

### **Contextual Privacy Preservation with Omnidirectional Cameras**

Siddharth Ravi, University of Alicante 18 Jun 2024



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 861091".



### Privacy-Aware and Acceptable Video-Based Technologies and Services for Active and Assisted Living







Trinity College Dublin Coláiste na Trionóide, Baile Átha Cliath The University of Dublin





# Background

- Marie Skłodowska-Curie PhD student in CS at the University of Alicante, Spain
- Interested in visual privacy preservation in video-based Active and Assisted Living (AAL).
- Masters in Systems and Control, TU Delft.
- Background in ML/AI/CV.



![](_page_1_Picture_7.jpeg)

![](_page_1_Picture_8.jpeg)

![](_page_1_Picture_9.jpeg)

![](_page_1_Picture_10.jpeg)

![](_page_1_Picture_11.jpeg)

### The Promise and Perils of AAL: **Empowering Users While Safeguarding Privacy**

AAL technologies have enormous potential to improve the lives of older adults and persons with disabilities.

Widespread adoption of these technologies raise privacy concerns.

![](_page_2_Picture_3.jpeg)

![](_page_2_Picture_4.jpeg)

Siddharth Ravi | 3

### Providing **Privacy by Context** is key

![](_page_2_Picture_7.jpeg)

![](_page_2_Picture_8.jpeg)

![](_page_2_Picture_9.jpeg)

![](_page_2_Picture_10.jpeg)

![](_page_2_Picture_11.jpeg)

![](_page_2_Picture_12.jpeg)

### **Privacy by Context Understanding Contextual Integrity**

- Introduced in Nissenbaum (2009)
- Emphasizes that privacy is preserved when personal information flows align with the norms, expectations, and values of a specific social context.

• This idea, known as contextual integrity, highlights three main parameters:

Siddharth Ravi 4

![](_page_3_Figure_7.jpeg)

Transmission principles -Constraints governing appropriate information flow, such as **context** 

being shared

![](_page_3_Picture_10.jpeg)

![](_page_3_Picture_11.jpeg)

![](_page_3_Picture_12.jpeg)

![](_page_3_Picture_13.jpeg)

![](_page_3_Picture_14.jpeg)

![](_page_3_Figure_15.jpeg)

![](_page_3_Picture_16.jpeg)

![](_page_3_Picture_17.jpeg)

### **Privacy by Context Understanding Contextual Integrity**

- Introduced in Nissenbaum (2009)
- Emphasizes that privacy is preserved when personal information flows align with the norms, expectations, and values of a specific social context.

• This idea, known as contextual integrity, highlights three main parameters:

![](_page_4_Figure_7.jpeg)

![](_page_4_Picture_8.jpeg)

![](_page_4_Picture_9.jpeg)

![](_page_4_Picture_10.jpeg)

![](_page_4_Picture_11.jpeg)

![](_page_4_Picture_12.jpeg)

![](_page_4_Picture_13.jpeg)

### **Privacy by Context Understanding Contextual Integrity**

- Introduced in Nissenbaum (2009)
- Emphasizes that privacy is preserved when personal information flows align with the norms, expectations, and values of a specific social context.
- This idea, known as contextual integrity, highlights three main parameters:

Sources: Nissenbaum, H. (2009). Privacy in Context: Technology, Policy, and the Integrity of Social Life. Redwood City: Stanford University Press. https://doi.org/10.1515/9780804772891 Cavoukian, A. (2009). Privacy by design.

Siddharth Ravi 6

![](_page_5_Figure_7.jpeg)

Privacy by design shows us the way

Transmission principles -Constraints governing appropriate information flow, such as context

> loss of privacy!

Information Types -Nature of information being shared

![](_page_5_Picture_12.jpeg)

![](_page_5_Picture_13.jpeg)

![](_page_5_Picture_14.jpeg)

![](_page_5_Picture_15.jpeg)

![](_page_5_Picture_16.jpeg)

![](_page_5_Picture_17.jpeg)

# **Research Goal**

Can we create an end-to-end private by design pipeline for contextual visual privacy preservation in AAL using omnidirectional RGB cameras, and which adheres to EU legal regulations?

