



(Crowdsourced) Image-based 3D Modeling

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Senior Scientist, Microsoft

MR & AI Zurich Launch, 2019

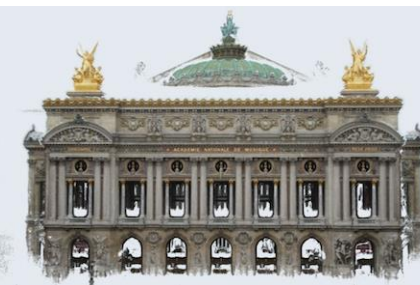


Image-based 3D Modeling

Images



3D Model



Applications

Archiving, Visualization



Mapping: Localization & Navigation



Mixed Reality



Autonomous Robots



Cameras Everywhere



Crowdsourced Imagery

- Statistics 2018 *InfoTrends
 - **Trillions** of images taken worldwide
 - **Billions** uploaded to online services



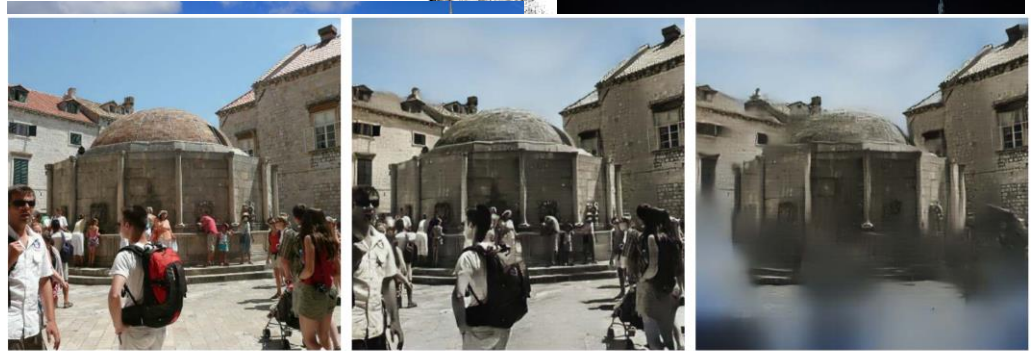
Crowdsourced Imagery



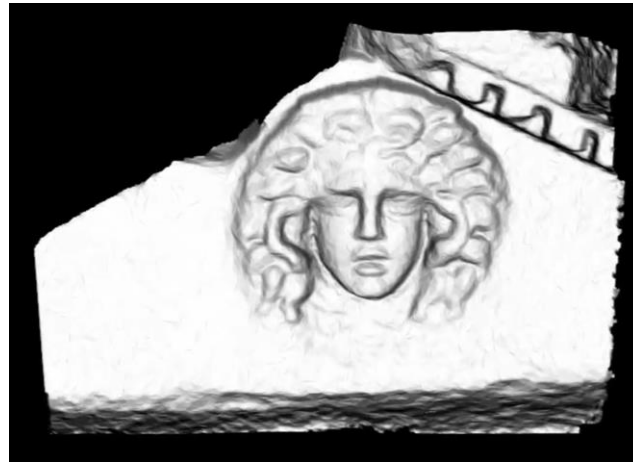
- Diverse
- Unstructured

Challenges

- Robustness
- Completeness
- Accuracy
- Efficiency
- Scalability
- Privacy



Pioneering Work



Pollefeys et al., 1997, ...

Visual Modeling from a Handheld Camera

...



Pioneering Work

F. Schaffalitzky and A. Zisserman, 2002

Multi-view Matching for Unordered Image Sets, or How Do I Organize my Holiday Snaps?



