Eric Wengrowski

eric.wengrowski@gmail.com
github.com/mathski https://ericwengrowski.com

EDUCATION

Rutgers Graduate School of Engineering, Rutgers University — Piscataway, NJ
Doctor of Science, Computer Engineering — Expected Graduation: Spring 2019
Concentration in Computer Vision & Computational Photography
GPA: 3.9/4.0

Rutgers School of Engineering, Rutgers University — Piscataway, NJ
Bachelor of Science, Electrical and Computer Engineering — May 2013
Concentration in Robotics & Computer Vision

WORK EXPERIENCE

Computer Vision Research Intern - Siemens — Summer 2017
Princeton, NJ
Member of medical imaging research team working on automated lymph-node detection under the leadership of Dr. Dorin Comaniciu and Dr. Bogdan Georgescu. Specific contribution were design and training of a fully-convoluted dense neural network trained with physician-annotated CT scans of mediastinal lymph-nodes.

Computer Vision Research Intern - Kitware — Summer 2016
Clifton Park, NY
Member of computer vision research team working on DARPA project Medifor under the leadership of Dr. Anthony Hoogs and Dr. Zhaohui Harry Sun. Medifor is a multifaceted image forensics project lead by Kitware. Specific contribution include reflection-based image authentication algorithms.

Research Intern - Microsoft Research — Summer 2015
Redmond, WA
Interned with the Interactive Visual Media Group lead by Dr. Richard Szeliski, under the close mentor-ship of Krishnan Ramnath, Dr. Michael Cohen, and Dr. Neel Joshi.

Computer Vision Software Engineer - Startup — Summer 2014
San Francisco, CA
Developed dense 3D reconstruction implementations for company's flagship product. Specific contributions include: SLAM improvements to Google Tango, Kinect 2.0 development, camera geometry, Android development, h.264 & MPEG compression, network and socket programming.

Part-Time Lecturer - Rutgers ECE Department — Autumn 2013
Piscataway, NJ
Assisted in teaching a joint graduate and undergraduate class, Robotics and Computer Vision under the supervision of Professor Peter Meer. The course rubric includes common geometric computer vision techniques such as detection, recognition, image transformations, SIFT feature point extraction, RANSAC, homography, mean-shift clustering, camera calibration, epipolar geometry, motion, and facial registration.

AT&T Labs - Technical Intern — Summer 2012
Middletown, NJ
Contributed to OPNET implementation of an experimental layer 3 network simulation model for transient and steady-state analysis of virtual network traffic. This model was equipped to simulate single or multiple link and/or node failure across the AT&T Common Backbone IP network. Focus included porting the simulation to 64bit operation, debugging memory leaks, and optimization of output data structures using BASH scripts.

United States Army Corps of Engineers - Coastal Engineering Intern — Summer 2011
New Jersey Air National Guard Base, William J. Hughes FAA Technical Center
Philadelphia District, Pomona, NJ
Performed contract negotiations as a liaison between USACE and contractors. Designed coastal structures and inspected their construction, including dredging operations, as well as explosive munitions inspections.

SELECT PUBLICATIONS

Deep Convolutional Neural Networks as a Method to Classify Rotating Objects based on Monostatic Radar Cross Section *In Review*

Authors: **Eric Wengrowski**, Matthew Purri, Kristin Dana, and Andrew Huston.

Radar systems emit a time-varying signal and measure the response of a radar-reflecting surface. In the case of narrowband, monostatic radar signal domain, all spatial information is projected into a Radar Cross Section (RCS) scalar. We address the challenging problem of determining shape class using monostatic RCS estimates collected as a time series from a rotating object tumbling with unknown motion parameters under detectability limitations and signal noise. Previous shape classification methods have relied on image-like synthetic aperture radar (SAR) or multistatic (multiview) radar configurations with known geometry. Convolutional neural networks (CNNs) have revolutionized learning tasks in the computer vision domain by leveraging images and video rich with high-resolution 2D or 3D spatial information. We show that a feed-forward CNN can be trained to successfully classify object shape using only noisy monostatic RCS signals with unknown motion. We construct datasets containing over $100,000$ simulated RCS signals belonging to different shape classes. We introduce deep neural network architectures that produce 2% classification error on testing data. We also introduce a refinement network that transforms simulated signals to appear more realistic and improve training utility. The results are a pioneering step toward the recognition of more complex targets using narrowband, monostatic radar.

Reflection Correspondence for Exposing Photograph Manipulation *Published in IEEE ICIP 2017*

Authors: **Eric Wengrowski**, Z. Harry Sun, Anthony Hoogs.

Modern photo editing software like Photoshop has made it difficult to trust the authenticity of digital images. In response, image forensic techniques have emerged to detect photo manipulations. When jpeg-based authentication methods fail, a photographs integrity can be examined by checking if scene geometry is preserved in reflections. Environmental reflections contain useful information about the geometry and photometry of objects in a scene. Ersatz reflective geometry might fool the human eye, but image integrity can be verified or questioned if reflective correspondence is known. Traditionally, human input was needed to manually annotate reflective correspondences, a tedious and error-prone process. We introduce a new algorithm for automatically finding correspondences between scene objects and their reflections, with manual specification of only reflec- tion regions instead of individual points. It is assumed that images contain scene elements that are imaged both directly and indirectly through planar reflection. Results are presented on interesting cases, both successes and failures where automated correspondence is very difficult. We also discuss the motivation and challenges associated with reflection correspondence within single images.

Reading Between the Pixels: Photographic Steganography for Camera Display Messaging
Published in IEEE ICCP 2017

Authors: **Eric Wengrowski**, Kristin Dana, Marco Gruteser, Narayan Mandayam.

