Assisting Users in a World Full of Cameras

Privacy-Aware Infrastructure for Computer Vision Applications

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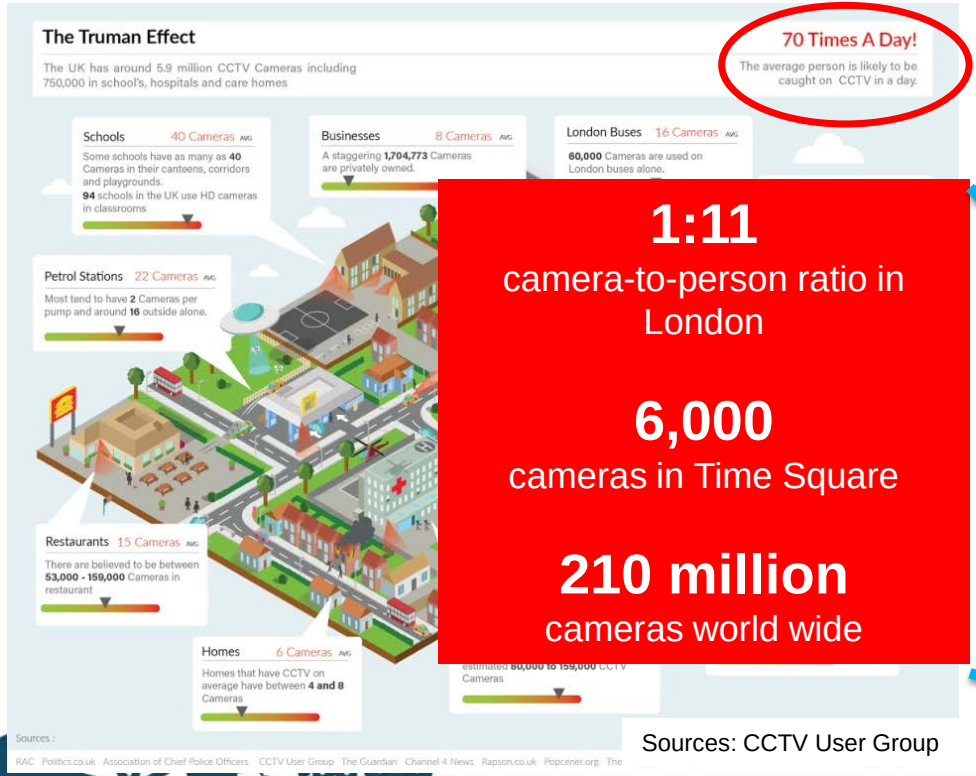
Cameras Are Everywhere



1:11
camera-to-person ratio in London

6,000
cameras in Time Square

210 million
cameras world wide

Sources: CCTV User Group

Source: UrbanEye, New York Civil Liberty Union

More Gadgets with Cameras

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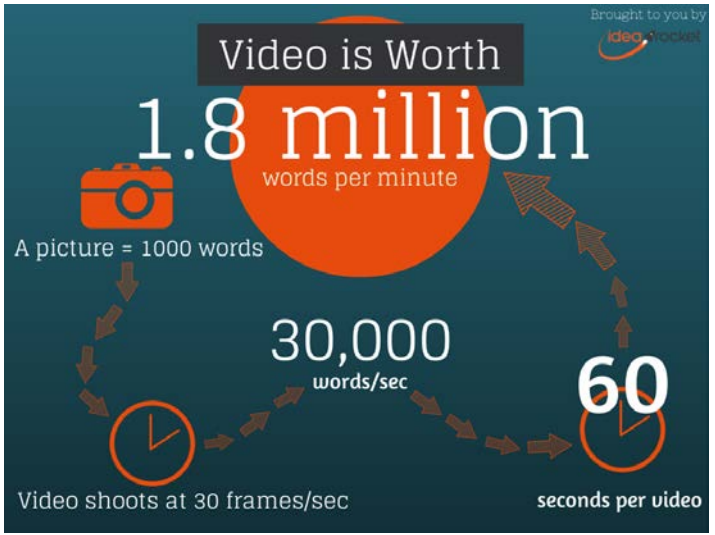
A Picture Is Worth 1000 Words

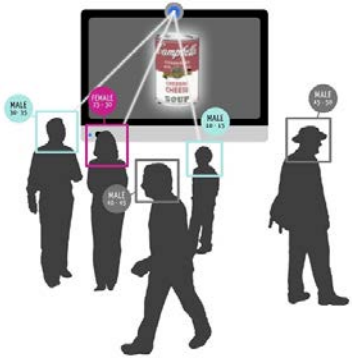
- Facial recognition
  - Identification
  - Mood / Expression / Health
  - Demographics
- Object recognition
- Scene recognition
- Activity recognition
- Safety and security
  - surveillance, criminal investigation



