A Comparative Analysis on QCA

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ABSTRACT:
Quantum Dot Cellular Automata (QCA) is the latest emerging technology. This technology is coming as a successful alternative to CMOS (Complementary Metal Oxide Semiconductor) technology. Nowadays in this technical era, we are used to gadgets. The best part of the technical platform is considered according to its power consumption or power dissipation parameter. In this context, QCA has proved itself the best alternative to CMOS. The Digital Logic Circuits are mainly designed QCA. These circuits consume very low power. This is the main key issue of the CMOS platform which is resolved by QCA. There are some best features of QCA that are attracting theattention of lots of researchers. The QCA is used for nanoscale devices. This platform is known forultra-low power consumption, high packing density, and High-Speed small size. The Basic circuits which act as a fundamental platform are inverter and majority Gate. The design proposed is a parity generator and parity checker circuit. These circuits are used in nano communication for error detection and correction in the message.
Keyword: Quantum-Dot Cellular Automata, QCA, Nanotechnology

I. INTRODUCTION

How can we fastly connect with a new topic of technology research? Well; it depends on our technical senses that how we creatively carve out the best possible, positive aspects. It is well understood that the development of any technology is based on the applications and users. The CMOS platform is based on transistors. It is a type of metal oxide semiconductor field-effect transistor fabrication process. It uses IC chips to construct analog circuits. This platform has been the heart of the technical era since the 1960s, after that lots of researchers have worked bitterly on this platform. The CMOS (complementary metal-oxide-semiconductor) has also been a part of lots of technical issues, due to its circuitry components.

The QCA is one of the most promising technology for nano work. It has the potential to replace CMOS (Complementary Metal Oxide Semiconductor) technology. The production of chips using CMOS technology is scaling down nowadays. The QCA is transistor-less technology and is purely based on the electron energy. The most interesting quality of QCA is extremely low power dissipation and consumption. The information flows in QCA without any flow of current.

The important features of QCA are
1.Extremely low power consumption
2. High Device packing density.
3.High speed in the order of THz
4. Enable realization of more Dense circuits with switching speed

The common computing modules are designed like adders, subtractors, multipliers, multiplexers. The common computing modules are designed like adders, subtractors, multipliers, multiplexers.

The QCA(Quantum Dot Cellular Automata) is coming as a complete replacement of transistor-based circuits. This is due to its outstanding features that are ultra-low power consumption, less cell density. The circuit designing in this platform is very easy and easily accessible to generate outputs, from which we can understand that the design is working or not. It is highly scaled, uses binary information, less area, the e-waste is also very less. Due to its appealing several workers have been experienced the QCA to be, the best platform for designing digital circuits..

II. BACKGROUND OF QCA

The QCA (Quantum Dot Cellular Automata) Technologywas come into light in 1993. The fundamental unit of the quantum-Dot

Cellular Automata (QCA) technologyis quantum cells.Quantum cells are the fundamental unit of this technology. We can term this new technology as a transistor less technology. Due to its modern way of functioning this platform is highlighted for its ultra low power consumption. The other points for this platform to becomecenter of attraction is its high speed that is in terahertz and high packing density.This technology is based on Quantum cells. It is square, contains four dots and two electrons. The electrons have coulombic interactions between them. The electrons occupy dots that are present on diametricsides. In CMOS(Complementary Metal Oxide Semiconductor), the voltage levels are used for binary computations. Whereas in QCA the location of the electron is inside the cell. The Binary computation is based on '0' and '1'. In QCA the cell polarization is used to represent '1' and '0'.Thefigure is shown below:
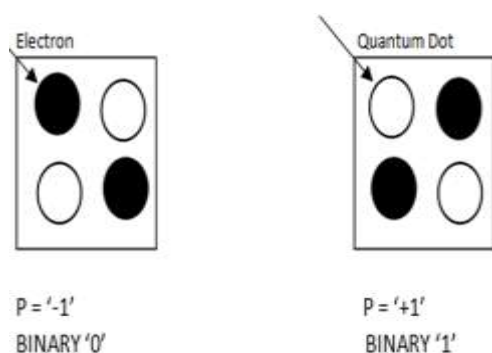
QCA cell uses specific polarization. This polarization depends on the electron's configuration. The particles or electrons tunnel between the dots mechanically. The electrons tunnel between the dots. This tunneling effect is responsible for the switching states. The switching state is carried out by the electrons.

The information in the QCA cell travel due to coulombic interaction. The information exchange between the cells. The input cells after getting the required input start working; by driving the neighboring cells. So this coulombic interaction between the electrons forces the input cell to a specific polarization.

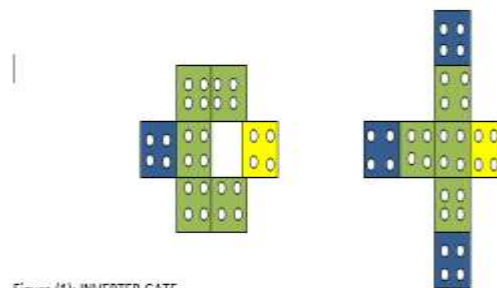The figure shown below is about two different types of polarization of QCA cells.

Figure (1): INVERTER GATE

Figure (2): MAJORITY GATE

Clocking

The clock signal is used to control the flow of data and input. There are several reasons for the use of clocking in the QCA circuit.

