Chapter 2

Background / Related Work

2.1 Two-Dimensional Image Representation on Computers

At it's most basic form, a sketch is an image drawn on a planar two-dimensional surface. On computers, there are two methods or storing two dimensional images: raster graphics and vector graphics. The underlying data structure has a large impact on the types of tools that can be designed to create and modify an image.

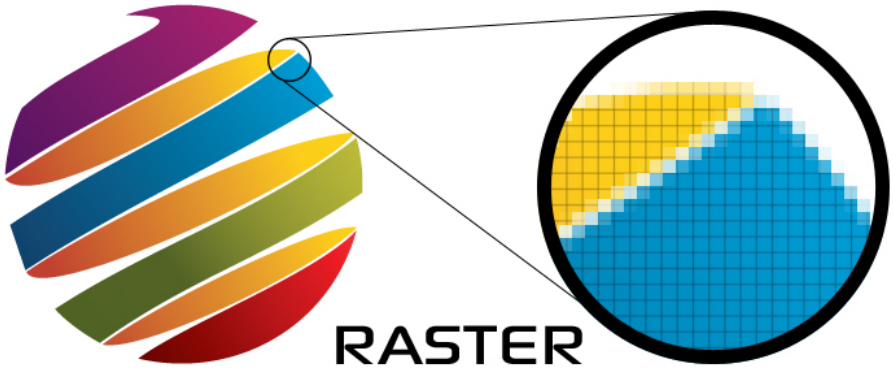

Figure 2.1: Zooming in on a Raster Graphics Image

2.1.1 Raster Graphics

Raster graphics is an image format that uses a two-dimensional grid to represent each pixel in the image. A raster image is characterized by its width and height in pixels and by its color depth, the number of bytes per pixel, which determines the colors each pixel can represent. The reasoning behind representing images by this method is most computer monitors have bitmapped displays, where each pixel on the screen corresponds to a set of bits in memory telling the pixel what color to display. This allows for computers to easily display raster images, since the formats are largely the same.

Raster graphics are limited by the fact that the images it produces are resolution dependent. If you were to continuously zoom in on a raster image, eventually the image would suffer from image degradation. Pixel editing makes creating different tools for raster graphics easier, since the makers can just define how pixels are effected based on where the user is working.

