MASTER OF SCIENCE
IN
SYSTEMS ENGINEERING

CIRCUIT DESIGN AND SIMULATION FOR A DIGITAL IMAGE SYNTHESIZER RANGE BIN MODULATOR

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This thesis documents the circuit design, schematic capture, and simulation of a digital Range Bin Modulator that will eventually be integrated into the Digital Image Synthesizer (DIS) ASIC. The DIS is a single-chip false target radar image generator for use in countering wide-band imaging radar. The purpose of a Range Bin Modulator is to take the 5-bit phase input from the Digital Radio Frequency Memory (DRFM), add a phase increment, generate the In-phase (I) and Quadrature (Q) signals, and amplify these signals to form the false target radar returns.

The circuit design, schematic capture, and simulations are done with the Tanner Tools Pro software suite running on a Personal Computer. The first part of the design includes lower-level cells such as D master-slave flip-flops and multiplexers. The design proceeds to higher-level cells such as registers, gain shifters, and adders. SPICE netlists are generated from the circuit schematics in order to run highly accurate simulations to prove logic validity and determine timing delays and power consumption.

KEYWORDS: Digital Image Synthesizer, DIS, Inverse Synthetic Aperture Radar, ISAR, Synthetic Aperture Radar, SAR, Countermeasure, ASIC, Chip Design

IEEE 802.11 MAC PROTOCOL PERFORMANCE EVALUATION IN OPERATIONAL ENVIRONMENTS

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The IEEE 802.11 MAC protocol is widely used for wireless local area networks. Consequently, it is important to examine the protocol performance in operational environments. This thesis presents a simulation study of the performance of the IEEE 802.11 MAC protocol in multihop, jamming, and mobile node environments. The effects of the request-to-send mechanism and fragmentation in these environments are also studied. The average throughput and delay are obtained from the simulation and these results are then used to analyze the protocol performance.

KEYWORDS: Mobile Ad Hoc Network, Optimum Network Performance, 802.11, Medium Access Control, Jamming, Multihop, Node Velocity

DEVELOPMENT OF A NAKAGAMI-LOGNORMAL MODEL FOR A CELLULAR CDMA FORWARD CHANNEL

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In this thesis, the performance of the forward channel of a DS-CDMA cellular system operating in a Nakagami-fading, Lognormal-shadowing environment is analyzed. Given the upper bound of bit error probability with FEC and including all the appropriate losses and interference terms, the bit error probability in various fading and Lognormal shadowing conditions is computed in two ways; firstly, by setting up a statistical model and secondly, by Monte Carlo simulations. The results predicted by the two methods take into account that the intended user is located at the corner of the hexagon of a seven-cell structure (worst case scenario). Furthermore, in order to obtain more realistic and accurate results, the user's distribution is incorporated in the cell and finally fast power control is applied to overcome the Lognormal shadowing effects.

KEYWORDS: Nakagami Fading, Lognormal Shadowing, CDMA, Forward Channel Model, Wireless, Performance Analysis, Antenna Sectoring, Sum Distribution, Power Control

ON THE CAPACITY OF A CELLULAR CDMA SYSTEM REVERSE CHANNEL

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In this thesis, the reverse channel model for a seven-cell cluster DS-CDMA cellular communications system operating in a slow-flat Nakagami fading and lognormal shadowing environment is developed. The aforementioned system uses imperfect power control to combat the near-far effect and the lognormal shadowing. Forward error correction is applied by using convolutional encoding and soft decision decoding. The probability of bit error is estimated by using a Gaussian approximation, sectoring antennas and a rake receiver at the base station in order to enhance the system's performance.

The performance of the system is examined under several values of the standard deviation of lognormal shadowing and the power control error for various numbers of users and values of the Nakagami-m variable by using simulations.

Finally, a barrage noise jammer will be introduced and its effect seen in the performance of the cellular communication system for a specific value of $\frac{E_b}{N_0}$.

KEYWORDS: Reverse Channel Cellular Communications

A DCT-BASED IMAGE WATERMARKING ALGORITHM ROBUST TO CROPPING AND COMPRESSION

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Digital watermarking is a highly evolving field, which involves the embedding of a certain kind of information under a digital object (image, video, audio) for the purpose of copyright protection. Both the image and the watermark are most frequently translated into a transform domain where the embedding takes place. The selection of both the transform domain and the particular algorithm that is used for the embedding of the watermark, depend heavily on the application. One of the most widely used transform domains for watermarking of still digital images is the Discrete Cosine Transform domain. The reason is that the Discrete Cosine Transform is a part of the JPEG standard, which in turn is widely used for storage of digital images. In the research, a unique method is proposed for DCT-based image watermarking. In an effort to achieve robustness to cropping and JPEG compression, an algorithm has been developed for rating the 8×8 blocks of the image DCT coefficients taking into account their embedding capacity and their spatial location within the image. The experiments show that the proposed scheme offers adequate transparency, and works exceptionally well against cropping while at the same time maintains sufficient robustness to JPEG compression.

KEYWORDS: Digital Image Watermarking, JPEG Compression, Discrete Cosine Transform

EFFECTS OF MUTUAL COUPLING IN SMALL DIPOLE ARRAY ANTENNAS

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In the classical approach of antenna theories, mutual coupling between elements is usually ignored. However, depending on the application, errors due to mutual coupling can be significant. This thesis investigates the effects of mutual coupling between elements in small dipole arrays via software simulations that use the Methods of Moment, a numerical technique that accounts for mutual coupling, as opposed to the classical approach, which does not. The simulations show that the active impedance of any element in an array depends on both the self and mutual impedances and that the terminal current phases, hence directivity, of an array are affected by mutual coupling such that the array pattern deviates from that defined by classical theoretical approach. In an active element pattern approach, the mutual couplings in an array are accounted for through the active element, making this approach a viable one to study the radiation patterns of practical dipole arrays. The examination of a small array provides a useful environment in which to develop, optimize and evaluate the radiating elements, thus providing better understanding of the effects of mutual coupling in antenna arrays and facilitating the design of corresponding compensation techniques in practical arrays.

KEYWORDS: Mutual Coupling, Mutual Impedance, Active Element Pattern, Patch