Source: IdeaRocket

Use of Facial Recognition Is on the Rise

Moments



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Privacy Implications of Facial Recognition

- Generate a customer/user profile
  - Serve customized ads/services
- Infer lifestyle, behavior, and habits
- Infer health conditions
- Track users' whereabouts
- Infer social associations and activities

Regulators and policymakers advocate the right to **notice** and **choice**

Privacy Preference Study

Vignette Study on IoT privacy preferences:

- 1007 Amazon MTurk participants gave feedback for 380 scenarios consisting of eight factors.
- Each user saw at least one scenario involving facial recognition.

Example Scenario:

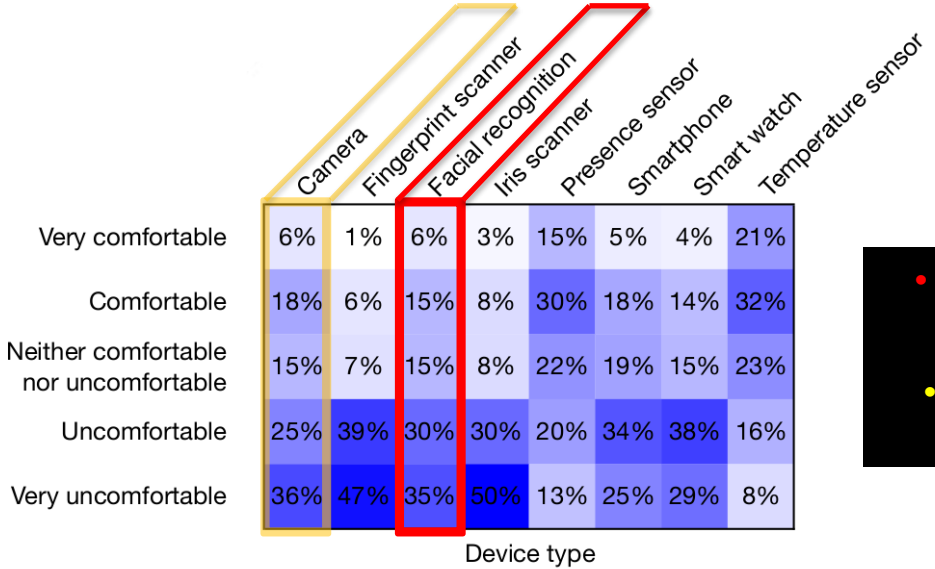
"You are at a [coffee shop]. This store uses [facial recognition system] to automatically [identify returning customers]. The system is also used to keep track of [your orders and make suggestions] based on your ordering habits. Your picture will be kept for [a few hours]".

P. Naeini, S. Bhagavatula, H. Habib, M. Degeling, L. Bauer, L. Cranor, and N. Sadeh, *"Privacy Expectations and Preferences in an IoT World."* SOUPS 2017

https://www.privacyassistant.org/publications

Users Are Uncomfortable with Image Data

- Self-reported comfort level for different data collection devices (regardless of the specific scenario)



- **65%** of the users were uncomfortable with **facial recognition**
- **61%** of the users were uncomfortable with **data captured by cameras**

Users Want Notice and Choice

- Users expressed interest in being **notified** about the presence of facial recognition especially when the data collection purpose is unclear.
- Most would **disable** facial recognition if given the option.
- **Context** has an impact on the decision.
  - More likely to allow in a library than in a department store.

Our Goals

- Support **notice and choice** in IoT.
- **Objective:** Selectively notify users without overwhelming them and help them configure available settings.
  - **Capture users' privacy preferences:**
    - Notification preferences (when, how often, how)
    - Data collection and sharing preferences

Building A Privacy-Aware Infrastructure

Internet of Things Resource Registry (IRR)

- Advertises privacy practices (including any privacy settings) and capabilities of IoT resources (e.g., apps, sensors, services)
- Multiple registries controlled by different entities

Personalized Privacy Assistants (IoT Assistant)

