Quaternion EKF

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文章导航

1 Quaternion Fusion

1. Initializes the Quaternion:

$$q0 = 1, q1 = 0, q2 = 0, q3 = 0 \tag{1}$$

2. Calculate direction of gravity indicated by algorithm:

$$\begin{aligned} halfvx &= q1 * q3 - q0 * q2 && (2)\\ halfvy &= q0 * q1 + q2 * q3 && (3)\\ halfvz &= q0 * q0 + q3 * q3 - 0.5f && (4) \end{aligned}$$

3. Calculate accelerometer feedback scaled by 0.5:

$$\begin{aligned} axNorm &= ax/InverseSqrt(ax * ax + ay * ay + az * az) && (5)\\ ayNorm &= ay/InverseSqrt(ax * ax + ay * ay + az * az) && (6)\\ azNorm &= az/InverseSqrt(ax * ax + ay * ay + az * az) && (7)\\ deviategx &= 1.f * (ayNorm * halfvz - azNorm * halfvy) && (8)\\ deviategy &= 1.f * (azNorm * halfvx - axNorm * halfvz) && (9)\\ deviategz &= 1.f * (axNorm * halfvy - ayNorm * halfvx) && (10) \end{aligned}$$

4. Convert gyroscope to radians per second scaled by 0.5:

$$halfgxdt = 0.5f * gx * dt \tag{11}$$

$$halfgydt = 0.5f * gy * dt \tag{12}$$

$$halfgzdt = 0.5f * gz * dt \tag{13}$$

$$\begin{aligned} q0 =& q0 - halfgxdt * q1 - halfgydt * q2 - halfgzdt * q3 \\ & - 0.5f * q1 * dt * deviategx - 0.5f * q2 * dt * deviategy - 0.5f * q3 * dt * deviategz \end{aligned} \tag{14}$$

$$\begin{aligned} q1 =& q1 + halfgxdt * q0 + halfgzdt * q2 - halfgydt * q3 \\ & + 0.5f * q0 * dt * deviategx - 0.5f * q3 * dt * deviategy + 0.5f * q2 * dt * deviategz \end{aligned} \tag{15}$$

$$\begin{aligned} q2 =& q2 + halfgydt * q0 - halfgzdt * q1 + halfgxdt * q3 \\ & + 0.5f * q3 * dt * deviategx + 0.5f * q0 * dt * deviategy - 0.5f * q1 * dt * deviategz \end{aligned} \tag{16}$$

$$\begin{aligned} q3 =& q3 + halfgzdt * q0 + halfgydt * q1 - halfgxdt * q2 \\ & - 0.5f * q2 * dt * deviategx + 0.5f * q1 * dt * deviategy + 0.5f * q0 * dt * deviategz \end{aligned} \tag{17}$$

5. Normalise quaternion:

$$q0* = InverseSqrt(q0 * q0 + q1 * q1 + q2 * q2 + q3 * q3) \tag{18}$$

$$q1* = InverseSqrt(q0 * q0 + q1 * q1 + q2 * q2 + q3 * q3) \tag{19}$$

$$q2* = InverseSqrt(q0 * q0 + q1 * q1 + q2 * q2 + q3 * q3) \tag{20}$$

$$q3* = InverseSqrt(q0 * q0 + q1 * q1 + q2 * q2 + q3 * q3) \tag{21}$$

2 Extended Kalman Filter

$$x(k) = f(x(k-1), u(k-1), w(k-1)) \tag{22}$$

$$z(k) = h(x(k), v(k)) \tag{23}$$

$$x = \begin{bmatrix} q0 \\ q1 \\ q2 \\ q3 \\ deviategx \\ deviategy \end{bmatrix} \quad z = \begin{bmatrix} accelxNorm \\ accelyNorm \\ accelzNorm \end{bmatrix}$$

1. $A = \frac{\partial f}{\partial x}$:

$$A = \begin{bmatrix} 1, -halfgxdt, -halfgydt, -halfgzdt, -0.5f * q1 * dt, -0.5f * q2 * dt \\ halfgxdt, 1, halfgzdt, -halfgydt, 0.5f * q0 * dt, -0.5f * q3 * dt \\ halfgydt, -halfgzdt, 1, halfgxdt, 0.5f * q3 * dt, 0.5f * q0 * dt \\ halfgzdt, halfgydt, -halfgxdt, 1, -0.5f * q2 * dt, 0.5f * q1 * dt \\ 0, 0, 0, 0, 1, 0 \\ 0, 0, 0, 0, 0, 1 \end{bmatrix}$$

2. $H = \frac{\partial h}{\partial x}$:

$$H = \begin{bmatrix} \frac{0.5f*q2*dt}{halfvz}, \frac{0.5f*q3*dt}{halfvz}, -\frac{0.5f*q0*dt}{halfvz}, -\frac{0.5f*q1*dt}{halfvz}, 0, -\frac{1}{halfvz}, \\ \frac{0.5f*q1*dt}{halfvz}, -\frac{0.5f*q0*dt}{halfvz}, -\frac{0.5f*q3*dt}{halfvz}, \frac{0.5f*q2*dt}{halfvz}, -\frac{1}{halfvz}, 0, \\ \frac{0.5*q1*dt}{halfvy} - \frac{0.5*q2*dt}{halfvx}, -\frac{0.5*q0*dt}{halfvy} - \frac{0.5*q3*dt}{halfvx}, -\frac{0.5*q3*dt}{halfvy} + \frac{0.5*q0*dt}{halfvx}, \frac{0.5*q2*dt}{halfvy} + \frac{0.5*q1*dt}{halfvx}, -\frac{1}{halfvy}, \frac{1}{halfvx}, \end{bmatrix}$$