



Design and Implementation of Content Addressable Memory Unit using Qunatum Dot

G Surya Kranth, R. S. Ernest Ravindran

Abstract: Quantum-dot cell automata is one of the upcoming new advances at the nanoscale that can be a reasonable substitution for CMOS innovation. The circuits built in QCA technology have attractive features like low power utilization, and low size. These features can be progressively particular in memory structures. In this paper, the new design another structure for substance addressable memory cell in QCA. For this reason, initial, an extraordinary gate is presented for mask task in QCA and afterward this gate is utilized to enhance the execution of CAM. These structures are assessed with QCA Designer test system.

Index Terms: Quantum Dot Cellular Automata, QCA Wire, Majority Gate, Polarization.

I. INTRODUCTION

Actualized circuits in CMOS technology have faults such as high power utilization, expansive physical size and high leakage current [1]. Experts are searching for new technology to beat these faults. QCA is one of these advances [1– 3]. QCA is one of the later new advances in the Nano-scale that can cover defects in CMOS technology. QCA is a decent option for circuit plan, because the capacity to accomplish superior with low energy consumption [4, 5]. QCA depends on the rule of capture and awful of electrons. The fundamental segment of the QCA is the square cell that contains four openings and two electrons. Coulomb aversion causes the electrons possessed the gaps uneven to one another [4]. Structuring an effective QCA memory cell is an issue that has pulled in the consideration of researchers. The works, for example, [6, 7] have centred on this issue. These works have displayed a Random Access Memory (Slam) cell in QCA. In this paper, it propose a Content-Addressable Memory (CAM) cell, which is not quite the same as RAM. CAM is a unique kind of computer memory that can be utilized in certain rapid looking applications. In this sort of memory, an opportunity to achieve a thing put away in memory is fundamentally decreased [4]. We present an exceptional structure that can enhance the execution of the CAM memory.

A two-input XOR gate and a three-input greater part entryway are utilized to plan the special structure. Finally, we use QCA Designer test system to assess the execution of the proposed CAM cell.

The rest of this paper is as per the following: Section 2 will review the QCA and CAM memory. In Section 3, the proposed one of a kind gate and proposed CAM cell will be presented. The reproduction results dependent on QCA Designer is given in Section 4. Conclusion is presented at last.

II. QCA

QCA is one of the most current advancements in nanometre measurements [5]. This technology depends on the cell and gives another technique to structure the advanced circuits. The execution of the cells in QCA depends on the situation of electrons. A square-formed QCA cell comprises of four quantum dots and two free electrons [3-4]. The development of electrons in these cells is because of Columbic repulsion. The position of electrons in the cell causes appropriate estimations of binary 0 and binary 1. The structure of QCA cell is appeared in Fig. 1

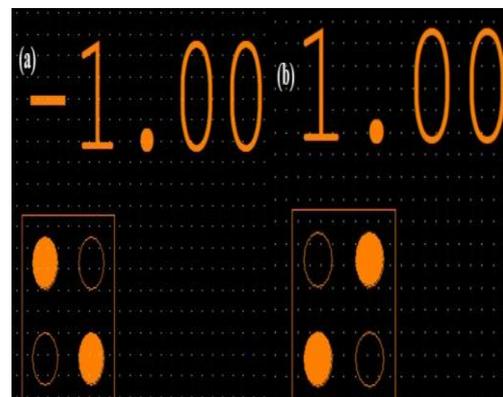


Fig. 1(a) P= -1 (Binary 0), (b) P= +1 (Binary 1)

By setting the polarization tunnel effect occurs at adjacent cells to propagate the signal from one to another location. For the different quantum dot of cell, there are different binary digits for polarization and to get the polarization value in QCA there is a mathematical expression, which is represented below.

$$P = \frac{(P_1+P_3)-(P_2+P_4)}{P_1+P_2+P_3+P_4} \quad (1)$$

2.1 Majority Gate

The three-input majority gate and inverter are the fundamental logic gates in QCA that are appeared in Fig. 2 [1, 4]. Three-input majority gate has three inputs like A, B and C, and one output majorly. The activity of this gate is $M(A, B, C) = AB + AC + BC$. Truth table of the three input majority gate is shown in Table 1.



Manuscript published on November 30, 2019.

