Sensor Calibration and Curve Fit

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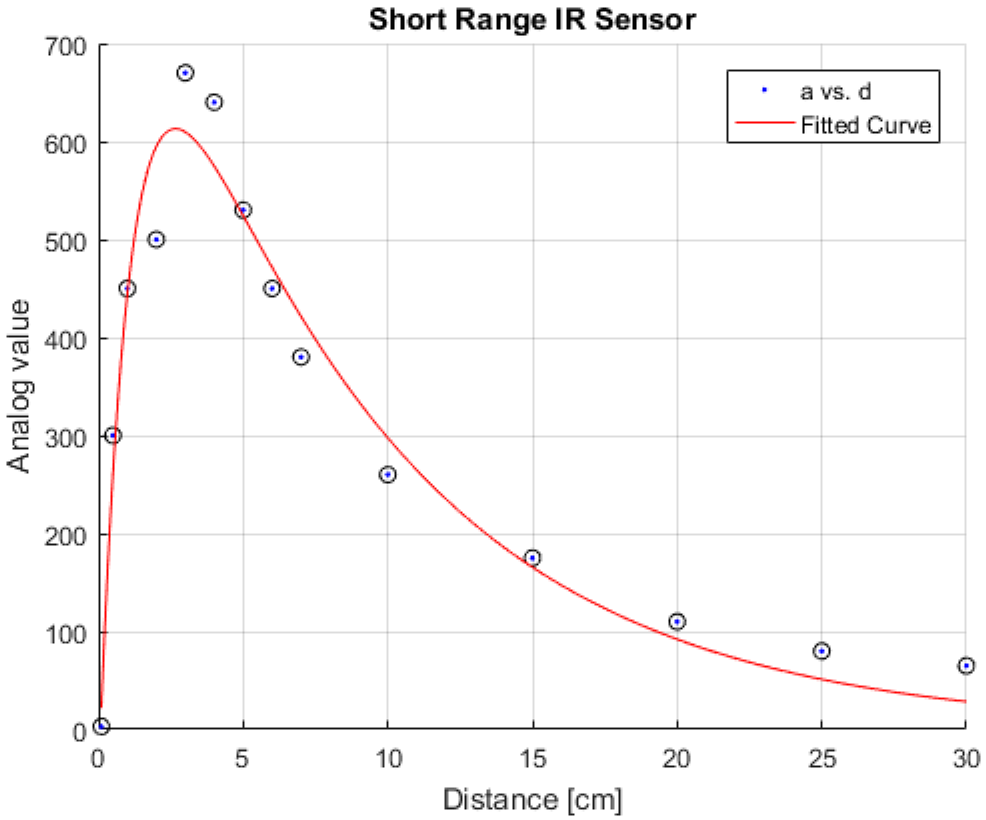
Short Range IR Sensor Data

```
clear all;
clc;
% Distance
d = [0.1, 0.5, 1, 2, 3, 4, 5, 6, 7, 10, 15, 20, 25, 30];

% Analog value
a = [3, 300, 450, 500, 670, 640, 530, 450, 380, 260, 175, 110, 80,
 65];

figure(1); clf; hold on;
plot(d, a, 'ko');
title('Short Range IR Sensor');
xlabel('Distance [cm]'); ylabel('Analog value');

createFitexp2(d,a);
```



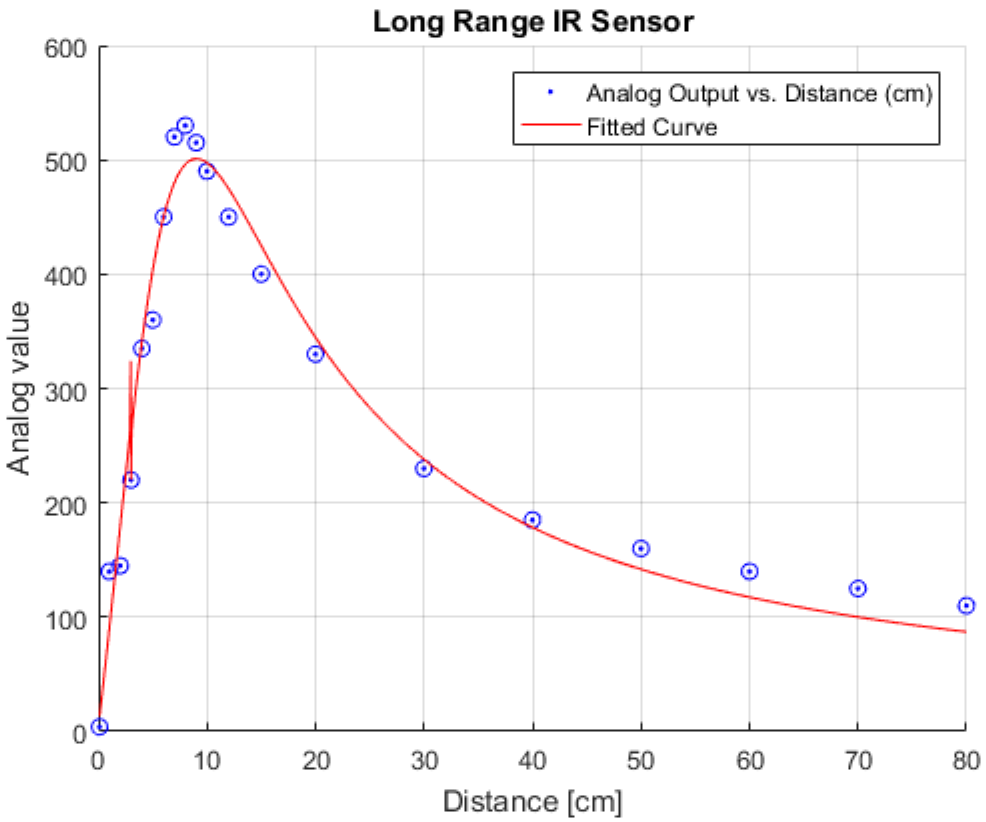
Long Range IR Sensor Data

```
clear all;
clc;
% Distance
d = [0.1, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 20, 30, 40, 50, 60,
 70, 80];

% Analog value
a = [4, 140, 145, 220, 335, 360, 450, 520, 530, 515, 490, 450, 400,
 330, 230, 185, 160, 140, 125, 110];

figure(2); clf; hold on;
plot(d, a, 'bo');
title('Long Range IR Sensor');
xlabel('Distance [cm]'); ylabel('Analog value');

createFitRat23(d,a);
```



