Reference frames for IMAV2013

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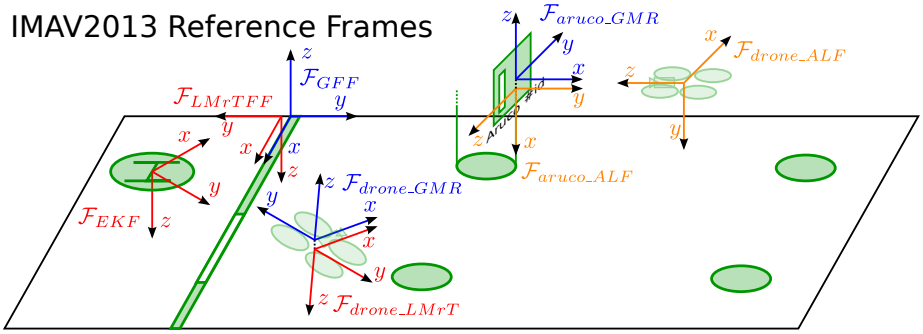

Figure 1: These are the main reference frames used on our IMAV2013 code.

Reference frames acronyms, see Fig. 1:

1. GFF: Global Fixed Frame
2. EKF, Extended Kalman Filter
3. Frames fixed on the ArUCo codes:
   (a) aruco_GMR, Ground Mobile Robotics
   (b) aruco_ALF, Aruco Library Frames
4. Frames fixed on the drone's COG:
   (a) drone_GMR
   (b) drone_ALF
   (c) drone_LMrT, Local Multirotor Telemetry (droneMsgs::droneNavData)

We send the relative position between the above mentioned frames using a droneMsgs::dronePose message, which contains: the translation vector $\{x, y, z\}$; and the relative attitude codified in an YPR system $\{yaw, \psi; pitch, \theta; roll, \phi\}$. The message also specified the YPR convention (which is need to ensure that the rotation matrix R is appopiately decodified), the reference frame and the target frame. This information can be converted into a homogeneous transformation matrix to perform the calculation:

$$\begin{bmatrix} p_{ref} \\ 1 \end{bmatrix} = \begin{bmatrix} R & O_{ref}O_{target} \\ 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} p_{rel} \\ 1 \end{bmatrix} = \begin{bmatrix} {}^{target}_{reference}T_{YPRconvention} \end{bmatrix} \cdot \begin{bmatrix} p_{rel} \\ 1 \end{bmatrix}$$

Used YPR convenctions:

1. **wYvPuR**, this is our main convention which is used in ROS topics. which is equivalent to $xRyPzY$
2. **xYyPzR**, which is equivalent to $wRvPuY$
3. to understand equivalences, checkout: http://en.wikipedia.org/wiki/Euler_angles#Conversion_between_intrinsic_a
4. to know how to perform the inverse mapping from rotation matrix to YPR values, checkout: http://en.wikibooks.org/wiki/Robotics_Kinematics_and_Dynamics/Description_of_Position_and_Orien
5. note that:
   (a) $R_{wYvPuR} = R_{wY}R_{vP}R_{uR}$
   (b) $R_{xYyRzR} = R_{xY}R_{yP}R_{zR}$

Inicialization:

- Configuration file giving an approximate location of the take off site.
- The yaw drift that occurs same time can be a problem: to address it we are going to use the initial value of the measured yaw to locate $\mathscr{F}_{EKF}$

Other things:

- We are going to locate the ArUCo so that the YPR representation singularities are located above and below them.
- Unfortunately, not all the EKF estimations are correct. The ones that are reliable are: x, y, z, yaw, vx, vy, vmx, vmy.
- For the rest of the required estimations we will use the telemetry data directly
- Notat that the magnetometer does not always correct the yaw drift. This issue is present in both, EKF and telemetry data.

A graph showing the modules and the topics that are exchanged among them is shown on Fig. 2.

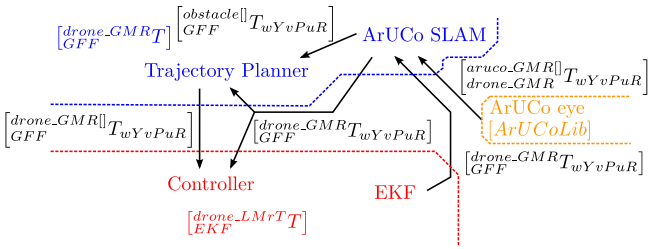

Figure 2: These are the main modules used on our IMAV2013 code. ROS topics are in black