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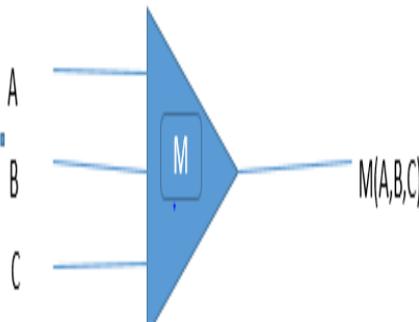
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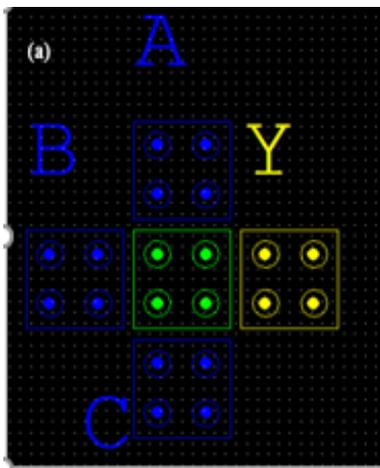
The two-input AND and OR gates are done by the three input majority gate. By fixing the estimation, value one of the inputs are may be -1 and +1 in the three input majority gate.

Table 1 Truth table of majority gate of three inputs A, B, C=M (A, B, C)

A	B	C	M(A,B,C)
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1



$$M(A, B, C) = AB + AC + BC$$



Three-input majority gate
Fig.2 Three input majority gate

2.2 Clocking in QCA

A clocking structure is required to control the flow of data in complex circuits [4]. One of the standard and generally utilized clocking structure in QCA is the four-zone structure. The cells can place into various polarization. The energy of a clock zone can cause the polarization of the cells in that clock zone. The clocking structure of QCA is shown in fig 3.

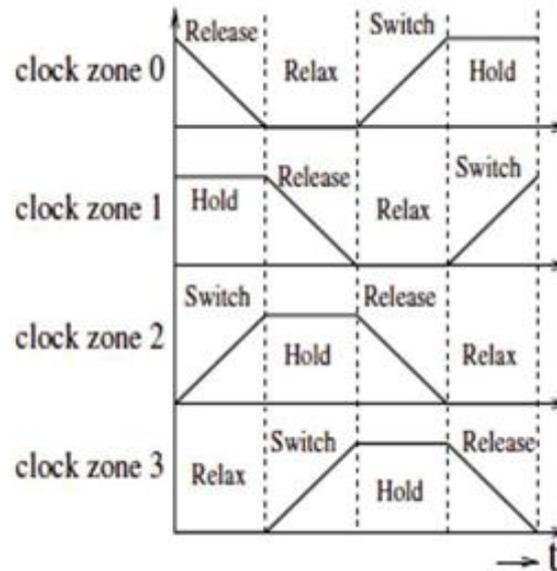


Fig 3 clocking structure in QCA

2.3 XOR gate

In QCA, design for designing the CAM structure two input XOR Gate is designed. Different design are implemented for the two input XOR gates in QCA [8-11]. The best design of XOR gate is appeared in Fig 4, which is presented in ref. [11].

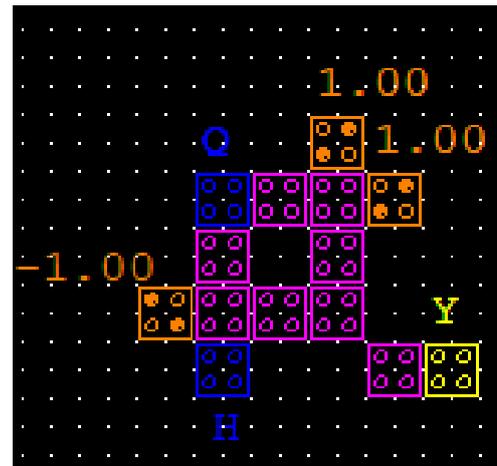


Fig 4. XOR gate

III. CAM

A CAM is structure that is purpose-built particularly for the quick memory lookups. CAM is accomplished of searching its entire contents in a single clock cycle. Data stored on CAM can be retrieved by searching for the content itself, and the memory produces by the match signal and retrieves addresses where that content can be create.

Content-addressable memory (CAMs) are equipment for web search tools that are a lot faster than algorithmic methodologies for analysis increased applications. CAMs are made out of traditional semiconductor memory (generally SRAM) with included correlation hardware that empower search activity to finish in a single clock cycle.

The two most normal search increased errands that utilization CAMs are parcel sending and bundle characterization in Web switches. I existing CAM application and circuits by first representing the use of location address lookup in Internet routers. Then we describe how to device this lookup function with CAM.

