Security Engineering: Development of Curriculum and Research for Homeland Security

- **Texas A&M University-Kingsville has received an award from the Department of Homeland Security (DHS)**
  - **To establish Curriculum and Research in the integrated study of UAVs, Wireless Sensors Networks, Data Mining, Optimization, and Information Analysis and Modeling,**

  - **Two-Phase Project:**
    - **Phase I: Project refinement, extended visits by TAMUK faculty to COE partner institution (UT-El Paso), equipment purchase, validation and testing to enhance internal capabilities (Two years, $700K).**
    - **Phase II: Full research project implementation and student participation (Three years, ~$750K).**

- **Faculty:**
  - **Dr. Selahattin Ozcelik (PI), Dr. Kai Jin (Co-PI), Dr. Hua Li (Co-PI)**
    Department of Mechanical and Industrial Engineering

  - **Dr. Nuri Yilmazer (Co-PI), Dr. Mais Nijim (Co-PI)**
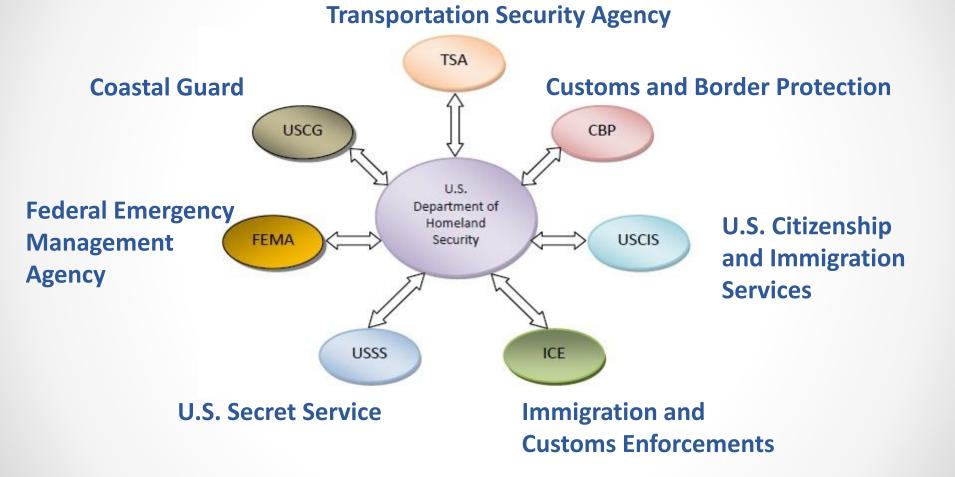   *Department of Electrical Engineering and Computer Science*

Table Content

- **Program Features**

  - ➤ **$7,000/academic year in Scholarships**

  - ➤ **10 weeks Fully Paid Internships or**

  - ➤ **Summer Research at DHS Facility or DHS Centers of Excellence**

  - ➤ **Earn a certificate in Security Engineering Field**

  - ➤ **Excellent Career Placement Opportunity**

  - ➤ **Graduate School Studies**

- **DHS Mission:** The unified national effort to secure the U.S.A.

- DHS will prevent, protect against and respond to threats and hazards to the Nation.

- The mission is extremely challenging and involves many different aspects of security and variety of operations from helping to defend the U.S.A. against threats, to providing timely and effective support in response to natural disasters.

- DHS and its sub-agencies deal with extremely large number of security and safety issues that require STEM educated technical workforce for solutions.

