



Privacy in Mini-drone Based Video Surveillance

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Mini-drones with sophisticated video acquisition devices on board

➔ Used as surveillance devices:

- Same scene from different points of view
- Vast area or Specific target monitoring

Possibility to collect **sensitive personal data**

➔ Appropriate **privacy protection** solutions



PHANTOM 2 VISION+

- 3-axis camera stabilization
- 14 Mpx
- 1080p, 30 fps
- FoV 110°/85°

- Suitable for both privacy inspection and video analytics evaluation
 - Temporary major event
- ➔ Mini-drones used for monitoring the parking lots

38 different contents captured in a parking lot
16-24 s shots





Video Dataset

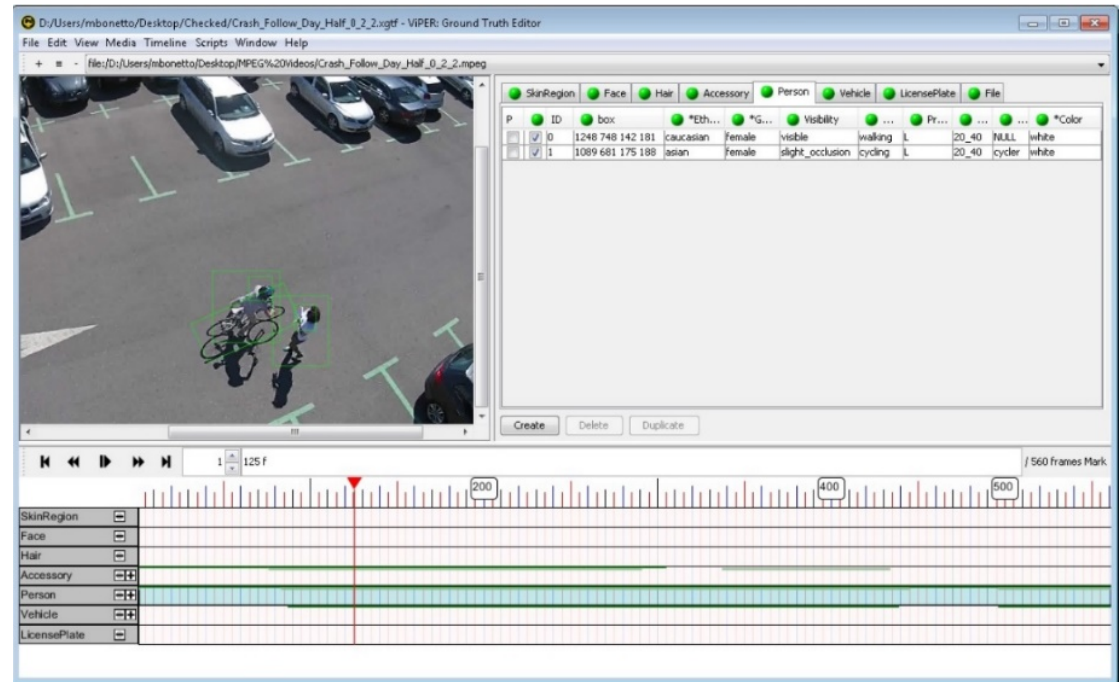
- Practical scenarios

Normal, suspicious and illicit behaviours in the parking lot

- Different levels of privacy intrusiveness
- Emphasis on people's visual privacy (ethnicity, age, gender, personal items, and accessories)
- Emphasis on vehicles visual privacy (license plate, model, and color)
- Varying environment and illumination conditions

Sensitive data manually annotated:

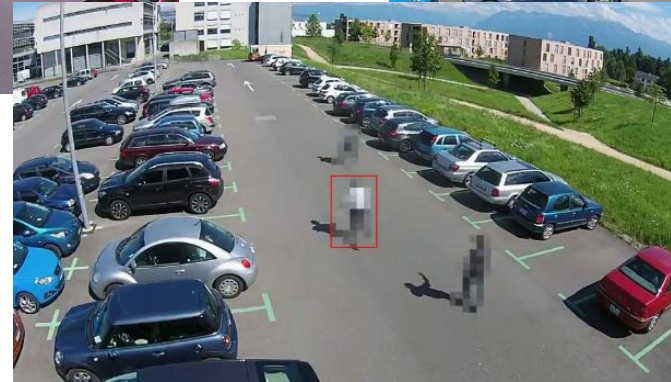
- Body silhouette
- Facial region
- Accessories
- Vehicle
- License plate



