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Web Log Preprocessing In Web Usage Mining Using Two-way Hash Table

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Abstract- This paper described about the fourth passive element memristor after resistor, capacitor and inductor. We know that the resistor determines the relation between current and voltage, the capacitor determines the relation between charge and voltage, and the inductor determines the relation between current and magnetic flux and they do not store information. Memristor short name of memory-resistor gives the relation between magnetic flux and charge. Memristor can save its electronic state even when the power is turned off, making it a great candidate to replace today's flash memory. An outstanding feature is its ability to remember a range of electrical states rather than the simplistic "on" and "off" states that today's digital processors recognize. Memristor-based computers could be capable of far more complex tasks.

Keywords- Memristor circuit elements, Memory, Fractional dynamic, Artificial intelligence, Nanotechnology

1.1 INTRODUCTION

When studying circuit theory, we learn that there are three fundamental circuit elements: the resistor, the capacitor, and the inductor. The resistor determines the relation between current and voltage, the capacitor determines the relation between charge and voltage, and the inductor determines the relation between current and magnetic flux (or the time integral of the voltage). However, we are also taught that they do not store information. [1]

Circuit elements that store information without the need of a power source would represent a paradigm change in electronics, allowing for low-power computation and storage. Such a concept is also likely to be at the origin of the workings of the human brain and possibly of many other mechanisms in living organisms so that such circuit elements may help us understandadaptive and spontaneous behavior, or even learning.

In 1971 Leon O. Chua [1], noticed that fundamental circuit theories miss an element determining the relation between magnetic flux and charge and this leads to the introduction of the concept of memristor. Memristor is a short name for memory-resistor. It is defined mathematically as the time integral of the voltage, which need not have a magnetic flux interpretation. This relation can be generalized to include any class of two-terminal devices which are called memristive systems whose resistance depends on the internal state of the system.

We have a good understanding of five of the possible six combinations. The three basic two-terminal devices of circuit theory namely, the resistor, the capacitor and the inductor are defined in terms of the relation between two of the four fundamental circuit variables. In addition, the current is defined as the time derivative of the charge and according toFaraday's law; the voltage is defined as the time derivative of the flux. Theserelations are shown in Fig. 1

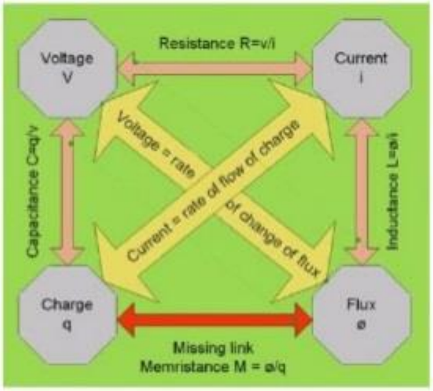
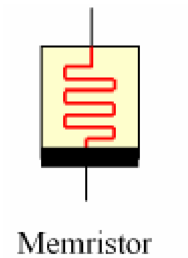


Fig.1: Missing link b/w charge and flux

Memristor is the contraction of memory resistor [3], is a passive device thatprovides a functional relation between charge and flux. It is defined as a two-terminal circuit element in which the flux between the two terminals is afunction of the amount of electric charge that has passed through the device.Memristor is not an energy storage



element. Symbol of a memristor is shown in Fig.
Fig.2: Symbol of memristor[2]

When current flows in one direction through a memristor, the electrical resistance increases; and when current flows in the opposite direction, the resistance decreases. When the current is stopped, the memristor retains the last resistance that it had, and when the flow of charge starts again, the resistance of the circuit will be what it was when it was last active. The memristor device described by HP is said to have a regime of operation with an approximately linear charge-resistance relationship as long as the time-integral of the current stays within certain bounds.

The memristor can be explained well by the pipe analogy:

A memristor is a pipe that changes diameter with the amount and direction of water (current) that flows through it. If water flows through this pipe in one direction, it expands (becoming less resistive). But send the water in the opposite direction and the pipe shrinks (becoming more resistive). Further, the memristor remembers its diameter when water last went through. Turn off the flow and the diameter of the pipe "freezes" until the water is turned back on. That freezing property suits memristors brilliantly for computer memory. The ability to indefinitely store resistance values means that a memristor can be used as a nonvolatile memory.

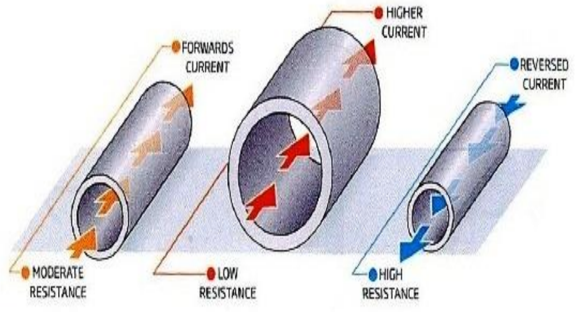


Fig.3: Pipe analogy of memristor [9]

1.2 THEORY

The memristor was originally defined in terms of a non-linear functional relationship between magnetic flux linkage Φ_m (t) and the amount of electric charge that has flowed, q (t):$f(\Phi_m (t),q (t)):=0$ [4]

The variable Φ_m ("magnetic flux linkage") is generalized from the circuit characteristic of an inductor. It does not represent a magnetic field here, and its physical meaning is discussed below. The symbol Φ_m may simply be regarded as the integral of voltage over time.