3.1. Proposed Unique gate

In this segment, we present a proposed one of a unique gate. As early referenced memory design with lower cell count and fast in one of the most critical difficulties for experts. This paper activity to present a one of a unique gate structure that can improve CAM memory execution. The ability of this gate is as Eq. (1). To design this gate, an XOR gate presented in the previous segment and a three-input majority gate is used.

$$Out = \bar{k} (A \odot B) + k \dots \dots \dots (1)$$

The preferred operation of this gate is shown in Table 2. If k is "0", the inputs A and B are related. If k is "1", input values A and B are deliberated as don't care. After comparing the function, design of unique gate in QCA is showed in Fig.5.

Table 2 Truth table of proposed unique gate

k	A	B	OUT
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	X	X	1

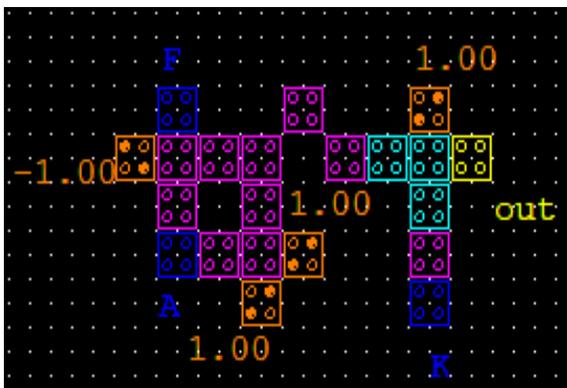


Fig 5.QCA design of proposed unique gate

3.2 Memory unit

Fast substance addressable memory with decreased size and less power consumption. Content Addressable Memory is an information storage device that is broadly utilized in number of applications. It is particularly utilized in number of areas for need of fast memory access.

Table. 3 Truth table of memory unit

Type of operation	R/W	Data	Enable	output
Write	0	1	X	1
Write	0	0	X	0
Read	1	X	1	1
Read	1	X	0	1

