Small-Form Spatially Augmented Reality on the Jetson TX1

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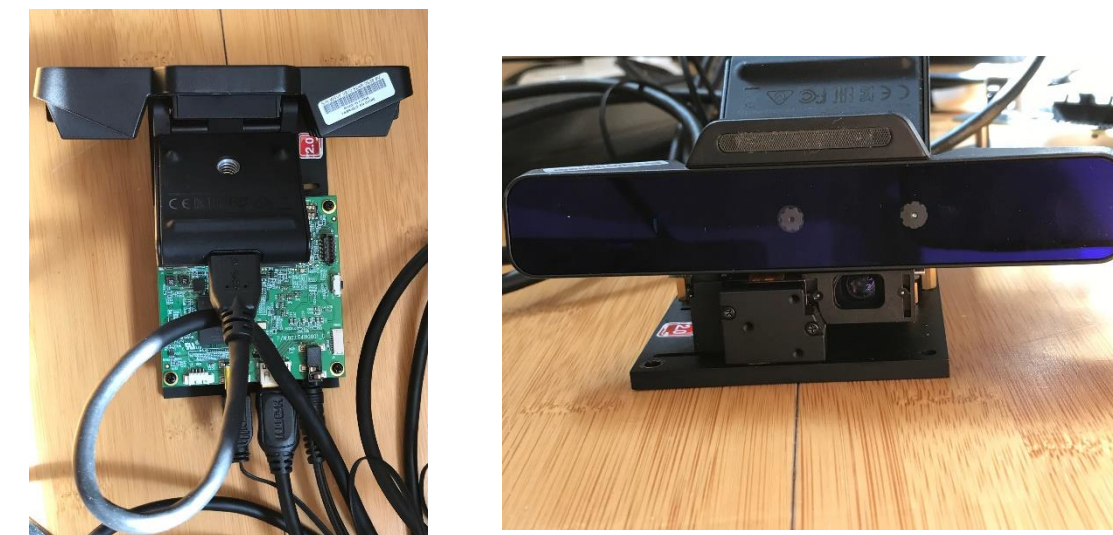
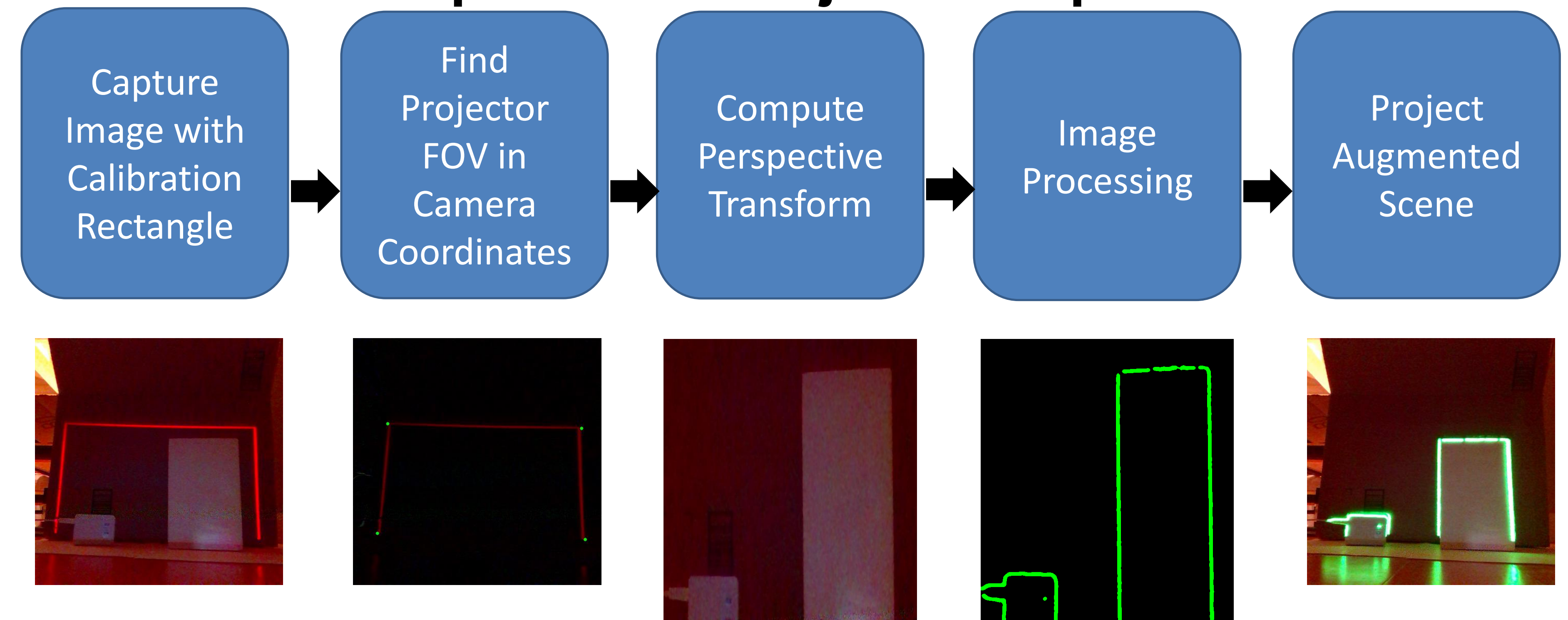Electrical Engineering, Stanford University