S. Agarwal, Y. Furukawa, N. Snavely,

I. Simon, B. Curless, S. Seitz, and R. Szeliski, 2009

Building Rome in a Day



N. Snavely, S. Seitz, and R. Szeliski, 2006

Photo Tourism: Exploring Photo Collections in 3D



Photo Tourism

Exploring photo collections in 3D

Microsoft



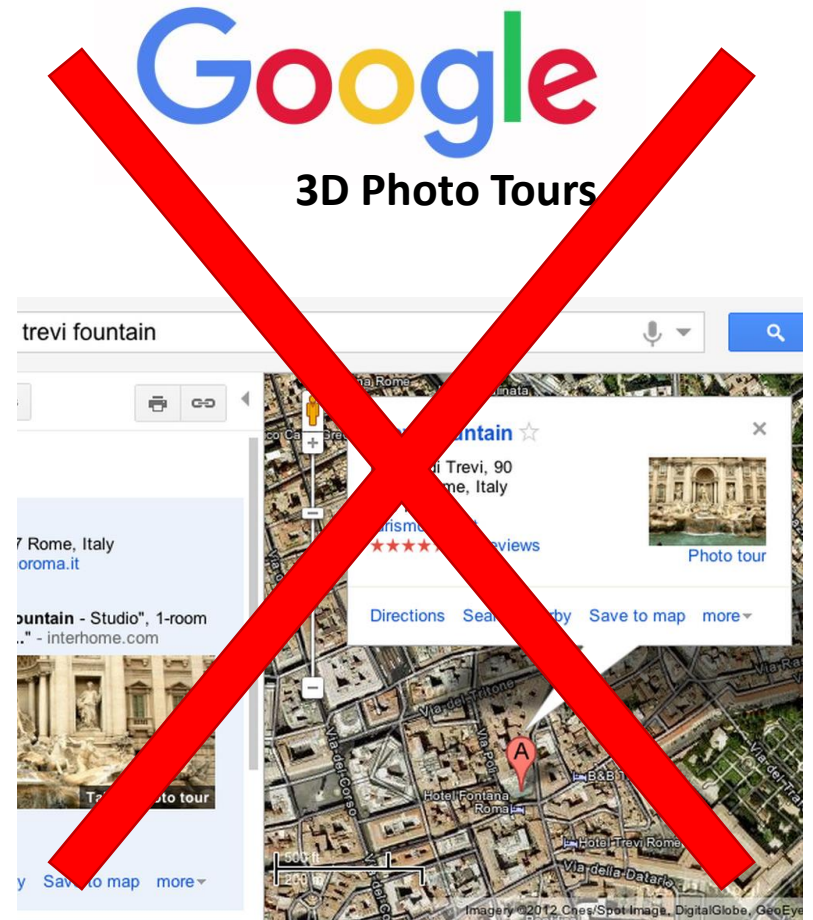
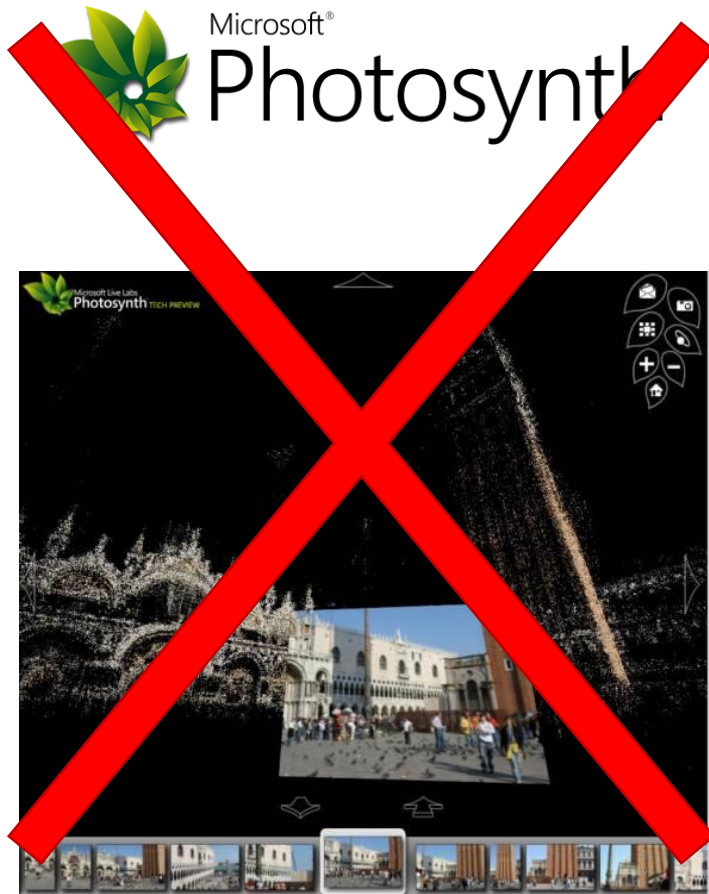
J.-M. Frahm, P. Fite-Georgel, D. Gallup, T. Johnson,

