Ultra Sound Scanning and the Internet of Things: A Theoretical Model

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Abstract: Nowadays, men have achieved extraordinarily high level of scientific achievements in all areas of disciplines. Considering the vast majority of scientific innovations that dictate man's everyday life, it is easily to deduce the common factor of them: The well Known Internet of Things (IoT). IoT is gaining attention from governments to companies and consumers alike, due to its potential to control and manipulate everything that surrounds the world. Yet, extensive research is needed, so as to obtain optimal, secure use of new applications. In this study, we hypothesize a machine (M) which is plugged and connected to the Internet. The target is to unlock its operational system and retrieve the stored information. Two devices (D1,D2) will be used to decode the M system. D1 will emit high frequency ultrasound signals scanning the M entirely, using a specific common Language of IoT (CLoIoT) which will be developed in this work, while D2 (often D2 = D1) will receive the feedback and decode the transferred information. The CLoIoT is based on the creation of sequential sinusoidal algorithms. The unlocking of M will take place through discovering the operational digital "frequency", under the continuous Nano-scanning of the device. It is a process termed as a lock-ultrasound-Key effect.

Keywords: Internet of things, Ultra-Sound wave, Electromagnetic Wave, High frequency, Nanotechnology.

I. INTRODUCTION

IoT has actually been conceived the last decade and comprises a extensive variety of applications, ranging from home personal to transport, community, national applications etc [1]. IoT has become a revolutionary, integrated idea connecting PC-users and devices alike. The future internet domain will be surrounded by platforms, sensors, actuators interwoven in such a way that information will be floating and exploited indiscriminately, wirelessly in time and space [2-4]. In addition, Ultra sound devices and IoT do cooperate in a great variety of scientific applications [5-7].

The common Internet system has been grown into a global interactive networking domain which has enabled not only people to communicate with each other but also the devices. It seems that the next revolution will include the interconnection between devices and an integrated system of sensing, actuation, command and finally providing control of its fundamental operational pathways to an independent user under certain prerequisites.

The operational pathways of an internet device (M) is hard to decode without being the owner of the device. Although, current research is focused in this very challenging area of IoT, little scientific knowledge has been added so far.

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Additionally, it is common knowledge that Von-Neumann architecture predominates in most modern computer design. On the one hand the Computer Data Storage (CDS) has received particular attention from the researchers, for it is the fundamental technology that comprises specific computer components and recording media to retain and manipulate digital information. On the other hand the Central Processing Unit (CPU) is divided into the control unit and the arithmetic unit so as to communicate with CDS. Hence, CDS and CPU forms a unique duo with high degree of interconnectivity and operational cooperation in integrating computer programming[8]. CDS follows certain hierarchy such as primary, secondary, tertiary, and off-line storage. Also, it is characterised by volatility, mutability, accessibility, addressability, capacity, performance and energy usage. While the main storage techniques include semiconductor, magnetic, optical, paper and a variety of innovative new applications.

Currently, Ultrasound Technology has been used experimentally in IoT applications, especially in cases of cross-device tracking information in connection with security issues.

This research deals with an alternative way to decode the digital stored programs of M, in such a way that the entire operational system to be revealed and exploited by an independent user. High frequency ultrasound transducers (HFUT) and Nanotechnology approach are implemented so as to scan and detect (D1) the stored programming information of M, and consequently to interpret (D2) the reflected signal which carry the digital information of the scanned

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device. Furthermore, it is easily deduced that vice-versa procedures may be introduced for security operational reasons.

II. MATERIAL AND METHODS

High frequency ultrasound applications range from biomedical issues to electronic semiconductor scanning. Currently, very high frequencies have been achieved (1GHz) which enable scientists to detect and evaluate characteristics in μm scale, depending on the material involved [9].

In our theoretical approach we assume a computer data semiconductor restoring system exposed and being scanned by the D1 device. The emitting signals follow a specific algorithm according to the golden ratio (1.618..) produced by the well-known Fibonacci sequence [10], which is defined by the recurrence relation:

$$F_n = F_{n-1}+F_{n-2} \text{ with seed values of } F_1=1,\ F_2=1,\ n=3\ldots \quad (1)$$

The selected frequencies are terms of the aforementioned sequence, while a basic simplified sinusoidal wave is described by the function:

$$Y = \sin(\omega t),\ \omega = 2\pi f\ (\pi = 3.14,\ f\text{-Hz})\text{-angular frequency, } t\text{-sec} \quad (2)$$