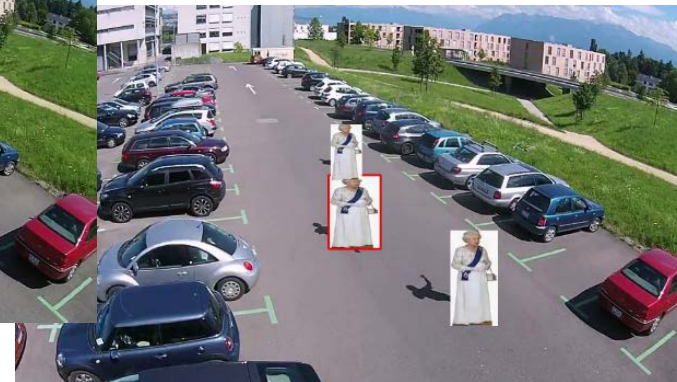
Regions of interest with attributes related to privacy content and to surveillance scenario

Privacy Protection Filters

1. Blurring
2. Pixelization
3. Masking

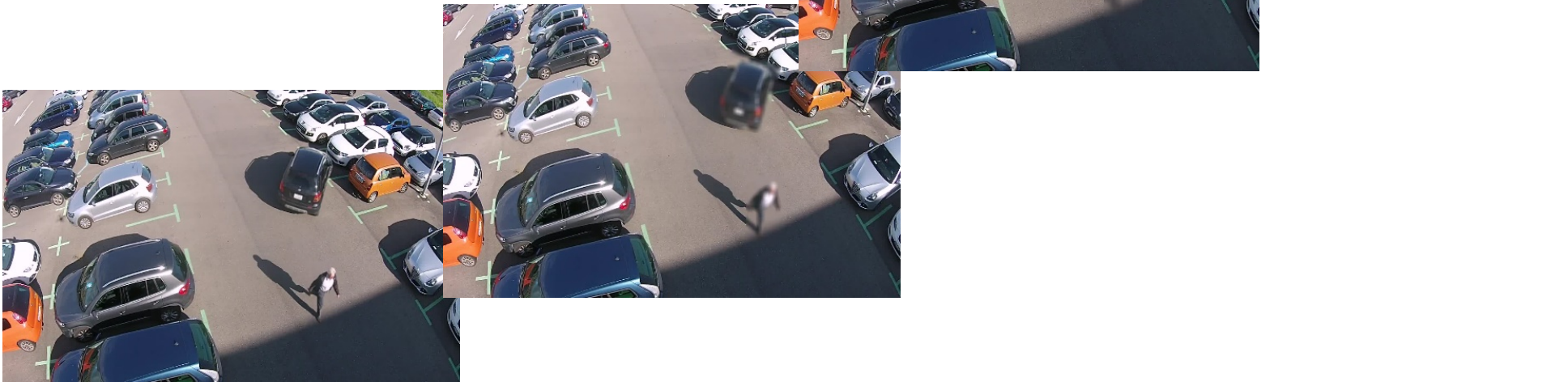


4. Warping
5. Morphing



Different strength levels:

- Mild
- Noticeable
- Clearly visible
- Completely obfuscating



Subjective evaluation with **crowdsourcing** approach

→ **microWorkers**  platform, **QualityCrowd2** sw
work & earn or offer a micro job

- Seven selected video contents;
- 21 sequences/content (1 orig. + 5 filter types * 4 filter strengths)
- Only one version of a given content assessed by each worker.
- Six questions related to
 - the level of visual privacy content, and
 - the achievement of surveillance tasks
- Subjects report also how certain they are about the answer

