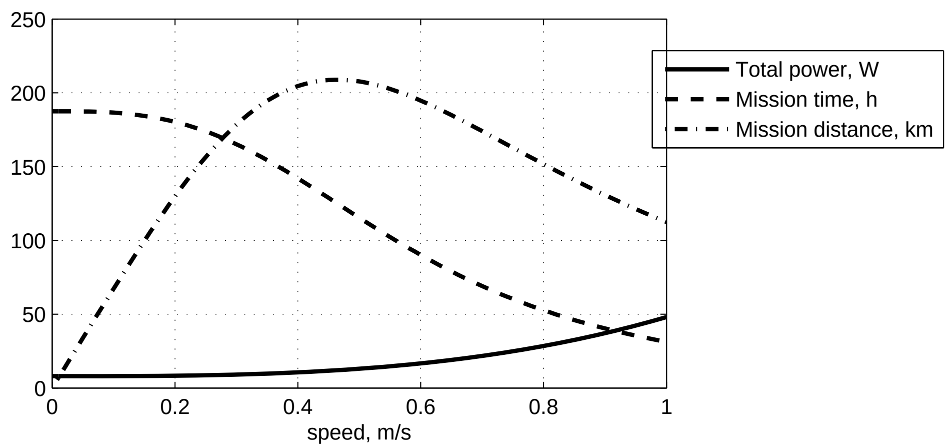
24 AUV Mission Optimization

Tradeoffs and optimization are demonstrated by the following simple example. An autonomous robot carries an energy source of $E = 1.5$ kiloWatt-hours. At operating speed U, the drive motors consume $P_d = 40U^3$ Watts. Additionally, no matter what the speed, the "hotel" load of the robot - the computers, sensors, communication equipment, etc. - consumes $P_h = 8$ Watts. What speed should the robot travel so as to achieve the greatest distance, how long does this mission last, and how far does the robot go in this case?

The drive power is $P_d = 40U^3$, and the hotel load is $P_h = 8$, so the total power is $P = 40U^3 + 8$, in Watts. The duration is the available energy divided by the total power, or

$$T = \frac{1500 \times 3600}{40U^3 + 8}$$

and the distance is simply $D = TU$. We see that D can be written then as a function of U, with a linear term in the numerator, and a cubic term plus a constant in the denominator. The solution can be obtained by either setting the $dD/dU = 0$, or looking at the function calculated numerically. The function is shown in the following plot, along with the optimum point. From the graph, the optimum speed is about 0.46m/s, the distance is 209km, and the duration is 127 hours.

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%-------------------------------------------------------------------
% Electrical Power Budget on an AUV

clear all;

Uvec = 0:.01:1; % set up a vector of speeds, m/s
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for i=1:length(Uvec),
    Pd(i) = 40*Uvec(i)^3 ; % propulsion power, W
    Ph(i) = 8 ;  % hotel power, W
    Pt(i) = Pd(i)+Ph(i) ; % total power, W

    T(i) = 1500 / Pt(i); % time of mission, h
    X(i) = T(i)*3600*Uvec(i) ; % distance traveled, m
end;

figure(1);clf;hold off;
subplot('Position',[.2 .2 .5 .4]);
plot(Uvec,Pt,'-',Uvec,T,'--',Uvec,X/1000,'-.','LineWidth',2) ;
legend('Total power, W', 'Mission time, h', 'Mission distance, km');
grid;
xlabel('speed, m/s');

%-----------------------------------------------------------------
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