![](_page_6_Picture_3.jpeg)

![](_page_6_Picture_4.jpeg)

![](_page_6_Picture_5.jpeg)

![](_page_6_Picture_6.jpeg)

# **Research Questions**

#### RQ1

Can we provide contextual visual privacy for individuals appearing in **RGB** images?

![](_page_7_Picture_3.jpeg)

![](_page_7_Picture_5.jpeg)

Siddharth Ravi | 8

#### RQ2

Can we provide privacy to individuals appearing in zenithalview omnidirectional camera images?

#### RQ3

Can a private by design pipeline be created for omnidirectional images that adheres to legal regulations?

![](_page_7_Picture_11.jpeg)

![](_page_7_Picture_12.jpeg)

![](_page_7_Picture_13.jpeg)

![](_page_7_Picture_14.jpeg)

![](_page_7_Picture_15.jpeg)

# **Research Questions**

#### RQ1

Can we provide contextual visual privacy for individuals appearing in **RGB** images?

![](_page_8_Picture_3.jpeg)

Can we provide privacy to individuals appearing in zenithalview omnidirectional camera images?

Siddharth Ravi | 9

#### RQ2

![](_page_8_Picture_7.jpeg)

#### RQ3

Can a private by design pipeline be created for omnidirectional images that adheres to legal regulations?

![](_page_8_Picture_10.jpeg)

![](_page_8_Picture_11.jpeg)

![](_page_8_Picture_12.jpeg)

![](_page_8_Picture_13.jpeg)

### Can we provide contextual visual privacy for individuals appearing in RGB images?

- Created a taxonomy of Visual **Privacy Enhancing Technologies** during literature review (Ravi et al., 2023).
- 5 major categories of importance highlighted.
- Connected to the taxonomy for privacy by design proposed in Mihailidis & Colonna (2020).

Sources:

Ravi, S., Climent-Pérez, P., & Florez-Revuelta, F. A Review on Visual Privacy Preservation Techniques for Active and Assisted Living. Multimedia Tools and Applications, 2023

Mihaildis, A., & Colonna, L. (2020). A Methodological Approach to Privacy by Design within the Context of Lifelogging Technologies. Rutgers Computer and Technology Law Journal, 46, 1.

![](_page_9_Picture_8.jpeg)

![](_page_9_Picture_9.jpeg)

![](_page_9_Picture_10.jpeg)

![](_page_9_Picture_11.jpeg)

![](_page_9_Picture_12.jpeg)

![](_page_9_Figure_13.jpeg)

![](_page_9_Picture_14.jpeg)

### Can we provide contextual visual privacy for individuals appearing in RGB images?

 Created a taxonomy of Visual **Privacy Enhancing Technologies** during literature review (Ravi et al., 2023).

Visual Privacy Preservation Techniques

- 5 major categories of importance highlighted.
- Connected to the taxonomy for privacy by design proposed in Mihailidis & Colonna (2020).

Sources:

Ravi, S., Climent-Pérez, P., & Florez-Revuelta, F. A Review on Visual Privacy Preservation Techniques for Active and Assisted Living. Multimedia Tools and Applications, 2023

Mihaildis, A., & Colonna, L. (2020). A Methodological Approach to Privacy by Design within the Context of Lifelogging Technologies. Rutgers Computer and Technology Law Journal, 46, 1.

![](_page_10_Figure_9.jpeg)

![](_page_10_Picture_10.jpeg)

![](_page_10_Picture_11.jpeg)

![](_page_10_Picture_12.jpeg)

![](_page_10_Figure_13.jpeg)

![](_page_10_Picture_14.jpeg)

# **RQ1** Can we provide contextual visual privacy for individuals appearing in RGB images?

- Created a taxonomy of Visual Privacy Enhancing Technologies during literature review (Ravi et al., 2023).
- 5 major categories of importance highlighted.
- Connected to the taxonomy for privacy by design proposed in Mihailidis & Colonna (2020).

Sources:

Ravi, S., Climent-Pérez, P., & Florez-Revuelta, F. A Review on Visual Privacy Preservation Techniques for Active and Assisted Living. *Multimedia Tools and Applications, 2023* 

Mihaildis, A., & Colonna, L. (2020). A Methodological Approach to Privacy by Design within the Context of Lifelogging Technologies. *Rutgers Computer* and Technology Law Journal, 46, 1.

