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Hohenheim Software for Plotting Field Experiments

The effects of various precision cultivation measures on agriculture are usually tested in extensive field trials on heterogeneous fields. In plot test variations are measured and marked out by hand. It is hardly possible to manually measure big field trials. Therefore, software was developed in Hohenheim, which makes it easily possible to realize complicated experimental designs on any sized area.

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Keywords

Field experimentation, precision farming

Variety and fertilization trials are usually set up in small plot tests to ensure homogeneous soil conditions. But the spatial heterogeneity is researched in Precision Agriculture Trials. Therefore field trials are designed on big heterogeneous fields. In addition it is important to repeat all variations enough times for a statistical analysis. On a 10 ha field it is easy to end up with an experimental design of 500 to 1000 plots. It's simply not possible to measure in such a big number of plots by hand in a short period of time.

Field trials in this extent can't be realized in a customary way. Therefore a software tool should be developed that enables to design an experiment on one hand and on the other hand it should realize the design on the field with the help of GPS. For example the amount of fertilizer should be varied on the field according to the experimental design autonomously by the software. But it is required that the appliance, in our example a fertilizer distributor, can change the application rate through an electronic signal. The software tool should determine the experimental variable with the aid of GPS and process the application rate on the machinery. The software should fulfil the following demands:

- Receive GPS-data through serial com port
- Coordinate conversion from geographic WGS84- to Gauß-Krüger-Coordinates
- Creation of experimental block designs in different sizes
- Display of the experimental design and the current position
- Processing of analogue and digital I/O's
- Realization of simple control systems
- Saving the current GPS-position and the experimental variable in point-shapefiles
- Saving the experimental design in polygon-shapefiles
- Saving all GPS protocols in text files

Coordinate conversion

Gauß-Krüger-Coordinates in the datum "Deutsches Hauptdreiecksnetz (DHDN)" are used in the German cartography. The coordinates are declared as easting and northing in meters. But GPS-receivers provide geographic coordinates in the datum WGS84. Therefore the GPS-positions must be transformed in Gauß-Krüger-Coordinates. First the geographic coordinates are transformed in cartesian coordinates. The cartesian coordinates have a X-, Y- and Z-value. The WGS84-datum is earth-centered because it is a global reference frame for the whole world. The DHDN is a local datum for Germany, which is the reason why the DHDN is not earth-centered like the WGS84-datum. The Helmert-Transformation is used to transform the cartesian WGS84-coordinates into DHDN-coordinates. Seven parameters are necessary for that calculation. Therefore it is also called seven-parameter-transformation. The precision of the calculations depends on the quality of the seven parameters. The cartesian coordinates are then converted into geographic coordinates and then into Gauß-Krüger-Coordinates [1, 2].

Addition and Realization of Experimental Design

The software provides the creation of experimental block designs in any size. First the block size and the number of variations is determined. The software tool then creates the experimental design and randomizes every variation in every block. Then the design is conferred on the field. Therefore an A-B-line is recorded on the field (*Fig. 1*). The experimental design is then aligned according to the A-B-line. It is also possible to use the A-B-Line from an Automatic Guidance so-

