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Image Based Weed Detection

At the Institute of Agricultural Engineering in Bornim a camera system for weed rating was developed, which can detect small weed heterogeneities while driving across the field in real time. The article describes the software required, as well as the steps involved in calibration and its practical application.

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Keywords

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Today herbicides are used on agricultural fields with nearly identical dose; a spatial treatment of field parts is used only in singular cases. The uniform cultivation leads to part fields with insufficient supply regarding weed control. Treatment with a low rate is bad for the yield; the parts with over supply increase costs and severe environmental impacts [1, 2]. The article introduces a hard- and software solution for automatic weed ratings, which was developed with funds from the BMBF and that can contribute to a better treatment of herbicides in the future.

Necessary software configurations

The software for weed rating was developed together with the project member, the company Symacon Bildverarbeitung Magdeburg. The connection to the ACT computer will be done by Mueller-Electronic, Salzkotten [3]. The software development process was carried by the company Symacon in C++ [4] on an interactive image processing system, in conjunction with the camera control software (DT Control) from the producer of the weed camera. The software solution called "Beikraut" controls the whole data flow out of the weed camera MS2100, through the Matrox frame grabber card and within the data processing of the industrial PC.

The camera is a MS2100 CIR of distributor Laser2000 (*Fig. 1*), bought with smaller filter for red, green and infrared compared to the product in the catalogue [5]. The camera is mounted on a vehicle for weed rating in a height of about 40 cm, so the object size is 20 cm • 15 cm when using the whole area of the image chip (*Fig. 2, 3*). The camera is oriented with the longer image side in relation to the drive direction. The user can choose an image series that depends on the path and is like a gapfree digital film. If the image frequency is 15 per seconds with 5 images per meter, that means the drive speed can be 3 meters per second or 10,8 km/h. *Figure 2* shows the camera mounted in front of a tractor.

Fig. 1: Camera MS2100

Calibration of the path signal

A signalling instrument is installed at the vehicle, which delivers a path signal for the software. The path signal can be derived with different methods, with pulse or incremental sensors at a drive wheel, a cardan shaft or a plate wheel. The calibration of the path signal is done on a measured distance of 100 m. The path signal on the display is manually changeable, because calibration differs with soil properties and the calibration must eventually be repeated several times. Even when no outdoor distance is used and the measurement takes place on a rotating disk in the laboratory, a path value must be set. The software needs a correct value for partitioning the path into images.

Realisation of the measurement

During a measurement the weed amount and the weed size are derived over a path length of 5 m, whereas a mean value with up to 25 images is possible. The result of the image processing with the PC software is the "Count value" of the measurement, which can be used for advanced data processing or as a control value for application technique (as analogue voltage from 1 to 4 V or as digital value).

The "Count value" is shown on the display and can be checked and stored in a result file. The data are stored in an ASCII-format, so calculation programs like Microsoft EXCEL can read the data. The display, storage and output of the additional result "Cover rate" can be done in the same way as for the parameter "Count value."

Calibration of a weed rating

The calibration assumes that a weed rating, the visual fixing of amount, size and type of weed species, is already done on a reference