![](_page_11_Figure_8.jpeg)

Privacy by Design

![](_page_11_Picture_10.jpeg)

![](_page_11_Picture_11.jpeg)

![](_page_11_Picture_12.jpeg)

![](_page_11_Figure_13.jpeg)

Universitat d'Alacant Universidad de Alicante

![](_page_12_Figure_1.jpeg)

Source: Mihaildis, A., & Colonna, L. (2020). A Methodological Approach to Privacy by Design within the Context of Lifelogging Technologies. Rutgers Computer and Technology Law Journal, 46, 1.

![](_page_12_Picture_4.jpeg)

![](_page_12_Picture_5.jpeg)

![](_page_12_Picture_6.jpeg)

![](_page_12_Picture_7.jpeg)

![](_page_13_Figure_1.jpeg)

- Methods often show overlap between levels!
- Stitching together methods that fall under each level of the methodology should get us closer to PbD.

Source: Mihaildis, A., & Colonna, L. (2020). A Methodological Approach to Privacy by Design within the Context of Lifelogging Technologies. Rutgers Computer and Technology Law Journal, 46, 1.

![](_page_13_Picture_8.jpeg)

![](_page_13_Picture_9.jpeg)

![](_page_13_Picture_10.jpeg)

![](_page_13_Picture_11.jpeg)

![](_page_14_Figure_1.jpeg)

- The level where data is presented to authorised viewers.
- Most visual obfuscation methods operate at this level lacksquare
- Eg: The pipeline from Climent-Perez & Florez-Revuelta (2021)

Source: Climent-Pérez, P., & Florez-Revuelta, F. (2021). Protection of visual privacy in videos acquired with RGB cameras for active and assisted living applications. Multimedia Tools and Applications, 80(15), 23649–23664.

![](_page_14_Picture_7.jpeg)

![](_page_14_Picture_9.jpeg)

![](_page_14_Picture_10.jpeg)

![](_page_14_Picture_11.jpeg)

![](_page_14_Picture_12.jpeg)

# A pipeline for privacy preservation

![](_page_15_Figure_1.jpeg)

Source: Climent-Pérez, P., & Florez-Revuelta, F. (2021). Protection of visual privacy in videos acquired with RGB cameras for active and assisted living applications. Multimedia Tools and Applications, 80(15), 23649–23664.

![](_page_15_Picture_4.jpeg)

![](_page_15_Picture_5.jpeg)

![](_page_15_Picture_6.jpeg)

![](_page_15_Picture_7.jpeg)

![](_page_15_Picture_9.jpeg)

# **Operating at the UI level**

![](_page_16_Picture_1.jpeg)

Source: Climent-Pérez, P., & Florez-Revuelta, F. (2021). Protection of visual privacy in videos acquired with RGB cameras for active and assisted living applications. Multimedia Tools and Applications, 80(15), 23649-23664.

![](_page_16_Picture_4.jpeg)

![](_page_16_Picture_6.jpeg)

![](_page_16_Picture_7.jpeg)

![](_page_16_Picture_8.jpeg)

![](_page_16_Picture_9.jpeg)

![](_page_16_Picture_10.jpeg)

### Person facing away from camera

Only part of the person observable

![](_page_17_Picture_2.jpeg)

#### Obtrusive camera placement

Occlusions

-----

![](_page_17_Picture_5.jpeg)

### **Zenithal-view dioptric omnidirectional cameras offer a compelling alternative**

![](_page_18_Picture_1.jpeg)

#### Wide field of view - Just one camera enough to

view an entire scene

![](_page_18_Picture_4.jpeg)

![](_page_18_Picture_6.jpeg)

![](_page_18_Picture_7.jpeg)

![](_page_18_Picture_8.jpeg)

![](_page_18_Picture_9.jpeg)

![](_page_18_Picture_10.jpeg)

![](_page_18_Picture_11.jpeg)

![](_page_19_Picture_0.jpeg)

Person standing, pouring water into glass

·al

×.

Unobtrusive camera placement

.

