Labor Windkanal/Strömungsmesstechnik

HOCHSCHULE REGENSBURG UNIVERSITY OF APPLIED SCIENCES

Development of a Software-Application for processing meteorological sensor data

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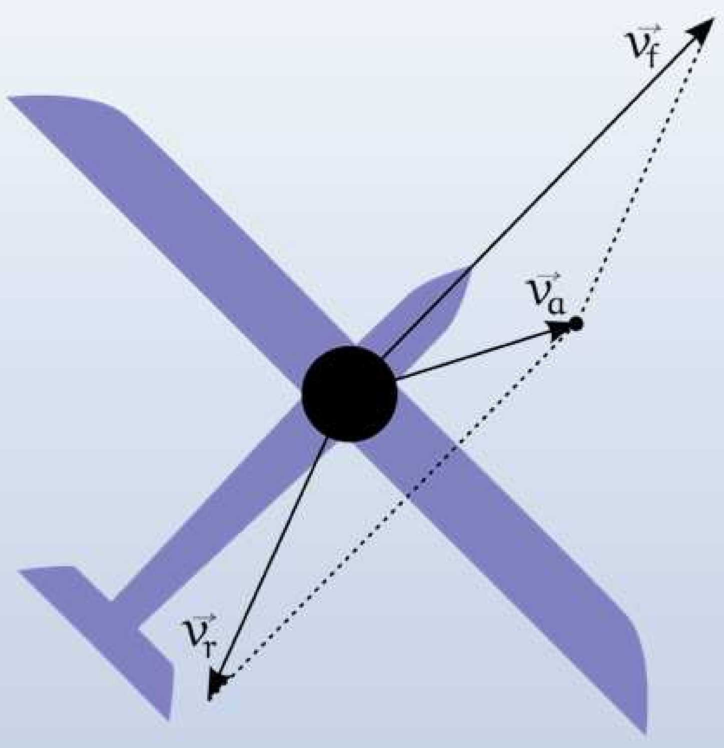
1. Motivation

In the past years a measuring platform for meteorological data which simply can be mounted onto a RC-plane was developed at the University of Applied Sciences Regensburg. As one main feature it is designed to determine the two-dimensional wind vector over ground. To accomplish this task, firstly a GPS-Receiver was integrated which provides direction and speed of the plane as the vector $\vec{v}_f$. Secondly for the wind vector relative to the plane $\vec{v}_r$, so-called ‚Constant Temperature Anemometers' (CTAs) by Continental were installed. The absolute wind vector can now be easily calculated by solving the equation $\vec{v}_a = \vec{v}_r + \vec{v}_f$.

