EE615 Control Computing Lab

Experiment 3-B

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1 Objective

The objective of this experiment is to calculate roll and pitch values from accelerometer and yaw values from magnetometer along with the gyroscope values and use complimentary filter to estimate final values of roll , pitch and yaw.

2 Complementry filter

The complementary filter is a computationally inexpensive sensor fusion technique that consists of a low-pass and a high-pass filter. Idea behind complementary filter is to take slow moving signals from accelerometer, magnetometer and fast moving signals from a gyroscope and combine them. When there are multiple sensors such as accelerometer and gyroscope, a complementary filter can perform a low-pass filtering on one sensor value and a highpass filtering on the other to integrate and produce a better output than the raw sensor values

3 Estimate the attitude by using gyroscope readings

We have already got the reading of roll,pitch and yaw from gyroscope from last experiment

4 Roll and Pitch values from accelerometer

Balance the acceleration equation that we are getting from accelerometer readings.

$$P_a = sin^{-1}(b_{a_x/g})$$
$$R_a = -sin^{-1}(b_{a_y/\,gcos(p))}$$

We pass these pitch and roll value of accelerometer from low pass filter and pitch and roll value from gyroscope that we got from last experiment.Thus we have estimated roll and pitch.

5 Yaw values from magnetometer

Firstly we take b_m (magnetometer reading vector) and take its projection on local level horizontal plane , i.e. , to put y=0 in R_b^l matrix and solve for:-

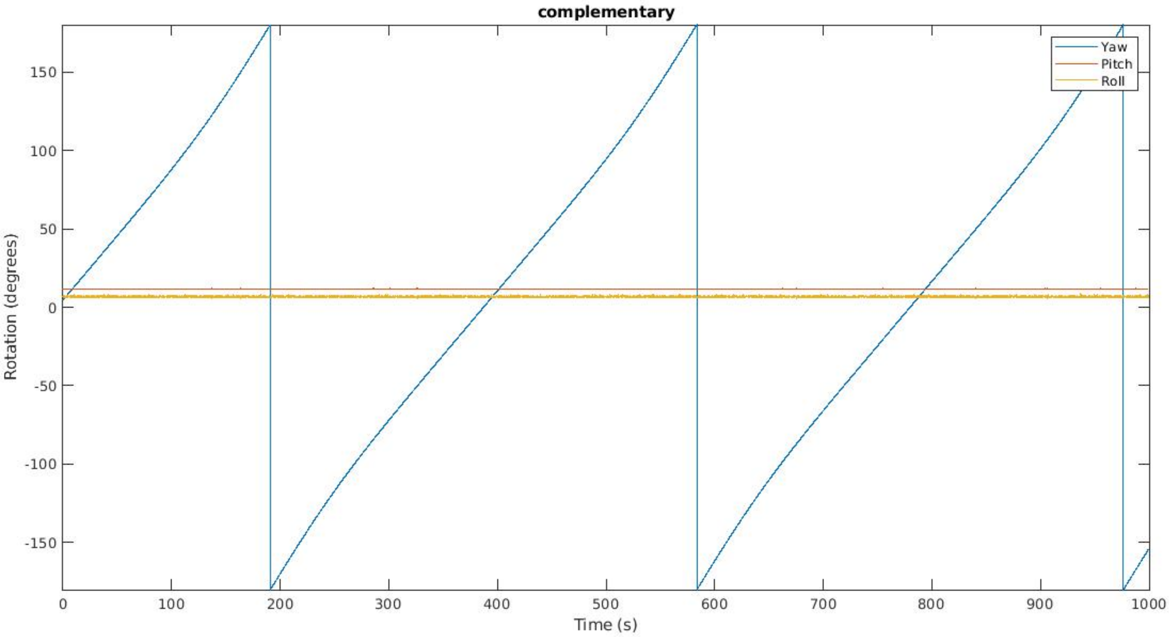
$$L_{p_m = R_b^l b_m \ \ at \ \ y=0.}$$

From above equation we will calculate yaw:-

$$y_m = tan^{-1}\frac{Lp_{m_y}}{Lp_{m_x}}$$

then this yaw values now pass from a low pass filter and yaw values that we estimated from gyroscope, through high pass filter and add them.This type of combination is called complimentary filter.Thus we have estimated yaw.

6 Result



6.1 Implementation:

6.1.1 MATLAB CODE

```
 %%
orient_measu=zeros(N,3);
i1=0;%roll
i2=pitch*(3.14/180);%pich
i3=initialYaw*(3.14/180);%yaw

orient_measu(1,3)=i1*(180/3.14);%roll
orient_measu(1,2)=i2*(180/3.14);
orient_measu(1,1)=i3*(180/3.14);%orient_measu(i,1):yaw
orientation_acc_readng=zeros(N,3);

%% accelerometer readings
for i=1:N
orientation_acc_readng(i,1)=asind(-(accelReadings(i,1))/9.8);%pitch
orientation_acc_readng(i,2)=-(asind((accelReadings(i,2))/(9.8*cos(orientation_acc_readng(i,1)))));%roll
end

%% magnetometer calculation

for i=1:N
p=orient_measu(i,2);r=orient_measu(i,3);
A=[cosd(p) sind(p)*sind(r) sind(p)*cosd(r);0 cosd(r) -sind(r);sind(p) -cosd(p)*sind(r) cosd(p)*cosd(r)];
ans1=A*[magReadings(i,1);magReadings(i,2);magReadings(i,3)];
y=ans1(2);x=ans1(1);
orientation_acc_readng(i,3)=-(atan2(y,x))*(180/3.14); %%yaw reading
end
%
 figure(1)
 plot(timeVector,orientation_acc_readng(:,3))
 figure(2)
 plot(timeVector,orientation_acc_readng(:,1))
 figure(3)
 plot(timeVector,orientation_acc_readng(:,2))

%% Complementry filter
```

```
% P_acc_low=zeros(N,1);
% R_acc_low=zeros(N,1);
% Pg_h=zeros(N,1);

P_acc_low=lowpass(orientation_acc_readng(:,1),10,fs);
R_acc_low=lowpass(orientation_acc_readng(:,2),10,fs);
Ym=lowpass(orientation_acc_readng(:,3),10,fs);
Pg_h=highpass(orient_measu1(:,2),10,fs);
Rg_h=highpass(orient_measu1(:,3),10,fs);
Yg_h=highpass(orient_measu1(:,1),10,fs);

P_added=P_acc_low+Pg_h;
R_added=R_acc_low+Rg_h;
Y_added=(Ym+Yg_h);



figure
plot(timeVector,Y_added,...
     timeVector,P_added,...
     timeVector,R_added)
 axis([0,duration,-180,180])
 legend('Yaw','Pitch','Roll')
 xlabel('Time (s)')
 ylabel('Rotation (degrees)')
 title('complementary')
```