14

1

![](_page_19_Picture_3.jpeg)

![](_page_20_Figure_1.jpeg)

#### Can we make it **applicable to omnidirectional images?**

![](_page_20_Picture_3.jpeg)

![](_page_20_Figure_5.jpeg)

![](_page_20_Picture_6.jpeg)

![](_page_20_Picture_7.jpeg)

![](_page_20_Picture_8.jpeg)

![](_page_20_Picture_9.jpeg)

![](_page_21_Figure_1.jpeg)

![](_page_21_Picture_3.jpeg)

Siddharth Ravi | 22

#### Can we make it applicable to omnidirectional cameras?

![](_page_21_Picture_6.jpeg)

![](_page_21_Picture_7.jpeg)

![](_page_21_Picture_8.jpeg)

![](_page_21_Picture_9.jpeg)

# **Research Questions**

#### RQ1

Can we provide contextual visual privacy for individuals appearing in **RGB** images?

![](_page_22_Picture_3.jpeg)

Can we provide privacy to individuals appearing in zenithalview omnidirectional camera images?

Yes, based on the review and pipeline. Siddharth Ravi | 23

#### RQ2

![](_page_22_Picture_8.jpeg)

#### RQ3

Can a private by design pipeline be created for omnidirectional images that adheres to legal regulations?

![](_page_22_Picture_11.jpeg)

![](_page_22_Picture_12.jpeg)

![](_page_22_Picture_13.jpeg)

![](_page_22_Picture_14.jpeg)

![](_page_22_Picture_15.jpeg)

# **Research Questions**

#### RQ1

Can we provide contextual visual privacy for individuals appearing in **RGB** images?

![](_page_23_Picture_3.jpeg)

Siddharth Ravi | 24

#### RQ2

Can we provide privacy to individuals appearing in zenithalview omnidirectional camera images?

![](_page_23_Picture_8.jpeg)

#### RQ3

Can a private by design pipeline be created for omnidirectional images that adheres to legal regulations?

![](_page_23_Picture_11.jpeg)

![](_page_23_Picture_12.jpeg)

![](_page_23_Picture_13.jpeg)

![](_page_23_Picture_14.jpeg)

![](_page_23_Picture_15.jpeg)

#### Can we provide privacy to individuals appearing in zenithal-view RQ2 omnidirectional camera images?

- Created ODIN, the first largescale multi-modal omnidirectional dataset aimed at human behaviour and scene understanding.
- Recorded activities of daily living in real indoor environments which have varying levels of occlusion.
- Collaborative project with Trinity College Dublin.

Source: Ravi, S., Climent-Perez, P., Morales, T., Huesca-Spairani, C., Hashemifard, K., & Flórez-Revuelta, F. (2023). ODIN: An OmniDirectional INdoor Dataset Capturing Activities of Daily Living From Multiple Synchronized Modalities. Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, pp. 6488–6497

![](_page_24_Picture_6.jpeg)

![](_page_24_Picture_7.jpeg)

![](_page_24_Picture_8.jpeg)

![](_page_24_Picture_9.jpeg)

![](_page_24_Picture_10.jpeg)

# **ODIN: An OmniDirectional INdoor Dataset**

![](_page_25_Picture_1.jpeg)

Source: Ravi, S., Climent-Perez, P., Morales, T., Huesca-Spairani, C., Hashemifard, K., & Flórez-Revuelta, F. (2023). ODIN: An OmniDirectional INdoor Dataset Capturing Activities of Daily Living From Multiple Synchronized Modalities. Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, pp. 6488–6497

Siddharth Ravi | 26

Modality/characteristic	Amo
<b>Omnidirectional RGB images</b>	332
Lateral-view RGB images	1.464
Lateral-view infrared images	1.464
Lateral-view depth images	1.45
Environment meshes	3
Egocentric videos	52
Physiological readings	39
Accelerometer measurements	39
Participants	15
Locations	4
Types of environments	5

![](_page_25_Picture_6.jpeg)

![](_page_25_Picture_7.jpeg)

![](_page_25_Picture_8.jpeg)

![](_page_25_Picture_9.jpeg)

### unt

#### **:K**

- **4M**
- **4M**
- **3M**

![](_page_25_Picture_23.jpeg)

