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CONVERSION OF GPS COORDINATES TO LOCALLY LEVELED FRAME

A lot of investigations have been devoted to creation of reliable and accurate navigation and piloting systems for various applications, among which unmanned aerial vehicles (UAV) attract growing interest, since they are widely used for different purposes, including scientific needs, geodetic survey, military and agricultural application. As a base of such navigation and piloting complexes the integrated Global Positioning System (GPS) and Inertial Navigation System (INS) are increasingly used as their common performance outweighs the shortcomings of the individual systems.

Therefore to be able to process the data from both systems commonly it is necessary to have them in one common coordinate frame. And this frame should be chosen based on the specific needs of application. It is more natural in UAV application to use north, east, and down (NED) directions for locally level coordinates. This coordinate frame coincides with vehicle-body-fixed roll, pitch, yaw (RPY) coordinates (shown in Fig.1) when the vehicle is level headed north. But by default GPS coordinates are represented in terms of latitude, longitude and height (or *XYZ* in Earth Centered Earth Fixed (ECEF) coordinate frame).

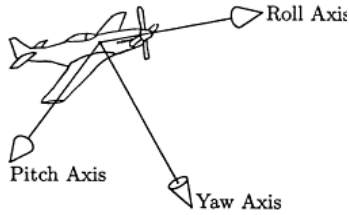

Fig. 1. Vehicle-body-fixed RPY coordinate frame

Thus, it is necessary to convert GPS coordinates in NED. For this we need to know the latitude φ, longitude λ and *XYZ* in ECEF of the point of origin, and current point in ECEF. First of all the displacements in ECEF coordinates (*dX, dY, dZ*) need to be found. It's performed by subtracting coordinates of origin from current coordinates. Then multiplying the displacements in ECEF coordinates by matrix of rotation R (1) we get these displacements in NED coordinate frame.

$$R = \begin{bmatrix} -\sin\varphi\cos\lambda & -\sin\varphi\sin\lambda & \cos\varphi \\ -\sin\lambda & \cos\lambda & 0 \\ -\cos\varphi\cos\lambda & -\cos\varphi\sin\lambda & -\sin\varphi \end{bmatrix}. \quad (1)$$

The same way it is possible to convert velocities from ECEF to NED. After performing this formality we can get common integrated solution for INS and GPS in NED frame.

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