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 3
- DHS Summary 4
- Main Components of Program 7
- Curriculum 9
- Courses 11
- Research 27
- Eligibility 36
• **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
CBP Air and Marine UAS Operating Locations

SOUTHEAST REGION
- Corpus Christi, TX: Maritime Operations Center 2010 Deployment
- Florida: Maritime Operations Center 2010 Deployment

SOUTHWEST REGION
- Riverside, CA: Air Operations Center
- Gray Butte, CA: Flight Test Center
- Sierra Vista, AZ: Flight Operations Center

NORTHERN REGION
- Grand Forks, ND: Flight Operations Center
- Washington, DC: Air & Marine Headquarters

Flight Operations Center
- Washington, DC
- Gray Butte, CA
- Riverside, CA
- Sierra Vista, AZ
• **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

- Lasting Impact on STEM Curriculum Environment at TAMUK in the form of a Security Engineering Minor/Certificate
- Development of a Research Program in Image Data Mining for Border Security
- Creation of a New Breed of Security Aware Engineers
• **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

<table>
<thead>
<tr>
<th>Core Curriculum Courses from each Major</th>
<th>Mechanical Engineering</th>
<th>Electrical Engineering</th>
<th>Computer Science</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MEEN 4344 Control of Systems</td>
<td>EEEN 4329 Communications Eng.</td>
<td>CS 4314 Database Systems</td>
</tr>
<tr>
<td></td>
<td>MEEN 4351 Machine Design</td>
<td>EEEN 4354 Linear Control Systems</td>
<td>CS 4320 Computer Networks</td>
</tr>
<tr>
<td></td>
<td>EEEN 3331 Circuits and Electro. Devices</td>
<td>EEEN 4355 Digital Systems Eng.</td>
<td>CS 4340 Computer Security</td>
</tr>
</tbody>
</table>

### 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.
• **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 (WSN)

Spatially distributed sensors to monitor physical/environmental conditions (temperature, sound, pressure, motion, CO₂)

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
• **Student Projects Related to New Course**

- To design and test of WSN for Border Protection and Environmental Applications
• 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.
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
Enhancement Techniques

Noisy, distorted Images
Safeguarding the United States’ 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 amounts of images require methods to analyze and classify these images to better use them for current and future use.
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 and Modeling

- Combine different simulation methods into one
- Rare-event (such as attacks) simulation validation
- Situation awareness
- Real-time simulation optimization
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).

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Questions