Joshua J. Engelsma

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RESEARCH INTERESTS

Pattern recognition, image processing, and computer vision with applications in biometrics.

EDUCATION

Since 2016 **Michigan State University**, *East Lansing*, MI.
Ph.D., Computer Science and Engineering
○ Advisor: Anil K. Jain
○ GPA: 4.00/4.00

2012–2016 **Grand Valley State University**, *Allendale*, Michigan.
B.S. **Major:** Computer Science **Minor:** Mathematics
○ GPA: 3.94/4.00

AWARDS AND SCHOLARSHIPS

05/2020 **Michigan State University**, *East Lansing*, Michigan.
Outstanding Graduate Research Fitch Beach Award, College of Engineering
(one winner per department)

06/2019 **International Conference on Biometrics (ICB)**, *Crete*, Greece.
Best Paper Award

2017 & 2018 **Michigan State University**, *East Lansing*, Michigan.
Computer Science and Engineering Graduate Research Poster Awards

08/2016 **Michigan State University**, *East Lansing*, Michigan.
Engineering Distinguished Fellowship, Computer Science and Engineering

05/2016 **Grand Valley State University**, *Allendale*, Michigan.
Magna Cum Laude

04/2016 **Grand Valley State University**, *Allendale*, Michigan.
Outstanding Computer Science Senior (Top 3 Senior)

04/2015 **Grand Valley State University**, *Allendale*, Michigan.
Computer Science Academic Scholarship

08/2012 **Grand Valley State University**, *Allendale*, Michigan.
Computer Science, Faculty, and Award of Excellence Academic Scholarships

EXPERIENCE

08/2016–present **Research Assistant**, *Department of Computer Science and Engineering*, Michigan State University, Pattern Recognition and Image Processing Lab.
○ Advisor: Anil K. Jain
○ Conducting research in the area of fingerprint recognition.

05/2020–08/2020 **Research Intern**, *Goodix*, San Diego, California.
○ Supervisor: Dr. Kai Cao
○ Worked on improving state-of-the-art video super resolution models. Internship was performed virtually due to COVID-19.

06/2017–08/2017	**Guest Researcher**, *National Institute of Standards and Technology (NIST)*, Gaithersburg, Maryland.

- Supervisor: Nicholas G. Paulter
- Developing 3D fingerprint targets to be used for simulating fingerprint distortions.

06/2015–07/2016	**Undergraduate Researcher**, *Computer Science*, Grand Valley State University.

- Advisor: Andrew Kalafut
- Conducted research in the area of network security (typosquatting).

RESEARCH

(2020) Infant Fingerprint ID.

A high-resolution (1900 ppi) fingerprint reader with ergonomics specifically tailored for infants is proposed. Additionally, a custom infant fingerprint matching algorithm and a mobile app for performing infant search on device is developed. We are actively working in collaboration with a reputable biometrics company to deploy our infant fingerprint recognition system at scale in the developing world for applications such as vaccination tracking.

(2020) HERS: Encrypted Representation Search.

A method to search for a query image representation against a large gallery within the encrypted domain. Our method, dubbed HERS (Homomorphically Encrypted Representation Search), operates by (i) compressing a given representation towards its estimated intrinsic dimensionality, (ii) encrypting the compressed representation using the proposed fully homomorphic encryption scheme, and (iii) searching against a gallery of encrypted representations directly in the encrypted domain, without decrypting them, and with minimal loss of accuracy. Numerical results on large galleries of face, fingerprint, and object datasets such as ImageNet show that, for the first time, accurate and fast image search within the encrypted domain is feasible at scale (296 seconds; $46\times$ speedup over state-of-the-art for face search against a background of 1 million).

(2019) DeepPrint: Learning a Fixed-Length Fingerprint Representation.

A fixed-length fingerprint representation which enables orders of magnitude faster matching than the prevailing variable length minutiae representations. We also demonstrate accurate and fast *matching within the encrypted domain*. We obtain a rank-1 search performance of 98.8% while requiring only 300 milliseconds of search time against a gallery of 1.1 million fingerprints. In comparison a state-of-the-art COTS system obtains 98.85% rank-1 accuracy, but requires 27 seconds of search time.

(2018) RaspiReader: Open Source Fingerprint Reader.

A custom, dual camera, spoof resistant, high-resolution fingerprint reader was prototyped using low-cost, components. The fingerprint reader is open-sourced. In real world evaluations simulated by Johns Hopkins Applied Physics Laboratory, RaspiReader has consistently been a top performing spoof detection system, amongst systems developed by other reputable academic and industrial competitors. The open-source design has been replicated by other academic and industry-based researchers github.com/engelsjo/RaspiReader.

(2017) Universal 3D Fingerprint Targets.

