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Circuits and Systems

Electronic Circuit Theory

Circuit Theory

Transmission Circuit Theory

Circuit and System Theory

Development of Graph-network Theory for Circuits and Information and Communications

Enzyme Transistor Circuits

In 1955, a study group of circuit networks was set up in the IEICE. During the 10 years after the end of World War II, many findings about classical circuit theory were achieved by major group members. M. Kawakami made it possible to systematically process electronic circuits using four-terminal network theory. R. Sato and N. Saito, et al., contributed to the establishment of design theory and the schematization of distributed constant circuits. H. Ozaki introduced the concept of multivariable positive real function, and T. Koga obtained many useful findings in multivariable circuits and the construction of time-varying circuits. Their findings made it possible to process circuits where lumped parameter elements and distributed parameter elements are mixed. Y. Oono completed passive multiterminal paring network synthesis as a general theory for filter design. H. Watanabe developed the computer for science technology using parametron for designing filters which requires a large amount of numerical calculations. H. Hirayama conducted pioneering studies about the analysis of linear active circuits, i.e., circuits including active elements such as transistors. From the viewpoint of energy in a given circuit, G. Kishi established the concept of conserved quantity in multiterminal circuits. Later, these two researchers had a head start on the study of circuit network topology (graph theory). T. Fujisawa established the theory and the method concerning design methods and quality control for circuits and systems.

In the 1960s through 1970s, developments of integrated circuits and computers were remarkable. K. Yanagisawa made pioneering results such as the establishment of the basic theory for the construction of active transmission circuits and monolithic integrated circuits. Regarding circuit analysis, the efficiency of algorithms became an important issue. T. Ohtsuki developed the minimization method of independent variables in circuit analysis and the analytical method for piecewise linear resistance circuits. M. Iri widely contributed to basic studies in information science such as network theory, combinatorial mathematics, and matroid theory in addition to circuit theory.

After 1980, research other than those in the field of circuit theory came out, e.g., the

network location theory by S. Shinoda and M. Sengoku. In addition, studies on non-electronic computation came out, e.g., bio-computing. The enzyme transistor circuit proposed by T. Aoki, M. Hiratsuka and T. Higuchi was one such new system.

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Digital Signal Processing

Regarding modern signal processing, first, common theories to pull up information from observational data and algorithms were created, next, they evolved into an integrated science to put them into practice. It was just after the rediscovery of the sampling theorem (1948) by Shannon, the originator of information theory, and K. Someya that studies on signal processing started in full swing in Japan. The invention of fast Fourier transformation (FFT) (Cooley – Tukey 1965) in the mid-1960s served as an impetus for the expansion of the range of applications of digital signal processing. In particular, the digitalization of information which started in the latter half of the 1970s pushed studies on digital signal processing. Accordingly, digital signal processing became a major research field at the IEICE study group on circuit network theory (started in May, 1955) and the study group on circuits and systems (started in 1980). S. Tsujii made remarkable achievements in theories of the design and construction of digital filters. In addition, he carried out unique studies about adaptive digital signal processing algorithms for echo cancelers and automatic equalizers, thereby making substantial contributions.

In April 1988, a study group on digital signal processing started (in April 2004, the name was changed to the study group on signal processing). The digital filter started from wavelet packet transformation and evolved into the filter bank, and then from the latter half of 1980s through 1990s, its theoretical systems were improved, thereby making substantial contributions to image coding. From the 2000s, signal processing based on a high level of statistics such as sparse signal representation, compressed sensing, and independent component analysis advanced. In the course of these developments, the optimization approach centering on convex optimization played an important role. From early on, I. Yamada worked on the study of optimization problems in signal processing and solved the problem of convex optimization on a fixed-point set of non- extension maps and the problem of asymptotical minimization for the convex sequence of functions, and these were recognized as world-class achievements.