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Importance Of Energy In The Advance Technology

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I. INTRODUCTION

The advances in technology enabled the improvements in every facet of human life and activity since the beginning. The progress of technological development, from the use of fire during the Neolithic period increased food security, the invention of the wheel improved traveling and provided a basic control of their environment, to the creation of telephone and internet which lessened the barriers to communication and allowed humans to interact even on the global scale, largely improved how humans interact with each other and control their environment. The improvements in the current technology through scientific research and development also further advance them. For example, with the increase in population, the demand for energy is likewise increasing. Meeting the increasing energy demands of a fast-growing world is made possible through advances in technology: installation of more efficient high-temperature superconducting (HTS) cables to improve grid capabilities, use of nanotechnology to improve properties such as strength and electrical and heat conductivity, and the continuous exploration to make renewable sources (e.g., solar, wind, hydropower) effective to meet the energy demand.

Energy is a critical factor in a modern and growing society as energy affects economic growth, progress, and development. Consumption of energy goes hand in hand with production in a global economy. Energy plays an important role in the provision of basic needs and services, and also fuels production activities. The use of modern forms of energy enables the reduction of poverty, especially in developing countries (Food and Agriculture Organization 4); however, the cost of producing energy has been increasing.

Rosenberg describes the modern society as energy-intensive (11). He adds that over the past century, the development has been characterized by the increase in the amount of energy utilized by workers. In his analysis, these societies depend on electricity in their operations. The electrification brought the widespread use of machinery and technology (13). These are not limited to the technology used in mass production but include precision instruments for monitoring, control, and inspection of operations.

The use of energy is vital in continuously growing modern societies; however, energy production is constrained with prices. With it, economies are struggling to keep up with the energy demand necessary for growth. With the advances in technology, energy production can continuously improve. The converse can also happen that with the improvements in energy production, technology can also further improve and advance.

This paper aims to discuss analog and digital electronics. Included in the discussion are their differences, as well as their applications in modern technology.

I. ANALOG VS. DIGITAL DEBATE

The debate on analog and digital technology is a never-ending. Various discussions center on their merits and advantages over the other. Before the discussion on their applications, analog and digital forms, whether it may be signal, electronics or technology, should be defined and differentiated. Afterward, their applications in advance technology will be tackled.

The basic definition of an analog is something that performs without processing of numbers electronically. Before computers dominate, every measurement was analog- dials and pointers were used. In contrast, digital technology has to convert the information into numbers or digits before it can be used. Almost every device used today use digital instead of analog.

Signals

Signals are quantities that change over time. They are used by devices to communicate information. The usual transmission is through wires but they can also be transmitted through radio frequency waves.

Analog signals are most common in the physical world (Agarwal and Lang 41). Analog signal shows information on a variation of a quantity (e.g., voltage or current) with respect to time continuously and smoothly (Fernandez-Canque1). There is no abrupt variation from one value to the

next; thus, analog signals are also termed as continuous-time signals. Changing normal waveforms are done by analog circuits. The waveform has a very high quality of output.
Figure 1 shows several examples of analog signals. Figure 1b is a DC current signal while the rest are voltage signals.

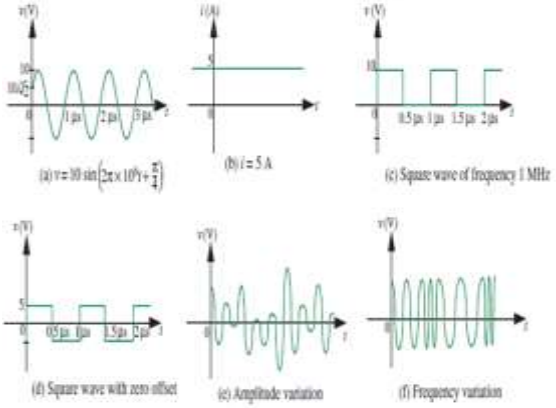

Figure 1. Several examples of analog signals (Agarwal and Lang 41).

In contrast to continuous analog signals, digital signals are defined at a finite number of levels and points in time (Luo, Ye, and Rashid86); thus, they are also known as discrete-data signals. Electrical pulses can be interpreted as "0" (absent) or "1" (present) of the binary numerical systems. Digital signals can also be a discrete representation of analog signals. Digital signals are convenient, compact, noise-free, can easily be stored, and can be processed by digital microprocessors. As digital signal is an estimate of the natural waveform, the quality of output is not on par with the analog signal. Figure 2 shows examples of digital signals.

