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Appendix A. MATLAB™ Digital Compensation Filter Algorithm

```
% Frequency Compensation Filter Example
% Load rate table encoder position and raw ARS data
load ars_exam %includes time (time), angle (ang), and raw MHD sensor (ars) data
srate=1/(time(2)-time(1)); %sample rate
tau=1/srate;              %sample period
Kwr=.050;      %example ARS-01 scale factor
Kw=Kwr*pi/180;  %converts scale factor into volts/(deg/s) from volts/(rad/s)
ars=(ars./Kw);  %scale raw ARS-01 data via scale factor in volts/(deg/s)
%Loop finds start of the impact using the encoder position data
i=1;
while ang(i) == 0,i=i+1;end
n_st=i-1
n=length(time); %total points
%Calculate and remove the pre-impact bias from the scale ARS-01 data
bias_ars=mean(ars(1:n_st));
ars=ars-bias_ars;  %ars is the scaled  ARS-01 data with pre-impact bias removed
%hpf pole descriptions
f1=.065;  %hpf corner due to ARS-01 electronics
f2=.25;   %hpf corner due to ARS-01 sense channel
f3=.002;  %new compensated hpf corner 1
f4=.002;  %new compensated hpf corner 2
%Calculate digital filter coefficients based on hpf poles & sample period tau
a=exp((-1)*2*pi*f1*tau);
b=exp((-1)*2*pi*f2*tau);
c=exp((-1)*2*pi*f3*tau);
d=exp((-1)*2*pi*f4*tau);
%
rate=zeros(n,1);      %initialize output rate vector to zero
fact=c*d/a/b;          %factor for unity gain at z = 0, s = inf
rate(n_st)=ars(n_st);       %initialize rate(1) to ars(1)
rate(n_st+1)=ars(n_st+1);   %initialize rate(2) to ars(2)
% Apply digital compensation filter, rate(i) is the frequency compensated ARS-01 rate
for i=n_st+2:n;
rate(i)=fact*(ars(i)-(a+b)*ars(i-1)+a*b*ars(i-2))+(c+d)*rate(i-1)-c*d*rate(i-2);
end;
%Overlay compensated vs uncompensated ARS-01 rates
plot(time,rate,'-',time,ars,'--');
title('Compensated vs Uncompensated ARS-01 Angular Rates'),
xlabel('Seconds'),
ylabel('Degrees/Second');
grid
pause
% Integrate compensated and uncompensated rates to obtain angular displacement
ang_comp =zeros(n,1);     %initialize output angle vector to zero
ang_noncomp =zeros(n,1);  %initialize output angle vector to zero
for i=2:n;
ang_comp(i)=rate(i)+ang_comp(i-1);
ang_noncomp(i)=ars(i)+ang_noncomp(i-1);
end
ang_comp=ang_comp/srate;       %apply sample rate factor
ang_noncomp=ang_noncomp/srate; %apply sample rate factor
% Overlay Encoder Angle, Compensated and Uncompensated ARS-01 results
plot(time,ang,'-',time,ang_comp,'--',time,ang_noncomp,'-');
title('Compensated vs Uncompensated ARS-01 Angular Displacement'),
xlabel('Seconds'),
ylabel('Degrees');
grid
break
```