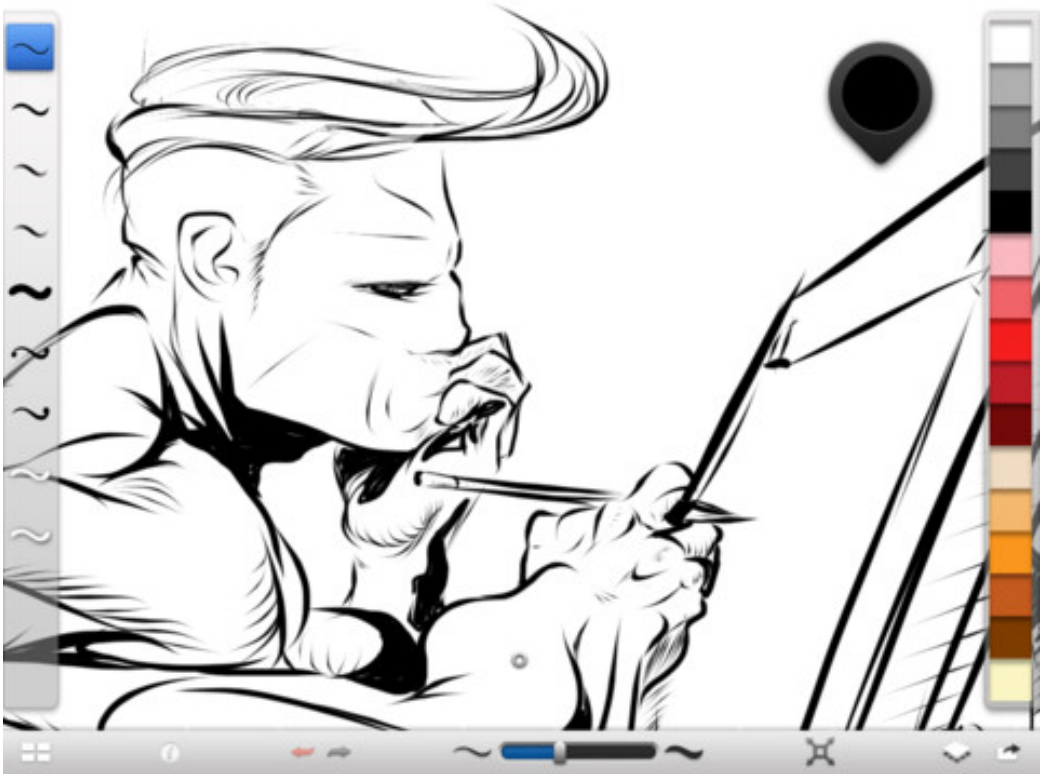

Figure 2.2: Creating a Raster Image in Sketchbook

Examples of popular raster graphics software are Corel Painter, Adobe Photoshop, Microsoft's Paint.NET and MSPaint, the open-source GIMP software, and Autodesk's Sketchbook.

2.1.2 Vector Graphics

Vector graphics is the representation of an image by the use of geometrical primitives such as points, lines, curves, shapes and polygons. Each of these primitives has a defined xy coordinate of the work space and determines the direction of the vector. Vectors can also be assigned a variety of properties such as its color, thickness, and fill. Because of their mathematical nature, they are theoretically similar to three-dimensional computer graphics, but the term specifically refers to two-dimensional images; in part to distinguish them from raster graphics. Vector graphics are primarily used for line art, images drawn with distinct straight or curved lines. While there have been displays specialized for rendering them in the past, vector graphics in modern times are converted to raster graphics when used outside of vector specific editing tools.

Vector graphics offer a number of advantages compared to raster images. First, since vector graphics are based on mathematical expressions, zooming in on the image does not cause image degradation like in raster graphics; the image will remain smooth. Second, objects made using vector

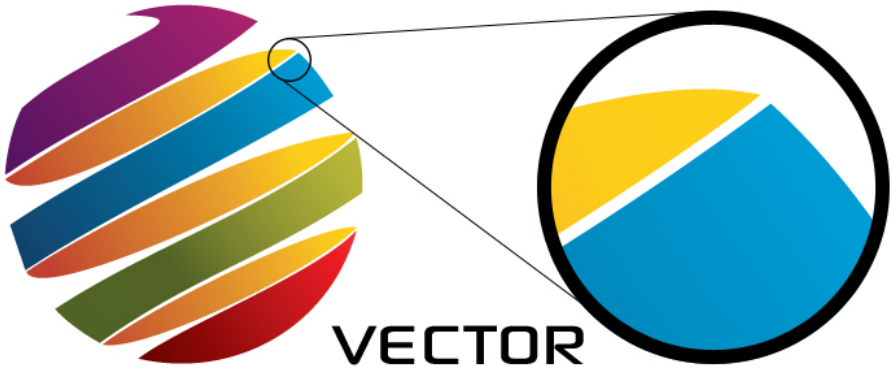

Figure 2.3: Zooming in on a Vector Graphics Image

graphics are independent from their visual representation. This allows for the editing of primitives after they have been put inside of a vector graphics workspace. For example, if I were to place a circle on top of a square in a raster graphics image, and then attempt to move the circle, there would be a circle-shaped hole in the square beneath. This is because the system does not actually know what a circle or a square is; it only knows that the tools fill a defined set of pixels that happen to form their shape. However, in a vector image, moving the circle would have no effect on the square underneath.

Examples of popular vector graphics editing software are Adobe Illustrator, Corel Draw, and Inkscape.

2.1.3 Adaptive Distance Fields: Mischief

https://www.madewithmischief.com/

Mischief is a pseudo-vector graphics editor created by Made With Mischief, now owned by The Foundry. Although its systems are based on vector graphics, it does not allow for the precise editing of curves as seen in traditional vector graphics programs such as Adobe Illustrator. Instead it attempts to use vector graphics to simulate real world art techniques, like Sketchbook does. This is possible by using a data-structure called Adaptive Distance Fields, which stores vectors in a tree data structure instead of the traditional vector format. Since the tree data structure ends up looking like a pseudo-raster, raster brushes and pens can be implemented in this system by just telling it what shapes go inside of the data structure. Adaptive Distance Fields also greatly reduce the storage size of large scale vectors, making it possible for the implementation of their infinite canvas; their infinitely zoomable, translatable workspace. This allows for incredibly detailed and large scale.

TODO: Add examples of the infinite canvas (bug Nick)

2.2 3-D Modeling in CAD

Rhino

AutoCAD

Maya / 3DMAX