# ENCODING OF DIGITAL CIRCUITS TO MIMIC THE GENOME OF A BIOLOGICAL ORGANISM

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The proposed work visualizes the digital circuit as a series of bits much the same way as the human genome is interpreted. The Binary strings are visualized to mimic the genetic imprint of a biological organism. The genotype given by the DNA determines the phenotype of the organism[1]. Similarly, the binary string is encoded in a way to reflect the components of the circuit. The 2800 Mega base pairs[2] constituting the human genome has a sequence of Adenine, Thymine, Cytosine and Guanine. These bases codes the amino acids which in turn make proteins. A digital circuit, thus, is visualized to have sequence of bits.

The component of the circuit mimics the natural cell. The genome consists of 5 frames representing particular attribute as shown in fig. 1. Frame C and E comprises two sub-frames.

| Start | A | B | C | D | E | Stop |
|---|---|---|---|---|---|---|
| Telo mere | Input Level | Circuit Level | Inputs & Groups | Type of inputs | Compo nent | Telom ere |

Figure 1: Genome of a component

Table 1 Frame A and Frame B Encoding

| String | Frame A (Input level) | Frame B (Circuit Level) |
|---|---|---|
| 001 | Level I | Level I |
| 011 | 2 | 2 |
| 010 | 3 | 3 |
| 110 | 4 | 4 |
| 111 | 5 | 5 |
| 101 | 6 | 6 |
| 100 | 7 | 7 |

Table 2 Frame C and Frame D Encoding

| Frame C (number of inputs and input groups) | | | | | | | Frame D (type of inputs) |
|---|---|---|---|---|---|---|---|
| Inputs, i c1 | | | Input groups c2 | | | | c-complement s-straight |
| i | w | string | W | | grouping | String | String |
| 1 | 3 | 000 | 1 | 1 | 1 | 1 | 1 – s |
| 2 | 3 | 001 | 2 | 2 | 2 | 11 | 00 – c,c<br>01 – c,s<br>10 – s,c<br>11 – s,s |
| 3 | 3 | 011 | 3 | 3 | 2 | 011<br>101<br>110 | 000 – -,c,c<br>001 – -,c,s<br>011 – -,s,s<br>010 – -,s,c<br>000 – c,-,c<br>. |
| 4 | 3 | 010 | 4 | 4 | 2 | 0011<br>0101<br>.<br>1100 | .<br>.<br>.<br>. |
| 5 | 3 | 110 | 5 | 5 | 2 | 00011<br>.00101<br>00110<br>11000<br>.<br>10001 | |
| 6 | 3 | 111 | 6 | 6 | 2 | .<br>. | |
| 7 | 3 | 101 | 7 | 7 | 2 | .<br>. | |
| 8 | 3 | 100 | 8 | 8 | 2 | 00000001<br>00000011<br>00000101<br>00000110<br>00011000<br>.<br>.<br>10000010 | .<br>.<br>- |

Table 3 Frame E Encoding

| Frame E (Components) | | |
|---|---|---|
| Index | Component | String |
| 00 | - | - |
| 01 (Gates) | Not Defined | 000 |
| | Ex-OR | 001 |
| | AND | 011 |
| | OR | 010 |
| | Ex-NOR | 110 |
| | Buffer | 111 |
| | NOR | 101 |
| | NAND | 100 |
| 11 (Circuits) | Mux | 000 |
| | Demux | 001 |
| | Decoder | 011 |
| | Encoder | 010 |
| | . | 110 |
| | . | 111 |
| | . | 101 |
| | . | 100 |
| 10 (Sequential Circuits) | D FF | 000 |
| | T FF | 001 |
| | JK FF | 011 |
| | SR FF | 010 |
| | SR | 110 |
| | - | 111 |
| | - | 101 |
| | - | 100 |

The Length of the genome (L) of a cell in a 7 level, 8 input digital circuit takes the empirical form, L = 2i + 16. Number of strips making up the complete genome is proportional to number of components of the circuit. The 20 bit string

  

10010010011111010111 (figure 2) represents the genome of a 2 input AND gate (Y = A.B).

| Start | A | B | C | D | E | Stop |
|---|---|---|---|---|---|---|
| 1 | 001 | 001 | 001 11 | 11 | 01 011 | 1 |

**Figure 2 Two input AND Gate**

A multiplexer circuit (Y = A.S' + B.S) has 3 cells with each cell's genome given by 1001001011011001010111, 1001001011101001010111 and 1011011011011011010101. All 3 strings make the genome of the multiplexer.

[1] J. M. W. Slack, "Essential Developmental Biology," 2nd edition, Wiley-Blackwell, A John Wiley & Sons, Ltd. Publication, 2013.

[2] International Human Genome Sequencing Consortium, "Finishing the euchromatic sequence of the human genome," Nature, vol. 431, October 2004.

  