Chapter XXVII
Mobile Fractal Generation

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ABSTRACT

Ever since the discovery of the Mandelbrot set, the use of computers to visualise fractal images have been an essential component. We are looking at the dawn of a new age, the age of ubiquitous computing. With many countries having near 100% mobile phone usage, there is clearly a potentially huge computation resource becoming available. In the past years there have been a few applications developed to generate fractal images on mobile phones. This chapter discusses three possible methodologies whereby such images can be visualised on mobile devices. These methods include: the generation of an image on a phone, the use of a server to generate the image and finally the use of a network of phones to distribute the processing task.

INTRODUCTION

The subject of Fractals has fascinated scientists for well over a hundred years ever since what is believed to be the discovery of the first fractal by Gregor Cantor in 1872 (The Cantor set). Benoit Mandelbrot (Mandelbrot 1983) first coined the term "Fractal" in the mid 1970's. It is derived from the latin "fractus" or "broken." Before this period, they were often referred to as "mathematical monsters." Fractal concepts can be applied to a wide-ranging variety of application areas such as: art (Musgrave & Mandelbrot, 1991), music generation (Itoh, Seki, Inuzuka, Nakamura, & Uenosono, 1998), fractal image compression

(Lu, 1997), or fractal encryption. The number of uses of fractals is almost as limitless as their very nature (fractals are said to display infinite detail). They also display a self-similar structure, for example, small sections of the image are similar to the whole. Fractals can be found throughout nature from clouds and mountains to the bark of a tree. To appreciate the infinite detail that fractal images posses it is necessary to be able to zoom in on such images. This "fractal zoom" allows the viewer to experience the true and infinite nature of the fractal. One typically cannot fully appreciate the fractals that exist in nature. To fully explore the true intricacies of such images one must visualise them within the computing domain.

The generation of a fractal image is a computationally expensive task, even with a modern day desktop computer, the time to generate such images can be measured from seconds to minutes for a moderately sized image. The chief purpose of this chapter is to explore the generation of such images on mobile devices such as mobile phones. The processing power of mobile devices is continually advancing, this allows for the faster computation of fractal images. The memory capacity so too increasing rapidly allowing for larger sized images to be generated on the mobile device. The current generation of smartphones have processing speeds with a range of 100 to 200Mhz and are usually powered by the ARM9 family of processors. The next generation of smartphones will be powered with the ARM11 processor family and should have speeds of up to 500Mhz. This is clearly a dramatic increase in speed and as such we will see that the next generation of smartphones will be able to run a myriad of applications that current phones are too slow to run effectively.

Certainly, this study can be applied to various visualisation problems that involve large amount of computation on mobile devices. Al-

though the computation power of mobile devices has increased, this may still be insufficient to rapidly generate the image of the object to visualise. Therefore, alternative solutions must be investigated.

FRACTAL GENERATION

In this section, we will outline the algorithms to generate the Mandelbrot and Julia sets. One can use the exact same algorithms to generate a fractal image on a mobile phone with slight differences in the implementation but the overall structure stays the same.

Mandelbrot and Julia sets

The Mandelbrot and Julia sets are perhaps the most popular class of non-linear self-similar fractals. The actual equation and algorithm for generating both the Julia and Mandelbrot like sets are quite similar and generally quite simple. They use the polynomial function $f : C \rightarrow C, f(z) = z^u + c^v$ to generate a sequence of points $\{x_n : n \geq 0\}$ in the complex plane by $x_{n+1} = f(x_n), \forall n \geq 0$. There have been several mathematical studies to prove that the sequence has only two attractors 0 and infinity. The Julia and Mandelbrot sets retain only those initial points that generate sequences attracted by 0 as Equations (1-2) show:

$$J_c = \{x_0 \in C : x_{n+1} = f(x_n), \qquad (1)$$
$$n \geq 0 \text{ are attracted by } 0\}$$

$$M = \{c \in C : x_0 = 0, x_{n+1} = f(x_n), \qquad (2)$$
$$n \geq 0 \text{ are attracted by } 0\}$$

The most important result (Mandelbrot, 1983) on this type of fractal shows that the set M is an index for the sets J (see Figure 1). In this case,

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