Evaluation Framework

Question	Choice of answers
1. What is the main activity happening in the video?	Stealing a car, attacking a driver, stealing an item, walking, parking a car, taking pictures, I do not know
2. How many people do you see?	One, two, three, four, five, I do not know
3. Is there any of the following items? (select all that apply)	Backpack, umbrella, photo camera, papers, wallet, none, I do not know
4. What is the GENDER of the person in the red box?	Male, female, I do not know
5. What is the ETHNICITY of the person in the red box?	White, African, Asian, I do not know
6. Which accessories does the person in the red box wear? (select all that apply)	Jacket, sunglasses, glasses, helmet, shorts, hat, hoodie, none of the above, I do not know

Privacy protection ↔ Intelligibility



Evaluation Framework

Screen Brightness Test

This image is just for checking your screen brightness.

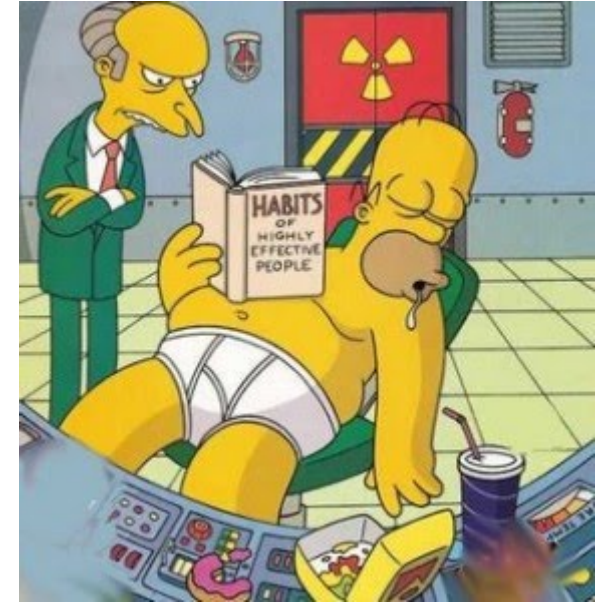


What is the highest number you can see?

