

An Extended Complementary Filter for Full-Body MARG Orientation Estimation

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$$q = \frac{1}{2} \int \dot{q} dt$$

$$\dot{q} = \frac{1}{2} q \otimes [0, \omega - K \cdot e]$$

$$a_{ref} = (0, 0, 1)$$

$$a_{predict} = q \otimes a_{ref} \otimes q^* = M_q \cdot a_{ref}$$

$$a_{error} = |a_{measure}| \times a_{predict}$$

$$m_{ref} = (0, m_y, m_z)$$

$$e_{ref} = |a_{ref} \times m_{ref}| = (-1, 0, 0)$$

$$e_{predict} = q \otimes e_{ref} \otimes q^* = M_q \cdot e_{ref}$$

$$e_{error} = |a_{measure} \times m_{measure}| \times e_{predict}$$

$$e = \begin{cases} a_{error} + e_{error} & \text{if } \|a_{measure}\| > 0 \text{ and } m_{min} < \|m_{measure}\| < m_{max} \\ a_{error} & \text{if } \|a_{measure}\| > 0 \\ (0,0,0) & \text{otherwise} \end{cases}$$

$$K = \begin{cases} K_{normal} + \frac{t_{init} - t}{t_{init}} (K_{init} - K_{normal}) & \text{if } t < t_{init} \\ K_{normal} & \text{otherwise} \end{cases}$$