In the relationship between Φ_m and q, the derivative of one with respect to the other depends on the value of one or the other, and so each memristor is characterized by its memristance function describing the charge-dependent rate of change of flux with charge.$M(q) = d\Phi_m/dq$

Substituting that the flux is simply the time integral of the voltage, and charge is the time integral of current, we may write the more convenient form

$$M(q(t)) = \frac{d\Phi_m/dt}{dq/dt} = \frac{V(t)}{I(t)}$$

To relate the memristor to the resistor, capacitor, and inductor, it is helpful to isolate the term *M* (*q*), which characterizes the device [4], and write it as a differential equation and it shown in Table.1

Table.1: Differential equations of passive elements

Device	Characteristic property (units)	Differential equation
Resistor	Resistance (V per A, or Ohm, Ω)	R = dV / dI
Capacitor	Capacitance (C per	C = dq / dV

	V, or Farads)	
Inductor	Inductance (Wb per A, or Henrys)	$L = d\Phi_m / dI$
Memristor	Memristance (Wb per C, or Ohm)	$M = d\Phi_m / dq$

1.3 V-I CHARACTERISTICS

This new circuit element shares many of the properties of resistors and shares the same unit of measurement (ohms). However, in contrast to ordinary resistors, in which the resistance is permanently fixed, memristance may be programmed or switched to different resistance states based on the history of the voltage applied to the memristance material. This phenomena can be understood graphically in terms of therelationship between the current flowing through a Memristor and the voltage applied across the Memristor. Fig.4 shows current vs. voltage behavior of memristance.

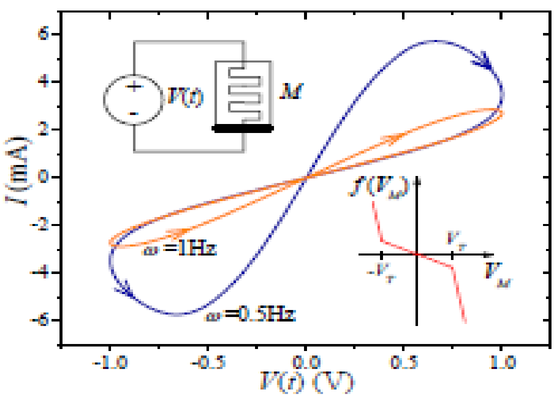


Fig.4: V-I characteristics of memristor [3]

Current vs. Voltage curve demonstrating hysteretic effects of memristance. In contrast to the straight line expected from most resistors the behavior of a Memristor appear closer to that found in hysteresis curves associated with magnetic materials. As observed above that two straight line segments are formed within the curve. These two straight line curves may be interpreted as two distinct resistance states with the remainder of the curve as transition regions between these two states.

1.4 APPLICATIONS

Memristors have found a large number of applications and these are shown in Fig.5

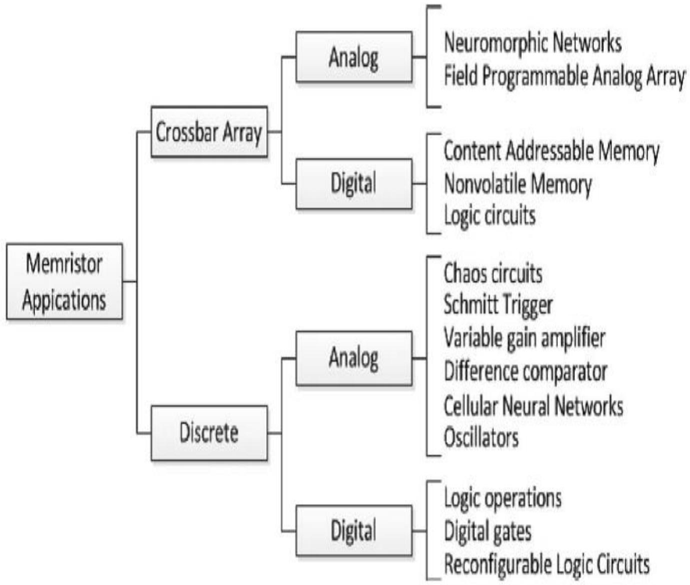


Fig.5: Applications of memristor [7]

- Non-volatile memory applications: Memristors can retain memory states, and data, in power-off modes. Non-volatile random access memory, or NVRAM, is pretty much the first to-market memristor application [5]. There are already3nm Memristors in fabrication now. Crossbar latch memory developed by Hewlett Packard is reportedly currently about one-tenth the speed of DRAM. The fab prototypes resistance is read with alternating current, so that the stored value remains unaffected.