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

Reliable workers detection

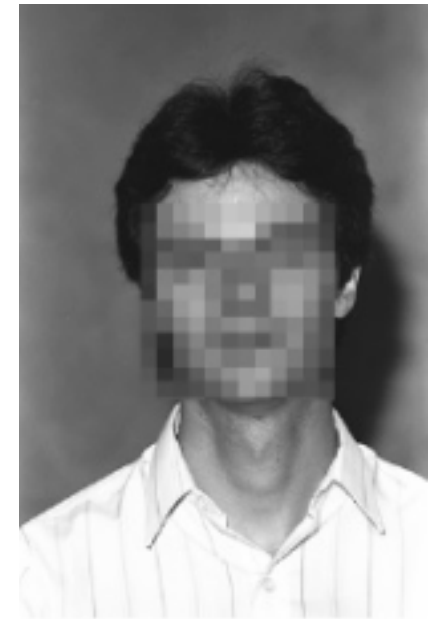
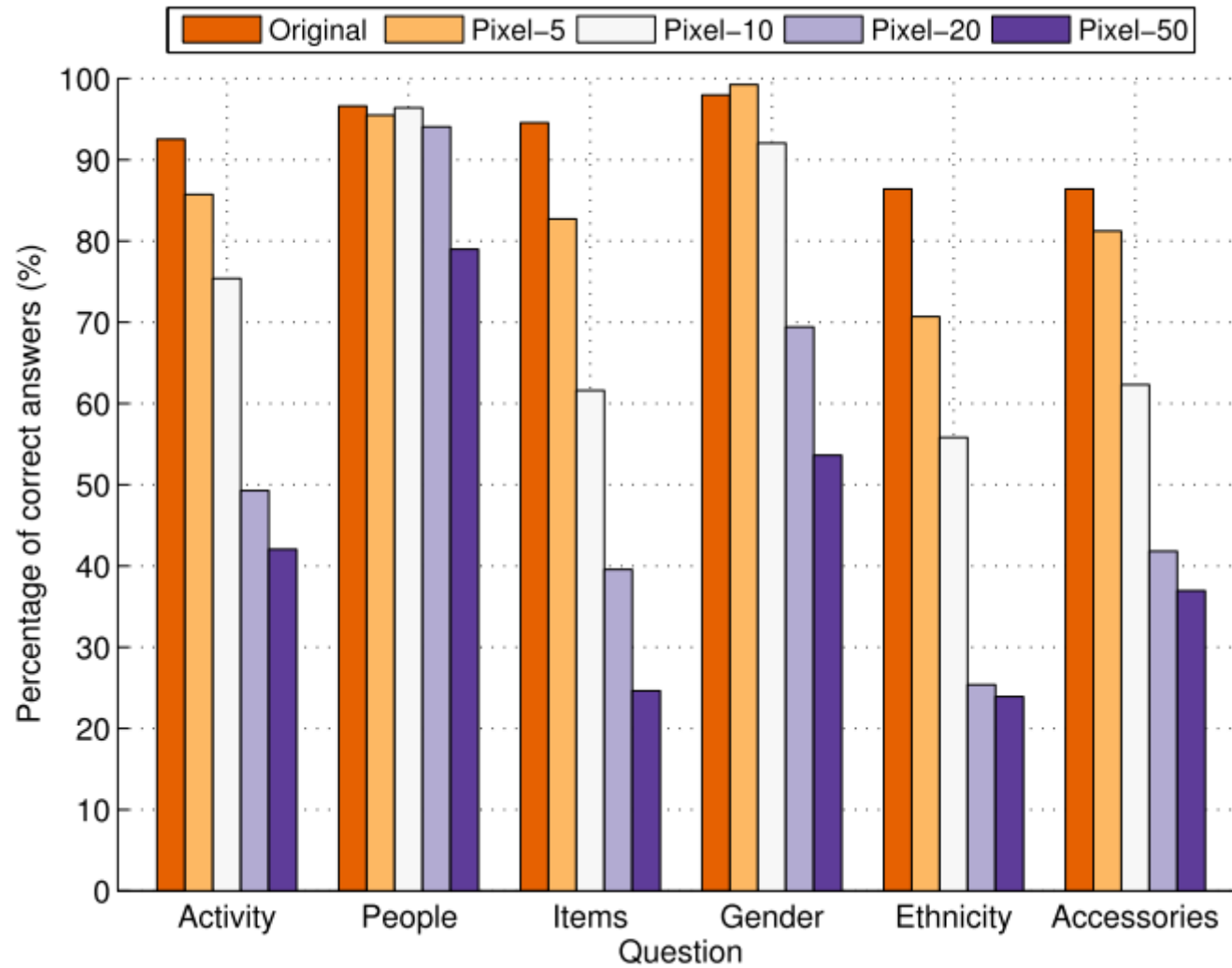
- “Honeypot” questions
- Time-based metrics:
 - Task completion time
 - Mean time spent on each question in a task
 - Standard deviation of the time spent on each question