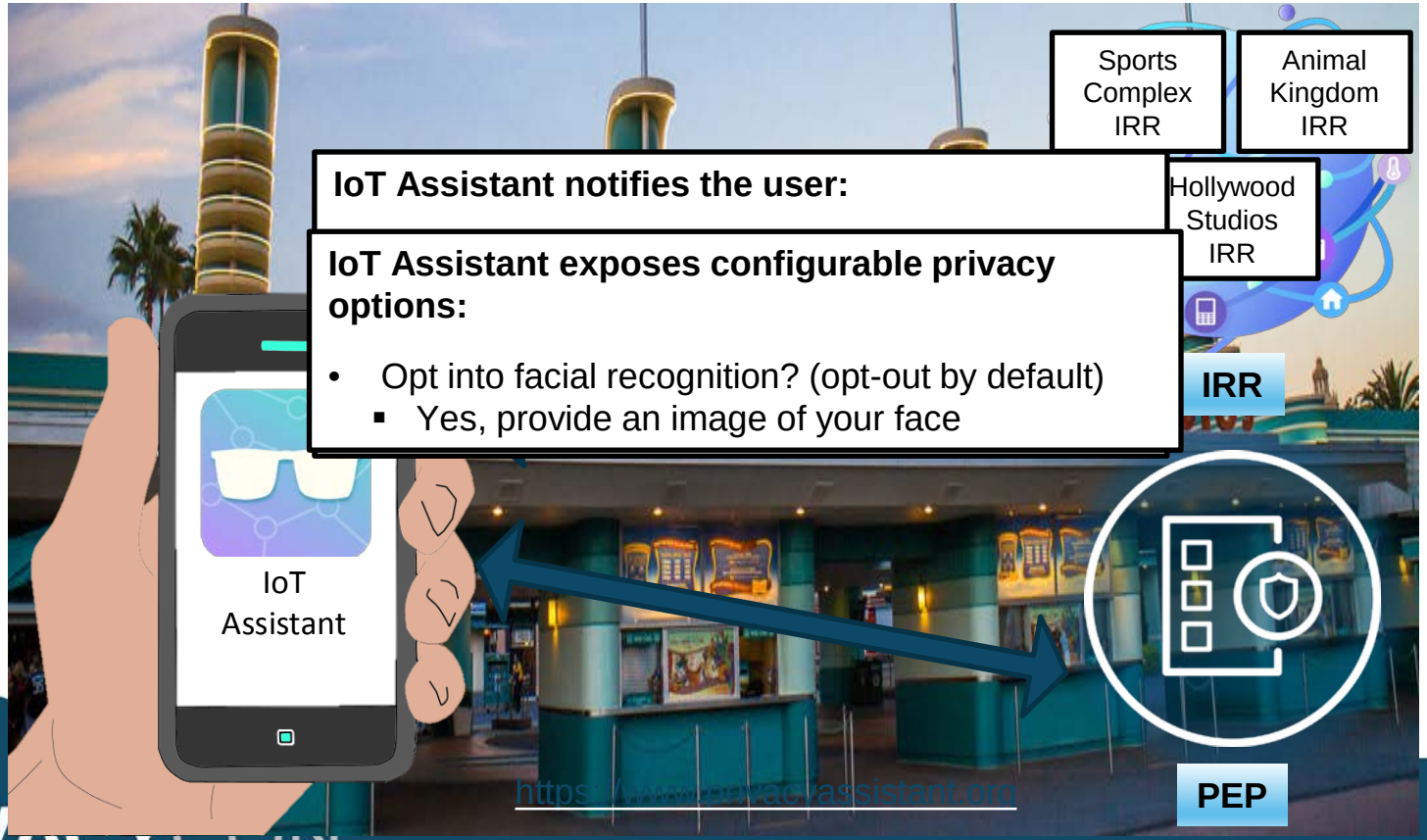
- Discovers IoT resources, their capabilities, and privacy practices (including any privacy settings)
- Learns user preferences; supports selective user notification, and semi-automated configuration of settings

Policy Enforcement Point (PEP)

