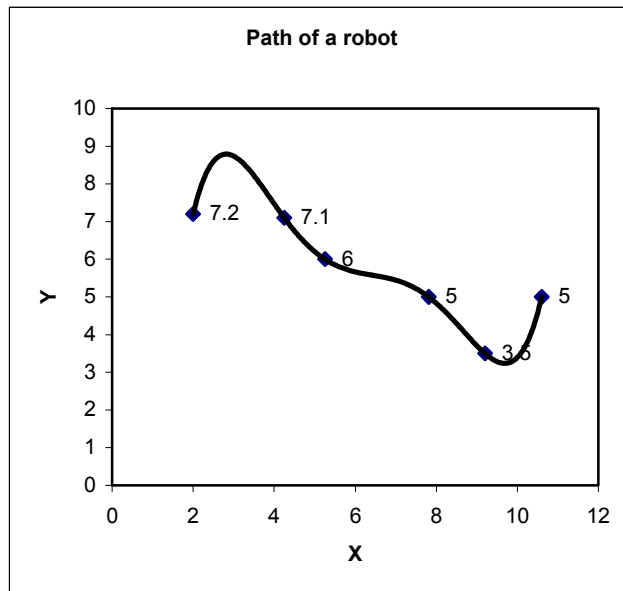


## Chapter 05.00D

### Physical Problem of Interpolation Computer Engineering

**Peter:** “Dr. Kaw, I am taking a course in Manufacturing. We are solving the following problem. A robot arm with a rapid laser is used to do a quick quality check, such as hole radius, on six holes on a rectangular plate 15"×10" at several points as shown in this table.



**Figure 1** Path of a robot arm

**Table 1** Coordinates of the points on the table

X	Y
inches	inches
2.00	7.2
4.25	7.1
5.25	6.0
7.81	5.0
9.20	3.5
10.60	5.0

I am using Excel to fit a fifth order polynomial through the 6 points. But, when I plot the polynomial, it is giving a long path!”

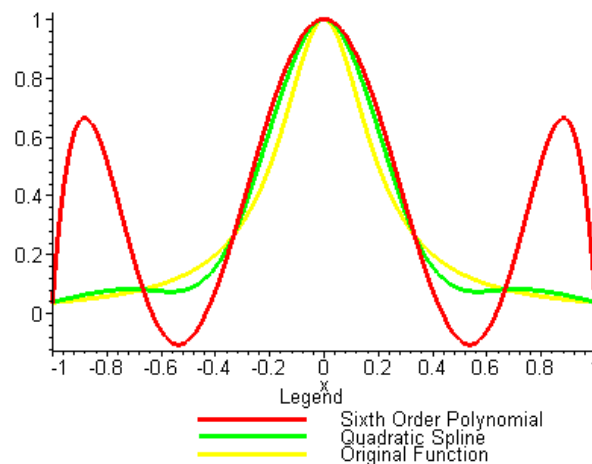
**Kaw:** “Why do you not just join the consecutive points by a straight line; just like the kids do at Pizza Hut with those ‘Connect the dots’ activities?”

**Peter:** “You are making me hungry and I wish it were that easy. The path of the robot going from one point to another needs to be smooth so as to avoid sharp jerks in the arm that can otherwise create premature wear and tear of the robot arm.”

**Kaw:** “As I recall, you took my course in Numerical Methods. What was that – one year ago?”

**Peter:** “Yes, your memory is sharp but my retention from that course – can we not talk about that!”

**Kaw:** “Come into my office. I wrote this program using Maple as you did. See this function,  $f(x) = 1/(1 + 25x^2)$ . I am choosing 7 points equidistantly between  $-1$  and  $1$ . Now look at the sixth order interpolating polynomial and the original function (See Figure 1). See the oscillations in the interpolating polynomial. In 1901, Runge [5] used this example function to show that higher order interpolation is a bad idea. A better alternative to getting a better representation of the curve is using splines. This is the solution to your problem as well. It will give you a smooth curve with less oscillations, and a shorter path. Try it!”

**Figure 2** Runge's function interpolated

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Topic	INTERPOLATION
Sub Topic	Physical Problem
Summary	A robot arm path needs to be developed over several points on a flat plate. The path needs to be smooth to avoid sudden jerky motion and at the same time needs to be short.
Authors	Autar Kaw
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Web Site	<a href="http://numericalmethods.eng.usf.edu">http://numericalmethods.eng.usf.edu</a>

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