

# MASTER OF SCIENCE IN ELECTRICAL ENGINEERING

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## **TIME DIFFERENCE OF ARRIVAL (TDOA) ESTIMATION USING WAVELET-BASED DENOISING**

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The localization of mobile wireless communication units is studied. The most important method of localization is the time difference of arrival (TDOA) method. The wavelet transform is used to increase the accuracy of TDOA estimation. Several denoising techniques based on the wavelet transform are presented in this thesis. These techniques are applied to different types of test signals as well as the GSM signal. The results of the denoising techniques are compared to the ones obtained using no denoising. The denoising techniques allow a 28 to 81 percent improvement in the TDOA estimation.

**DoD KEY TECHNOLOGY AREA:** Command, Control, and Communications

**KEYWORDS:** Time Difference of Arrival, Wavelet, Denoising, GSM

## **HARDWARE INTEGRATION OF THE SMALL AUTONOMOUS UNDERWATER VEHICLE NAVIGATION SYSTEM (SANS) USING A PC/104 COMPUTER**

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At the Naval Postgraduate School (NPS), a small AUV navigation system (SANS) has been developed for research in support of shallow-water mine countermeasures and coastal environmental monitoring. The objective of this thesis is to develop a new version of SANS, aimed at reducing size and increasing reliability by utilizing state-of-the-art hardware components.

The new hardware configuration uses a PC/104 computer system, and a Crossbow DMU-VG Six-Axis Inertial Measurement Unit (IMU). The PC/104 computer provides more computing power and more importantly, increases the reliability and compatibility of the system. Replacing the old IMU with a Crossbow IMU eliminates the need for an analog-to-digital (A/D) converter, and thus reduces the overall size of the SANS.

The new hardware components are integrated into a working system. A software interface is developed for each component. An asynchronous Kalman filter is implemented in the current SANS system as a navigation filter. Bench testing is conducted and indicates that the system works properly. The new components reduce the size of the system by 52% and increase the sampling rate too more than 80Hz.

**DoD KEY TECHNOLOGY AREAS:** Electronics, Sensors, Surface/Under Surface Vehicles – Ships and Watercraft

**KEYWORDS:** INS, GPS, AUV, SANS, Navigation, Kalman Filter

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## MASTER OF SCIENCE IN ELECTRICAL ENGINEERING

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### **DETECTION AND GEOLOCATION OF WIDEBAND TRANSMISSIONS (U)**

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This thesis investigates the capabilities of existing and planned systems to detect and geolocate wideband and higher order modulation signals. A detailed assessment of factors effecting the link budgets of such systems and techniques to improve performance is presented. Conclusions on the likelihood of successfully processing the signals are drawn from the results of extensive simulated data.

**DoD KEY TECHNOLOGY AREAS:** Space Vehicles, Electronics, Electronic Warfare, Sensors

**KEYWORDS:** Very Small Aperture Terminal, Conference European Telephone Postal Low Elliptical Orbit

### **EVALUATION AND METHODS TO REDUCE CO-CHANNEL INTERFERENCE ON THE REVERSE CHANNEL OF A CODE DIVISION MULTIPLE ACCESS (CDMA) CELLULAR SYSTEM**

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With increasing exploitation of information, the demand for mobile access to high data rate multimedia services including high speed internet connection, high quality video/images, teleconferencing, and file transfer continues to grow rapidly for a wide variety of military as well as commercial applications.

The current mobile communication systems are narrowband and optimized for voice. They can't support high data rate applications. Simply increasing the bandwidth of existing systems will result in severe degradation due to frequency selective fading, resulting in loss of quality and reliability. It appears that CDMA is the strongest candidate for the third generation mobile communication systems to support these demands. CDMA minimizes the effects of frequency selective fading while reducing the probability of detection and interception by non-authorized users.

The primary restriction of the performance of CDMA is the co-channel interference. Since CDMA capacity is only interference limited, the interference reduction equates to better quality of service and greater user capacity. This thesis focuses on analyzing the co-channel interference on the reverse channel of the proposed CDMA cellular systems operating with perfect power control and investigating methods such as sectoring and microzoning in an effort to reduce the interference.

