MASTER OF SCIENCE
IN
SYSTEMS ENGINEERING

BLUETOOTH TECHNOLOGY AND ITS IMPLEMENTATION IN SENSING DEVICES

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Bluetooth Wireless technology is the world's new short range RF transmission standard for small form factor, low cost, and short-range radio link between portable and desktop devices. This technology does not replace Wireless LANs rather it compliments them. Bluetooth wireless technology has many advantages over other Wireless LAN technologies, which makes it attractive to many applications. One such application is in the area of sensors and gauges on-board ships and submarines. If these are connected wirelessly, a huge amount of cables are eliminated and more user mobility is gained.

This thesis studies the theories and principles of Bluetooth technology and discusses the approaches of connecting Bluetooth to sensors and gauges. Some of the Bluetooth products available in the market were acquired for testing and evaluation. In the course of the study, it was found that the technology was not mainly developed with sensor and gauge applications in mind. However, integrating sensors with Bluetooth modules can be achieved by one of two approaches. One approach requires an expensive Development Kit and is limited to manufacturers integrating Bluetooth technology into their sensor products in compliance with Bluetooth Specifications. The other inexpensive approach requires custom circuit designing and program coding and is preferred by university researchers.

POTENTIAL OPERATIONAL APPLICATIONS FOR HIGH POWER MICROWAVES

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This abstract is classified.

DEVELOPMENT OF AN RF WEAPON USING OPEN SOURCE INTELLIGENCE

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The world's increasing reliance on computers and electronics has made the employment of radio frequency (RF) weapons against electronic systems an attractive concept. Electromagnetic interference (EMI) effects

from RF radiation are well known. Recent advances in high-power microwave (HPM) technology and the increasing commercial availability of conventional RF sources have made the development of such systems for other than scientific pursuits not only feasible, but probable.

This thesis explores the technical requirements, costs, and timelines necessary to build such a system. It documents the processes that a team of "non-experts" undertook to design and build a microwave transmitter capable of disrupting unshielded electronic systems. The researchers investigated how to design and build a viable RF weapon capable of use in terrorist applications on a limited budget, with no external guidance from HPM experts, and using only open source information and Commercial-Off-The-Shelf (COTS) technology. This work documents useful sources of information, the development of a preliminary system design, the acquisition of components, and planning for system fabrication, component modification, and integration into a disguised mobile platform.

MEASUREMENTS AND MODELING ENHANCEMENTS FOR THE NPS MINIMUM RESOLVABLE TEMPERATURE DIFFERENCE MODEL, VISMODII

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Minimum Resolvable Temperature Difference (MRTD) measurement has long been used to describe the performance of thermal imaging systems. Computer models such as U.S. Army's FLIR92, that were developed to predict the MRTD, were reported to have deficiencies in dealing with sampling and aliasing effects. The models also include assumptions regarding the observer recognition process and therefore cannot predict the MRTD of an imager that incorporates an "objective" automatic target recognition device instead of a "subjective" human observer. The Visibility Model II developed for second generation thermal imaging systems at the Naval Postgraduate School (NPS) in the mid 90s takes sampling and aliasing issues into account and makes no assumptions about the observer. Modeling enhancements in VISMODII and its extension to predict objective MRTD are proposed and tested in this thesis. A parallel thesis at the NPS has shown that aliasing effects on image appearance are fundamentally different from noise. The improved VISMODII model accounts for the fact that unlike noise, aliasing may have a visual enhancing effect and therefore may lower MRTD. Experiments were conducted to measure subjective and objective MRTD. Experimental results demonstrated that the VISMODII model successfully predicts the MRTD both for the subjective and the objective schemes.

THERMINATOR 2: DEVELOPING A REAL TIME THERMODYNAMIC BASED PATTERNLESS INTRUSION DETECTION SYSTEM

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A novel system for conducting non-signature based, or patternless, intrusion detection of computer networks is presented. This system uses principles of thermodynamics to model network conversation dynamics. A notion of baseline operating conditions is developed by observing the properties of entropy, energy and temperature within the system. Perturbations in these properties are considered potential intrusions for further investigation. This thesis focuses on the design and architecture of this system. System functions are decomposed into a network sensing device, a real-time processing component and a

forensics component. A mechanism for forwarding and storage of sensed data is developed and discussed. Similarly, a novel three-dimensional display technique and the data structure that allows direct access of raw packet information from energy levels within this display is constructed and discussed. A system configuration language is defined and presented and additional tools for follow-on forensic analysis are developed. Finally, examples of valid intrusions and other network perturbations in real traffic collected in Department of Defense network operation center backbones are presented. Preliminary results indicate this system has significant potential for revealing anomalies in large network systems.

RADAR TARGET IMAGING USING TIME-REVERSED PROCESSING

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This thesis investigates and demonstrates the workability of the time-reversed process for radar imaging applications, particularly, for bi-static or multi-static radars. One benefit of the time-reversed process is its ability to reduce the calculation to determine the targets' shape. The finite-difference-time-domain (FDTD) method is used to demonstrate the time-reversed process.

