

Animating Vector Value Functions in 3 Space

In this discussion we want to develop the template for generating animations of vector valued functions in 3 space. You may want to consider the animations on the vector value function page on Calculus7.com to remind yourself what we are leading up to. At the end I will also describe how to add in the x,y, and z axes.

Recall that the basic idea of a vector valued function is that instead of thinking of a curve in 3 space as being generated by 3 parametric equations $x(t), y(t)$, and $z(t)$ it is generated by a single vector equation:

$$\vec{r}(t) = x(t)\cdot\vec{i} + y(t)\cdot\vec{j} + z(t)\cdot\vec{k} \quad \text{where } \vec{r}(t) \text{ is a vector from the origin to the point } (x(t), y(t), z(t)) \text{ for each } t.$$

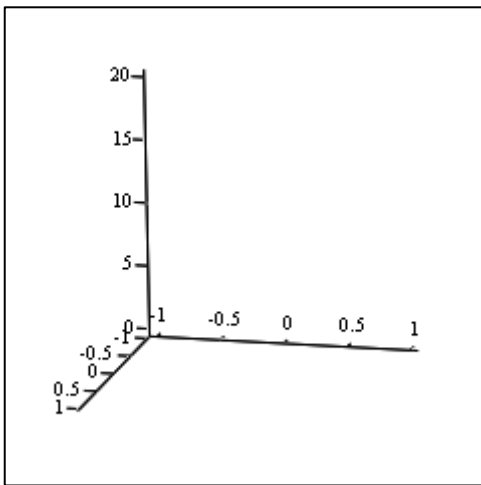
The curve is then swept out by the terminal points of $\vec{r}(t)$ as t increases .

So we need to simply develop a way of graphing $r(t)$ for each t .

We saw that to animate parametric equations in 3- space the template is :

```

s := 0..FRAME
t(s) := s.1
i := 0..1
x1,s := cos(t(s))    y1,s := sin(t(s))    z1,s := t(s)
    
```



(x, y, z)

We also saw that to animate 2 sets of parametric equations the template is:

```

s := 0..FRAME

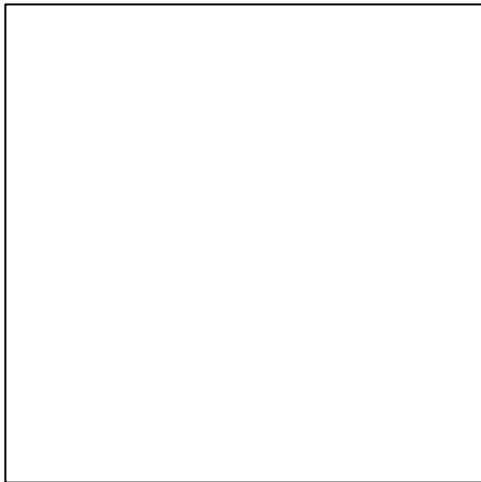
t(s) := s.1

i := 0..1

xi,s := cos(t(s))    yi,s := sin(t(s))    zi,s := t(s)

x1i,s := cos(t(s))    y1i,s := -sin(t(s))    z1i,s := t(s)

```



$(x, y, z), (x1, y1, z1)$

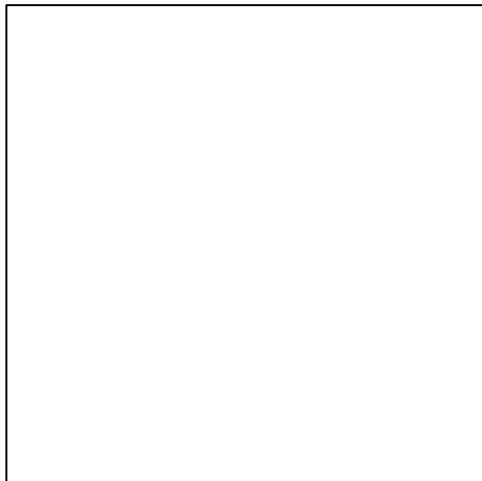
The setup starts the same with one very significant difference. We still want $s := 0..FRAME$ to graph the curve. We also define $s1 := FRAME$ so we can generate the line segment from the origin to the point $(x(t(s)), y(t(s)), z(t(s)))$ (Of course you can use any variable not necessarily $s1$)

We then define: (for the helix but obviously you can use any 3 functions you want depending on the curve)

$xv(t(s1)) := \cos(t(s1))$ $yv(t(s1)) := \sin(t(s1))$ $zv(t(s1)) := t(s1)$ I use xv etc to indicate this is part of a vector but again you choose just don't use x,y, and z again.