**DoD KEY TECHNOLOGY AREA:** Electronics

**KEYWORDS:** Cellular Communications, Spread Spectrum, CDMA, Co-Channel Interference, Reverse Channel, Interference Reduction

### **INTERACTIVE MULTIMEDIA FOR CLASSROOM AND WEB USE**

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Today's advances in technology have provided new tools that allow us to be more creative. The focus of this research is on interactive lesson plans and a web-based tutorial for a graduate level computer architecture class. It

contains recommendations for software selection and development methods. In addition, this thesis examines the learning process and describes the necessary ingredients of developing an effective multimedia-based production. Instructional system design (ISD) principles are examined in depth and used as a basis to design the interactive tutorial. Finally, the study discusses the feasibility of developing these productions considering the cost and time investment.

**DoD KEY TECHNOLOGY AREAS:** Computing and Software, Manpower, Personnel, and Training, Modeling and Simulation

**KEYWORDS:** Computer-Based Learning, Multimedia, Tutorials, Lesson Plan Development

### **DESIGN OF A SERIAL COMMUNICATION PROTOCOL AND BUS INTERFACE CHIP FOR TACTILE COMMUNICATIONS**

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Tactile communication requires rapid data transfer along a common bus. The developed communication protocol and application-specific interface chip enable precise control of multiple tactile transmitters (tactors) to convey information to military users. This extrapolation of the Tactile Situation Awareness System developed by the Naval Aerospace Medical Research Laboratory uses a serial data bus and individual interface chips to communicate commands with a minimum number of conductors. This thesis develops the communication protocol and the design of the Tactor Interface Chip (TIC). This work also includes a computer-driven tactile array controller and Parallel Port Data Modulator for TIC testing and demonstration.

**DoD KEY TECHNOLOGY AREAS:** Human Systems Interface, Electronics, Computing and Software, Modeling and Simulation, Biomedical

**KEYWORDS:** Electronics, Tactile, Interface, Tactor, TSAS, Serial Communications

### **FREQUENCY-BASED LOAD SHARING IN CURRENT-MODE-CONTROLLED BUCK CONVERTERS**

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Modular DC Zonal Electrical Distribution (DC ZEDS) offers advantages in both cost and weight over traditional radial shipboard distribution. In order to equip the next class of surface combatant with DC ZEDS, preparative research includes the design of autonomous dc-to-dc power converter modules having robust load sharing capability. This thesis examines the combined utility of current-mode switch control and frequency-based load sharing to promote equal load sharing among parallel dc-to-dc converter modules.

Current-mode control with frequency-based load sharing is analyzed primarily with digital simulation. To that end, a state-space representation for a system of two converters and an Advanced Continuous Simulation Language (ACSL) simulation for a system of three converters are developed. Various studies were conducted to evaluate the performance of a proposed system for load sharing performance between dissimilar converters, for step changes in load, and for bringing a converter off-line. Additionally, a sub-circuit of frequency-based control—the rms frequency estimation circuit—was built, and its static performance evaluated. Finally, recommendations are made for further simulations, which will better test the dynamic performance of this rms estimation circuit and the system of parallel converters employing frequency-based load sharing as a whole.

**DoD KEY TECHNOLOGY AREAS:** Electronics, Modeling and Simulation

**KEYWORDS:** DC-to-DC Buck Converter, Current-Mode, Frequency-Based Load Sharing, Paralleling, ACSL

### INVESTIGATION OF NEAR-FIELD ELECTROMAGNETIC SOURCE IMAGING USING INVERSE GREEN'S FUNCTION INTEGRATIONS

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As continued efforts are made to reduce the radar cross sections of aircraft and ships, designs are first modeled with computers and then tested in the lab. In the far-field of these tested objects, actual sources of high reflectivity or "Hot Spots" on the tested objects can be isolated to within only one half the wavelength of the electromagnetic wave used for testing. Ideally, a probe could measure fields on the surface of the object being tested to completely isolate the source of the hot spot. Unfortunately, the presence of the probe on the surface of the object will disturb the very fields it is attempting to measure. Probe measurements made in the near field, close to but not on the object, can be designed to reduce the influence of the probe while providing accurate field data. The data thus measured, while not able to determine the source location perfectly, can be used to localize a source to less than one half wavelength, the far-field diffraction limit. This thesis tests a technique for back propagating computer generated near field measurements of an axisymmetric field source to determine the fields closer to the source. Several cases are examined that test the accuracy and resolving capability of the technique.

**DoD KEY TECHNOLOGY AREA:** Modeling and Simulation

**KEYWORDS:** Electromagnetic Waves, Electromagnetic Imaging, Inverse Source Problem, Back-Propagation