- $83 Billion, projected UAV business worldwide between 2012-2021
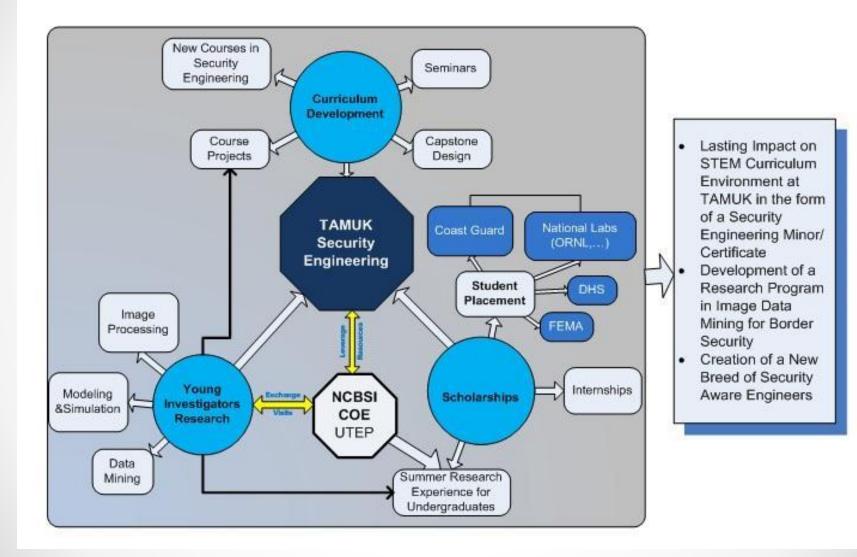
DHS and Its Sub-Agencies

Transportation Security Agency

Coastal Guard

Customs and Border Protection

Federal Emergency Management Agency

U.S. Citizenship and Immigration Services

U.S. Secret Service

Immigration and Customs Enforcements

TSA

USCG

CBP

U.S. Department of Homeland Security

FEMA

USCIS

USSS

ICE

CBP Air and Marine UAS Operating Locations

NORTHERN REGION

Grand Forks, ND
Flight Operations Center

Washington, DC
Air & Marine Headquarters

Gray Butte, CA
Flight Test Center

Riverside, CA
Air Operations Center

Sierra Vista, AZ
Flight Operations Center

SOUTHEAST REGION

SOUTHWEST REGION

Corpus Christi, TX
Maritime Operations Center
2010 Deployment

Florida
Maritime Operations Center
2010 Deployment

- **The Program has four main components**

  ➢ **Curriculum development in support of DHS-STEM disciplines,**

  ➢ **Scholarships, training, and research experiences for undergraduate students,**

  ➢ **Research support and enhanced research collaboration for the young investigators,**

  ➢ **Internships and career placement support for undergraduate students.**
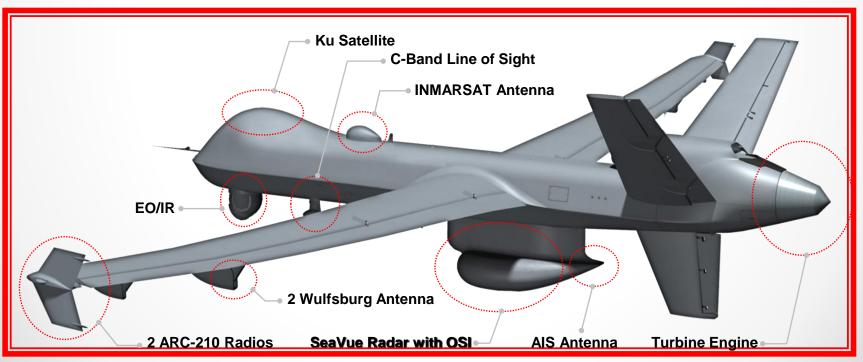
Functional Relation of Program Components

- **Curriculum**

  - **Multidisciplinary curriculum within Departments of Mechanical and Electrical Engineering and Computer Science,**