R. Raguram, C. Wu, Y.-H. Jen, E. Dunn, et al., 2010

Building Rome on a Cloudless Day



Industry Examples



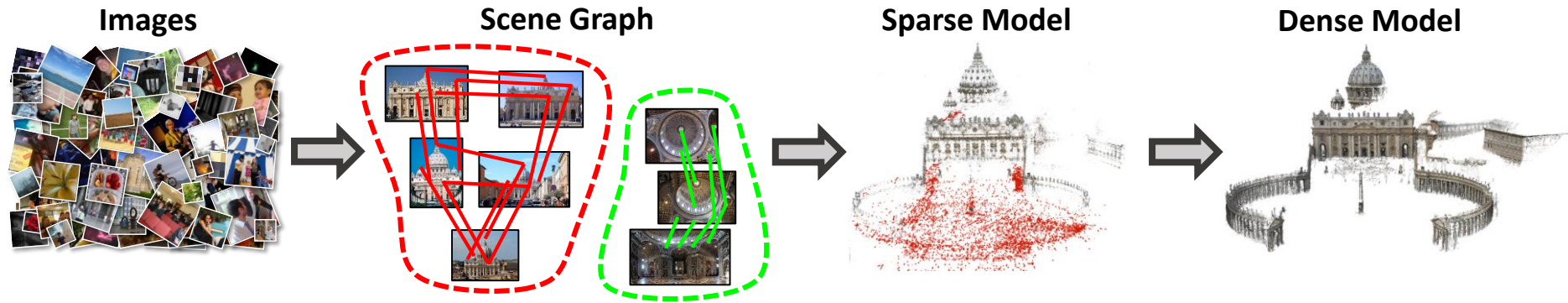
Industry Examples



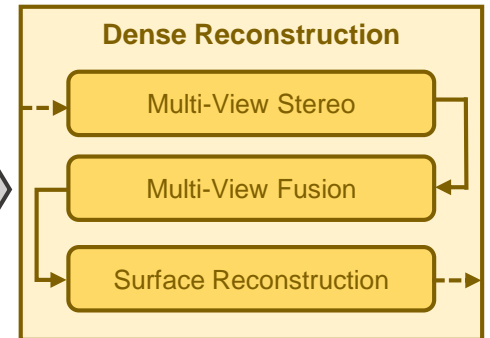
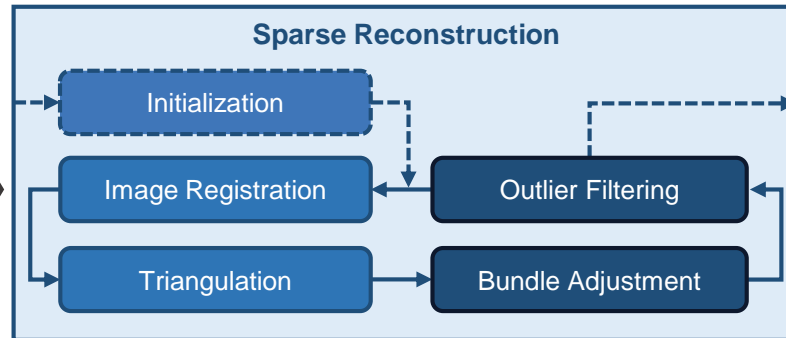
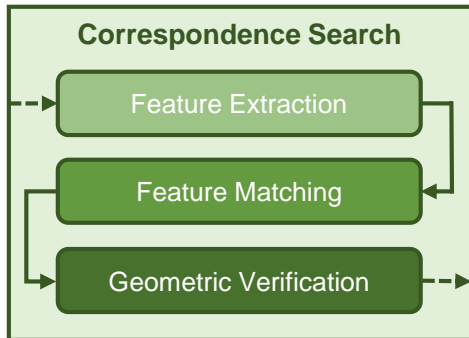
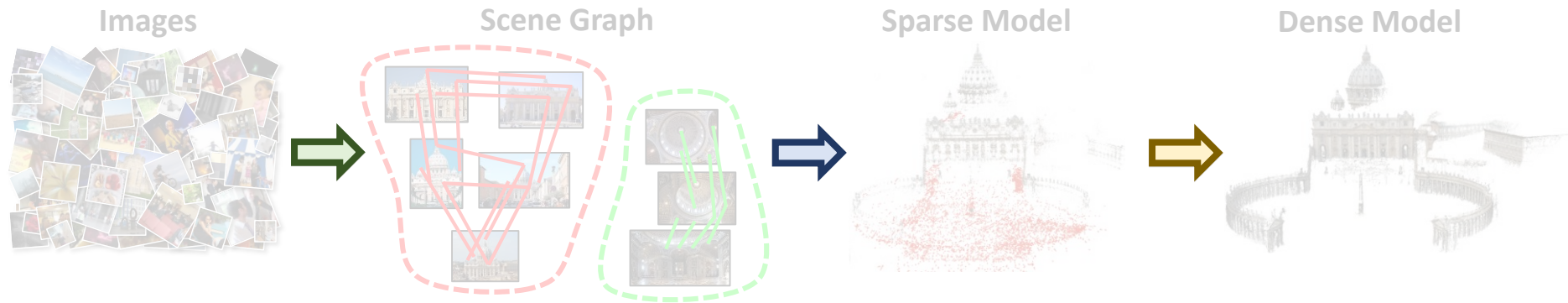
Microsoft ASA
(Azure Spatial Anchors)