1.The clock signal controls the direction of the flow of information from input to output cell.

2.The clock signal is used to control the timing of QCA circuits. The timing in QCA circuits controlled is of quick switching and quick relaxation. The reason is that the clocked cell relaxes faster than the cells which are not clocked.

3.The use of too many clocked QCA cells creates a KINK state.

4.The clocking creates pipelines. The QCA (Quantum Dot Cellular Automata) circuit splits into multiple specific zones.

5.These zones are clocked with multiple clock signals. By doing this the issue of KINK state is handled.The proposed XOR GATE designs of different cells and their output are shown below. The cells are reduced according to the variations of their output.

Wire Crossing

The wire crossing in QCA is a technique that allows the wire of QCA cells composed of one type to pass through the wire of QCA cell of another type perpendicularly. The Wire Crossing in QCA cells can be done by using two different types of orientations of QCA wire. Both QCA wires are at 45 degrees to each other. The coulombic interactions between the dots are the same in both types of cells. The crossing point of different wire types produces no polarization. Therefore the signals on both the wires are preserved.

 There are methods to handle wire crossing in QCA.

1. Coplanar Crossing

This method uses two types of QCA wires. Both wires are perpendicular to each other.

The cells used in the wires are of two types. One of the wires has rotating type cells and the other wire has non-rotating type cells. This type of crossing is easily affected in the manufacturing process. This is the disadvantage of coplanar crossing.

2.Multiplanar Crossing

This is the second type of strategy of wire crossing. In this strategy, one layer is crossed to another. There is enough distance between two wires. There is enough distance between two wires. Due to this distance, the leakage of the signal is prevented. The space between two wires creates wy to stack the cells. Multiple active QCA layers implement on top of each other. The third type of wire crossing is logical wire crossing.

Parity Generator Circuit

The parity generator circuit proposed in the paper is based on XOR GATE. The XOR gate is a logic gate that gives output for an odd number of 1's input. The parity generator circuit is also known as an error detecting circuit. The error that occurs in the transmitted data, is checked by matching the transmitted data with the original data.

Odd Parity Generator Circuit

The odd parity generator circuit is used to check the counted number of 1's in the transmitted data is odd or not. The transmitted data has an even number of 1, then the sum of the binary numbers is zero. Now to correct this error 1 is added as a parity bit to make the sum one. As we know the sum of bits in transmitted data is one in an odd parity generator.

Even Parity Generator Circuit

The even parity generator circuit is used to check the counted number of i's in the transmitted data is even or not. The transmitted data has an odd number of, then the sum of the binary numbers is one. Then, one is added as a parity bit to make the sum zero.
As we know that the sum of bits in transmitted data is zero in an even parity generator.

Updated Work Till Now

A widespread study has been done in this context to achieve XOR Designs. The authors havestudied deeply the designs of the exclusive-OR gate. The comparison table below shows the
work done in this context.
The proposed XOR GATE consists of 10n cells, and the area is 0.01-micrometer square.
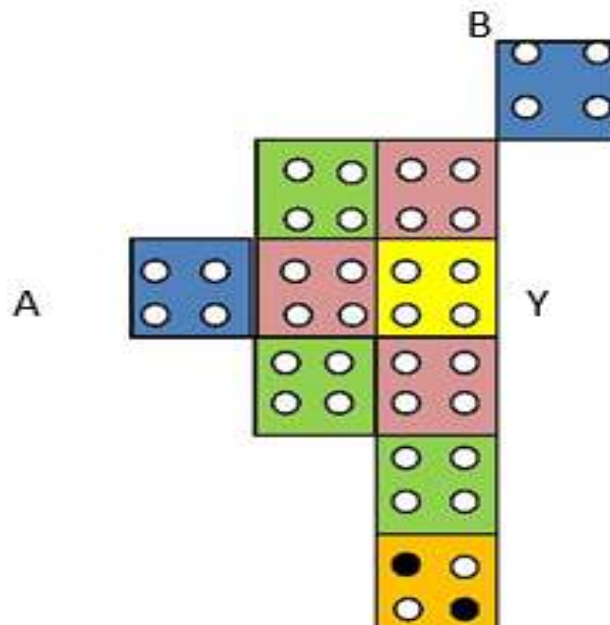
COMPARISONTABLE

Circuit	Area (micrometer square)	Cell count	Clock	Crossover
XOR 1	0.09	60	1.5	coplanar
XOR 2	0.08	54	1.5	coplanar
XOR 3	0.06	67	1.25	coplanar
XOR 4	0.03	37	1	Not Required
Proposed circuit	0.01	10	0.75	Not Required

III. CONCLUSION ND FUTURE SCOPE OF THE QCA TECHNOLOGY BASED ON THE COMPARISON TABLE

The QCA (QUANTUM DOT CELLULAR AUTOMATA) technology is the latest upcoming technology which is transistor less and based on the energy of the electron. The circuit designed using this platform is of ultra-low power consumption. This is the reason it is proved as a new sunrise in technology. The CMOS despite a lot of drawbacks but it struggled a lot in meeting the interests of the researchers and proved best till now upholding drawbacks

The future of the technology can be seen secure on this platform as it is of ultra-low power consumption and due to transistor less technology so it is cheap to design and nano works can be done safely and efficiently with less e-wastage.

The Output of the Proposed Circuit is shown below

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