![](_page_25_Picture_24.jpeg)

# **ODIN: An OmniDirectional INdoor Dataset**

![](_page_26_Figure_1.jpeg)

Source: Ravi, S., Climent-Perez, P., Morales, T., Huesca-Spairani, C., Hashemifard, K., & Flórez-Revuelta, F. (2023). ODIN: An OmniDirectional INdoor Dataset Capturing Activities of Daily Living From Multiple Synchronized Modalities. Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, pp. 6488–6497

#### Siddharth Ravi | 27

![](_page_26_Picture_4.jpeg)

![](_page_26_Picture_7.jpeg)

![](_page_26_Picture_8.jpeg)

End

![](_page_26_Picture_9.jpeg)

![](_page_26_Picture_10.jpeg)

# **ODIN: An OmniDirectional INdoor Dataset**

Dataset	Omni	Ego	RGB	3D scans	Stereo	IMU	Synced- cam	Phys. signals	Pose	Activity labels	Audio
ODIN	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	✓	(Partial)	$\checkmark$	$\checkmark$	✓	(×)	×
PIROPO Database	$\checkmark$	×	×	×	×	×	$\checkmark$	×	×	$\checkmark$	×
WEPDTOF	$\checkmark$	×	×	×	×	×	×	×	×	×	×
Fisheye dataset	$\checkmark$	×	×	×	×	×	×	X	×	×	×
MPII Human Pose	×	×	√	×	×	×	×	×	√	×	×
Human3.6M	×	×	$\checkmark$	×	×	×	$\checkmark$	×	$\checkmark$	×	×
Toyota Smarthome	×	×	$\checkmark$	×	$\checkmark$	×	$\checkmark$	×	$\checkmark$	$\checkmark$	×
NTU RGB+D Dataset	×	×	$\checkmark$	×	$\checkmark$	×	$\checkmark$	×	$\checkmark$	$\checkmark$	×
ADL Dataset	×	×	$\checkmark$	×	×	×	×	×	×	$\checkmark$	×
EPIC KITCHENS	×	$\checkmark$	×	×	×	×	×	×	×	$\checkmark$	×
Ego4D	×	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	×	×	$\checkmark$	$\checkmark$

- Made to be used for tasks as varied as activity recognition, person tracking and modelling, 3D scene reconstruction, and image registration.
- activity recognition models.

Source: Ravi, S., Climent-Perez, P., Morales, T., Huesca-Spairani, C., Hashemifard, K., & Flórez-Revuelta, F. (2023). ODIN: An OmniDirectional INdoor Dataset Capturing Activities of Daily Living From Multiple Synchronized Modalities. Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, pp. 6488–6497

#### Siddharth Ravi 28

• All modalities are synchronised, static cameras are all calibrated for perspective projection.

monitoring, scene understanding, biometric monitoring, novel view synthesis, generative

Currently training omnidirectional 3D human pose estimation, semantic segmentation, and

![](_page_27_Picture_10.jpeg)

![](_page_27_Picture_11.jpeg)

![](_page_27_Picture_12.jpeg)

![](_page_27_Picture_13.jpeg)

# **Omnidirectional pose estimates**

![](_page_28_Picture_1.jpeg)

- lacksquare
- This is being used to train omnidirectional 3D human pose estimators. •
- Also created a data augmentation toolkit to work on fisheye images.

Siddharth Ravi | 29

Obtained 3D human pose estimates through a semi-automated pipeline (3D meshes + skeletons).

![](_page_28_Picture_9.jpeg)

![](_page_28_Picture_10.jpeg)

![](_page_28_Picture_11.jpeg)

![](_page_28_Picture_12.jpeg)

# **Omnidirectional Segmentation Masks**

![](_page_29_Picture_1.jpeg)

- 3D pose estimates were rasterised into binary human semantic segmentation masks
- These are further refined using estimates from a vision-language model (GroundingDINO + Segment Anything) working directly on omnidirectional images.
- Segmentation models currently under training.

