

## Overview

The digital kaleidoscope is a reference to a favorite childhood game, usually in the form of a magical telescope or magical binoculars.

A similar, although more impressive, effect can be created using contemporary synchronous digital circuit technology for implementing two-dimensional cellular automata. In our case, these automata comprise of a two-dimensional matrix composed of identical cells, the internal state of which can be visualized by assigning it to pixels of a display through a palette of 256 colors.

## Operation

The digital kaleidoscope belongs to a class of 2D automata which implement the so-called rug rule. For a cell with a given value,  $C$ , its subsequent value,  $C'$ , is calculated based on the values of its 8 immediate neighbors such as those illustrated below (Moore neighborhood).

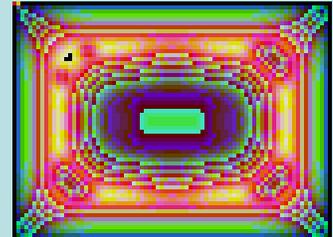
NW	N	NE
W	C	E
SW	S	SE

According to the rug rule, the following three steps are executed:

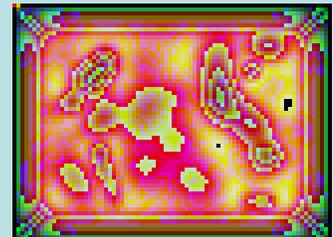
- 1) First, we sum the values of the 8 neighbors:  
 $sum = (NW+N+NE+W+E+SW+S+SE)$
- 2) Then, we divide by 8 to get their floored average value:  
 $avg = sum / 8$
- 3) We calculate  $C'$  by adding a small integer increment ( $incr$ ) to  $avg$ . This computation takes place in modulo 256 arithmetic:  
 $C' = (avg + incr) \bmod 256$

Following these simple steps for every cell, the digital kaleidoscope presents an explosive, chaotic and at the same time, highly interesting behavior.

## SCREENSHOTS



Sample automaton phase (generation 116)



Sample automaton phase (generation 999)

## TECHNOLOGY

The digital circuit was designed in the **VHDL** hardware description language.

To dramatically reduce design time, the behavior of the circuit was first described in the C programming language. The C program was automatically translated to VHDL using the **HercuLeS** high-level synthesis tool.

The resulting description was then synthesized on an **FPGA** integrated circuit (Xilinx XC3S700AN) using the Xilinx ISE/XST logic synthesis environment.

The development board which has been used is the Xilinx Spartan-3AN Starter Kit by Digilent.