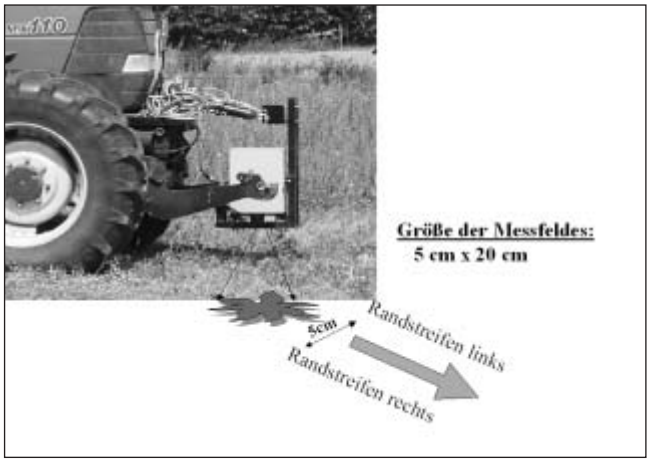

Fig. 2: Size of the measuring region during weed rating

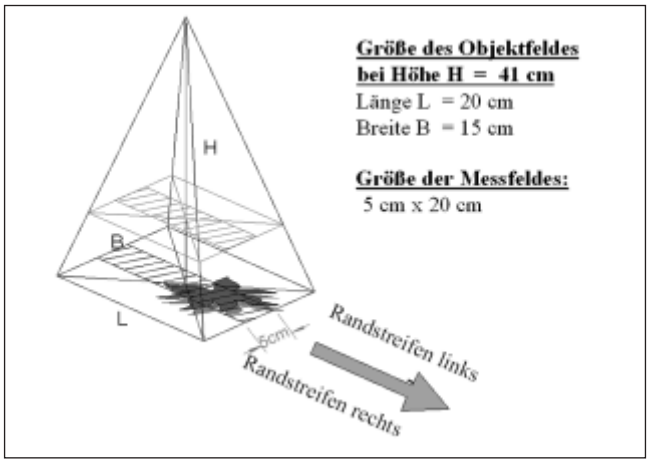

Fig. 3: Camera height and object size

area. After that, the same area is scanned with the weed camera (*Fig. 2*). A special calibration mode is useful for comparing the weed rating by hand with an automatic camera based weed rating. The weeds are counted on the selected area and the results are compared with the camera based "Count value."

Figure 3 outlines the course of time for a calibration. During the crossing of the rating area the camera delivers a consecutive number of images (TTL 1) and the whole number of images are processed to the result "Count value". The start point and the end point of the rating area are electronically marked by signal TTL 2 and are electronically detected to ensure a correct detection of the rating area. The length of the rating area has to be determined before the calibration and should be a multiple of the object length for the camera related to *Figure 3*. This number of object lengths within the rating area should be between 25 and 50 to ensure a good measuring result.

Additional evaluations

Additionally to the results "Count value" and "Cover rate" the size of the weeds can be measured and stored in a result file. A sufficient classification is achievable with 10 fixed ranges, e.g. with the values:

2, 16, 64, 100, 225, 400, 900, 1600, 2500, 3600 [per m^2]

Only the central part inside the image area with about 33 % is used for weed detection. But the left and right edge parts of the image (*Fig. 3*) will also deliver control information for the weed rating in an improved future software revision.

Software solution scheme

The hardware parts i.e the frame grabber Meteor2, Comp. Matrox Imaging, and measuring card DAS-6025, Measurement Computing Corp., are addressed via driver and DLL-libraries of the manufacturers. The Matrox Imaging Library 6.1 (MIL 6.1) is used for the Meteor2/Digital. This library delivers a huge number of image processing functions. For the DAS-6025 the Universal Library 5.33 is used to parameter and control the I/O-card.

The whole software "Beikraut" is a modular solution. The modules communicate via internal interfaces. The modules are object oriented designed and work together on a message transfer basis.

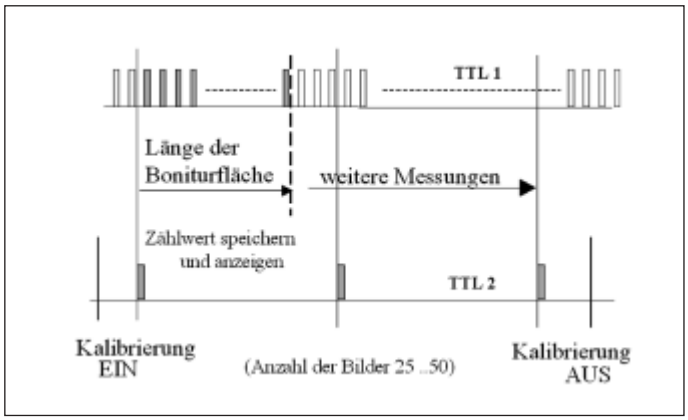

Fig. 4: Calibration of a weed rating

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