CZ2003 Computer Graphics and Visualization

Report for Lab 2

In this report creation of parametric functions is described with respect to the attached files consisting of circle, ellipse, spiral, helix among others.

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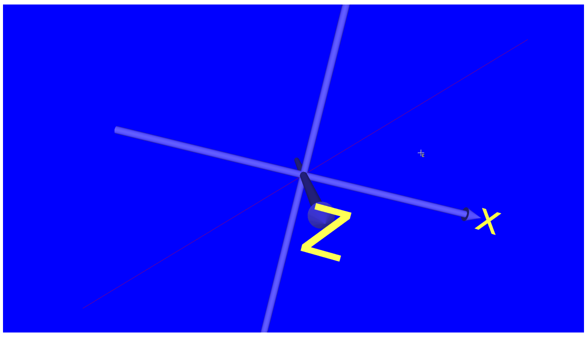
Problem 1: Define shapes

Line

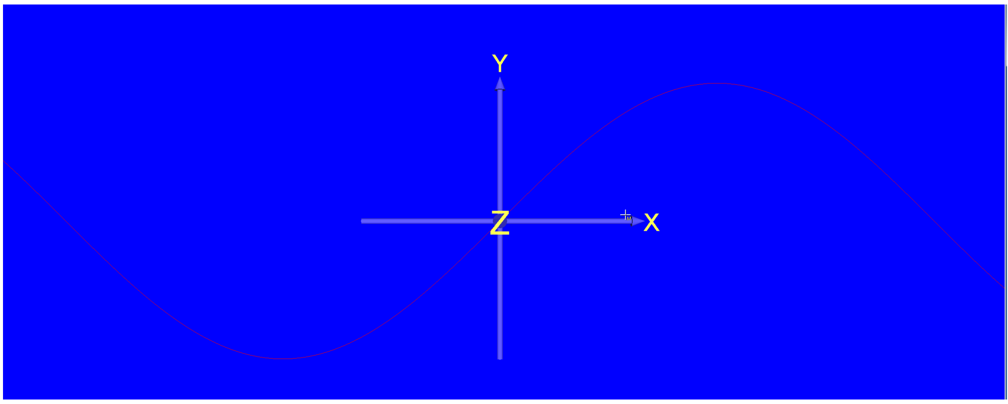
The parametric representation of a line can be as simple as $x = u$, $y = u$ with u having a limited domain as it is sufficient for the observing window.



A picture of the line

Sin

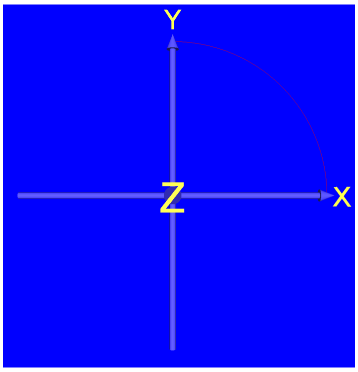
To represent $y = \sin(x)$ as a parametric function the substitution $u = x$ was done which resulted in $y = \sin(u),\ x = u$. Since this function in trigonometric u serves as the angle which implies that the domain of u is expressed in radians.



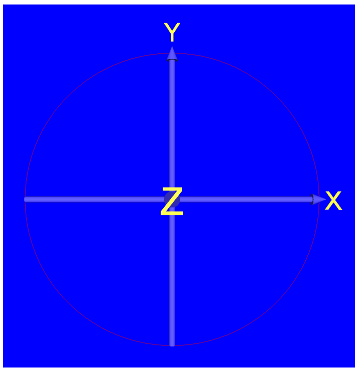
The sin function with domain [-2π, 2π] on u

Circle and arc

One parametric representation of a circle is $x = \sin(u)$, $y = \cos(u)$. To represent an arc we simply limit the domain of the circle from $[0,\ 2\pi]$ to $[0,\ \pi/2]$.



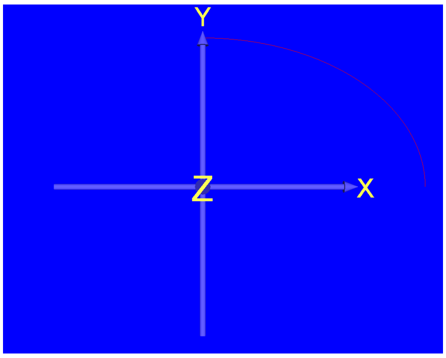
Arc of circe with domain $[0,\ \pi/2]$



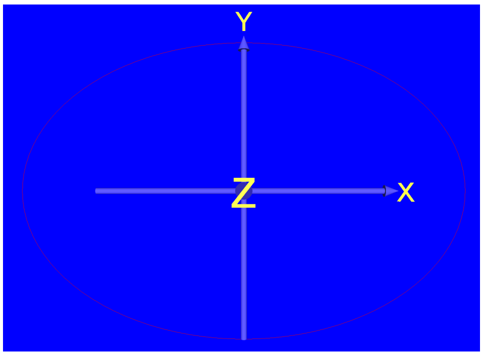
Circle

Ellipse and arc

The parametric representation of an ellipse can be very similar to a circle except that it has a coefficient, it is expressed as $x = a\ \sin(u)$, $y = b\ \sin(u)$ where $a,b\ \in \mathbb{R}$ and $a,b \neq 0$ with u having a limited domain similar to the previous section.



