What I have done ?

**Sensor Fusion Using Complementary Filter — Summary and Formulas**

**1️)Accelerometer: Calculating Pitch and Roll**

The accelerometer measures gravity components along x, y, z axes (dx, dy, dz). From these, pitch and roll angles can be estimated as:

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| --- |
| pitch = atan2(-ax, sqrt(ay^2 + az^2))  roll = atan2(ay, az) |

**Note:** Yaw can't be calculated from accelerometer because gravity does not affect yaw direction.

**2️)Gyroscope: Calculating Pitch, Roll, and Yaw Rates**

The gyroscope gives angular velocity rates around x, y, z axes (gx, gy, gz).

To update the angles from gyro:

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| --- |
| PITCHgyro = PITCHprev + ωx × dt  ROLLgyro = ROLLprev + ωy × dt  YAWgyro = YAWprev + ωz × dt |

Where:

* dt = time interval between measurements
* pitch\_prev, roll\_prev, yaw\_prev = previous angle values

**3️)Magnetometer: Calculating Yaw**

Using magnetometer readings (Mx, My, Mz), yaw (heading) is calculated as:

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| --- |
| mx\_comp = mx \* cos(pitch) + mz \* sin(pitch)  my\_comp = mx \* sin(roll) \* sin(pitch) + my \* cos(roll) - mz \* sin(roll) \* cos(pitch) |

|  |
| --- |
| yaw\_mag = atan2(-my\_comp, mx\_comp) |

This gives magnetic heading relative to magnetic north.

**4️)Complementary Filter: Fusing Data**

To combine noisy, drifting gyro data and stable but slow accelerometer/magnetometer data, use complementary filters:

* For pitch and roll:

pitch = α \* (pitch\_gyro) + (1 - α) \* pitch\_acc

roll = α \* (roll\_gyro) + (1 - α) \* roll\_acc

* For yaw (using gyro + magnetometer):

yaw = α \* (yaw\_gyro) + (1 - α) \* yaw\_mag

Where:

* alpha is the filter constant (usually 0.95 to 0.98)
* angle\_prev and yaw\_prev are previous fused angles

**5️)Plotting and Visualization**

* First, plotted pitch and roll from accelerometer and gyroscope separately.
* Then, plotted yaw from gyroscope and magnetometer separately.
* After that, combined the complementary filter output and plotted fused pitch, roll, and yaw.
* Finally, used fused pitch, roll, and yaw angles to rotate a **3D cube** for animation over 10 seconds.

**6️)What We Learned**

* Accelerometer gives absolute pitch and roll but noisy
* Gyroscope gives smooth angle changes but drifts over time
* Magnetometer helps correct yaw drift
* Complementary filter balances fast gyro and slow accel/mag for stable angles