

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).

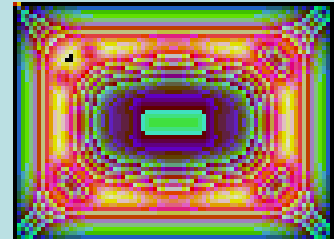
NW	N	NE
W	C	E
SW	S	SE

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

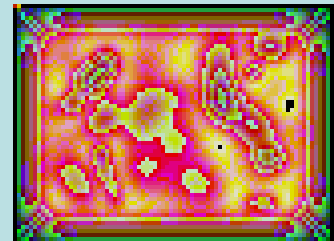
- 1) First, we sum the values of the 8 neighbors:
 $sum = (NW+N+NE+W+E+SW+S+SE)$
- 2) Then, we divide by 8 to get their floored average value:
 $avg = sum / 8$
- 3) We calculate C' by adding a small integer increment ($incr$) to avg . This computation takes place in modulo 256 arithmetic:
 $C' = (avg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

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.