fields the soil texture, moisture, and other factors having an impact on the outcome of the tillage operation are highly variable. Hence, current soil treatment machinery does not ensure an optimal tillage as they lack the necessary sensory feedback for automatic control. Automatic sensing of soil surface properties provides extensive information relevant for soil treatment, creating a knowledge base for future automated cultivation systems capable of establishing homogeneous, high quality seedbeds under heterogeneous soil conditions. Modern cultivators have numerous possible adjustments and finding an optimal setting for different types of tillage and soil types is difficult and time consuming. In real life this is likely not possible since the soil type changes within a single field and an optimal setup is too time-consuming and hard for the farmer, so usually a fixed setting is used. A picture of a Kongskilde Industries Germinator seedbed cultivator is shown in figure 1.

The PhD work addresses the problem of making a seedbed cultivator operate adaptively and optimally on the soil surface, and provides an overview of possible challenges and benefits of such a solution. The benefits include continuous optimization of the growing conditions for the seeds and potentially reducing the fuel consumption and wear on the machinery during the tillage operation.

Figure 1: Kongskilde Germinator

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The system will include a vision system for characterising the seedbed quality and may consist of a series of laser scanners positioned on the seedbed cultivator which continuously generates a 3D map of the raw and processed soil. The quality of the seedbed is correlated with aggregate size in the soil surface, i.e. the cloddiness of the soil. Large clods result in a too airy seedbed and thus the risk of drying out the seeds. On the other hand, a too processed seedbed has the risk of sealing the soil surface after heavy rain and thus resulting in bad germination. Additionally, it is a sign of too intensive seedbed cultivation and thus unnecessarily high energy consumption while cultivating. Figure 2 shows a concept drawing of the seedbed cultivator.

The control of tillage intensity is based on signal processing algorithms and image analysis of the 3D images of the soil surface gathered with the laser scanners. The seedbed cultivator is adjusted continuously while operating in the field and since the same field often consists of many types of soil conditions, the system must be able to react to the changes in the soil and adjust the tillage intensity accordingly.

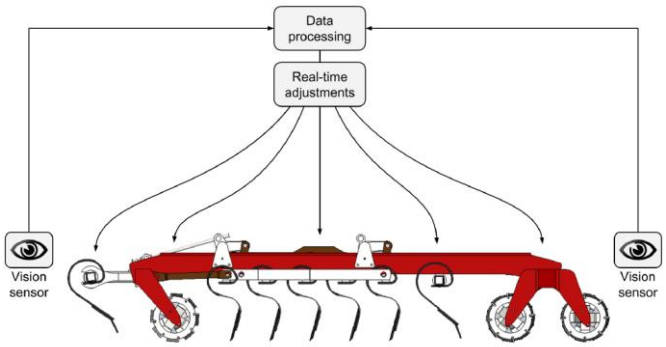

Figure 2: Concept drawing of the Kongskilde Germinator with sensors and real time adjustment.

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