RSAConference2019

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BETTER.

SESSION ID: SEM-M01

Privacy in the Age of Pervasive Cameras
When Electronic Privacy Gets Physical

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#RSAC

Cameras have proliferated in the last decade

http://www.steves-digicams.com/New-pope.jpg

Redefining "photography" with lifelogging cameras

http://www.getnarrative.com

http://www.google.com/glass

http://www.vuzix.com

http://www.autographer.com

http://ioncamera.com

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Newer first person cameras for capturing moments

http://www.snapchat.com

://www.google.com/glass

http://www.autographer.com

http://ioncamera.com

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Newer first person cameras for capturing moments

http://www.autographer.com

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Why?
!!

Why not?

‘Tivo’/DVR/Record your life

A DAY IN YOUR LIFE

(PhD Student’s lifelog)

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Document interesting moments…

http://gallery.autographer.com

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…or important moments

http://gallery.autographer.com

Ryan Johnson,
https://commons.wikimedia.org/w/index.php?curid=52373022

http://blog.memoto.com

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How will such collection affect our privacy?

Contextual Integrity
Nissenbaum, 2004

Violating norms of collection

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Rampant sharing on social media

People upload more than 1.8 billion photos to social media each day

source: Flickr (creative commons license)

source: elitenewsfeeds.com

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Tells a detailed story about the wearer

Impression management
Goffman, 1959

What I eat

What I watch

What I say

Whom I meet

Where I go

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Our ‘physical privacy’ is no longer sacred

Virtual Theft
‘Download the house’ using the victim’s camera

*Can the attacker reconstruct a **3D model** of the victim’s space for structured navigation?*

Robert Templeman, Zahid Rahman, David Crandall, and Apu Kapadia, "PlaceRaider: Virtual Theft in Physical Spaces with Smartphones," Network & Distributed System Security Symposium **(NDSS '13)**

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How can we improve privacy in the age of digital + wearable + social photography?

What makes an image **sensitive**?

Can we **detect** regions that violate privacy?

How should we **obscure** these regions?

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Google Faculty Research Awards

NSF

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TWC SBE: Medium: Collaborative: A Socio-Technical Approach to Privacy in a Camera-Rich World
With: David Crandall (IU) and Denise Anthony (Dartmouth)
National Science Foundation, $1.2M

CAREER: Sensible Privacy: Pragmatic Privacy Controls in an Era of Sensor-Enabled Computing
National Science Foundation, $559K

Privacy-Enhanced Life-Logging with Wearable Cameras
With: David Crandall (IU)
Google Research Award, $46K

FRSP Type II: Vision for Privacy: Privacy-Aware Crowd Sensing Using Opportunistic Imagery
With: David Crandall (IU)
Office of the Vice Provost of Research at Indiana University Bloomington, $50K

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Privacy behaviors and preferences of lifeloggers

Roberto Hoyle, Robert Templeman, Steven Armes, Denise Anthony, David Crandall, and Apu Kapadia, "**Privacy Behaviors** of Lifeloggers using Wearable Cameras," To appear in The ACM International Joint Conference on Pervasive and Ubiquitous Computing (**UbiComp '14**)

Roberto Hoyle, Robert Templeman, Denise Anthony, David Crandall, and Apu Kapadia, "Sensitive Lifelogs: A **Privacy Analysis of Photos** from Wearable Cameras," To appear in The ACM SIGCHI Conference on Human Factors in Computing Systems (**CHI '15**)

What makes an image sensitive?

Lifelogging User study (N = 36)

photos captured every 5 min, 3 days

~15,000 images captured

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What makes an image sensitive?

Lifelogging User study (N = 36)

photos captured every 5 min, 3 days

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Photo Study Do's and Don'ts for Participants

During this study, you will be carrying a device on your neck that will be taking a picture of your surroundings every five minutes. It will also be taking samples of your movement, via an accelerometer, ambient sound levels, ambient light, and your location. There will be no audio recording of conversations. To make this experience pleasant for everyone involved, please observe a few guidelines while participating in the study.

DO's:

- **DO** keep the harness around your neck with the phone's screen facing you, and the rear camera of the phone facing out so that it is just peeking out of the harness.
- **DO** keep the harness outside of your regular clothing, so that it has an unblocked view of your surroundings.
- **DO** wear the harness so that the label is observable by those around you and in the phone's view.
- **DO** explain to persons who may be recorded the purpose of the study and the device.
- **DO** offer the informational cards provided, if you encounter anyone who requests more information about the study. The identifier on the card can be used to reference photos in an anonymous manner.
- **DO** put the device away if people around you express discomfort with the device or express their desire not to be recorded.
- **DO** pause the device whenever you want to stop recording, even if you need to put the device away. Pausing recording allows us to track how frequently people choose to avoid recording.
- **DO** contact us if you have any questions or concerns. We can be reached by email at photostudy@cs.indiana.edu.
- **DO** protect the device from water. For example, please put the device away if you're outdoors and it is raining, or when you engage in sports or recreation where the device can get wet.
- **DO** exercise caution with the lanyard so that it does not strangle or choke you.