3D Modeling Pipeline



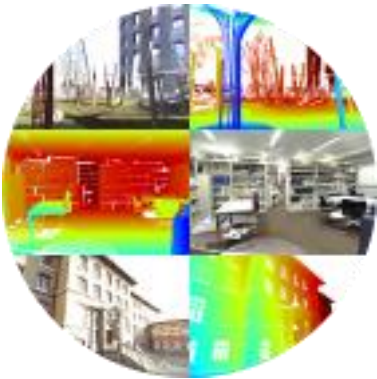
3D Modeling Pipeline



End-To-End Image-Based 3D Modeling

OpenSource Software: COLMAP

<https://github.com/colmap/colmap>



T. Schöps, J.L. Schönberger, S. Galliani, T. Sattler, K. Schindler, M. Pollefeys, A. Geiger.
"A Multi-View Stereo Benchmark with ...". CVPR 2017.

A. Knapitsch, J. Park, Q.Y. Zhou, V. Koltun. "Tanks and Temples:
Benchmarking Large-Scale Scene Reconstruction". SIGGRAPH 2017.



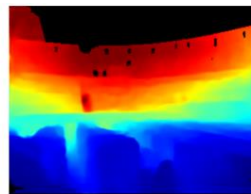
COLMAP Research Applications

- **Papers**

- Learning the Depths of Moving People by Watching Frozen People, Li et al., CVPR 2019, **Best Paper Honorable Mention**
- Neural Rendering in the Wild, Meshry et al., CVPR 2019
- Revealing Scenes by Inverting Structure from Motion Reconstructions, Pittaluga et al., CVPR 2019
- Privacy-Preserving Image-Based Localization, Speciale et al., CVPR 2019
- Understanding the Limitations of CNN-based Absolute Camera Pose Regression, Sattler et al., CVPR 2019
- D2-Net: A Trainable CNN for Joint Detection and Description of Local Features by Dusmanu et al., CVPR 2019
- ...

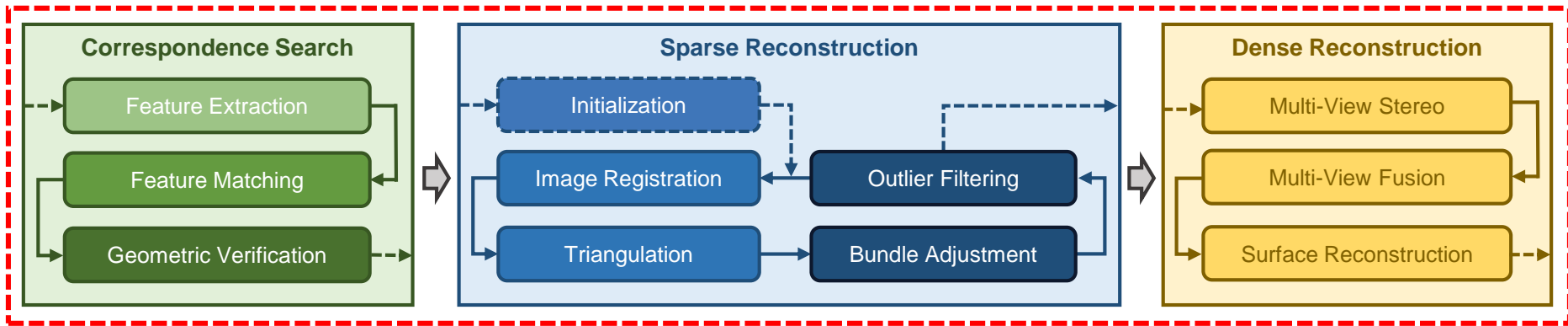
- **Datasets, Workshops, and Benchmarks**