Following an overview and description of the principles of the time-reversed process, the FDTD method is applied to the wave equation and the time reversed-process in 2-D space. The FDTD numerical model is developed and used for producing fundamental examples on conducting targets. The examples reveal that the time-reversed process can be employed for radar imaging within certain constraints. Finally, conclusions regarding the time-reversed-process are presented and recommendations for future research are provided.

THE NPS VIRTUAL THERMAL IMAGE PROCESSING MODEL

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A new virtual thermal image-processing model that has been developed at the Naval Postgraduate School is introduced in this thesis. This visualization program is based on an earlier work, the Visibility MRTD model, which is focused on predicting the minimum resolvable temperature difference (MRTD). The MRTD is a standard performance measure for forward-looking infrared (FLIR) imaging systems. It takes into account thermal imaging system modeling concerns, such as modulation transfer functions (MTFs), sampling, aliasing and noise, and provides virtual visual images that are associated with the thermal imaging system being modeled. This capability of the model allows the user to virtually evaluate the effects of component variation, noise, sampling and aliasing on the final four-bar image. The analysis demonstrated that aliasing effects in thermal images of four-bar patterns cannot, in general, be adequately modeled as noise. For example, the simulation experiments showed that under the right conditions aliasing can create a noticeable contrast enhancement in the output images.

MODELING MEDIA INFLUENCES IN INFORMATION OPERATIONS

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Military engagements are disruptive and expensive, draining economic and natural resources. As a result, military strategists, particularly in the nuclear age, seek to deter aggressive actions by historical and emerging challengers. Strategies that employ inexpensive, unobtrusive means to dissuade adversaries from aggressive action are particularly desirable.

Steady globalization and the concurrent rise of international media presence provide a promising, and perhaps overlooked, means for influencing adversary decision-making. Through a detailed case study, this paper provides a framework for leveraging media influences as an integral part of a broad deterrent strategy. Among the findings, the researchers discuss the expected complications and intricacies associated with implementing such an effort, as well as demonstrate how influence new modeling techniques can assist in identifying target audiences. The criticality of considering associated socio-cultural, historical, and geo-political contexts is also explored.

COMBINED ADAPTIVE POWER-RATE CONTROL IN CDMA SYSTEMS

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In this thesis, combined power and rate adaptations in the reverse channel of a multicell CDMA cellular system over a Nakagami-Lognormal frequency selective fading channel are considered. Imperfect power control, user traffic distribution, Intracell interference, co-channel interference, a RAKE receiver and spatial diversity are also considered. Numerical results obtained by Monte Carlo simulation show that power and rate adaptations result in an increase of the system capacity and prolong the mobile station's battery life.

MODELING JAMMING EFFECTS ON ROLLING AIRFRAME MISSILE

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Development of countermeasures against infrared and optical guided missiles is enhanced by an ability to quantify the effects of the countermeasure. Analysts must be capable of accurately determining the attitude of the missile throughout its flight. This thesis describes the use of microelectronic-miniature (MEM) technologies to measure the strap down rates experienced by a rolling airframe missile and the model required to effectively determine the missile's attitude during its flight. The Tokin America CG-16D rate sensors and the Honeywell, SSEC, HMC 1002 roll sensor were used in an inertial measurement unit (IMU). The size of the IMU is small and rugged enough to be installed in a small diameter missile. A SIMULINK model is presented that performs the tasks of demodulating the sensors, performing coordinate transformation, and providing animation of the missile attitude for analysis. The model was evaluated for its ability to accurately determine the attitude of the missile based on input from the IMU packages. Sensor

data was obtained from testing performed on a CARCO table flight motion simulator, and compared to the ground truth data provided by the CARCO table. Previous research had proved that this model worked for slow-spinning missile (5 Hz in roll). This thesis research expands that research to a fast spinning missile (15 Hz in roll). Through testing, the model was capable of providing solutions within the 2 degrees RMS requirement.

AIRBORNE EXPLOITATION OF AN IEEE 802.11B WIRELESS LOCAL AREA NETWORK

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Deployment of IEEE 802.11b wireless local area networks is increasing around the globe due to their cost compared to wired infrastructures, availability, versatility and recent performance gains in the areas of transmission speed. Coupled with its ease of implementation, IEEE 802.11b wireless local area networks provide a viable solution for convenient information access. Unfortunately, wireless LANs remain a new technology not fully understood by the organizations implementing them. IEEE 802.11b wireless local area networks are vulnerable to intrusion and exploitation due to its broadcast infrastructure. Adding a wireless network to an organization's internal LAN may open a potential backdoor into the existing wired network. This research investigates the feasibility of exploiting an IEEE 802.11b WLAN from an airborne platform for the purpose of gaining access into the backbone wired network. It explores the viability of exploiting the 802.11 standard through the Medium Access Control (MAC) Layer, looking at link analysis and the use of high-gain antennas and commercial-off-the-shelf (COTS) software to intercept and process these radio frequency signals. The research concludes with an evaluation of optimum flight profiles for intercepting and collecting IEEE 802.11b signals based on the performance in actual test flights.