Labor Windkanal/Strömungsmesstechnik

FACHHOCHSCHULE REGENSBURG
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Ascertaining of flow mechanical values from multidimensional sensor characteristics

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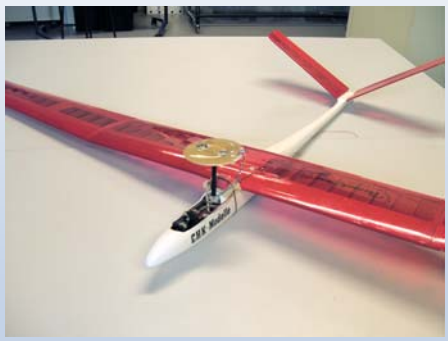
1. Introduction

The rapid development in computer technology in the past 20 years allows it to simulate more and more complex climatic models. Thereby ever more frequent the problem arises that not sufficiently many measuring data are available. In particular in non or only very thinly populated areas (e.g. oceans, Africa) as well as in larger heights above ground, the possibility to get sufficient measured values for a representative forecast was very difficult.
The laboratory wind tunnel flow measuring technique of the university of applied science Regensburg is occupied for some time with the project WindMAN. Using commercial measuring technique onto a flying measuring platform, they collect measured values within the atmosphere up to approximately 1500 meters.

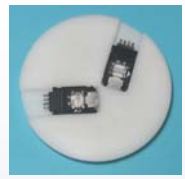
In several diploma theses already different sensors and recording devices for the project WindMan were examined. To practically us this equipment, a suitable software should be developed. Thus it is possible to filter, to present and to export the recorded data for further processing.



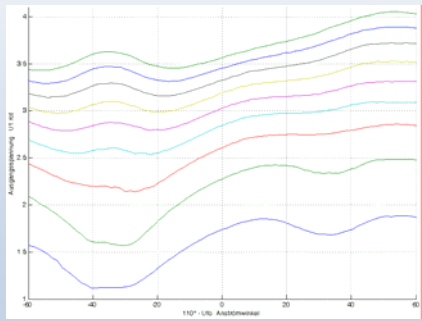
Glider with SondenUFO, GPS, temperature probe and data logger

2. The Problem

For back calculation of the measured values into physical data of the atmosphere the SondenUFO represents the largest obstacle. By contrast to temperature and humidity sensor, which have known characteristics defined by the manufacturer, and the GPS receiver, which spends directly digital position data, the SondenUFO is an proprietary development of the laboratory wind tunnel flow measuring technique. For this so far no practicable possibility was present of reconstructing the physical dimensions wind velocity and wind direction from the two sensor voltages U1 and U2.



SondenUFO with two SIMAFs

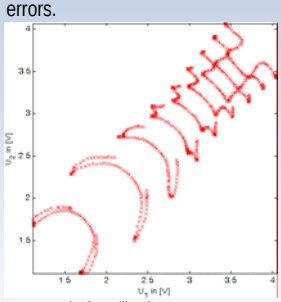


Output signal of one sensor as a function of the inflow angle for different wind velocities

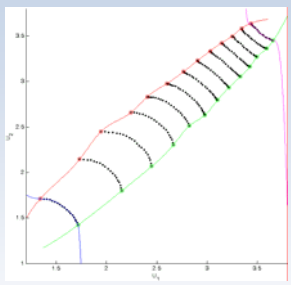
The behavior of the output signal of a sensor on the probe carrier exhibits very strong changes over the necessary speed range (5-30 m/s). Because of the design of the UFO, a mathematical remodeling was practically not possible. In addition it comes that the signal supplies clear results only in a fixed narrow range.

3. Approach for back calculation

In order to achieve as good results as possible, a precise calibration measurement is strongly necessary. Afterwards the recorded data will rectified of non clear values and errors.

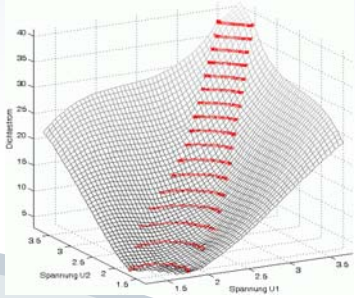


Result of a calibration measurement



Preprocesses calibration data

By the separation into two two-dimensional polynomials (one case for density flow and one for angle of attack) now the calibration values are independently approximated. Therewith now the angle of attack directly and the density flow can be directly calculated from U_1 and U_2.



Polynomial approximation of density flow

4. Conclusion

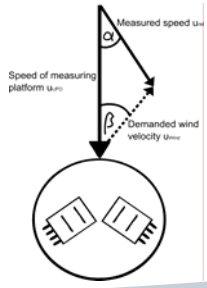
Two different programs were developed. The program „Kal-i-BUS“ evaluates the data of the calibration measurement and provides a calibration file from it . These files can be loaded afterwards in the program „Wind-i-BUS“ to determine the wind vector out of the logged data. The results also can be displayed graphically.

Illustration of trajectory using Google Earth©

Wind-i-BUS Ver. 1.0

With the program „Wind-i-BUS“ the data from the dataloggerfiles can be loaded and processed. It is possible to display the data direct with freely selectable axles. Also it is possible to export the data for a later subsequent treatment. Files in the Excel- and Google Earth format as well as the diagrams as pictures are supported.

Additionally to the evaluation software still simulations with the sensor carrier were accomplished. It turned out that for an intermediate angle of 110° the best results in the necessary speed range are to be expected. This could be confirmed by series of measurements with different angles.



References: Gösta Liljequist, Konrad Cehak: Allgemeine Meteorologie. Springer Verlag 1999