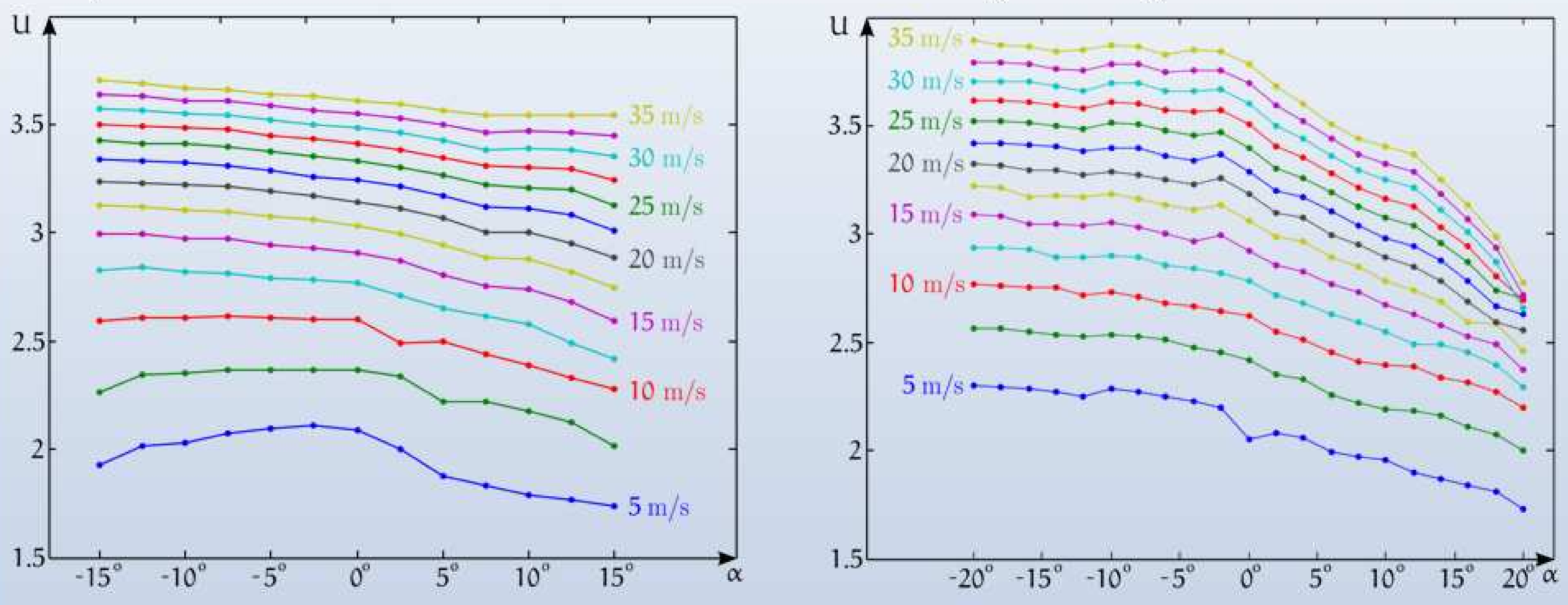


For a correct interpretation of the two CTAs, a calibration had to be done first. After that the Software-Application WindPal can use this calibration and apply it on the dataset gathered during a flight.

2. Installation of the CTAs

Opened sensor   Closed sensor

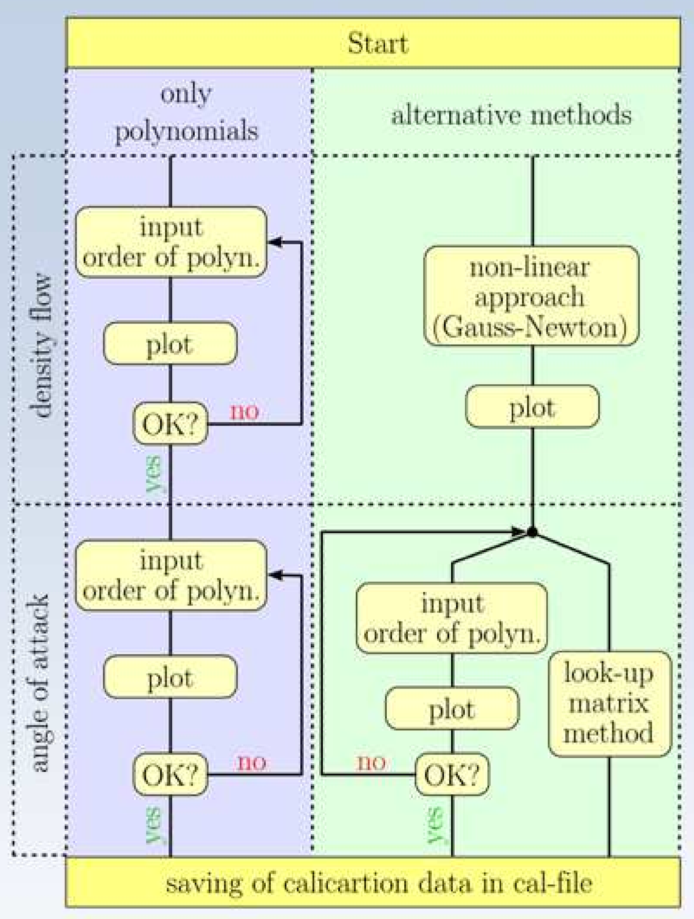
Until now the CTAs were used in opened form as shown above. Because the signal-dependency in respect to the angle of attack is relatively low in that form it was now compared to the sensor in closed form which showed significantly better results.