DO NOT's:

- **DO NOT** record any form of nudity or illegal activity.
- **DO NOT** use the device in places where recording could cause a violation of privacy, including: restrooms, locker rooms, changing rooms, bedrooms, and other private spaces where individuals have heightened expectations of privacy.

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This is a study about how people use photologging applications, such as Google Glass and has been approved by Indiana University's Institutional Review Board and General Counsel. If you have any questions, please contact the researchers at photostudy@cs.soic.indiana.edu or view our FAQ at https://juhu.soic.indiana.edu/photoapp/faq

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Reasons not to share photos (~8% photos)

	Reason	Responses
ScreenAvoider	Objects (other than people) in the photo	30.7%
PlaceAvoider	Where this photo was taken	22.6%
Obfuscations	People within the photo	18.4%
	Participant was in the photo	11.5%
	It had private information	11.5%
	It would have been embarrassing to share it	5.4%
Obfuscations	It would have violated someone else's privacy	3.8%
	It was a bad photo	1.5%

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Detecting sensitive spaces with PlaceAvoider

Robert Templeman, Mohammed Korayem, David Crandall, and Apu Kapadia, "PlaceAvoider: Steering First-Person Cameras away from **Sensitive Spaces**," The 21st Annual Network & Distributed System Security Symposium **(NDSS '14)**

Using landmarks to detect sensitive spaces

space= _____

space= _____

space= _____

local image feature classifier

global image feature classifier

HMM

space= bathroom

space= bathroom

space= student lounge

PlaceAvoider is effective, especially for lifelogging applications

	House 1	House 2	House 3	Workplace 1	Workplace 2
Accuracy	89%	75%	99%	88%	99%

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Detecting screens with… ScreenAvoider

Mohammed Korayem, Robert Templeman, Dennis Chen, David Crandall, and Apu Kapadia, "Enhancing Lifelogging Privacy by **Detecting Screens**,"
In Proceedings of The ACM SIGCHI Conference on Human Factors in Computing Systems (**CHI '16**)

Screen detection using Deep Learning

- **Author** dataset: 18,769 images collected by us, split into disjoint training and testing sets, manually annotated

- CNN gives **99.8% accuracy** (92% with lifelogging dataset)

False negative

False positives

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92% Accuracy on User Study Dataset (2,742 images)

117 False Negatives
Video games (50%)
Half visible (50%)
Out of focus (35%)
Photo content (13%)
Sensitive apps (7%)

116 False Positives
Physical windows (34%)
Framed objects (33%)
Other screens (16%)

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Will anybody use these (ugly) transforms?

Need to understand privacy vs. aesthetics

Rakibul Hasan, Eman Hassan, Yifang Li, Kelly Caine, David J. Crandall, Roberto Hoyle, and Apu Kapadia, "**Viewer Experience** of **Obscuring** Scene Elements in Photos to Enhance Privacy," In Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems (**CHI '18**)

Does obscuring have to be ugly?

Unfiltered

Redact

Silhouette

Blur

Pixel

Edge

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Some combinations balance privacy and aesthetic appeal (N=570)

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Examples of combinations that work

Document (silhouette)

Age (blur-high)

Dress (silhouette)

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Can we compensate for the ugly transforms?

Rakibul Hasan, Yifang Li, Eman Hassan, Kelly Caine, David J. Crandall, Roberto Hoyle, and Apu Kapadia, "**Can Privacy Be Satisfying?** On Improving Viewer Satisfaction for Privacy-Enhanced Photos Using Aesthetic Transforms," ACM SIGCHI Conference on Human Factors in Computing Systems (**CHI '19**)

Ponderables and future directions

- Can we leverage people's '**sense of propriety**' when they capture and share your images?
  - Socio-Technical Strategies for Enhancing Privacy in Photo Sharing. With Bennett Bertenthal. National Science Foundation, $500K
- **Tangible privacy** designs so we know how/when data is being collected?
  - Tangible Privacy: User-Centric Sensor Designs for Assured Privacy. With Adam J. Lee, Rosta Farzan (Pitt). National Science Foundation, $450K
- Where do we **draw the line** with pervasive cameras? GPS units, Toaster, Air Conditioners,… What's next? Why .

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Toaster Ovens

Air Conditioners

GPS Units

Apply what you have learned today

- **Immediately (Start with your home!)**
  Conduct an **inventory** of cameras in your home
  Policy on smartphones/cameras in **bedrooms**/bathrooms
  Be **aware** that your actions are fair game for social media
- **Within 3 months**
  Organization policy with cameras and microphones
  Do we really need a camera? Conduct **privacy assessment**

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