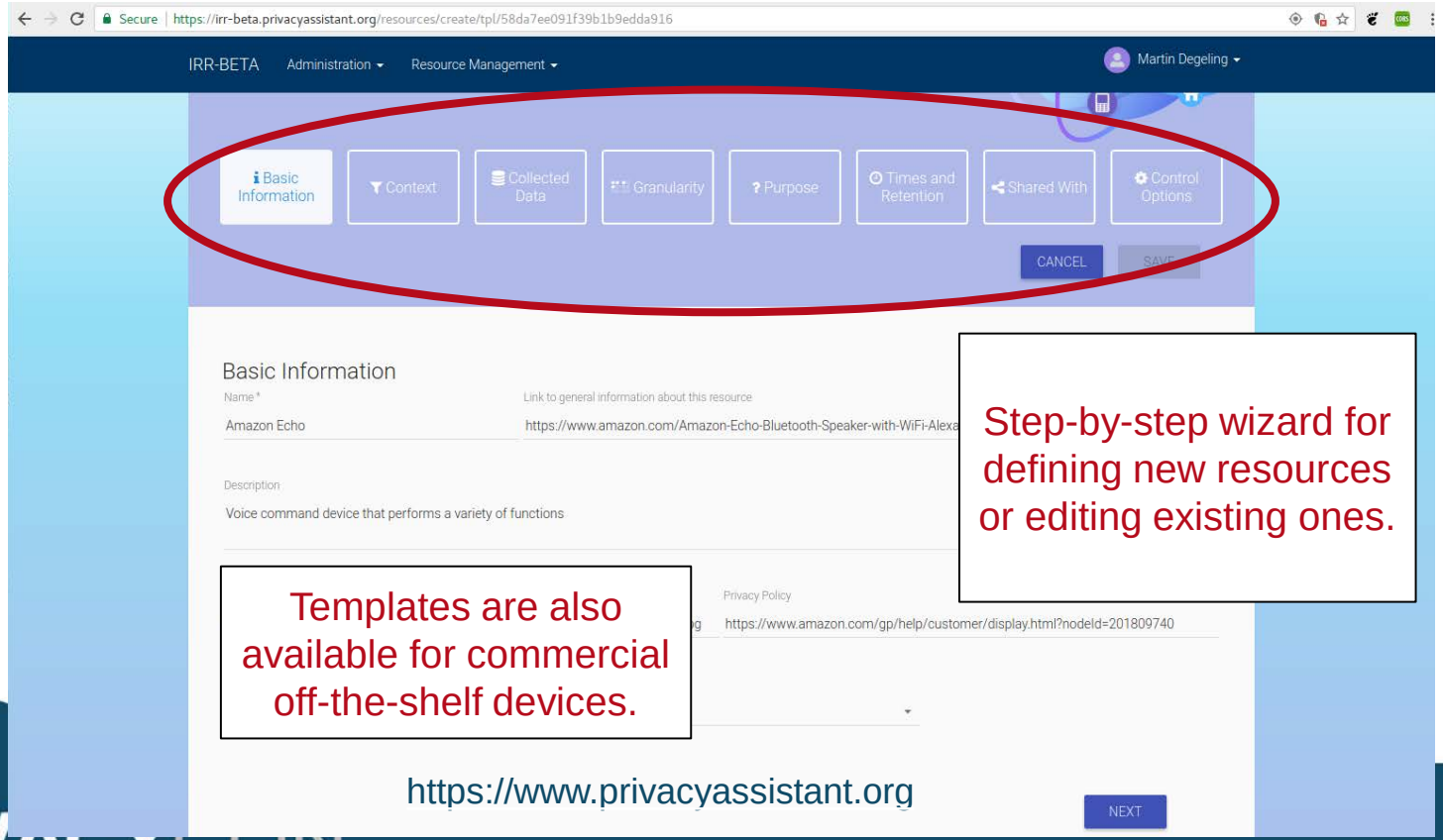
- Captures and stores user-specific privacy settings (e.g., opt in/out)
- Enforces users' privacy settings