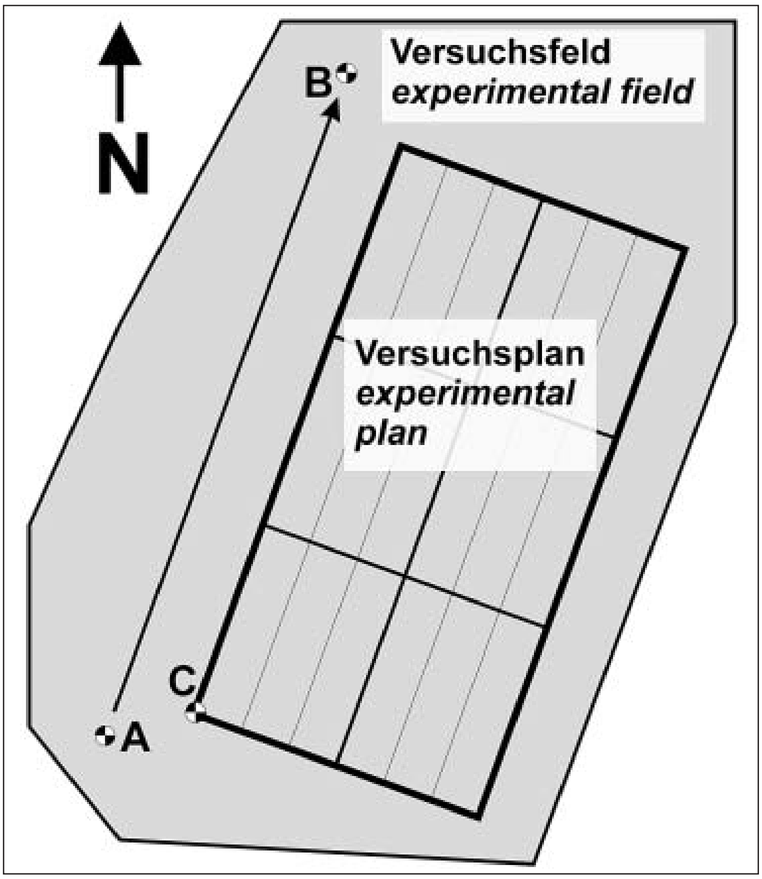

Fig. 1: Realization of an experimental plan on the field

lution on the tractor. The reference point C shows the distance from the A-B-line to the field experiment. The software calculates guidelines from the A-B-line and the working width. The distance to the next guideline is determined from the current GPS-position and displayed in the monitor. Beside the guidelines and the position, the monitor shows the experimental design as well as the current value of the experimental variable. The driver can supervise the creation of the field experiment but he has not to interfere.

The experimental variable is determined from the GPS-position and the deposited experimental design. The desired value is transmitted over usual bus systems or analogue outputs to the controlled machinery. Simple feedback control systems can be realized with the software tool.

The field trial is completely documented. The GPS-positions are saved in WGS84- and DHDN-datum. The positions are saved in text files with all of the values of the analogue and digital I/O's. In addition the software creates point-shapefiles with all values, so it is possible to view and edit the data in GIS-software. The experimental design is saved in a polygon-shapefile.

Acquisition of spatial data

The software tool has more features beside the experimental design. It is easy to acquire spatial data like soil water content or soil electric conductivity (EM38). It is possible to save every value of the analogue or digital inputs with the according GPS-position in a point-shapefile. The values are saved after a certain period of time (e.g. 5 sec) or after a certain distance (e.g. 5 meters). As the software saves in shapefiles there is no time-consuming conversion into a GIS-format. The measurements can be displayed and edited immediately. The software is an interface between measuring instruments, data acquisition and GIS.

Results

It is possible to realize huge and elaborate experimental designs on the field. Even more than one design can be realised at a time. For example when the seeding depth and the seeding rate should be varied in the field. One of the software's features is the great flexibility. Every trial variable, which is controlled by an electronic signal, can be accessed. No matter if the seeding depth, the amount of fertilizer or the tillage depth should be varied.

Literature

Books are marked by •

[1] • *Großmann, W.*: Geodätische Rechnungen und Abbildungen in der Landesvermessung. Stuttgart, 1976

[2] • *Bill, R.*: Grundlagen der Geo-Informationssysteme, Band 1: Hardware, Software und Daten. Heidelberg, 1999

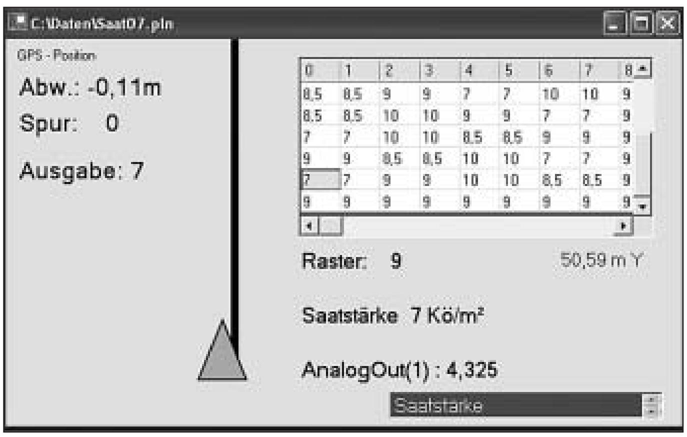

Fig. 2: Display of the experimental design (top right) and the guideline (left) on the screen. The black line shows the guideline, the yellow triangle displays the vehicle: the driver has to steer 0,11 m to the right to keep the tractor on the guideline.