  - **Five new undergraduate courses**

  - **These courses are designed carefully that**

    - **Take into account different backgrounds of students from different majors**

    - **Require senior standing as prerequisite.**

    - **Any science and engineering senior student can satisfactorily perform in these required minor program courses.**
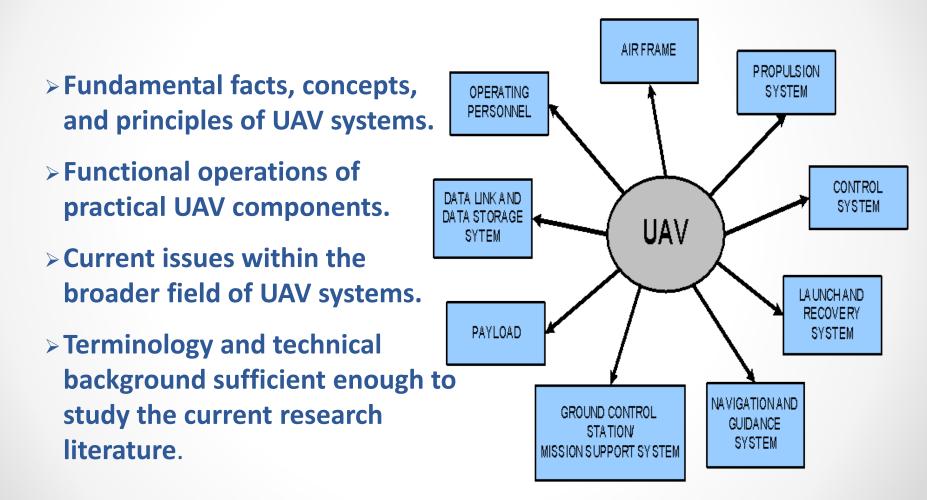
Curriculum for Minor in Security Engineering

Security Engineering Minor Program Curriculum		
Core Curriculum Courses from each Major		
Mechanical Engineering	Electrical Engineering	Computer Science
• MEEN 4344 Control of Systems • MEEN 4351 Machine Design • EEEN 3331 Circuits and Electro. Devices	• EEEN 4329 Communications Eng. • EEEN 4354 Linear Control Systems • EEEN 4355 Digital Systems Eng.	• CS 4314 Database Systems • CS 4320 Computer Networks • CS 4340 Computer Security
Elective Courses for the Minor Program **(Program students must take at least 4 of the following 5 courses)**		
• MEEN 43XX Intro. to Information Analysis and Modeling in Security Engineering • MEEN 43XX Resource Optimization for Security • EEEN 43XX Wireless Sensor Networks • MEEN 43XX Intro. to UAVs • CSEN 43XX Data Mining		
• Security Engineering Seminar Series Attendance is required by all program students. Non-credit.		

Introduction to Unmanned Aerial Vehicles

Dr. Selahattin Ozcelik

- **Foundations and basic components of Unmanned Aerial Vehicles (UAVs) from a system point of view, design considerations, payloads, communications, control and stability, navigation, UAV system roles and operations, control stations.**
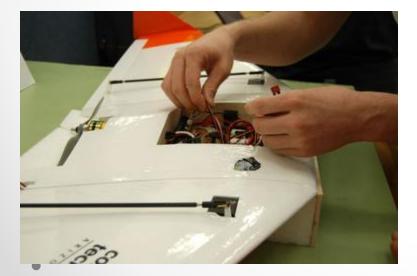

Ku Satellite

C-Band Line of Sight

INMARSAT Antenna

EO/IR

2 Wulfsburg Antenna

2 ARC-210 Radios

SeaVue Radar with OSI

AIS Antenna

Turbine Engine

- **Students will be able to demonstrate knowledge and understanding of**

  ➢ **Fundamental facts, concepts, and principles of UAV systems.**

  ➢ **Functional operations of practical UAV components.**

  ➢ **Current issues within the broader field of UAV systems.**

  ➢ **Terminology and technical background sufficient enough to study the current research literature**.

- **Student Projects Related to New Course**

  ➤ **To gain hands-on experience work on simple UAVs.**

  ➤ **Learn major components of UAVs,**

  ➤ **Investigate how to control a UAV**

  ➤ **Study how to design communication and vision systems.**

Resource Optimization for Homeland Security
Dr. Kai Jin

- **This course will introduce students to the basic operation research problems in homeland security control, such as resource optimization, airport security, and patrol scheduling. Students will learn how to model the problems and use appropriate algorithms and technologies to solve them.**

- **This course will provide students the basic scientific knowledge on modeling and optimization and prepare them for the research on homeland security simulation and modeling.**