The complete set up is

```
s := 0..FRAME      s1 := FRAME
t(s) := s.1
i := 0..1
xi,s := cos(t(s))   yi,s := sin(t(s))   zi,s := t(s)
xvi,s1 := cos(t(s1))   yvi,s1 := sin(t(s1))   zvi,s1 := t(s1)
```



$(x, y, z), (xv, yv, zv)$

[See Animation Vector Valued 1](#)

Let's refine our work by adding in the x, y and z axes.

This is making sausage and isn't pretty but adds a lot to the animation.

In our helix example x and y go from -1 to 1 and z goes from 0 to 20. We Define X1,Y1, and Z1 as below

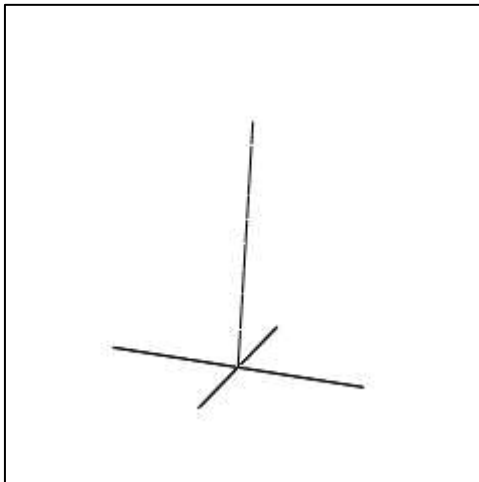
$i := 0..1$ $m := 0..40$

$X1_{i,m} := 0$ $Y1_{i,m} := 0$ $Z1_{i,m} := (m - 20)$

Note Z varies from -20 to 20 but since we fixed the z axis from 0 to 20 only that part will appear.

So we don't have to define 9 functions we permute the variables as below to graph the axes.

The order is z axis, y-axis, x-axis. Note since we fixed the x and y axes the axes on the graph will only appear for the ranges we want



$(X1, Y1, Z1), (Y1, Z1, X1), (Z1, X1, Y1)$

So now putting it all together:

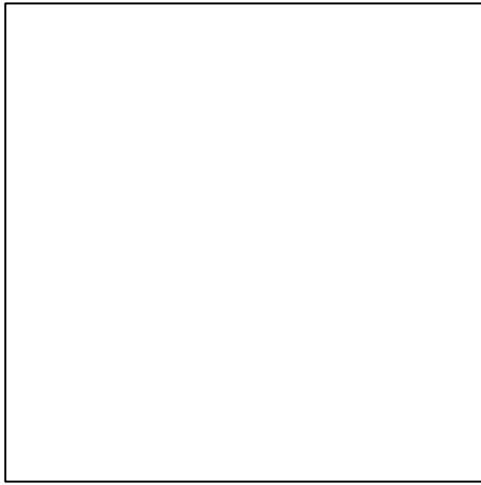
$s := 0..FRAME$ $s1 := FRAME$

$t(s) := s \cdot 1$ $i := 0..1$ $m := 0..40$

$x_{i,s} := \cos(t(s))$ $y_{i,s} := \sin(t(s))$ $z_{i,s} := t(s)$

$xv_{i,s1} := \cos(t(s1))$ $yv_{i,s1} := \sin(t(s1))$ $zv_{i,s1} := t(s1)$

$X1_{i,m} := 0$ $Y1_{i,m} := 0$ $Z1_{i,m} := (m - 20)$



$(x, y, z), (xv, yv, zv), (X1, Y1, Z1), (Y1, Z1, X1), (Z1, X1, Y1)$

[See Animation Vector Valued 2](#)