Reliable workers: 54% (456 out of 840), 19-24 workers/sequence

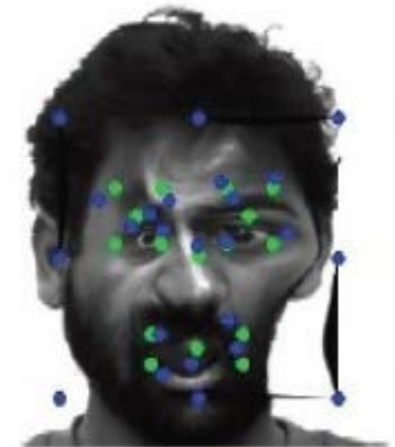
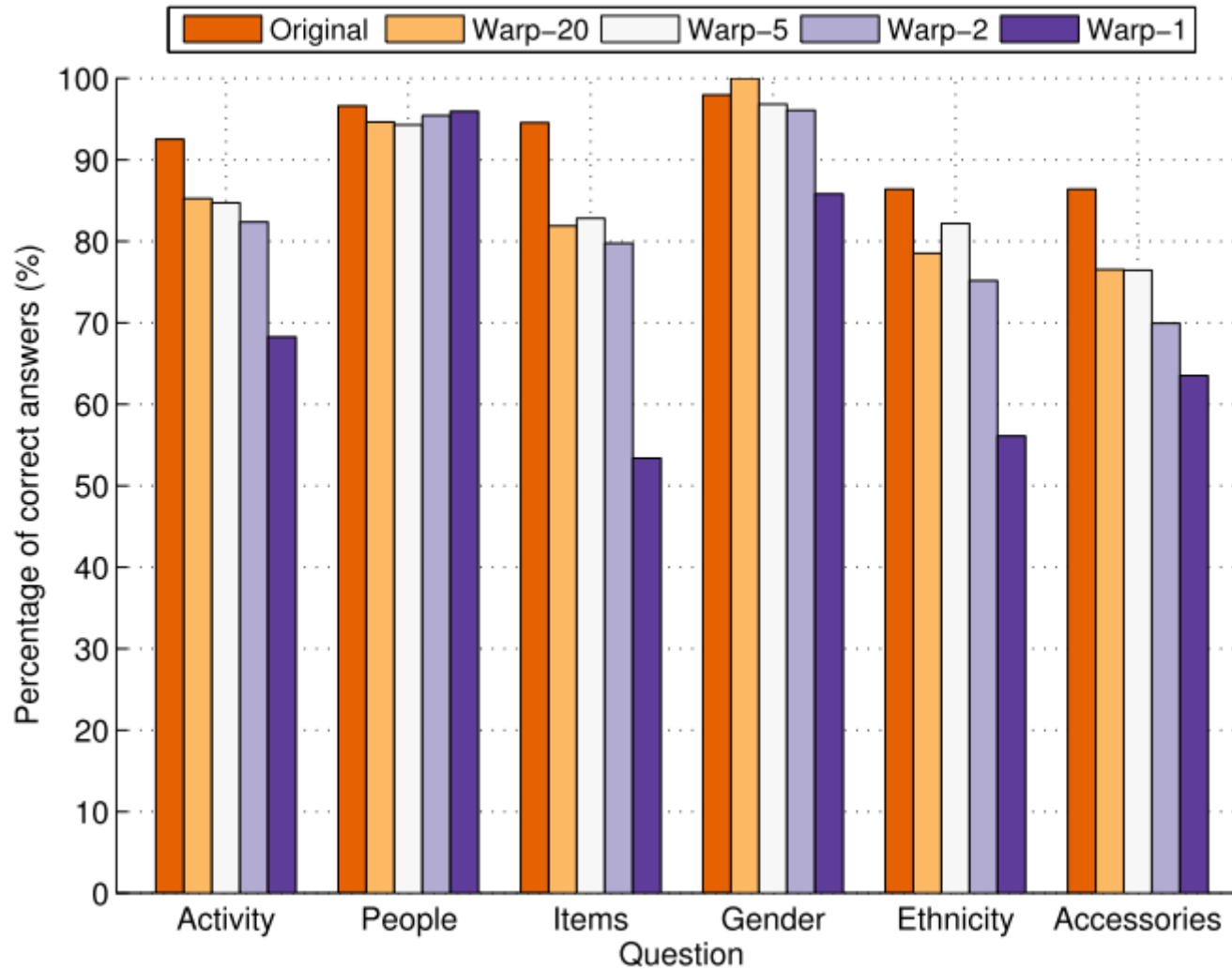
Results

