The Progress of Research on Signals and Systems in China of Year 1998~2001

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ABSTRACT

Signals and systems is an important aspect of radio science. The recent progress of the research activities of signals and systems in China is reviewed in this paper. It covers the most advanced and important developments during years of 1998~2001. The review is based on the following categories: wideband CDMA, software radio, digital audio broadcasting technologies, information processing, radar target recognition, electronics design automation, integrated circuit design.

I. WIDEBAND CDMA

Mobile communications services are penetrating our society at an explosive rate. CDMA, especially wideband CDMA, has received growing attention in recent years, especially in multiuser detection, smart antennas, spreading codes design and channel coding. In [1], a new blind adaptive multiuser detector for synchronous DS/CDMA systems based on a low computational complexity high order statistics-based least mean kurtosis algorithm is presented by Tang, Zuqiang from Tsinghua University. In general, most of applications are used in the base station receiver due to complexity; less work has been done in the mobile terminal. In [2], a MAI cancellation detector is proposed at the mobile station receiver. Yong, Z from Tsinghua University discussed a smart antenna receiver capable of interference suppression [3]. He also investigated the capacity improvement with base-station antenna array [4]. In [5], a new set of spreading codes is designed which have low crosscorrelation around the origin. The performance was evaluated according to the criteria of the bit error rate. The results indicated that the performance of the resulting QS-CDMA system is much improved. Channel coding is one of the key technologies of WCDMA. The FEC technologies adopt advanced codes including serial concatenated Reed-Solomon (RS) codes and Turbo codes. Zhang, L. from Tsinghua University proposed two RS coded hybrid ARQ schemes based on syndrome calculation [6]. In [7], a modified decoding algorithm of Turbo code on multipath frequency-selective fading channels is proposed. Computer simulations indicated that the modified algorithm improves greatly the performance of DS/CDMA systems. One of the problems for decoding turbo-code in the receiver is the complexity and the high power consumption. In [8], O. Y.-H. Leung from Hong Kong proposed a dynamic voltage scaling approach to further reduce the power consumption, several heuristic algorithms are put forward to assign supply voltage for different decoding iterations. Experimental results show that up to 70% reduction in energy consumption is achieved when comparing with the system using fixed supply voltage.

II. SOFTWARE RADIO

Software-defined radio is an extremely promising technology. Ji Xiang from Beijing University of Posts and Telecommunications considered receiver architecture of multiuser detection for direct-sequence spread-spectrum multiple-access communication systems and outlined configurable architecture via software radio implementation of

this receiver [9]. By exploiting Discrete Fourier Transform and Inverse Discrete Fourier Transform, Wu, X. from Xi'an Jiaotong University developed a general baseband digital model for different OFDM-CDMA schemes [10].

III. DIGITAL AUDIO BROADCASTING TECHNOLOGIES

The Digital Audio Broadcasting (DAB) system offers high-quality audio services, supports multimedia data to mobile reception and might replace the traditional radio system. Its key technologies including OFDM transmitting technique, source coding and channel coding. In [11], Hui Lu from Tsinghua University presented a new method to estimate coarse carrier frequency offset and fine carrier frequency offset in a DAB receiver based on an analysis of phase reference symbol. The result shows that the estimation function is almost linear to frequency offset.

IV. INFORMATION PROCESSING

Image and video compression have become one of the hottest research areas in information technology. Lossless image compression is used in many applications. Much research has been carried out into methods for obtaining higher compression ratio, but no such bound has established and no reliable method for estimating it has been proposed. Zhang N from Tsinghua University proposed a practical method for estimating lossless image compression bound based on high-order conditional entropy analysis [12]. Wavelets have attracted great attention in both still image compression and video coding. A new post-processing method is proposed in the wavelet domain for the suppression of blocking artifacts in compressed images. The threshold value is made adaptive to different images and characteristics of blocking artifacts [13]. In [14], Cheng YM, from University of Science and Technology of China, used a genetic algorithm to generate a good global optimal codebook for vector quantization (VQ). Chinese scientists presented good work on image restoration and enhancement. Several infrared image enhancement methods based on BD-TDI technique [15] and a novel histogram equalization technique, equal area dualistic sub-image histogram equalization [16] are put forward. Digital water marking has been widely used in copyright protection. Based on a model of the human visual system, Zhu, X. from Nanjing University of Science and Technology presented a novel approach for static image watermarking by employing multiresolution fusion techniques of the image [17]; experimental results show high robustness of the approach to most of the processing techniques. Speech recognition is to use computer to recognize person through his pronunciation. Shi YY, from Tsinghua University, described a single-chip speech recognition system [18]. It recognizes up to 20 phrases with an average length of 1 second and the recognition accuracy reaches more than 95% with the background SNR above 10dB. Reference [19] and [20] are about Chinese speech recognition. How to reduce channel width without loss of speech quality remains a crucial problem in speech coding theory. A multi-domain speech compression method based on a wavelet packet transform is presented [21]. It is shown that this method is simple to implement and is effective at compressing speech and audio signals, even at bit rates as low as 2kbit/s.

V. RADAR TARGET RECOGNITION

Radar target recognition is being studied more and more thoroughly with the development of radar technology. Chen MQ from Beijing University of Posts and Telecommunications introduces Wavelet analysis into the target recognition of MMW radar [22]; it overcomes the shortcomings of the traditional methods and improves the target recognition performance. Radar target recognition based on parameterized high resolution range profiles [23], fractal compression characteristic [24] are also proposed.

VI. ELECTRONIC DESIGN AUTOMATION

The EDA issues highlighted during recent years include advanced simulation techniques, new modeling techniques for analog and high frequency designs and designing in a deep submicron environment. In [25], Xin CAI from Tsinghua University presented a new fast timing simulator RSPICE for very large-scale digital MOS circuits. Experimental results show that the speedup of RSPICE over HSPICE is 1-2 orders on a large scale circuits, and the error is within 3%. Further more, RSPICE is capable to simulate analog circuits too. How to establish precise equivalent models of all kinds of using devices and elements, and meet the demands of computer aided analyses for automatic black box to establish models is a difficult problem for EDA. This problem has been well overcome theoretically by adopting math equation's derivation and further perfection using fellow equation [26]. The operating frequency of high-speed integrated circuits (IC) has increased very fast in the past several years, and is approaching gigahertz range. Meanwhile, the system scale and integration density in modern IC's are also growing quickly. In [27], a new capacitance model is presented for circuit simulation of interconnects and packaging structures.

VII. INTEGRATED CIRCUIT DESIGN

High integration level, coupled with mainstream technology such as CMOS, is critical to high-volume, low-cost wireless communications solutions. Zhihua Wang from Tsinghua University discussed special issues to implement RF integrated circuits, and dressed a perspective for the development of CMOS RF integrated circuits [28]. In [29], he presented a new method for analog fault detection that fully considers the statistical tolerances and mismatches of the circuit parameters and uses the ratio of likelihood to decide whether the circuit is most likely fault free or faulty, so that the probability of an erroneous decision is minimized.

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