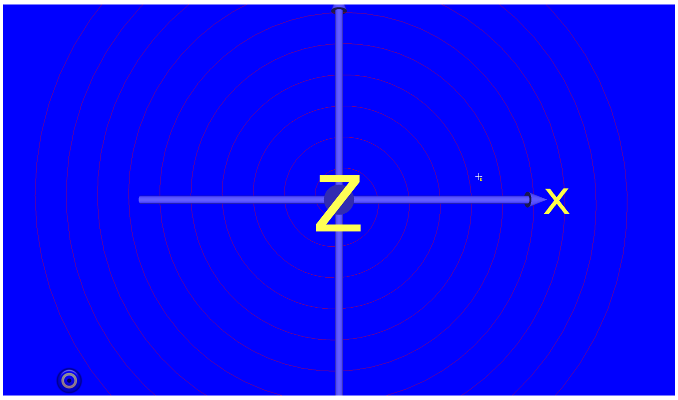
Arc of ellipse with domain $[0,\ \pi/2]$



Ellipse

2D Spiral

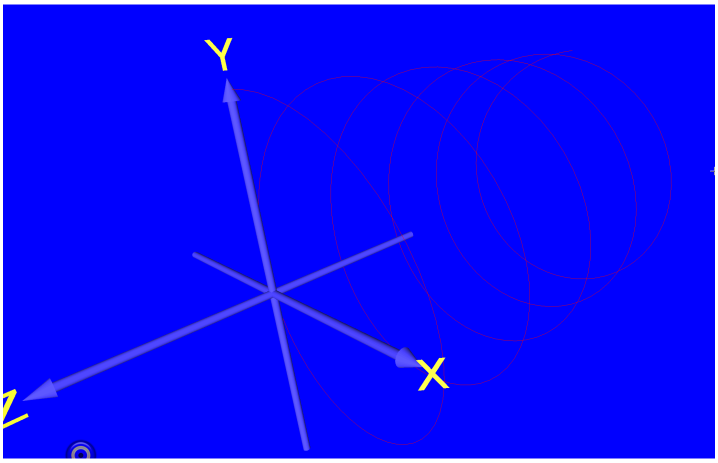
The parametric representation of a 2D spiral can be similar to an ellipse except that it has an additional coefficient u this results in $x = ua\ \sin(u),\ y = ub\ \sin(u)$ where in this case $a = b$. To allow the spiral to form the domain of u should be a rather high multiple of 2π where the multiple indicates how many turns the spiral will make. To make the spiral display properly an increase of resolution was needed since the length of the line, or rather, the domain of the ange has a much wider field than previous sections. Insufficient resolution results in incorrect visual representation of the function by for example showing edges when the function is a curve. Too high resolution will however result in unnecessary computations with respect to the viewing window.



The spiral with a domain of $[0,\ 20\pi]$ *on the angle and* $a = b = 1/40$ *and resolution* 600

Helix

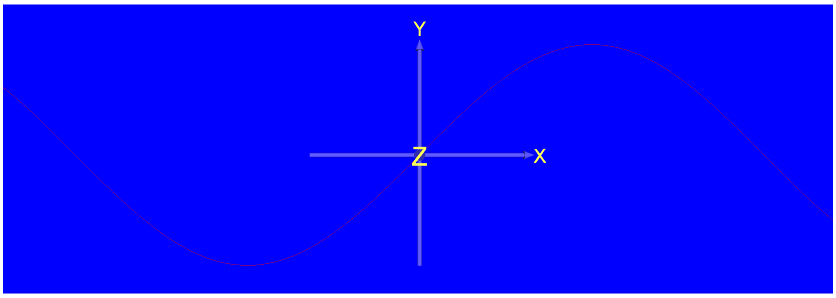
The parametric representation of a helix can be very similar to a circle. Up until now we have only showed functions which move through the xy-plane which was achieved by setting $z = 0$. In this case we need to use z to express the helix properly. For these reasons one parametric representation of a helix is $x = \sin(u)$, $y = \cos(u),\ x = au$ where $a \in \mathbb{R}$ and $a \neq 0$. In this case a is used to control the derivative of the helix in the z-axis. As in previous section an increase of resolution was also needed as a result of the expanded domain.