https://www.privacyassistant.org

Workflow Example: Theme Park



Registering an IRR Resource

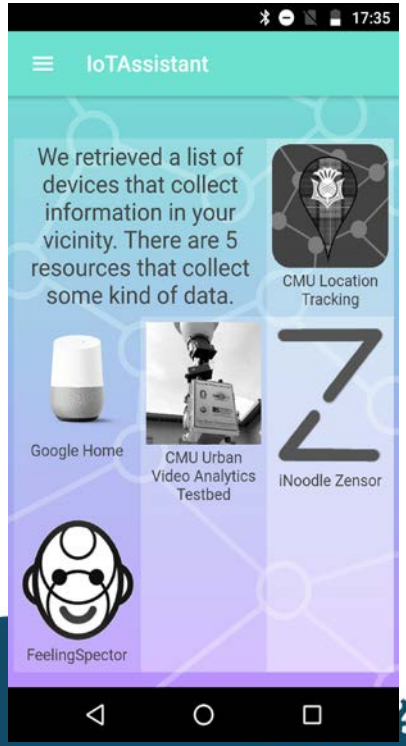


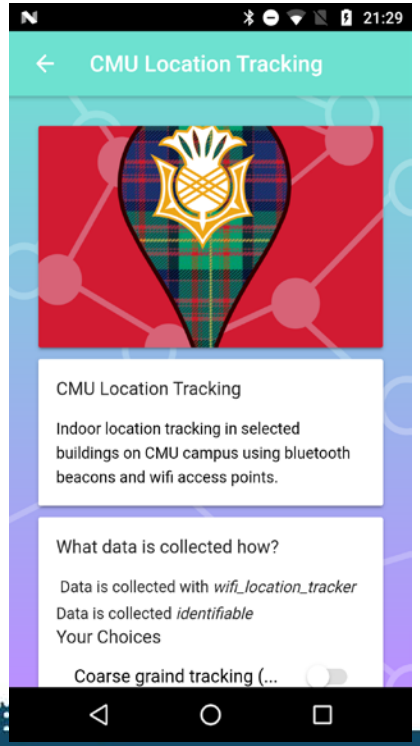
Step-by-step wizard for defining new resources or editing existing ones.

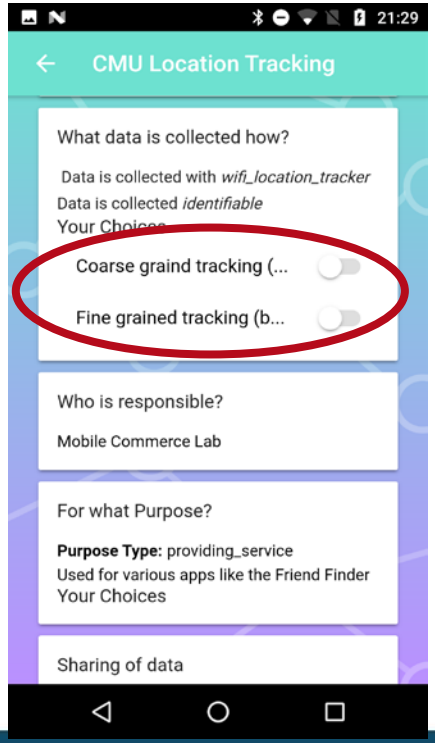
Templates are also available for commercial off-the-shelf devices.

https://www.privacyassistant.org

IoT Assistant Discovering IRR Resources



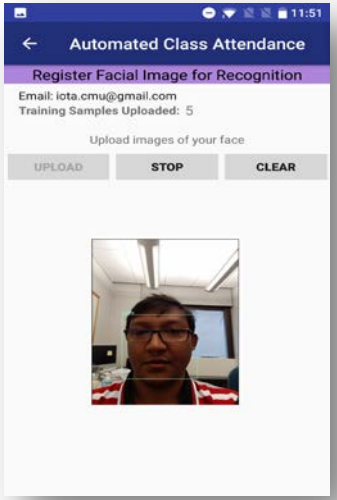




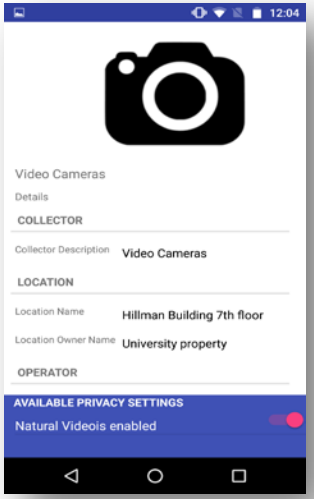
Exposes privacy settings.

Automated Attendance Tracker

Train Facial Features

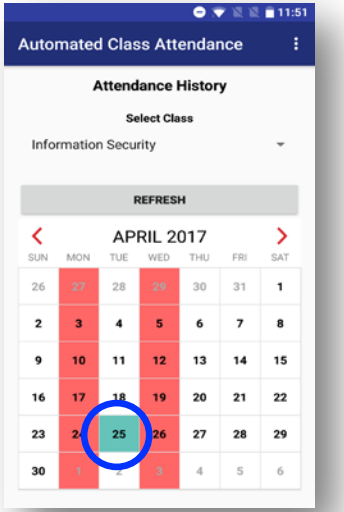


Control Opt-in



Live Video Stream

Monitor Class Attendance



- Planning to pilot this system in classrooms at CMU

Conclusion

- The use of computer vision is expanding with the rise of IoT cameras.
- Our studies show that:
  - Users want to be **notified** about how their data is being used
  - Users want to **choose** (control) how their data is being used
- We are working on an **infrastructure** that supports **notice and choice**, and captures users' **privacy preferences** in IoT settings.

For more information:

https://www.privacyassistant.org

Demonstration

https://goo.gl/gtpbpK

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