createFitRat23.m function

```
createFitRat23.m

function [fitresult, gof] = createFitRat23(d, a)
%CREATEFIT(D,A)
%  Create a fit.
%
%  Data for 'Fitted Curve' fit:
%      X Input : d
%      Y Output: a
%  Output:
%      fitresult : a fit object representing the fit.
%      gof : structure with goodness-of fit info.
%
%  See also FIT, CFIT, SFIT.

%  Auto-generated by MATLAB on 12-Oct-2017 12:06:21

%% Fit: 'Fitted Curve'.
[xData, yData] = prepareCurveData( d, a );

% Set up fittype and options.
ft = fittype( 'smoothingspline' );

% Fit model to data.
```

```
[fitresult, gof] = fit( xData, yData, ft, 'Normalize', 'on' );

% Plot fit with data.
h = plot( fitresult, xData, yData );
legend( h, 'Analog Output vs. Distance', 'Fitted
 Curve', 'Location', 'NorthEast' );
% Label axes
xlabel('Distance (cm)');
ylabel ('Analog Output');
grid on
```

createFitexp2.m

```
function [fitresult, gof] = createFitexp2(d, a)
%CREATEFIT1(D,A)
%  Create a fit.
%
%  Data for 'Fitted Curve' fit:
%      X Input : d
%      Y Output: a
%  Output:
%      fitresult : a fit object representing the fit.
%      gof : structure with goodness-of fit info.
%
%  See also FIT, CFIT, SFIT.
%  Auto-generated by MATLAB on 12-Oct-2017 13:28:41

%% Fit: 'Fitted Curve'.
[xData, yData] = prepareCurveData( d, a );
%% Set up fittype and options.
ft = fittype( 'exp2' );
opts = fitoptions( 'Method', 'NonlinearLeastSquares' );
opts.Display = 'Off';
opts.Normalize = 'on';
opts.StartPoint = [406.819274003059 -0.790773877804884
 -49.3302971635946 -2.83787732353216];

% Fit model to data.
[fitresult, gof] = fit( xData, yData, ft, opts );

% Plot fit with data.
h = plot( fitresult, xData, yData );
legend( h, 'a vs. d', 'Fitted Curve', 'Location', 'NorthEast' );
% Label axes
xlabel d
ylabel a
grid on
```

Calibration Equations

```
General model Rat23:
       f(x) = (p1*x^2 + p2*x + p3) /
                 (x^3 + q1*x^2 + q2*x + q3)
```

```
  Coefficients (with 95% confidence bounds):
         p1 =        6641  (5112, 8171)
         p2 =  -1.943e+04  (-2.784e+04, -1.103e+04)
         p3 =       -1236  (-1.51e+04, 1.263e+04)
         q1 =      -7.766  (-12.13, -3.398)
         q2 =        96.4  (60.56, 132.2)
         q3 =      -245.3  (-395.4, -95.09)

           Goodness of fit:
             SSE: 1.219e+04
             R-square: 0.9764
             Adjusted R-square: 0.968
             RMSE: 29.51

General model Exp2:
       f(x) = a*exp(b*x) + c*exp(d*x)
         where x is normalized by mean 9.186 and std 9.644
  Coefficients (with 95% confidence bounds):
         a =       327.5  (276.3, 378.7)
         b =      -1.132  (-1.528, -0.7353)
         c =     -0.2471  (-1.278, 0.7837)
         d =      -8.738  (-12.95, -4.528)

           Goodness of fit:
             SSE: 2.503e+04
             R-square: 0.9602
             Adjusted R-square: 0.9483
             RMSE: 50.03
```

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