# Measurement of the Wind Vector Field with Unmanned Aerial Systems

K. Kufieta

Germany (karl.kufieta@tu-bs.de)

The measurement of the wind vector is an important topic in meteorological analysis. Unmanned aerial systems (UAS) have proven to be a good instrument in measuring small-scale turbulence. An inertial measuring unit (IMU) and the Global Positioning System (GPS) are used to calculate a navigation solution. With the navigation solution the UAS is able to fly automatically along a pre-programmed path. Also the wind vector is calculated from the aerodynamic variables of the airplane and the navigation solution. The aerodynamic variables, namely airspeed, angle of attack and sideslip can be measured with a 5 hole probe or a small vane. In this work a new attempt of calculating the aerodynamic variables is presented in which 5 hole probes or vanes are unnecessary. Instead of these expensive sensors, only the accelerometers are used which are indispensable in the IMU. Looking at the balance of forces on the airplane it is apparent that the sum of accelerations is a result of the interaction of the aerodynamic variables with the internal states and the coefficients of the airplane. Here the internal states are the rudder positions and the propulsive forces. As widely used in airplane simulations, the accelerations are calculated from this data. But the inverse case, to find the aerodynamic variables from the acceleration data if the airplane coefficients are known, is also possible. As it is hard to find an analytical inversion of the force balance equations of the airplane, a search algorithm is used. Looking at the simulation data and later at measurements of a UAS flight, the calculated aerodynamic variables from accelerometer data are compared to simulated and to measured aerodynamic variables. In the presented comparison it will become apparent that the calculated data can be transformed to the wind vector information.