We exploit human color metamers to send light-modulated messages decipherable by cameras, but camouflaged to human vision. These time-varying messages are concealed in ordinary images and videos. Unlike previous methods which rely on visually obtrusive intensity modulation, embedding with color reduces visible artifacts. The mismatch in human and camera spectral sensitivity creates a unique opportunity for hidden messaging. Each color pixel in an electronic display image is modified by shifting the base color along a particular color gradient. The challenge is to find the set of color gradients that maximizes camera response and minimizes human response. Our approach does not require a priori measurement of these sensitivity curves. We learn an ellipsoidal partitioning of the 6-dimensional space of base colors and color gradients. This partitioning creates metamer sets defined by the base color of each display pixel and the corresponding color gradient for message encoding. We sample from the learned metamer sets to find optimal color steps for arbitrary base colors. Ordinary displays and cameras are used, so there is no need for high speed cameras or displays. Our primary contribution is a method to map pixels in an arbitrary image to metamer pairs for steganographic camera-display messaging.

Optimal Radiometric Calibration for Camera-Display Communication *Published in IEEE WACV 2016*

Authors: **Eric Wengrowski**, Wenjia Yuan, Kristin Dana, Ashwin Ashok, Marco Gruteser, Narayan Mandayam.

We present a novel method for communicating between a moving camera and an electronic display by embedding and recovering hidden, dynamic information within an image. A handheld camera pointed at the display can receive not only the display image, but also the underlying message. These active scenes are fundamentally different from traditional passive scenes like QR codes because image formation is based on display emittance, not surface reflectance. Detecting and decoding the message requires careful photometric modeling for computational message recovery. Unlike standard watermarking and steganography methods, our message recovery algorithm uses illumination to optically communicate hidden messages in real world scenes. The key innovation of our approach is an algorithm that performs simultaneous radiometric calibration and message recovery in one convex optimization problem. By modeling the photometry of the system using a camera-display transfer function (CDTF), we derive an *optimal online radiometric calibration (OORC)* for robust computational messaging as demonstrated with nine different commercial cameras and displays.

High-Rate Flicker-Free Screen-Camera Communication with Spatially Adaptive Embedding
Published in IEEE INFOCOM 2016
Authors: Viet Nguyen, Yaqin Tang, Ashwin Ashok, Marco Gruteser, Kristin Dana, Wenjun Hu, **Eric Wengrowski**, Narayan Mandayam.
We investigate a new visible light communication method, in which messages are embedded inside high frame rate videos and decoded by high speed cameras. This method preserves the quality of original videos, while offering a high information-transferring capability. We conduct detailed experiments to understand the factors contributing to the flicker perception of high frame rate encoded videos. Based on these understandings, we propose a video content adaptive encoding method that produces videos which have near-zero flicker while being decodable by high speed cameras. The evaluation shows that the videos with embedded messages have no distortion and artifact compared to the original videos, and the bit error rate when decoding is in the range of 1-4%.

SELECT LARGE PROJECTS

Lockheed Martin Research Collaboration *2016-2018*
Full tuition support with research grant from Lockheed Martin. Solving non-traditional classification problems using deep learning. Our findings have been compiled into a journal paper out for submission.

Visual MIMO Computer Vision Research – *2013-present*
Visual MIMO is a Visual-Light Communications (VLC) system that operates in real-time. In a traditional transmitter-receiver communications model, light-emitting arrays such as LCD screens serve as transmitters, while cameras serve as receivers. Messages are transmitted through modulated light, difficult for humans to see, but easy for cameras to detect. In this way, we are able to send invisible messages embedded in regular photo/video content. The current design utilizes ubiquitous, low-cost hardware (LCD monitors, Android phones, and Google Glass). This work was supported primarily by the National Science Foundation under NSF grant CNS-1065463.

TECHNICAL AWARDS

Siemens FutureMakers Hathathon - 2nd Place	May 2018
GAANN Fellowship - 5-Year Full PhD Funding Support	September 2017
IEEE Cybersecurity Symposium at Fairleigh Dickinson University - 2nd Place Poster	September 2016
Rutgers ECE Research Day - 2nd Place - Conference Travel Grant Prize	February 2016
Conference Travel Award sponsored by Rutgers Graduate School	November 2015
Nvidia Academic Hardware Grant	August 2015
ECE Capstone Design - Top 10 Project	Fall 2013
New Jersey Beach Buggy Association Scholarship Award Winner	2012
WOBM Student of the Month	2009

EXPERIENCE and SKILLS

Programming Languages: Python, Matlab, C++, Lua, C#
Favorite Python Libraries: PyTorch, TorchVision, PIL
Favorite C++ Libraries: OpenCV, Eigen, PugiXML, Boost, protobuf
Favorite MATLAB Libraries: CVX, VLFeat
Other Experience: Deep Learning with PyTorch, Torch, MatConvNet, .NET Environment (Visual Studios), Linux Development Environments, Windows Development Environments, Linux/Unix Shell, BASH Scripting, LaTeX, Unity, Vuforia, Kinect Development, OPNET, US Department of Defense Resident Management System (RMS)

RELEVANT COURSEWORK

Robust Computer Vision, Convex Optimization, Computer Vision, Pattern Recognition, Robotics & Computer Vision, Regression Analysis, Research in Human-Computer Interaction (HCI), Algorithms and Data Structures, Software Engineering, Control Systems Design, Probability and Stochastic Processes, Linear Algebra, Malware Analysis and Reverse Engineering, CTEC: Discovery to Business Model

FACTS (FUN)

Rutgers U. Mens Alpine Snowboard Racing Team - USCSA Mid-Atlantic Regionals - Giant Slalom - 3rd Place
Summited 8 Colorado 14ers
Improv Comedy Player
Completed 1 Semester of College Ballet