- Image Matching: Local Features & Beyond, CVPR Workshop 2019
- Long-Term Visual Localization under Changing Conditions, CVPR Workshop 2019
- MegaDepth Dataset, Li et al., CVPR 2018
- Benchmarking 6DOF Outdoor Visual Localization in Changing Conditions, Sattler et al., CVPR 2018
- ETH3D Dataset & Benchmark, Schöps et al., CVPR 2017
- ...



Related Scientific Projects Today

Related Scientific Projects Today

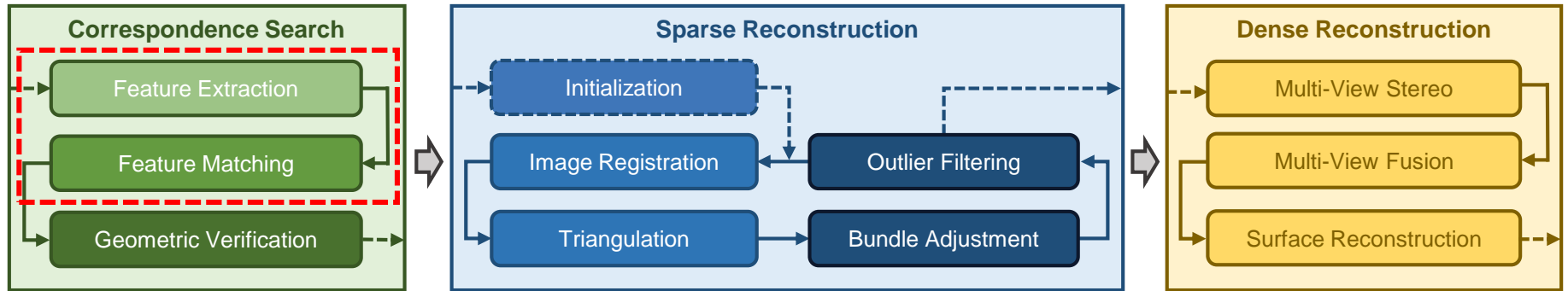


- **Lifelong Mapping**

Lukas Schmid, ETH Zurich

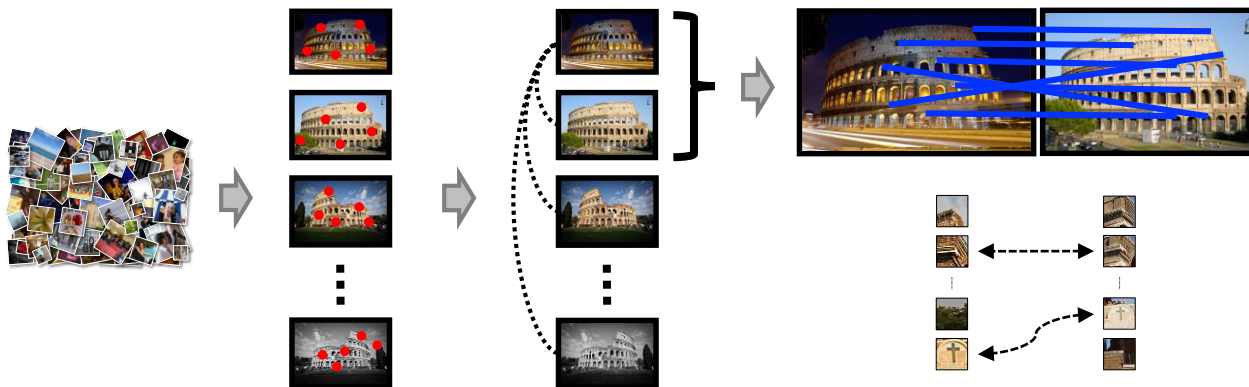


Related Scientific Projects Today

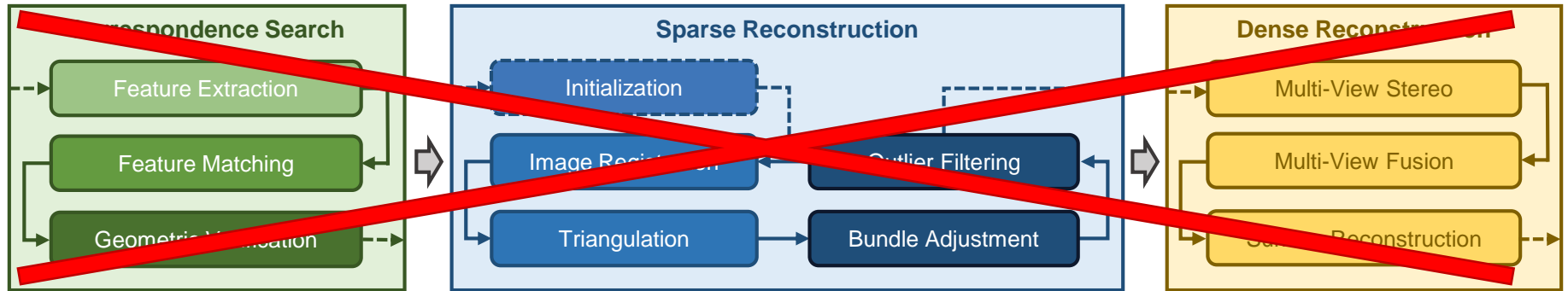


- **Learning Feature Representations for Localization and Mapping**

Mihai Dusmanu, ETH Zurich

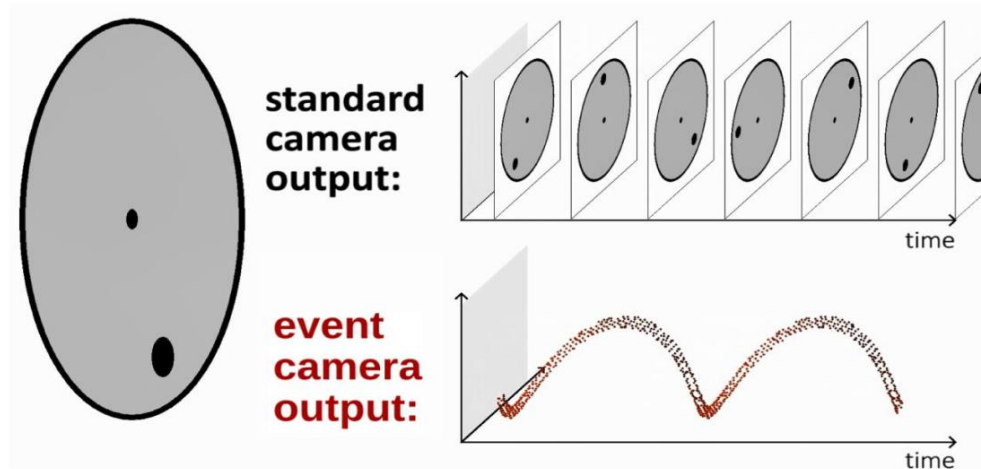


