Computational Forensics and Investigative Intelligence

Lectures may change order during the course at the instructor's discretion.

Lecture 1: Introduction to 21st century crime and computational forensics
- The taxonomy of crimes under international law and laws of specific countries
- The role of computational forensics in criminal investigations
- Broad divisions of forensic sciences and focus areas for this course

Lecture 2: Introduction to investigative intelligence
- Intelligence as a global industry
- Intelligence agencies in different nations
- Artificial intelligence in intelligence practices: systems and methods

Lecture 3: Intelligence
- Intelligence methodologies contd.
- GEOINT: key algorithms
- HUMINT: key algorithms
- SIGINT: key algorithms

Lecture 4: Intelligence (contd.)
- MASINT: key algorithms
- OSINT: key algorithms

Lecture 5: Intelligence (contd.)
- Other intelligence disciplines and their computational tools

Lecture 7: Intelligence (contd.)
- Counterintelligence: algorithms that break algorithms

Lecture 8: Forensic fingerprint analysis
- Computer assisted fingerprint matching: capture, normalization, segmentation (block and pixel based; variance and coherence based), finding the orientation field

Lecture 9: Forensic fingerprint analysis (contd.)
- Denoising techniques
- Poincare index for finding additional features
- Automated minutiae discovery
- Alignment and matching: lights-out and semi-lights-out methods

Lecture 10: Validation before investigation: Images
- Basics of image processing: storage and manipulation of images
- Detecting forged and tampered images

Lecture 11: Validation before investigation: Video
- Basics of video processing: storage and manipulation of videos
- Detecting fake videos

Lecture 12: Validation before investigation: Audio
- Basics of audio processing: storage and manipulation of audio
- Detecting tampered audio and audio piracy

Lecture 13: Image forensics
- Iris and face recognition
- Scene recreation: creation of 3-D structures from 2-D images

Lecture 14: Video forensics
- Deriving evidence from crime scene videos
- Linking video evidence from multiple sources
- Scene reconstruction from crowdsourced videos

Lecture 15: Audio forensics
- Voice based crimes
- Speaker matching and verification
- AI-driven micro-articulometry and speaker profiling

Lecture 16: Audio forensics (contd.)
- Sonic weapons and their identification
- Tracing sound evidence: source identification
- Tracing sound evidence: location identification

Lecture 17: Audio forensics (contd.)
- Geo-locating audio soundscapes
- Audio fingerprinting
- Soundscape reconstruction

Lecture 18: Introduction to Cyberforensics
- Cybercrimes
- Basics of the internet, deep web, dark web and the internet of things
- Cyberforensic investigation basics

Lecture 19: Computer networks
- Introduction to computer networks and protocols

Lecture 20: Network vulnerabilities and attack techniques
- Vulnerabilities in computer networks and clouds
- Vulnerabilities in mobile device networks
- Relating attack techniques and types to network structures

Lecture 21: IoT Cyberforensics
- IoT devices and the IoT ecosystem
- Exploit techniques in IoT crimes
- Tracking IoT crimes

Lecture 22: Social network forensics
- Introduction to data exploits and information theft
- Introductory account hacking
- Anonymization techniques

Lecture 23: Text forensics
- Text based cybercrimes
- Fraud detection
- Authorship determination (authored text, SMS and chatrooms)
- Tracing email, phishing and spear-phishing attempts

Lecture 24: Tracing cybercrimes
- Tracing cyber attack chains on the internet

Lecture 25: The deep web and the dark web
- Basics of bullet-proof hosting
- Onion routers and other anonymization mechanisms

Lecture 26: Tracing crimes on the dark web
- Fast flux: how it works

Lecture 27: Cryptography and its role in cyberforensics
- Crypto-ransomware
- Cryptocurrency: financial fuel of the dark web
- Cryptographic functions and cryptographic hash functions
- Block chains
- Mining cryptocurrency: computational issues

Lecture 28: Information hiding

- Basics of steganography
- Steganography in cybercrimes
- Detecting hidden information