- **Students will be able to demonstrate knowledge and understanding of**

  ➢ **Linear Programming**

  ➢ **Simplex Method**

  ➢ **Duality Theory and Sensitivity Analysis**

  ➢ **The Transportation and Assignment Problems**

  ➢ **Network Optimization Models**

  ➢ **Integer programming**

  ➢ **Game Theory**

  ➢ **Decision Analysis**

- **Student Projects Related to New Course**

  ➤ **Develop multi-objective optimization problem**

  ➤ **Explore the tools and software to solve the optimization problem**

  ➤ **Design the decision-making support system**

  ➤ **System simulation**
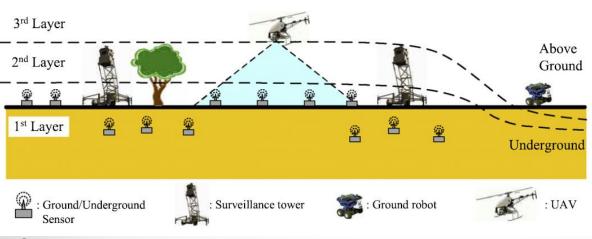
Wireless Sensor Networks

Dr. Nuri Yilmazer

Spaced at ~250 to 300 meters

Detection

Detection

Sensor Field

Self forming wireless network

[Wiki]

Alternate access schemes

Remote Monitoring Facility

Local Monitoring Base Station

Wireless Sensor Networks (WSN)

Spatially distributed sensors to *monitor* physical/environmental conditions (temperature, sound, pressure, motion, CO_2)
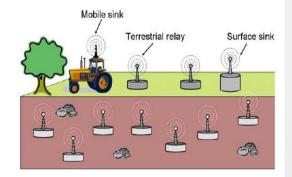
Work cooperatively to transmit the data to the center !

Limited energy !   Not practical to replace the battery !

• **Applications of WSN**

- ➢ **Forest fire detection**
- ➢ **Air pollution monitoring**
- ➢ **Landslide detection**
- ➢ **Machine health monitoring**
- ➢ **Water/wastewater monitoring**
- ➢ **Greenhouse monitoring**
- ➢ **Structural monitoring**
- ➢ **Passive localization and tracking (Border Protection)**
- ➢ **Smart home monitoring**
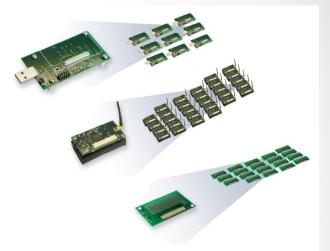- ➢ **Tracking and monitoring doctors/patients**
- ➢ **Smart Irrigation**
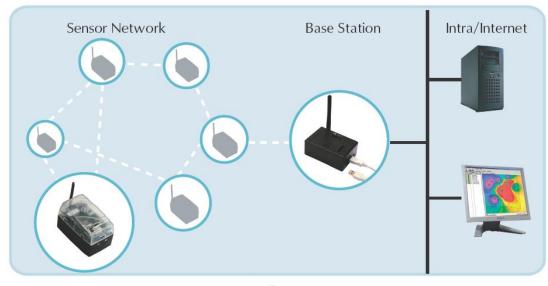

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- **Student Projects Related to New Course**

➢ **To design and test of WSN for Border Protection and Environmental Applications**

Network Architecture

Sensor Network   Base Station   Intra/Internet

Intro. to Info. Analysis and Modeling in Security Engineering
Dr. Hua Li

- Present the fundamental methods and tools used for information analysis and modeling related to homeland security.