Related Scientific Projects Today

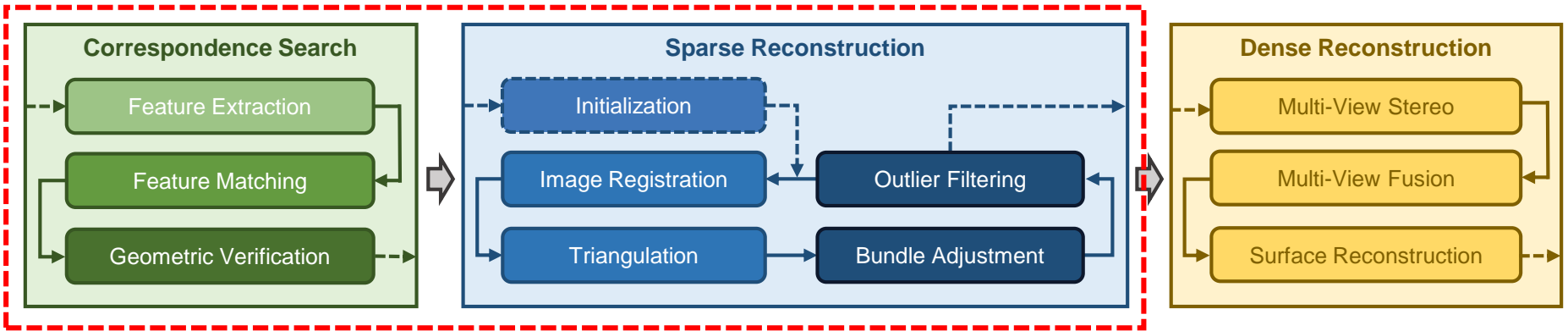


- **Event Cameras**

Davide Scaramuzza, University of Zurich

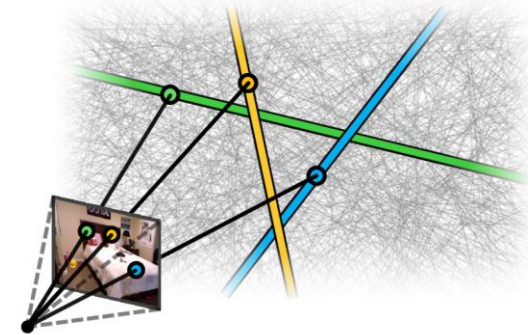
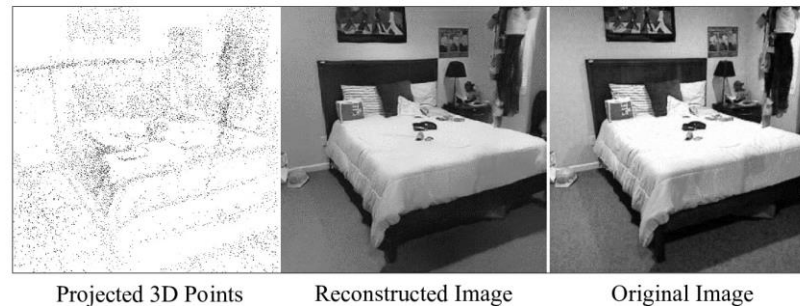
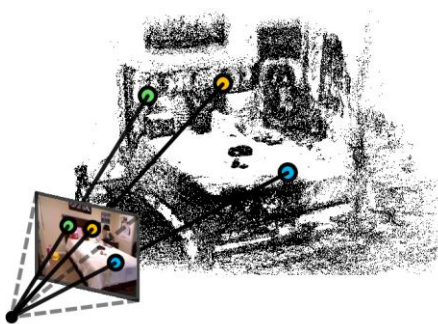


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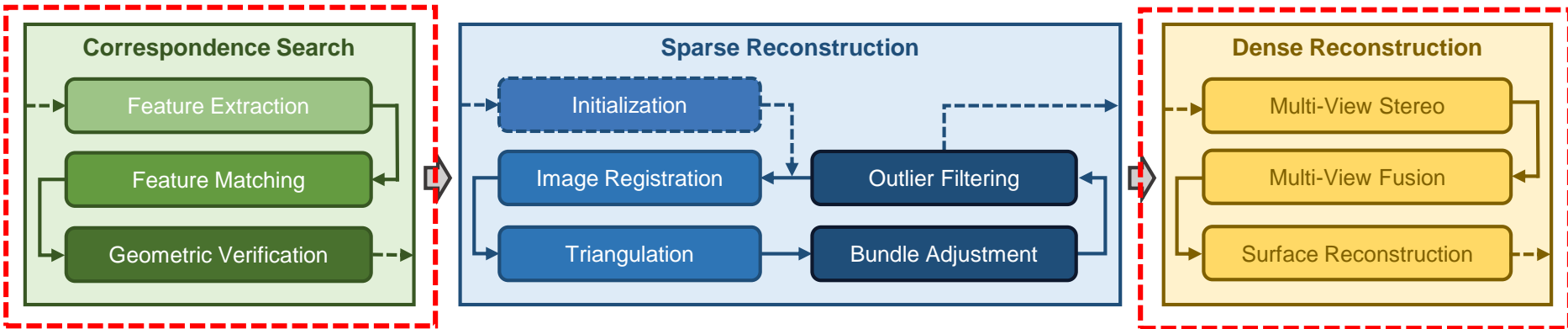