A wide ultra sound spectrum is created following the previous pattern, thus an ultra sound “language” is born. Various combinations are implemented representing “vowels”, “consonants”, “words” and “sentences”. The vowels are formed by even frequency numbers (2,8..), the consonants by odd frequency numbers (1,3..), the words by combining the previous elements and the sentences by using all of them. A characteristic representation follows:

$$Y1 = \sin(1t),\ y2 = \sin(2t),\ y3 = \sin(3t),\ y5 = \sin(5t),\ y8 = \sin(8t) \quad (3)$$

$$Y12 = y1*y2,\ y23 = y2*y3,\ y35 = y3*y5,\ y58 = y5*y8 \quad (4)$$

$$Y357=y3*y5*y8,\ y1{,}2 = y1+y2,\ y2358 = y2*y3*y5*y8,\ y12{,}23 = y12+y23 \quad (5)$$

Apparently, there is a limitless ultra sound “wording” that may cover any particularities on the scanned surface. By choosing the most appropriate algorithm for the storage system at hand, the stored information will create a unique veil recorded on the incident wave, corresponding to the 0 or 1 state, which in turn will be reflected and decoded by the receiver D2 (usually D2 = D1).

III. RESULTS

In our application, the selected frequencies are Fibonacci F-terms, multiple of a constant basic frequency ω. In Figure **1** we have the sinusoidal graphs of the three first F-terms. Obviously, the higher the frequency the smaller the length wave and the higher the achieved scanning resolution. Yet, possible particularities on the semiconductor storing surface may be missed by this basic approach.

Attempting to enhance resolution, in Figure **2**, a high-frequency mixed sinusoidal signal has been introduced and compared to basic ones of 5th and 6th F-terms. The amplitude min and max values of the mixed signal are significantly lower than the respective basic

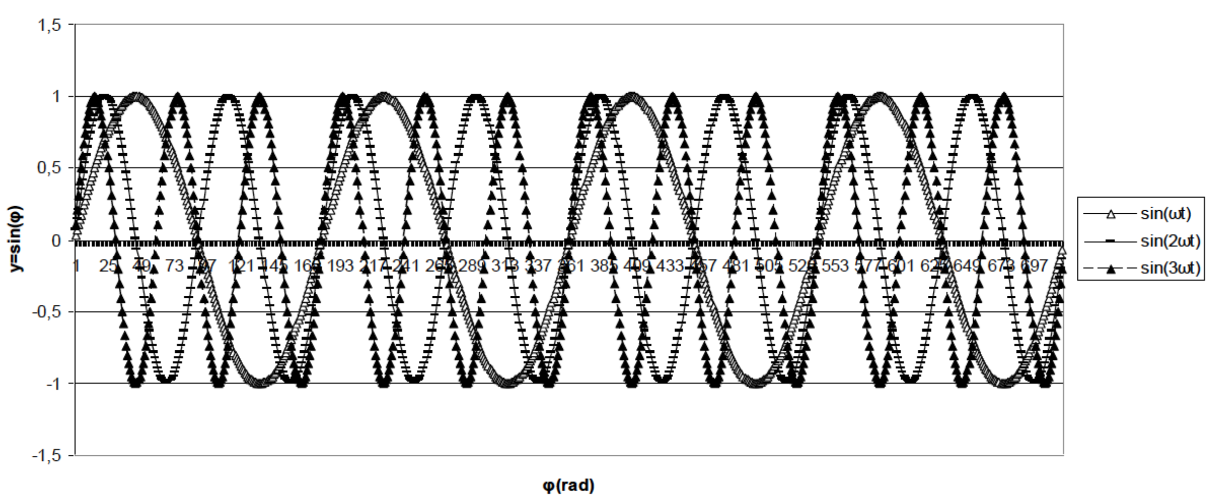

Figure 1: Common Ultra-Sound Waves.

