Introduction

A vector is a mathematical concept that is useful in modeling various physical/mechanical properties, such as force, velocity, and acceleration. Vectors will also be useful in modeling various properties used in video engineering, such as (**TBD**).

Vector Properties

Each vector has a magnitude and a direction. The magnitude can be a positive or negative value, or can be zero. The direction can be any degree from 0, inclusive, up to 360, exclusive (in polar coordinates).

Vector Arithmetic

Vectors can be added and subtracted according to the rules for vector arithmetic. What would be called the sum of an addition in arithmetic is called the resultant in vector arithmetic, replacing two or more vectors with a single vector that represents the combination of vectors.

There are two graphical methods used in vector addition and subtraction: the daisy-chain method and the parallelogram method. There is also algebraic methods for vector addition and subtraction.

Graphical Methods of Vector Arithmetic

The graphical methods of vector arithmetic are not as accurate as algebraic methods; they are more useful in illustrating the concepts as you learn about vectors.

Graphing Vectors

Graphically, vectors are represented by arrows, the length of which represents the magnitude and the orientation of which represents the direction.

Vector Addition by Daisy-Chaining

Daisy-chaining relies on the fact that vectors can be moved around in a graphical environment without changing their properties. In other words, as long as you don't stretch or shrink the vector, or point it in some other direction, moving the vector around won't change it.

Daisy-chaining involves moving the vectors around so that the head of one points to and is just touching the tail of another. When you have moved all the vectors around so they create one multi-segmented line, you can draw a vector whose

tail is the tail of the first vector and whose head is the head of the last vector; this vector will be the resultant of the vector addition.

[**TBD** – *put a graphic here that illustrates this concept*]

Vector Addition by the Parallelogram Method

A parallelogram is a four-sided figure having opposite sides that are parallel to each other and of equal length. If you move two vectors into a daisy-chain so that they form two adjacent sides of a parallelogram, the resultant is the parallelogram's diagonal.

You can then take the resultant and add it to another vector by this method, and continue this process with as many vectors as you need to add together. This makes the parallelogram method a step-wise version of the daisy-chain method.

[**TBD** – *graphic of this method*]

Vector Subtraction

Subtracting one vector from another using the daisy-chain method involves negating the magnitude of the vector being subtracted and adding it to the other vector being subtracted from.

[**TBD** – *graphic of this method*]

Subtracting one vector from another using the parallelogram method involves placing the vector to be subtracted from in the diagonal of the parallelogram and placing the vector being subtracted as one of the adjacent sides. Set this up either by placing the heads of the two vectors together or by placing the tails of the two vectors together. The result of the subtraction is the vector that makes up the other adjacent side of the parallelogram.

[**TBD** – *graphic of this method*]

Vector Trigonometry

In order to perform algebraic operations on vectors, it's useful to learn the concepts of vector trigonometry. In a Cartesian (x-y) coordinate system, each vector has an x component and a y component. If you move the vector so that the tail of the vector is at the origin, the coordinates of the head are the x component and y component of the vector.

Just as in trigonometry applied to triangles, you can determine the x component of a vector by multiplying the magnitude of the vector by the cosine of the angle representing the direction of the vector. Similarly, you can determine the y component of a vector by multiplying the magnitude of the vector by the sine of the angle representing the direction of the vector.

You can obtain a vector from its x and y components. You can calculate the angle of the vector by taking the arctangent of the ratio of the y component over the x component. You can use the Pythagorean theorem to calculate the magnitude of the vector, which will be the square root of the sum of the squares of the x component and the y component.

Algebraic Vector Arithmetic

You can add two or more vectors together by:

1. calculating the x and y components of each vector,
2. adding the x components of each vector to obtain the x component of the resultant vector,
3. adding the y components of each vector to obtain the y component of the resultant vector,
4. calculating the vector's direction and magnitude from the x and y component sums

You can subtract two vectors in a similar fashion:

1. calculating the x and y components of each vector,
2. subtracting the x component of one vector from the x component of the other vector to obtain the x component of the difference vector,
3. subtracting the y component of one vector from the y component of the other vector to obtain the y component of the difference vector,
4. calculating the vector's direction and magnitude from the x and y component differences