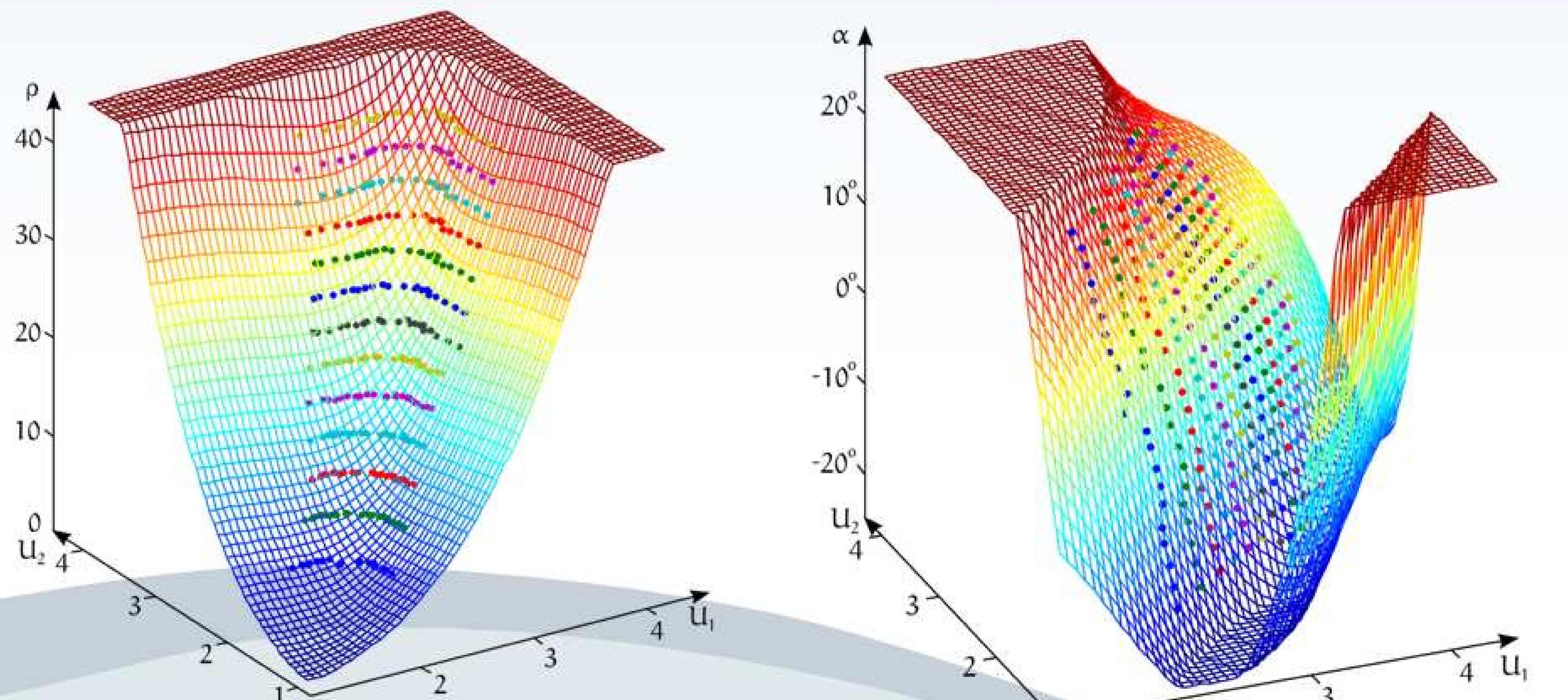


Shown above are the output signals of single sensors as a function of the angle of attack at different wind velocities. The gradient of the opened sensor (left) is considerably lower than the gradient of the closed one (right).
With a single sensor it isn't possible to measure the magnitude and direction of the wind. Therefore the measuring platform always carries two of them.