A manufacturing process for creating wearable, 3D fingerprint targets mapped with a 2D fingerprint image. These fingerprint targets are mechanically, electrically, and optically similar to the human finger tip enabling imaging by all major types of fingerprint readers. These targets have been used to evaluate and break current spoof detection systems as well as realistically evaluate commercial fingerprint readers.

PUBLICATIONS

1. **Joshua J. Engelsma**, Kai Cao, Anil K. Jain, "Learning a Fixed-Length Fingerprint Representation". **IEEE Transactions on Pattern Analysis and Machine Intelligence** (2019). **Impact Factor: 17.73**

2. **Joshua J. Engelsma**, Kai Cao, Anil K. Jain, "RaspiReader: Open Source Fingerprint Reader". **IEEE Transactions on Pattern Analysis and Machine Intelligence** (2018). **Impact Factor: 17.73**

3. **Joshua J. Engelsma**, Sunpreet Arora, Anil K. Jain, Nicholas G. Paulter. "Universal 3D Wearable Fingerprint Targets: Advancing Fingerprint Reader Evaluations." **IEEE Transactions on Information Forensics and Security** (2018). **Impact Factor: 6.21**

4. **Joshua J. Engelsma**, Anil K. Jain, "Generalizing Fingerprint Spoof Detector: Learning a One-Class Classifier", **IEEE International Conference on Biometrics (ICB)** [**BEST PAPER**, oral], 2019

5. **Joshua J. Engelsma**, Debayan Deb, Kai Cao, Prem Sudhish, Anjoo Bhatnager and Anil K. Jain, "Infant-ID: Fingerprints for Global Good", arXiv:2010.03624 [cs.CV], 2020

6. **Joshua J. Engelsma**, Anil K. Jain, Vishnu N. Boddeti, "HERS: Homomorphically Encrypted Representation Search", arXiv:2003.12197 [cs.CV], 2020

7. **Joshua J. Engelsma**, Debayan Deb, Anil K. Jain, Prem Sudhish, Anjoo Bhatnager, "Infant-Prints: Fingerprints for Reducing Infant Mortality", **IEEE CVPR Workshops (Computer Vision for Global Challenges)**, 2019

8. **Joshua J. Engelsma**, Kai Cao, Anil K. Jain, "Fingerprint Match in Box", **IEEE Biometrics Theory Applications and Systems (BTAS)**, (2018)

9. Steven Grosz, **Joshua J. Engelsma**, N.G. Paulter Jr., Anil K. Jain, "White-Box Evaluation of Fingerprint Matchers: Robustness to Minutiae Perturbations", **in IEEE International Joint Conference on Biometrics (IJCB)**, 2020

10. Vishesh Mistry, **Joshua J. Engelsma**, Anil K. Jain, "Fingerprint Synthesis: Search with 100 Million Prints", **in IEEE International Joint Conference on Biometrics (IJCB), 2020**

11. Debayan Deb, Tarang Chugh, **Joshua J. Engelsma**, Kai Cao, Neeta Nain, Jake Kendall, Anil K. Jain, "Matching Fingerphotos to Slap Fingerprint Images", arXiv:1804.08122 [cs.CV], 2018

Patents Filed

Fixed-Length Fingerprint Representation.

Presentations

IARPA Kickoff Meetings (2018, 2019), BTAS 2018 (Los Angeles, CA), ICB 2019 (Crete, Greece), MSU-Notre Dame Biometrics Workshop 2019 (South Bend, IN), ID4Africa 2019 (Johannesburg, South Africa), Indian Statistical Institute 2020 (Kolkata, India), IIT Bombay 2020 (Mumbai, India).

Media

USAToday, The Verge, Science Channel, Science Daily, Raspberry Pi official blog, The New Humanitarian, Biometric Update, WKAR, MSU Today.

Science Channel (Universal Fingerprint Targets): **1.1 million views** `https://bit.ly/38D5uZH`.

RaspiReader DIY video: 17.7K views `https://bit.do/RaspiReader`.

SERVICE

Reviewer: IEEE Transactions on Information Forensics and Security (TIFS), IEEE Transactions on Biometrics, Behavior, and Identity Science (T-BIOM), Pattern Recognition, Winter Conference on Applications in Computer Vision (WACV), and International Joint Conference on Biometrics (IJCB).

Graduate Student and Faculty Recruitment Activities, Research mentorship to new PhD students in PRIP lab, Coordination of undergraduate lectures and tours of the PRIP lab research.

Open Source Software: 2516 reputation, top 15% overall Stackoverflow.

SKILLS

Python, OpenCV, Sklearn, Numpy, Tensorflow, Deep Learning, Machine Learning, Pattern Recognition, Matlab, Latex, Rapid Prototyping with 3D printing and Raspberry Pi, Fingerprint Recognition, Technical Writing