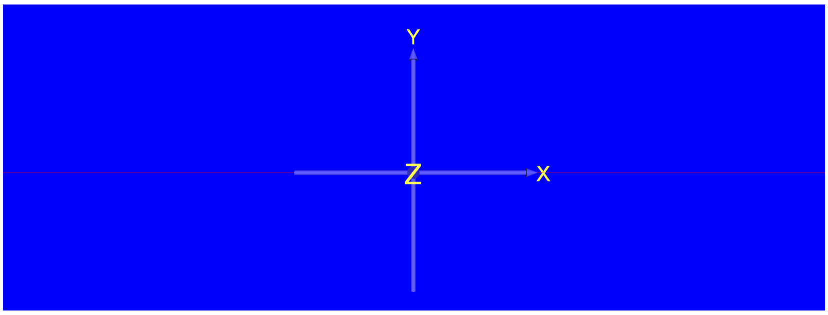
A picture of the helix with domain $[0,\ 10\pi]$ *on the angle and* $a =$ -0.1

Problem 2: Resolution

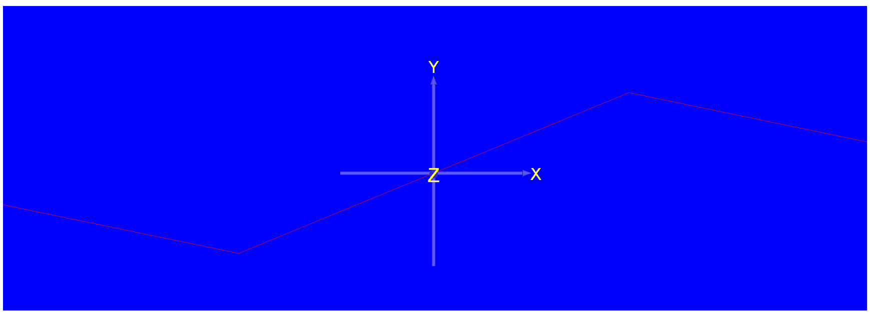
In this comparison $y = \sin(x)$ is used to show how the resolution changes the appearance of the curve. Since the resolution defines the sample of amount of points in the bounding box to be used the most precise representation is when the resolution is infinite. However for obvious reasons that is not achievable. Use to low resolution and the appearance of the representation diverges too much from the function and too high resolution will result in unnecessary computation. This section presents what happens when the resolution is too low.



$y = \sin(x)$ with sufficient resolution



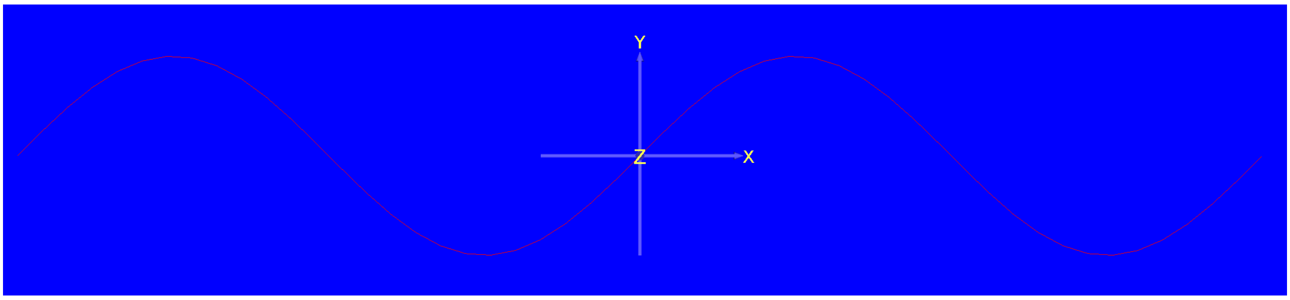
$y = \sin(x)$ with resolution 2, note that VRML represents the function with only 2 lines which best represent the function as a straight line parallel with the x-axis.



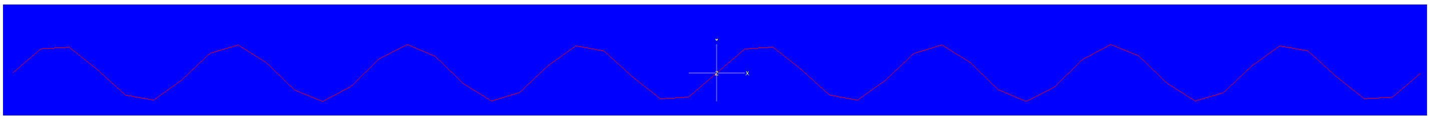
$y = \sin(x)$ with resolution 3. The representation is now zig-zagged as it more accurately resembles the function compared to a straight line.

Problem 3: Parameter domains

Changing the domain of the parameters yields in a longer span of values used for the representation. Since an increase of domain gives a longer function an increase in resolution may also be required to provide a proper representation. Using the function $y = \sin(x)$ we can prove this by setting a resolution which is just sufficient to represent the function and then increase the domain.



$y = \sin(x)$ with resolution 50 and domain [-2π, 2π]



$y = \sin(x)$ with resolution 50 and domain [-8π, 8π]. One can clearly see the lines due to less sampling