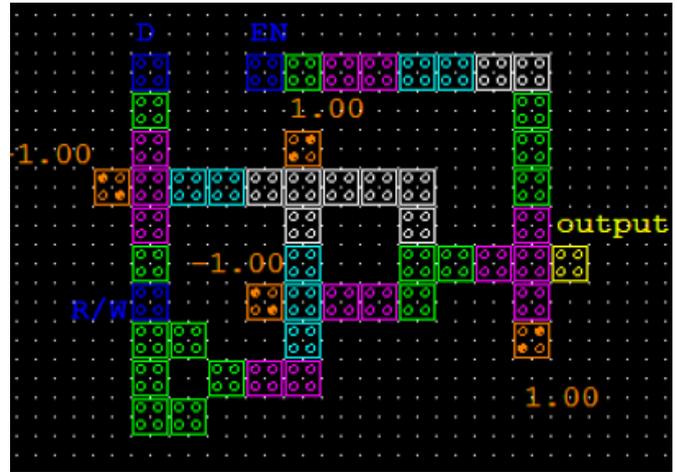


Fig 6. Design of memory unit

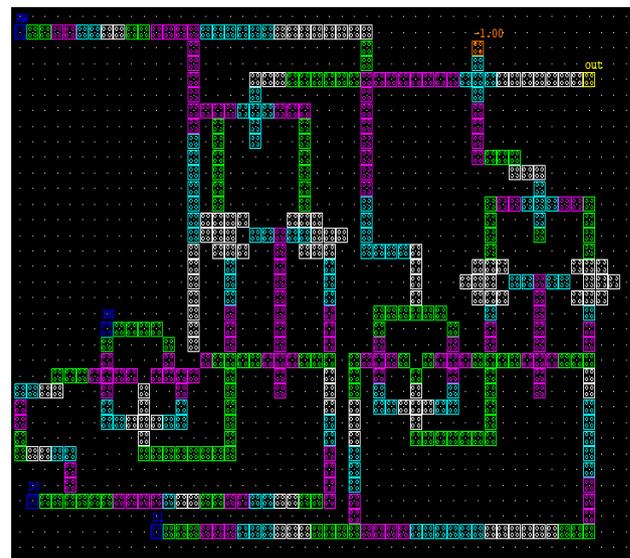


Fig7. STRUCTURE OF CAM CELL

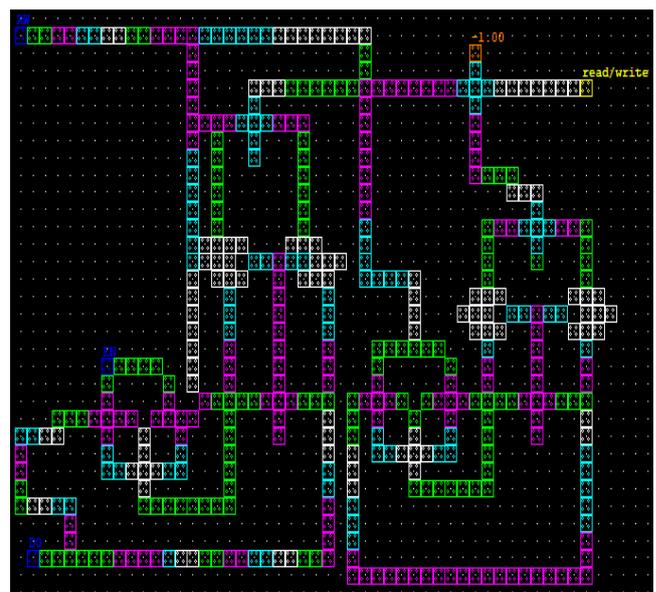


Fig 8.STRUCTURE OF 16 Bit CAM CELL

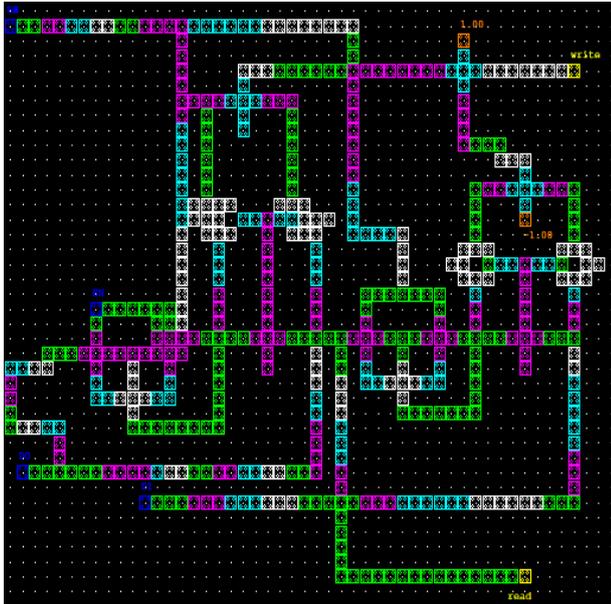


Fig 8.STRUCTURE OF 32 Bit CAM CELL

IV. RESULT AND DISCUSSION:

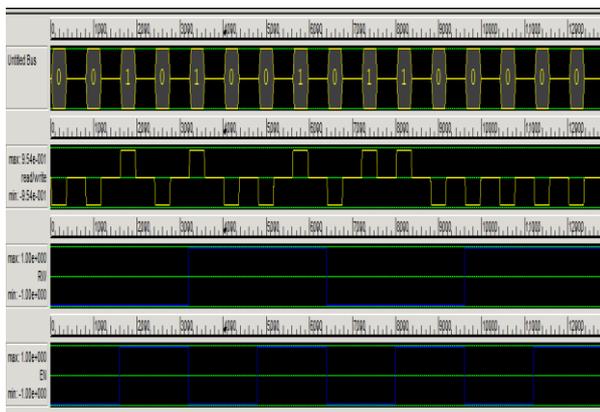


Fig 9. 16 Bit CAM wave form

From the above waveform, it shows the 16-bit CAM memory waveform in the read and write operations.

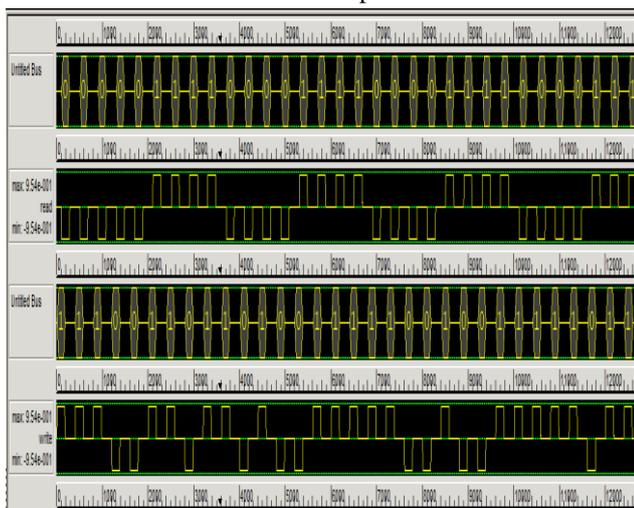


Fig 10. 32 Bit CAM wave form

From the above waveform, it shows the 32-bit CAM memory waveform in the read and write operations.

IV. CONCLUSION

In this paper, a unique gate was introduced for use in CAM memory. Then, we proposed a new 16-bit and 32-bit structure for CAM memory cell. QCA Designer simulates the proposed structures. Simulation results confirmed their operations. Comparison result of the different structure of 16-bit and 32-bit are shown in the waveform results

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