Pixelization - correct answers



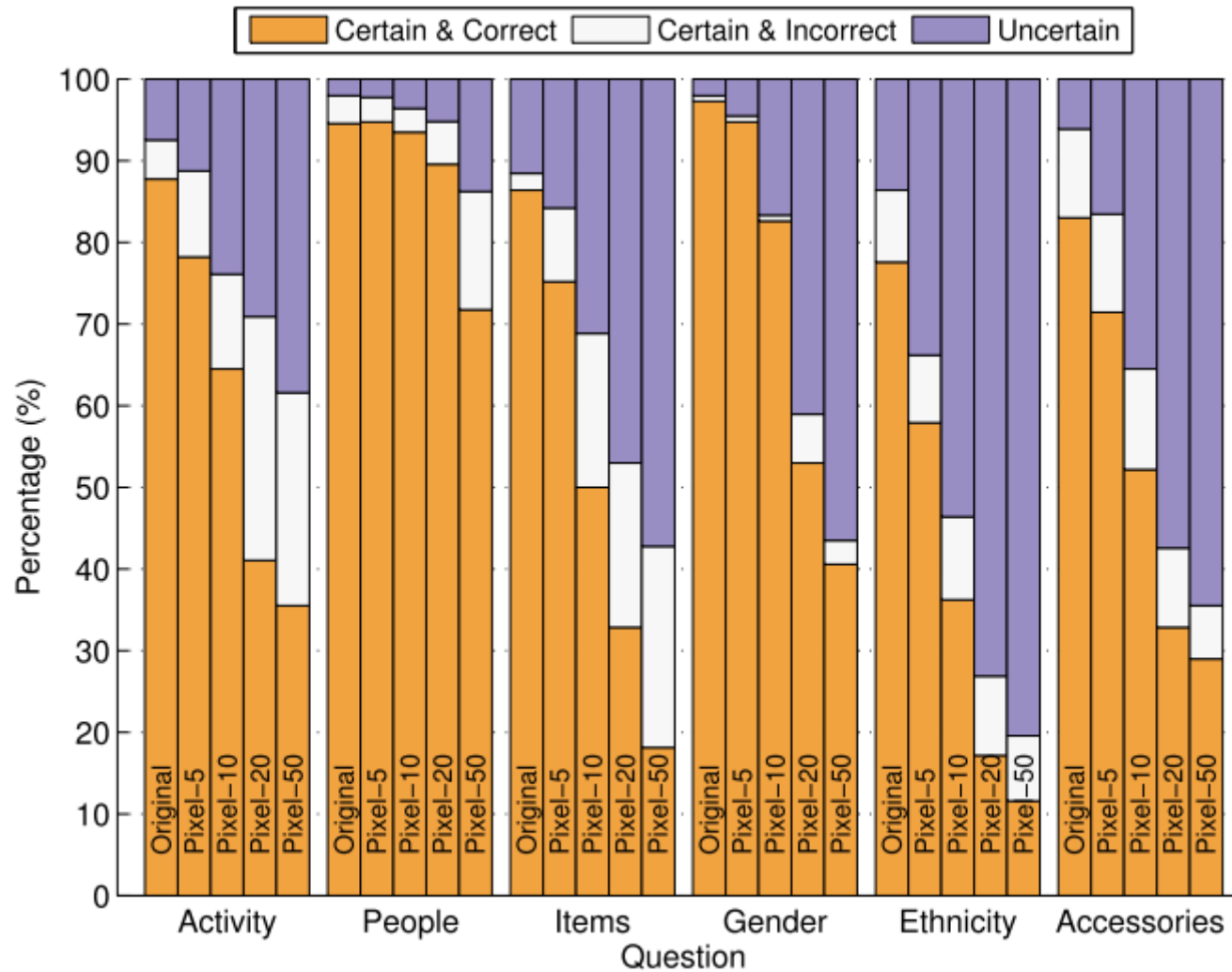
Results

Warping - correct answers



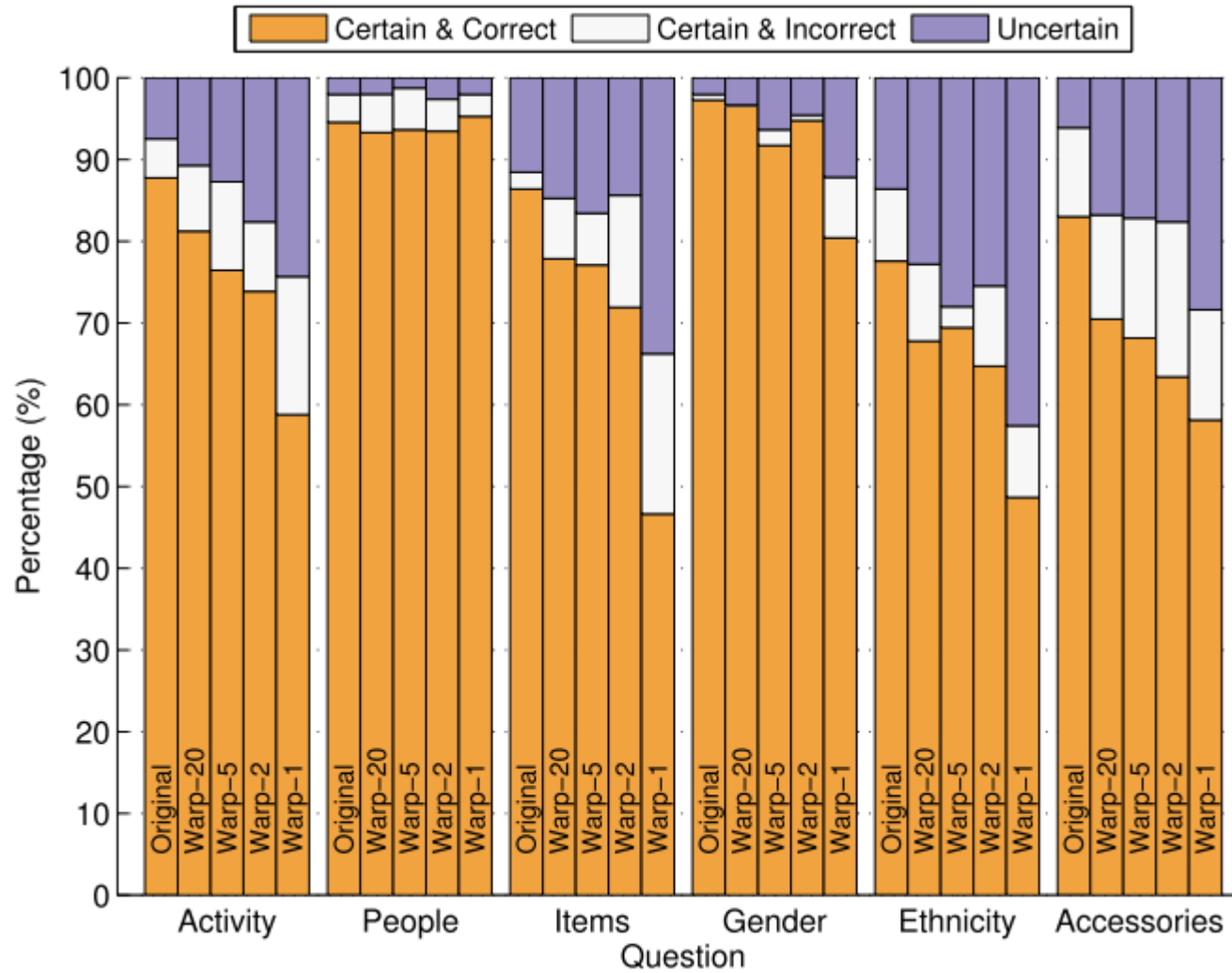
Results

Pixelization - are you sure?



Results

Warping - are you sure?



Automatic detection of privacy-sensitive objects



is much more challenging in drone- than in CCTV-surveillance:

- **fast** and **large** changes in objects' **size**, **pose**, **illumination**



Challenges

Crowdsourcing evaluation

Difficult to obtain useful results:

- workers are laymen, actual users are professionals
 - workers can examine a sequence many times, users may not
 - short videos are submitted to workers, long videos are used in practice
- more strict reliable workers' selection

Questions' selection and formulation is a critical issue

<http://mmspg.epfl.ch/mini-drone>