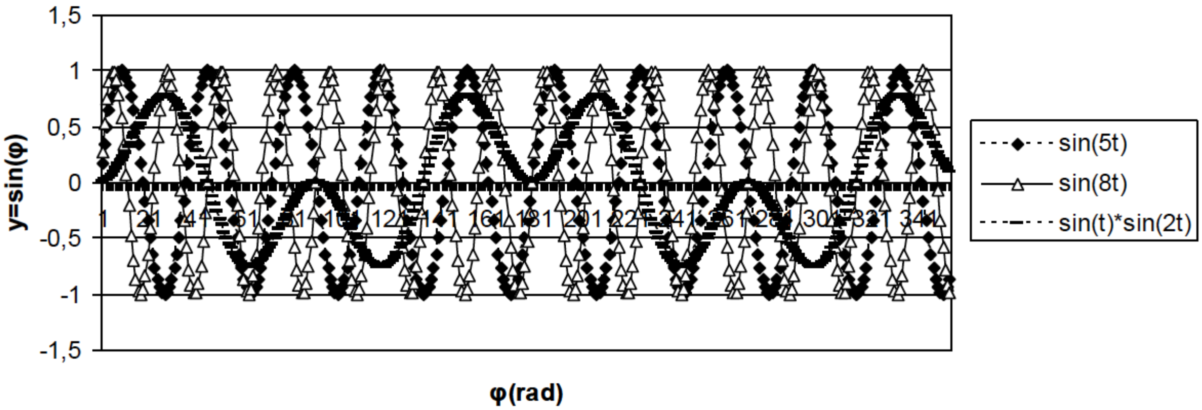

Figure 2: Mixed and common u/s signals.

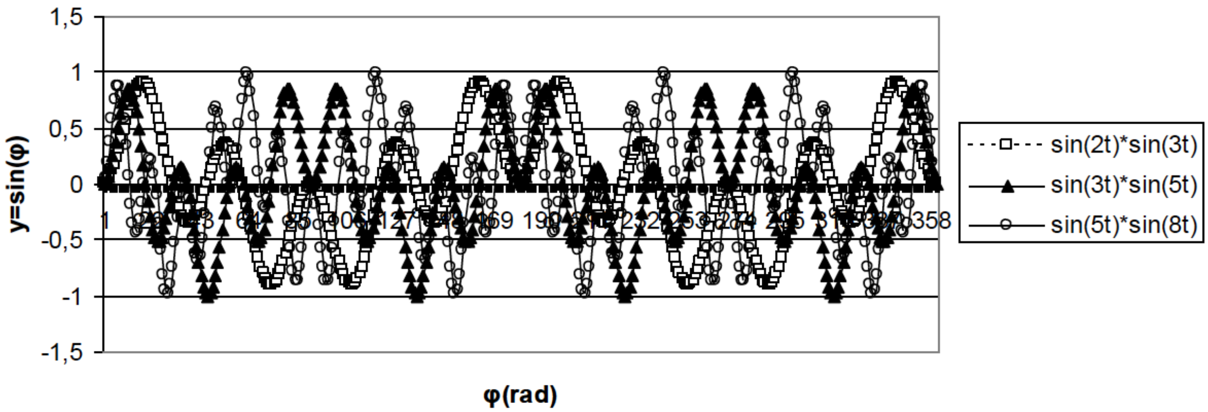

Figure 3: Mixed u/s signals.

ones, and follow alternating consecutive positive and negative loops. Thus, scanning sensitivity has been increased.

Moreover, in Figure **3** mixed sinusoidal signals are presented, giving equivalent outcome to the Figure **2**. The min and max amplitude values have an harmonic distribution along the incident wave, providing a high frequency scanning spectrum.

Additionally, in Figure **4**, a mixed multiplied signal is compared to a sum of basic signals. As expected, the sum-signal exhibit much higher amplitude values than the mixed ones, and at the same time shows a detailed scanning between 90 to 110 rad. On the other hand the mixed signal has a significant smaller wave length than the sum-signal.

Finally, in Figure **5**, a four-term complex signal is illustrated, combining relatively low amplitude with