Sources: Climent-Pérez, P., & Florez-Revuelta, F. (2021). Protection of visual privacy in videos acquired with RGB cameras for active and assisted living applications. Multimedia Tools and Applications, 80(15), 23649-23664. Tianhe Ren et al., Grounded SAM: Assembling Open-World Models for Diverse Visual Tasks, arXiv (2024)

![](_page_29_Picture_7.jpeg)

![](_page_29_Picture_8.jpeg)

![](_page_29_Picture_9.jpeg)

![](_page_29_Picture_12.jpeg)

# **Research Questions**

#### RQ1

Can we provide contextual visual privacy for individuals appearing in images?

![](_page_30_Picture_3.jpeg)

![](_page_30_Picture_4.jpeg)

Siddharth Ravi | 31

#### RQ2

#### RQ3

Can a private by design pipeline be created for omnidirectional images that adheres to legal regulations?

![](_page_30_Picture_11.jpeg)

![](_page_30_Picture_12.jpeg)

![](_page_30_Picture_13.jpeg)

![](_page_30_Picture_14.jpeg)

# **Research Questions**

#### RQ1

Can we provide contextual visual privacy for individuals appearing in images?

![](_page_31_Picture_3.jpeg)

Can we provide privacy to individuals appearing in zenithalview omnidirectional camera images?

Siddharth Ravi | 32

#### RQ2

![](_page_31_Picture_7.jpeg)

#### RQ3

Can a private by design pipeline be created for omnidirectional images that adheres to legal regulations?

![](_page_31_Picture_10.jpeg)

![](_page_31_Picture_11.jpeg)

![](_page_31_Picture_12.jpeg)

![](_page_31_Picture_13.jpeg)

![](_page_31_Picture_14.jpeg)

# What does the legal literature say about PETs?

•Anonymisation: Irreversible de-identification of data •Pseudonymisation: Reversible de-identification of data

Takeaways	<ol> <li>There is a need for concrete guid under EU data protection laws.</li> <li>There are multiple guidelines wh</li> <li>The EU AI act is a step in the right</li> <li>Mihailidis and Colonna (2020) stip</li> </ol>
-----------	--

Source: He, Z. (2022). Privacy-enhancing Technologies for Active and Assisted Living: What Does the GDPR Say? Proceedings of the 15th International Conference on PErvasive Technologies Related to Assistive Environments, 430-433. Mihaildis, A., & Colonna, L. (2020). A Methodological Approach to Privacy by Design within the Context of Lifelogging Technologies. Rutgers Computer and Technology Law Journal, 46, 1.

#### **Relevant points**

- •Data Protection by Design: Privacy ought to be integrated into systems from the start
- •Most PETs can be considered pseudonymisation due to technical reversibility.

#### delines on what constitutes privacy by design

- ich one can follow to get closer to the goal. ht direction.
- Il pave the way forward.

![](_page_32_Picture_14.jpeg)

![](_page_32_Picture_15.jpeg)

![](_page_32_Picture_16.jpeg)

![](_page_32_Picture_17.jpeg)

![](_page_32_Picture_18.jpeg)

# **Research Questions**

#### RQ1

Can we provide contextual visual privacy for individuals appearing in images?

![](_page_33_Picture_3.jpeg)

#### RQ2

Can we provide privacy to individuals appearing in zenithalview omnidirectional camera images?

![](_page_33_Picture_8.jpeg)

#### RQ3

Can a private by design pipeline be created for omnidirectional images that adheres to legal regulations?

Yes, design elements were investigated and legal literature was consulted.

![](_page_33_Picture_12.jpeg)

![](_page_33_Picture_13.jpeg)

![](_page_33_Picture_14.jpeg)

![](_page_33_Picture_15.jpeg)

# **Dissemination Overview**

Journal / Conference / Workshop papers:

- Multimedia Tools and Applications. pp. 1-41
- Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, pp. 6488-6497,

**Collaborative works:** 

- Proceedings of the 15th International Conference on PErvasive Technologies.
- Algorithms, Presented at the Privacy preserving AI workshop at AAAI 23. arXiv preprint arXiv:2301.05012

**Position Papers:** 

- 1. S Aleksic, et al., (2022). State of the art in privacy preservation in video data

1. S Ravi, P Climent-Pérez, F Florez-Revuelta. (2023). A review on visual privacy preservation techniques for active and assisted living,

2. S Ravi, P Climent-Pérez, T Morales, C Huesca-Spairani, K Hashemifard, F Florez-Revuelta. (2023). ODIN: An OmniDirectional INdoor Dataset Capturing Activities of Daily Living From Multiple Synchronized Modalities. Proceedings of the IEEE/CVF

1. S Noiret, S Ravi, M Kampel, F Florez-Revuelta. (2022). On The Nature of Misidentification With Privacy Preserving Algorithms.