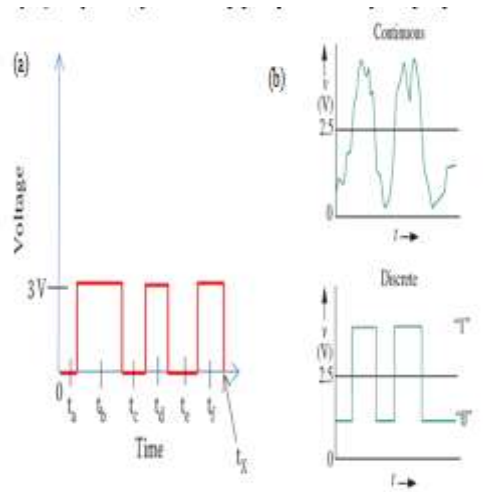

Figure 2. Examples of digital signals (Fernandez-Canque, 2; (Agarwal and Lang 42).

Circuit Design

The basic electronic components – resistors, capacitors, inductors, diodes, transistors, and amplifiers, are analog. The analog electronics are more difficult to design sinceanalog circuits consider the whole circuit because the design deals with the transistor and element level. One error in one component can have a major influence on the entire circuit. Many parameters need to be considered in the design that designers need to acquire the necessary expertise to develop analog circuits (Nomura 22). Analog circuits are also more susceptible to noise as small variations in voltage level can produce significant errors.

Digital circuits alter waves, transforming them to pulse waves by measuring a waveform many times every second and storing them in binary form. Digital circuitsbeginwith the learning of Boolean algebra. After that, logical circuits are learned. Unlike analog circuits, digital circuits are made of transistors and elements are black-boxed (Nomura 22). Designers of such circuits only need to consider logic gates, the function that combines them, and how input and output terminals are related to each other. Considering the macro and the details of the gates is not required.Digital circuits tend to be more expensive than analog ones. They are also less prone to degradation, unlike analog circuits.

Analog technology is essential for electronics; however, it has but been given the necessary support due to the focus on digital technology. As the years progress, it has become clear that knowledge of analog circuit design is necessary in order to advance digital circuit performance (Nomura 23).

Applications of Analog and Digital Electronics

Nowadays, digital electronics are widely used in electronic systems. Despite the wide application of digital devices in the modern world, analog devices are still part of the new technology.

Analog technology is used as human interface components of displays, speakers, and microphones; analog circuits in wireless components; conversion components at the interface between digital and analog; cameras; and sensors (Nomura 20). In mobile phones, analog circuits can be found in antennas, display, cameras, chargers, biometric authentication, and two-way data processing, among others.
In the biomedical field, analog circuits are incorporated into biomedical measurement systems. Four examples were discussed by Northrop to illustrate the use of analog electric circuits (537):

- Microedge polarimeter whose optical rotation is used to measure D-glucose concentration in clear liquids;

- Closed-loop laser velocimeter and ranging system in which a laser beam was sinusoidally amplitude modulated producing two analog outputs designed for blind persons;
- Self-balancing impedance plethysmograph designed to detect small changes in volume in certain parts of the body such as chest or legs and detect respiration and heartbeat simultaneously; and
- Respiratory acoustic impedance measurement system (RAIMS) which is a prototype intended to detect obstructive lung disease by comparing to normal lung records. An "acoustic pressure source" compared to a voltage from a loudspeaker "forced acoustic volume flow through a real acoustic resistance and unknown acoustic impedance of the respiratory system".

Digital technology is used in industrial operations. These need to have increased power, voltage and current rates, with applying frequency greatly enlarged (Luo, Hong and Rashid 32). In energy applications, digital energy technologies play a role in improving the performance of renewable sources of energy and energy storage systems (National Instruments 4). Digital control through electricity is in the form of smart sensors that regulate voltage and current, fast digital signal processing to change measurements into information, and special switched-mode power supply (SMPS) (National Instruments 3). Digital energy through smart meters, energy management systems, microgrids help everyone access reliable and affordable sources of energy.

II. COMBINED ANALOG AND DIGITAL APPLICATIONS

In a circuit, it is common nowadays to have a mixture of analog and digital electronics in a circuit. Microcontrollers are digital in nature but they have circuitry that enables them to operate with analog circuitry (e.g., analog-to-digital converters, pulse-width modulation, and digital-and-analog converters).