- Low-power and remote sensing applications: memristors can possibly allow for nano-scale low power memory and distributed state storage, as a further extension of NVRAM capabilities. These are currently all hypothetical in terms of time to market.

- Crossbar Latches as Transistor Replacements: The hungry power consumption of transistors has been a barrier to both miniaturization and microprocessor controller development. Solid-state memristors can be combined into devices called crossbar latches [5], which could replace transistors in future computers, taking up a much smaller area. There are difficulties in this area though, although the benefits these could bring are focusing a lot of money in their development.

- Analog computation and circuit Applications: Analog computations embodied a whole area of research which, unfortunately, were not as scalable, reproducible, or dependable (or politically expedient in some cases) as digital solutions. However, there still exist some very important areas of engineering and modeling problems which require extremely complex and difficult workarounds to synthesize digitally: in part, because they map economically onto analog models. Memristor applications will now allow us to revisit a lot of the analog science [5].

- Circuits which mimic Neuromorphic and biological systems (Learning Circuits): This is a very large area of research, in part because a large part of the analog science detailed above has to do with advances in cognitive psychology, artificial intelligence modeling, machine learning and recent neurology advances. The ability to map people's brain activities under MRI, CAT, and EEG scans is leading to a treasure trove of information about how our brains work. But **modeling a brain using ratiocinated mathematics is like using linear algebra to model calculus**. Simple electronic circuits based on an LC network and memristors have been built, and used recently to model experiments on adaptive behavior of unicellular organisms. The experiments show that the electronic circuit, subjected to a train of periodic pulses, learns and anticipates the next pulse to come, similar to the behavior of the slime mold Physarumpolycephalum periodic timing as it is subjected to periodic changes of environment. Therecent memristor cat brain is also getting a lot of mention [5]. These types of learning circuits find applications anywhere from pattern recognition to Neural Networks.

- Programmable Logic and Signal Processing: The memristive applications in these areas will remain relatively the same, because it will only be a change in the underlying physical architecture, allowing their capabilities to expand, however, to the point where their applications will most likely be unrecognizable as related [5].

1.5 BENEFITS OF USING MEMRISTORS

The advantages of using memristors are as given below:

- It provides greater resiliency and reliability when power is interrupted in data centers.
- Memory devices built using memristors have greater data density
- Combines the jobs of working memory and hard drives into one tiny device.
- Faster and less expensive than present day devices
- Uses less energy and produces less heat.
- Would allow for a quicker boot up since information is not lost when the device is turned off.
- Operating outside of 0s and 1s allows it to imitate brain functions.
- Eliminates the need to write computer programs that replicate small parts of the brain.
- The information is not lost when the device is turned off.
- Has the capacity to remember the charge that flows through it at a given point in time.

A very important advantage of memristors is that when used in a device, it can hold any value between 0 and 1. However present day digital devices can hold only 1 or 0. This makes devices implemented using memristors capable ofhandling more data.

1.6 CONCLUSION

This report presents a detailed study of the memristor. This report also presents a brief insight into the potential applicationsof the memristor. Nanotechnology is fast emerging, and Nano scale devices automatically bring inmemristive functions. Thus, memristors might revolutionize the 21st century as radically as the transistor in the 20th century. Memristor memories havealready been developed and the researchers at HP believe that they can offer aproduct with a storage density of about 20 gigabytes per square centimeter by this year. Leon Chua rightly said ― "It's time to rewrite all the Electronics Engineeringbooks"

1.7 FUTURE RESEARCH

Recently, researchers have defined two new memdevices- memcapacitor andmeminductor [2], thus generalizing the concept of memory devices to capacitorsand inductors. These devices also show ―pinched‖ hysteresis loops in twoconstitutive variables— charge—voltage for the memcapacitor and current—flux for meminductor. Fig.6 shows the symbol for the memcapacitor andthe meminductor.

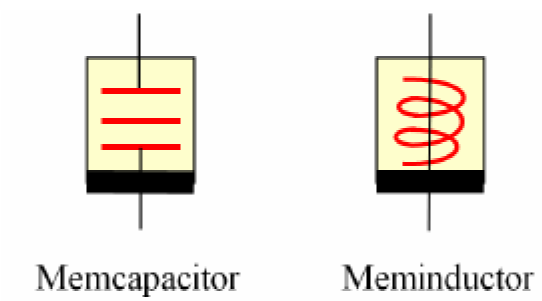


Fig.6: Symbol of memcapacitor and meminductor[2]

Memristors are not lossless devices. As non-volatile memories, memristors donot consume power when idle but they do dissipate energy when they arebeing read or written. Hence, there is a need to invent lossless non-volatile device. Memcapacitors and meminductors are good contenders as they arelossless devices

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