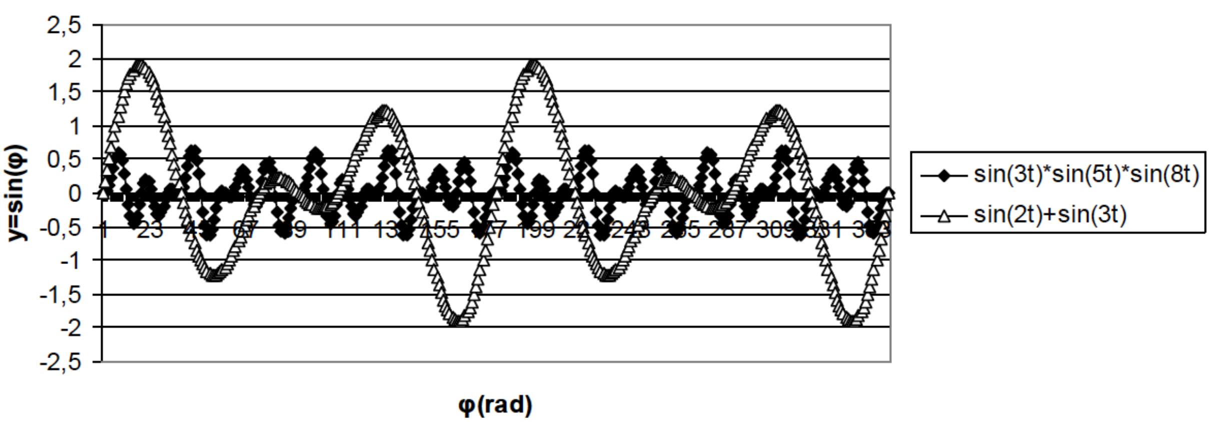

Figure 4: Mixed u/s multiplied or added signals.

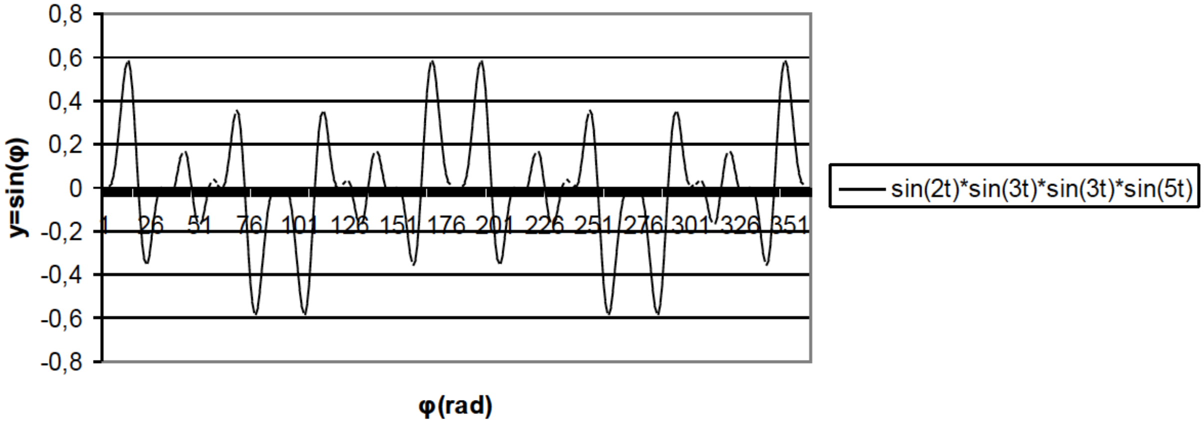

Figure 5: Highly mixed u/s signal.

harmonic detailed scanning of 30 to 60 rad. It seems that, the more F-terms are used in combined signals the better scanning sensitivity is achieved.

IV. DISCUSSION

In this study, ultra sound scanning waves with various frequencies have been used to "read" an exposed computer data semiconductor storage system. The terms of Fibonacci sequence have been selected as frequency variant. This choice is based on the fact that the golden ratio ($F_{n+1}/F_n \approx 1.618$) represents an extraordinary ubiquitous characteristic observed both in macrocosms (i.e. phyllotaxis) and microcosms (i.e. DNA helix).

By using proper combination of frequencies (Figures **1-5**) the incident ultra sound wave appears to be more dense and covers a wider area of the scanned surface. In this way a common ultra sound language is created (CLoIoT). Moreover, F-terms provide a vast variety of wave distribution which could be selected so as to meet the specific attributes of the storage system. The digital information will create a unique veil (0 or 1 state) imprinted on the reflected signal. The receiver will decode the reflected wave carrying the digital information and by reverse process the data will be retrieved.

Apparently, there are many questions that need further research in this theoretical approach, such as how the sequential digital information can be imprinted reliably in the incident wave and how will be maintained safely during the propagation of the wave. Are there any frequencies that can transport digital information safer than others? How close should be the D1 devise to the storage system? May current high frequency technology be implemented by a long distance? These are just a few questions that should be addressed in this theoretical proposal.

V. CONCLUSIONS

In conclusion, it seems that ultra sound technique may be a new "communicating language" in the IoT domain. High frequency waves exhibit certain advantages that may be useful in encoding and embedding digital information in a process named ultra-sound-key effect. Additionally, security issues is of grave concern amongst researchers who study all aspects of this new challenging domain. Undoubtedly, much research in needed towards this direction, both theoretical and experimental.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest included in this study.

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GLOSSARY

IoT = Internet of Things

CLoIoT = Common Language Of internet of Things

CDS = Computer Data Storage

CPU = Central Processing Unit

F-terms = Fibonacci sequence terms

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