

Virtual Reality Summative

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for 15th March 2019

Question Remarks

1. `get_raw_imu_data()` returns the raw data readings from the `.csv` file (given that it is located in the same directory), returning a 2D array of data rows.
`sanitize_imu_data(data)` cleans the data as specified, returning a 2D array of rows of the modified data.
`euler_to_qtrn(euler)` computes a quaternion (a, b, c, d) from a given array of Euler angles (x, y, z) .
`qtrn_to_euler(qtrn)` computes the Euler angles (x, y, z) for a given quaternion representation (a, b, c, d) .
`qtrn_conj(qtrn)` takes a quaternion (a, b, c, d) and returns its conjugate, $(a, -b, -c, -d)$.
`qtrn_mult(qtrn_1, qtrn_2)` computes the product of 2 quaternions, returning this product (a, b, c, d) .
3. For the smallest values of α_{tilt} (< 0.001), very little drift correction is applied and the headset is able to maintain smooth, albeit slightly misaligned motion after correction. For high values of α_{tilt} ($0.1-1$), after around 20 seconds I noticed the Euler angle around the x -axis begins to drift by around -25° towards the end of the readings. This is due to the fact that as the IMU is drift corrected, drift correction rotation occurs around the x - y plane only (as z is the ‘up’ axis, pointing upwards initially according to the accelerometer, shown in Figure 1). As such, a yaw motion around the z -axis is represented by the x (or θ) Euler angle here. The action of correcting the tilt can slightly induce a drift into this angle, so high values of α_{tilt} are not preferable, as this effect becomes more exaggerated. Additionally, high values of α_{tilt} can cause very noisy positional readings as each movement is precisely drift corrected. This would cause a very unpleasant viewing experience for a VR user as the viewport abruptly snaps back to a correct position with each IMU reading. I found that an α_{tilt} value of around 0.01 resulted in good drift correction without the large amount of noise caused by correction. This is visible in Figure 2. A reduction in the noise could be reduced by taking the average position of the ‘up vector’ over a number of samples in proximity.
4. Yaw correction effects the Euler angle around the x -axis (θ angle) because of the initial mounted positioning of the IMU, explained above. I found that all values of α_{yaw} greater than 0.0001 were able to correct drift induced into the θ angle by the tilt correction and, as such, I found that $\alpha_{tilt} = 0.1$ allowed a for more stable output in the other two axes. Increasing the value from this point all the way up to $\alpha_{yaw} = 1$ maintained the positioning of the drift correction of the x -axis, but induced more noise into the Euler angle. Therefore, the best angles for the combined tilt and yaw correction I found were $\alpha_{tilt} = 0.1$ and $\alpha_{yaw} = 0.0001$. The result of this correction can also be seen in Figure 2.

Visualisations

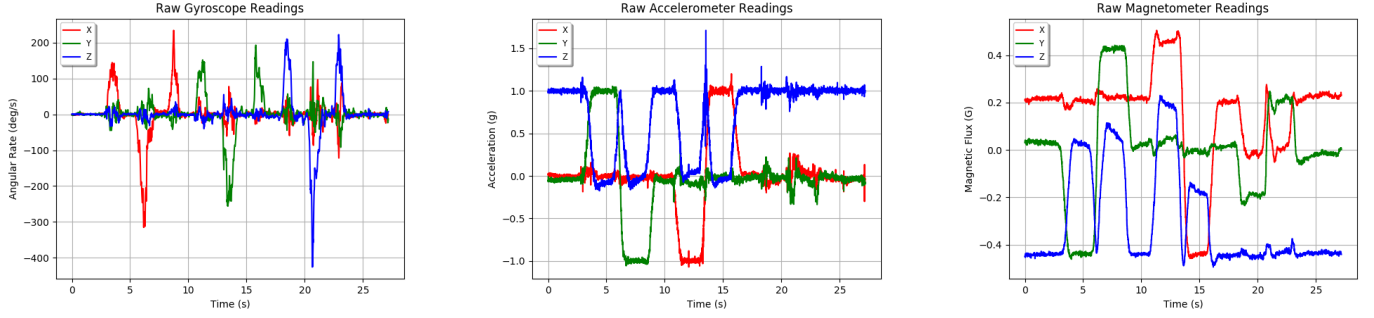


Figure 1: Raw sensor readings from the IMU.

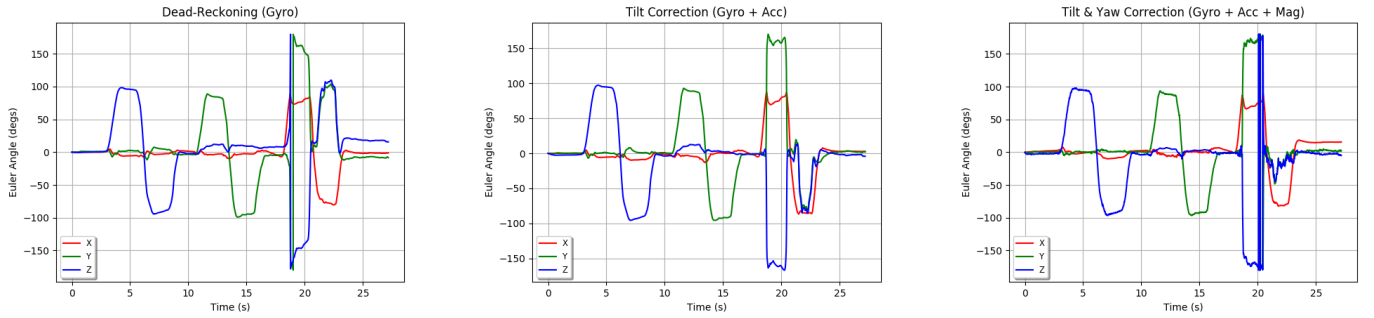


Figure 2: Euler angle readings, with and without various levels of correction. For tilt correction, $\alpha_{tilt} = 0.01$. For tilt & yaw correction, $\alpha_{tilt} = 0.1$, $\alpha_{yaw} = 0.001$.