- **Privacy Preserving Mixed Reality Cloud**

Pablo Speciale, Microsoft

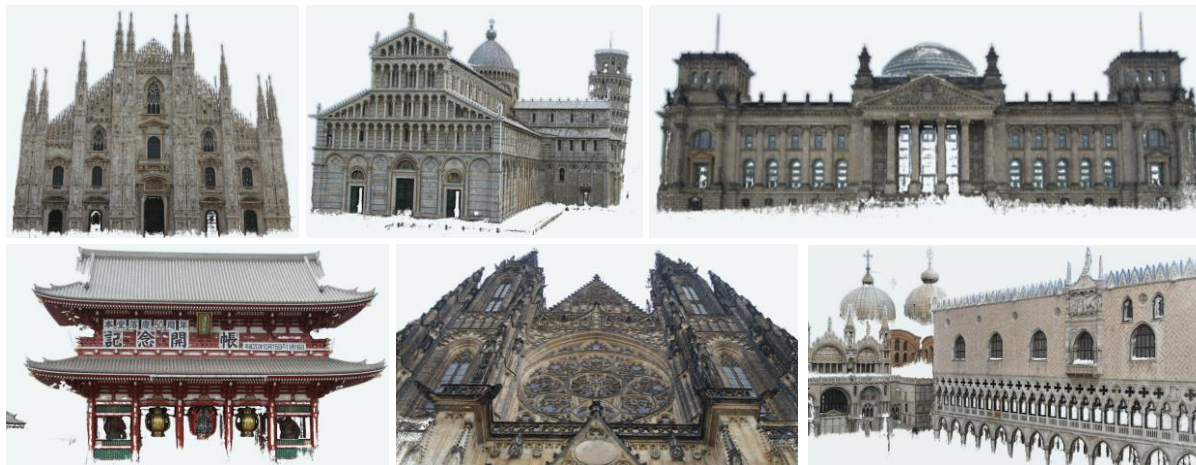


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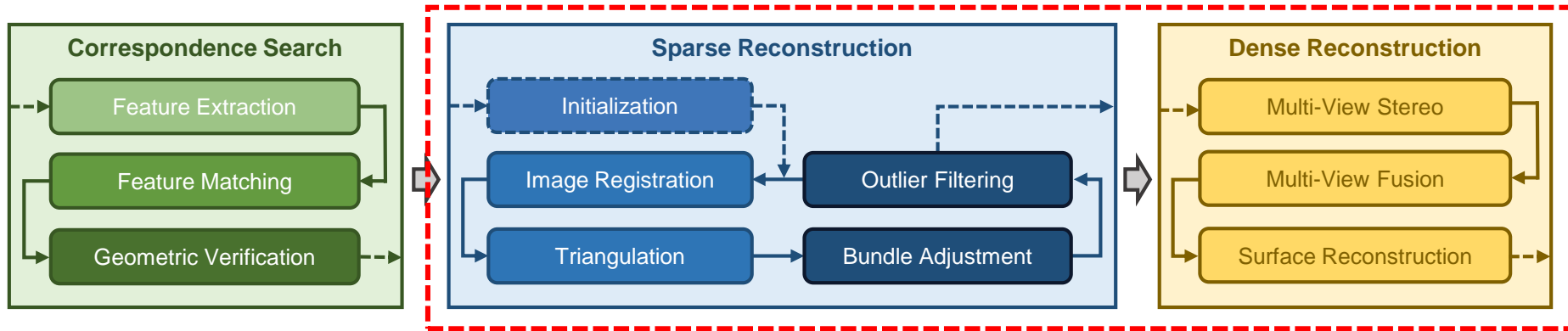


- **Adaptive Mesh Texture for Multi-View Appearance Modeling**

Edmond Boyer, INRIA



Related Scientific Projects Today



- **Semantic 3D Reconstruction**

Martin Oswald, ETH Zurich



Other Talks

- **Eye Tracking – the Key to Computational Understanding of Human Behavior and Cognition**
Mirko Meboldt, ETH Zurich
- **Medical Augmented Reality: State of the Art, Requirements and Challenges**
Nassir Navab, TU Munich, JHU and Balgrist Hospital



Questions?