2. S Noiret, **S Ravi**, M Kampel, F Florez-Revuelta. (2023). Fairly Private: Investigating The Fairness of Visual Privacy Preservation

2. A Klimczuk et al., (2022). Position Paper on Ethical, Legal and Social Challenges Linked to Audio-and Video-Based AAL Solutions.

![](_page_34_Picture_17.jpeg)

![](_page_34_Picture_18.jpeg)

![](_page_34_Picture_19.jpeg)

![](_page_34_Picture_20.jpeg)

![](_page_35_Picture_0.jpeg)

# Thank you! siddharth.ravi@ua.es

![](_page_35_Picture_2.jpeg)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 861091".

![](_page_35_Picture_4.jpeg)

Privacy-Aware and Acceptable Video-Based Technologies and Services for Active and Assisted Living

![](_page_35_Picture_7.jpeg)

![](_page_35_Picture_8.jpeg)

![](_page_35_Picture_9.jpeg)

![](_page_35_Picture_10.jpeg)

**Trinity College Dublin** Coláiste na Trionóide, Baile Átha Cliath The University of Dublin

![](_page_35_Picture_12.jpeg)

![](_page_35_Picture_13.jpeg)

# Ongoing work

- Training lightweight pose estimation models through the obtained poses for omnidirectional pose estimation.
- Training lightweight semantic segmentation models for omnidirectional semantic segmentation.
- Integrating trained models into the pipeline from Climent-Perez and Florez-Revuelta (2021).
- Also collaborating on creating activity recognition models with omnidirectional images.

Sources: Climent-Pérez, P., & Florez-Revuelta, F. (2021). Protection of visual privacy in videos acquired with RGB cameras for active and assisted living applications. *Multimedia Tools and Applications*, 80(15), 23649–23664.

![](_page_36_Picture_7.jpeg)

![](_page_36_Picture_8.jpeg)

![](_page_36_Picture_9.jpeg)

![](_page_36_Picture_10.jpeg)

### RQ3 Can a private by design pipeline be created for omnidirectional images that adheres to least regulations? adheres to legal regulations?

![](_page_37_Picture_1.jpeg)

![](_page_37_Picture_3.jpeg)

![](_page_37_Picture_4.jpeg)

![](_page_37_Picture_5.jpeg)

![](_page_37_Figure_6.jpeg)

![](_page_37_Picture_7.jpeg)

### Creating and analysing an end-to-end PbD system

- Secondment completed in Stockholm (May-July '23)
- Investigated system design elements to create an end-to-end private by design pipeline.
- Did a study of the legal scholarship pertaining to the system's design.
- As part of the AI act proposal of April 2021, the system can be considered as high-risk.

![](_page_38_Picture_5.jpeg)

Stockholm University

![](_page_38_Picture_8.jpeg)

![](_page_38_Picture_9.jpeg)

![](_page_38_Picture_10.jpeg)

![](_page_38_Picture_11.jpeg)

### Creating and analysing an end-to-end PbD system

![](_page_39_Figure_1.jpeg)

- pipeline.
- Both have advantages and disadvantages, but encryption schemes were deemed more suitable for our use-case.
- necessary, and for the model / system level phases of the pipeline.

Source: Mihaildis, A., & Colonna, L. (2020). A Methodological Approach to Privacy by Design within the Context of Lifelogging Technologies. Rutgers Computer and Technology Law Journal, 46, 1.

Siddharth Ravi | 40

Investigated the feasibility of using steganography and encryption schemes to safely transmit and store data from within the

Schemes were investigated under the idea that data can be hidden in the system that allows to reconstruct the original if

![](_page_39_Picture_10.jpeg)

![](_page_39_Picture_11.jpeg)

![](_page_39_Picture_12.jpeg)

![](_page_39_Picture_13.jpeg)