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Precise Sowing with a Grain Counter Sensor

Two laser light barriers in the new grain counter introduced here make it possible to register grain frequency in the seed tube. By processing the measurement signals, grains per second and forward speed, as well as the working width entered, the board computer can accurately regulate the desired number of grains per square meter. No calibration test is necessary anymore and errors and inaccuracies in metering are compensated for.

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At seed drills the seed rate setting is achieved with the aid of a calibration test and by weighing the calibrated amount of seed. Via the thousand grain weight the connection between the calibrated amount of seed (kg) and the seed rate (grains per m^2) is created.

This method is incorrect and imprecise as flowing properties and the thousand grain weights may continually vary due to external influences, as for example, dressing agents and humidity.

State of the art

For counting seed flows, commercial frame light barriers or sensors created by discrete light barriers were used so far [1]. Problems resulted due to the wide range of grain size of the different seed types (rape, beans). In addition other inaccuracies were caused by high grain frequencies and uneven seed flows. By different regression models [2, 3] one tried to clearly reduce the counting errors. It was not possible, to achieve a readiness for practice with these conventional light barriers.

During drilling there is an exponential distribution of grain spacing, short distances show the highest frequency. Common light barriers are not able to realise high grain frequencies in combination with the virtually simultaneously passing of the measuring level [4].

Tests to divert the seed flow via a bypass to a singling device and to count during the sowing operation have not been put into practice yet [5].

Composition of sensor

The new sensor concept uses high definition CCD-lines (*Fig. 1*) instead of discrete light barriers. The 15 pixel per millimetre are read out every 116 micro seconds by the microcontroller. Due to the high volume of data the evaluation takes place directly in the grain counter. The aim is to register continuously the grain frequency during the sowing operation. In a pneumatic seed drill the fitting position of the sensor is in the seed tube behind the distributor head. In fact the grains are only counted in individual rows but this fitting position offers the advantage

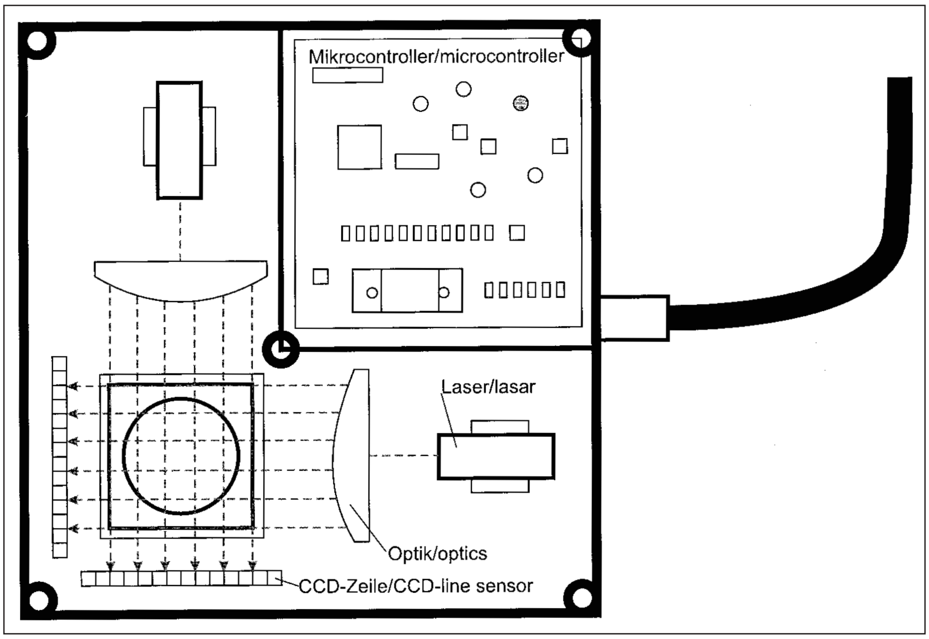

Fig. 1: Schematic composition of the grain counter

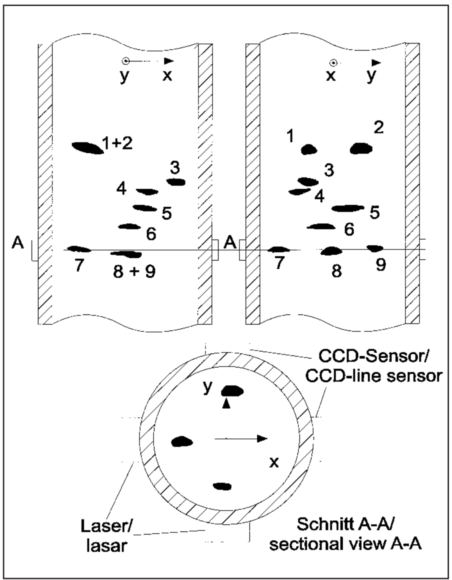

Fig. 2: Grain counting unit realised by CCD lines arranged at 90°

that the grain frequency has already been considerably reduced.

In order to be independent from the distance of the seed grain to the CCD chip an almost parallel light is created via an optic from a laser beam. This allows the direct assignment of the shaded pixel of the CCD line to the size of the seed.

Thus the arrangement of the optics results in a rectangular measuring diameter. In order to avoid deposits of dust and dressing agent due to whirling, a favourable flow transition from the round diameter of the seed tube to the rectangular diameter of the measuring level has been realised.

By the simultaneous measuring with two CCD lines arranged at 90° towards each other, the mutual shading of grains [6] which are simultaneously falling through the measuring level is considerably reduced.

Figure 2 shows that the evaluation of two CCD-lines allows a considerable increase of accuracy. Shades which – seen from the x-direction – may be understood as one grain, are realised as two grains due to the combination with the shade of the Y-direction (grains 1 and 2 or 8 and 9).

Integration of system

Via the CAN-Bus link the grain counter is connected to the on board computer system allowing the flexible choice of the number of grain counters. On CAN-Bus the grain counter makes the actual grain frequency available to the control circuit of the seed drill. The job computer controls with the aid of the desired seed rate and the registered forward speed, with the working width of the machine it calculates the rev. speed of the metering motor making the calibration test unnecessary.

Results

In the laboratory comprehensive measuring series were determined. With the determined data on hand the effect of the granule properties on the recognition rate could be optimised with the aid of an algorithm for automatic grain size recognition.

The measuring of the grain frequency via grain counters is only intended for two seed tubes. For the calculation of the seed rate for the control it is assumed that the seed rate in all seed tubes is approximately the same [7]. The installation of grain counters on opposite side seed tubes compensates slope inclinations.

As shown in *Figure 3*, the sensor provides – via a wide grain frequency range – a very high measuring accuracy which partly lies at the controllable limits.

When testing the sensors in the field the focus of the evaluations was the sensitiveness of the optics against pollution caused by the dressing agent and dust within the conveying medium air. Repeated optimising of the flow conditions within the sensor resulted in the desired insensitiveness to pollution. The sensor is provided with an integrated pollution monitoring and increased the laser capacity depending on the pollution level.

The grain counter is suited for pneumatic seed drills. In the next stage of development the sensor will be designed for seed drills with single metering.

Summary

With the new grain counter the machine specific pre-conditions for the precise sowing with variable seed rates – as desired for Precision Farming – is fulfilled.

Due to the exact counting and the continuous monitoring the farmer is able to adapt the seed rate exactly to the demands of crop production.

Literature

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Bild 3: Messfehler in Abhängigkeit von der Kornfrequenz

Fig. 3: Measuring errors in dependence on the grain frequency