The availability of increasing conversion speeds and resolutions enable a wide range of applications. These include software radios, smart antennas, digital satellite payloads, radars, electronic warfare, sampling oscilloscopes and instrument acquisition boards, medical imaging, data storage, among others (Angeletti, Gallinaro, Hili and Maufroid 1). Angeletti et al. arguethat through the continuous evolution of digital devices, reducing power consumption and increasing operating speeds enable the extension of digital electronics to RF frequencies (9). In this situation, the application of analog to digital plays an important role within the two electronic circuitries.

Another application of combined analog and digital electronics was tackled by Shoop et al. in a paper on pixel technology. The 2-D application of analog-to-digital conversion of this research is called digital image halftoning (3175). Half-toning is an image compression technique applied in laser printing, xerography and facsimile wherein binary-valued pixels are used to display or print continuous-tone, gray-scale image.

III. FUTURE APPLICATIONS OF ANALOG AND DIGITAL ELECTRONICS

Analog systems are not as widely used as digital systems in electronics; however, it is expected that the analog will match the advances in digital systems, as well as complement it. The analog electronics should progress like that of digital to improve electronic systems and reduce, if not stop, problems in new applications. Digital systems require improvements in terms of design and performance through software-based programs. Analog systems, on the other hand, require the interventions of humans. They will require clever design and more expenses than their digital counterpart.

In the semiconductor technology, the size of electrical components was improved from micro-level channel transistors to nano-level channel transistors, offering improvements in size, power consumption, speed, and frequency range (Fernandez-Canque355). The challenge, therefore, is to perform analog operations in such a small device. Further improvements in technology can help answer this challenge.

Analog systems are also seen in the music industry. On a wider scale, recording studios use purely digital processes but currently, some incorporate analog elements (Fernandez-Canque 359). Some digital software does not work as quickly as their analog counterpart for some sound effects. It is expected that in the future, there will be hybrid solutions incorporating analog processes directly into digital systems.

Current research and development trends in various countries also look at analog-related circuits. In the USA, one university has been researching on 60-GHz CMOS radio systems; one corporation is looking at advances in the field of high-performance analog products for x-ray CT equipment (Nomura 26).

The future is a mix of analog and digital technology, working in complement of each other in a complex system.

IV. CONCLUSION

Energy is a critical component of every nation. More so the developing countries. The

progress of technological development largely improved the lives of humans. Development and technological advancement largely depend on the availability of energy. As countries continue to progress, populations increase, and technology advances, energy is likewise increasing. Energy plays an important function in the provision of basic needs and services. With continuous advancements, energy needs to be met.

Analog and digital technology debates are never ending. These are basic in energy production and technological advancements. Various discussions center on their merits and advantages over the other. The main differences between analog and digital are summarized below:

- Analog signals are known as continuous-valued signals;
- Digital signals are discrete-data signals and exist at two levels;
- Designing analog circuits is difficult since the design considers the whole circuit;
- Designing digital circuits is simple since automation can be used at every level of the design;
- No change needed on input signals in analog circuits before processing and generates the analog output;
- Input digital signals need to change from analog to digital (A/D) before processing as digital circuits process digital signals only and the output generated is changed back to analog signals;
- Analog circuits are generally inflexible; and
- Digital circuits have elasticity.

Analog and Digital are used on a wide variety of applications; however, modern applications favor digital technology. Analog technology is used as human interface components of displays, speakers, and microphones; analog circuits in wireless components; conversion components at the interface between digital and analog; cameras; and sensors. Analog technology is also used in communications in the form of mobile phones' antennas, display, cameras, chargers, biometric authentication, and two-way data processing, among others. Analog is also used in the biomedical field, especially in measurement and detection. Digital technology is widely used in industrial operations. In energy applications, digital energy technologies play a role in improving the performance of renewable sources of energy and energy storage systems. Also, digital energy through smart meters, energy management systems, microgrids help everyone access reliable and affordable sources of energy.

Not only analog and digital are separately used in various applications. Combined analog and digital electronics can be found in a circuit. Microcontrollers are digital in nature but they have a circuitry that enables them to operate with analog circuitry (e.g., analog-to-digital converters, pulse-width modulation, and digital-and-analog converters). These include software radios, smart antennas, digital satellite payloads, radars, electronic warfare, sampling oscilloscopes and instrument acquisition boards, medical imaging, data storage, among others.

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