3. Calibration algorithm

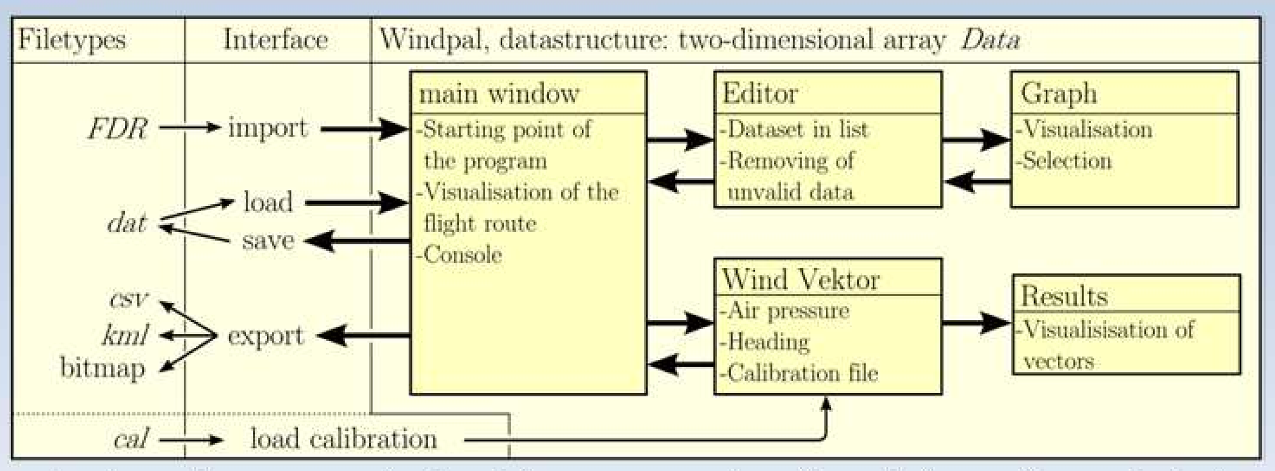
During the calibration in the wind tunnel the signals of the sensors are recorded at known wind velocities and angles. Using this data it is now possible to find a mathematical inverse function which can approximate the two-dimensional wind vector for any given signals coming from the sensors.
For that a program in Matlab was developed which uses either polynomials or a nonlinear approach and a look-up matrix method.
The result are two two-dimensional functions (below), which can be stored in a calibration file.





Left: Density flow as function of sensor signals. (With density flow, temperature and air pressure it is possible to calculate the Wind velocity.)
Right: Angle of attack as function of sensor signals.
(The dots in the graphs represent different velocities/angles from the calibration)

4. The Software-Application WindPal

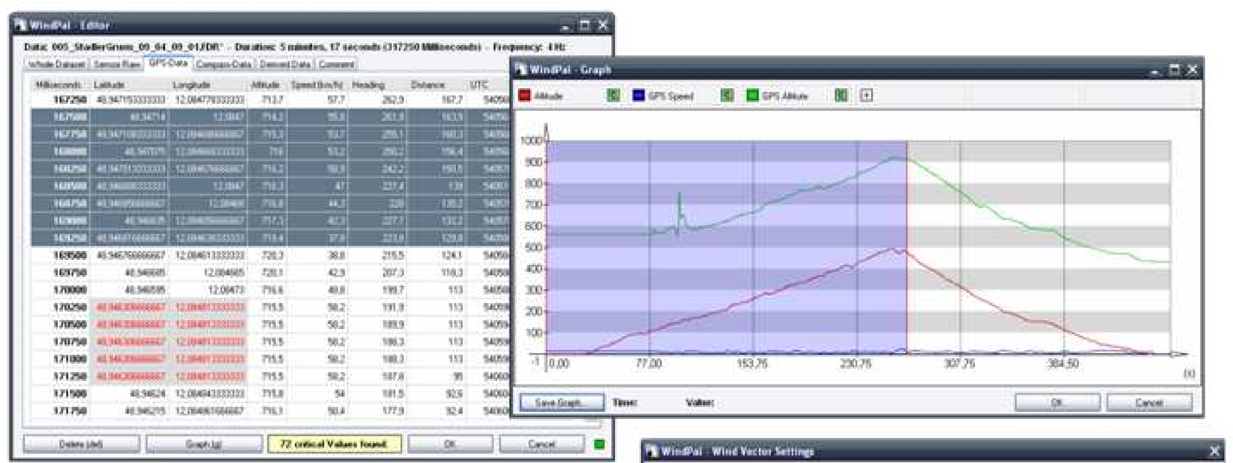


WinPal was designed as a main tool for processing the data gathered during a flight. The following windows make working with this data as easy as possible:

- Main window

Flight route exported into GoogleEarth

- Editor / Graph



- Wind Vektor