- Introduce engineering and technical challenges of homeland security, including modeling and analysis, technological issues, command, control & situational awareness and data integration requirements.
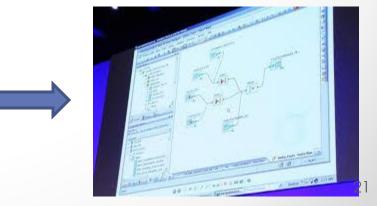
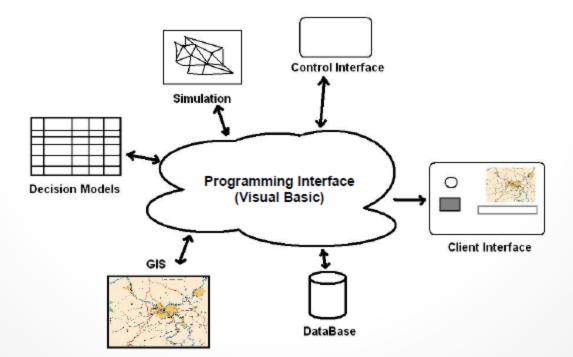# Intro. to Info. Analysis and Modeling in Security Engineering

- **Upon completing the course, students should be able to:**
  - ➤ **Analyze discrete, continuous & dynamic systems**
  - ➤ **Search necessary information from national/global terrorism database.**
  - ➤ **Be familiar with advance simulation and data analysis software, such as Minitab and Arena.**
  - ➤ **Understand how homeland security agents work, especially USBP**

- **Student Projects Related to New Course**

➢ **Develop efficient simulation optimization algorithms to assist in making high-quality, timely decisions.**

➢ **Develop platforms for multi-domain simulation**
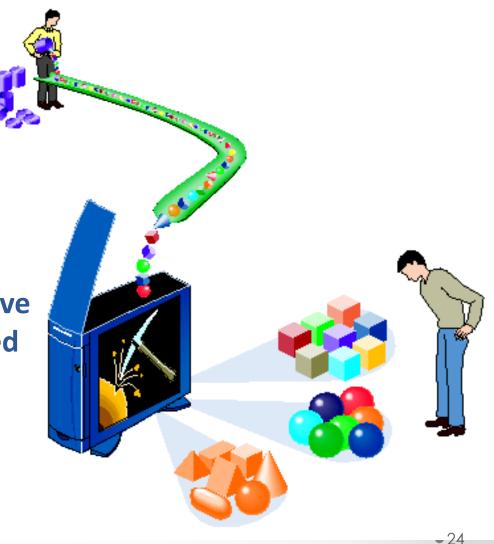
Data Mining
Dr. Mais Nijim

- Forecasting what may happen in the future

- Classifying people or things into groups by recognizing patterns

- Clustering people or things into groups based on their attributes

- Associating what events are likely to occur together

- Sequencing what events are likely to lead to later events

What is Data Mining

- **A hot buzzword for a class of techniques that find patterns in data**

- **A group of techniques that find relationships that have not previously been discovered**

- **Student Projects Related to New Course**

➤ **Students will participate in developing image and data mining techniques.**

➤ **Students will be able to learn the current related theoretical algorithms and conduct simulations. They will learn feature extractions and predictions that could be used in other computer science or engineering related fields.**

➤ **Real time analysis.**

- **Capstone Design Experiences**

  ➢ **Students minoring in Security Engineering program will be required to do their capstone design projects in the area of Security Engineering.**

  ➢ **Faculty collaborating with DHS operation sites, DHS COEs will identify the existing challenges of the operations and bring those into the classroom as capstone design projects.**

- **Research Support for Early–Career Faculty**

  ➤ **To support the educational objectives and to promote the professional development, three early career faculties, namely Drs. Yilmazer, Nijim and Li will be involved in the research activities supportive of HS-STEM research areas**.

Image Enhancement Techniques for Homeland Security Applications
Dr. Nuri Yilmazer

Motivation:

Images taken from the UAV or Multimedia WSN cameras: noisy, degraded (images usually contain Gaussian, impulse noise as well as periodic noise usually arises during the image acquisition from electrical or electromechanical interference).
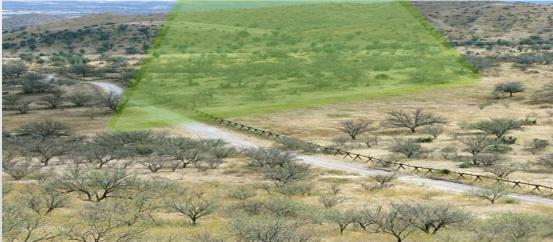
Research Topics:

Spatial Domain/Frequency Domain Filtering

Noise reduction

Image enhancement

Compression techniques

Noisy, distorted Images

Enhancement Techniques

Data Mining for Border Security Applications
Dr. Mais Nijim

- **Safeguarding the united state's border is crucial**

- **Threats could be illegal immigrations, gun trafficking, drug trafficking, and terrorists attacks**

- **Several types of images are captured through satellites or UVAs**

- **On earth devices such as tracking and sensing devices**

- **Collecting huge amount of images require methods to analyze and classify these images to better use them for current and future use**

Data Mining for Border Security Applications
Dr. Mais Nijim

- **The following research questions:**

➢ **How does image mining help toward border threats?**

➢ **How to get useful data from image data mining?**

➢ **How to reason and extract patterns with incomplete collection of images?**
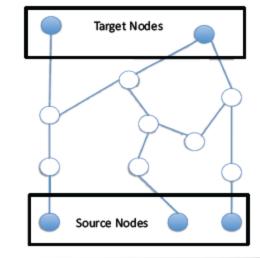
➢ **What kind of images would be collected?**

Proposed Algorithms

- **Feature extraction that includes processing the images, modeling, prediction, and image analysis.**

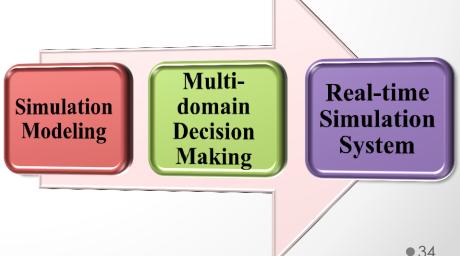- **Real time image analysis**

Simulation and Modeling
Dr. Hua Li

- **Motivation:**

  ➢ **Man-made events are hard to control and estimate**

  ➢ **It is not feasible to evaluate the efficiency and effectiveness of different response policies using actual, real homeland security events**

  ➢ **Efficient, comprehensive decision support systems are needed to address real-time homeland security decision problems.**
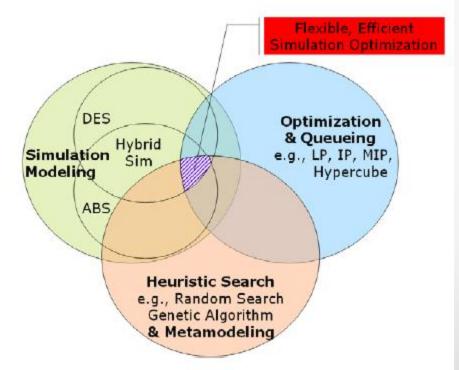
Simulation and Modeling

- **Combines both flexibility in operations and computing efficiency**

- **Reduces computational difficulty and allows timely decision making for large-scale problems in real-time settings**

- **Analyzes and optimizes the homeland security related events**

Simulation Modeling → **Multi-domain Decision Making** → **Real-time Simulation System**

Simulation and Modeling

- **Combine different simulation methods into one**

- **Rare-event (such as attacks) simulation validation**

- **Situation awareness**

- **Real-time simulation optimization**

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- **Eligibility for Scholarships and Paid Internships**

  ➢ **U.S. Citizen**

  ➢ **GPA of 3.3 or higher**

  ➢ **Full-time senior standings of Mechanical, Electrical Engineering and Computer Science at Texas A&M University - Kingsville**

  ➢ **Demonstrated interest (through essays and/or course selection) to pursue a career in Homeland Security related sciences or engineering fields.**

Thank You

- **Application forms can be picked up by MEEN or EECS departments secretaries (Cynthia or Star).**

For any questions contact our faculty members:

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- **Dr. Nuri Yilmazer , nuri.yilmazer@tamuk.edu**

- **Dr. Mais Nijim, mais.nijim@tamuk.edu**

- **Dr. Hua Li, hua.li@tamuk.edu**

Questions