Motivation

- Spatially Augmented Reality (SAR) uses objects in the real world as digital canvases to provide new user experiences
- Advances in computing technology allow for projection-based systems with low power and mobility

Hardware System

- NVIDIA Jetson TX1
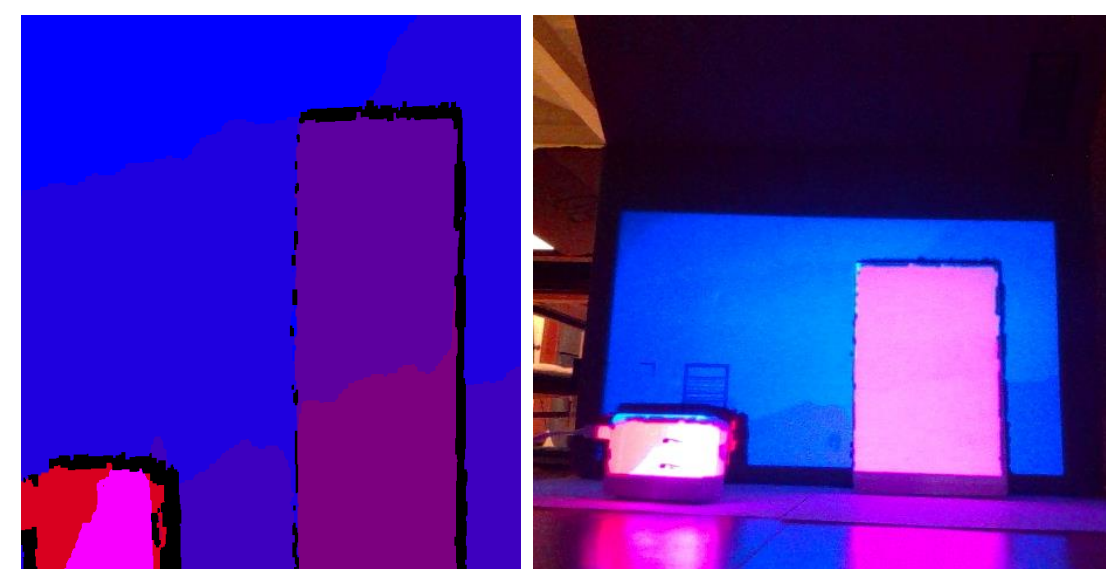- Intel RealSense SR300
- TI DLP3000

Capture and Projection Pipeline

Capture Image with Calibration Rectangle → Find Projector FOV in Camera Coordinates → Compute Perspective Transform → Image Processing → Project Augmented Scene
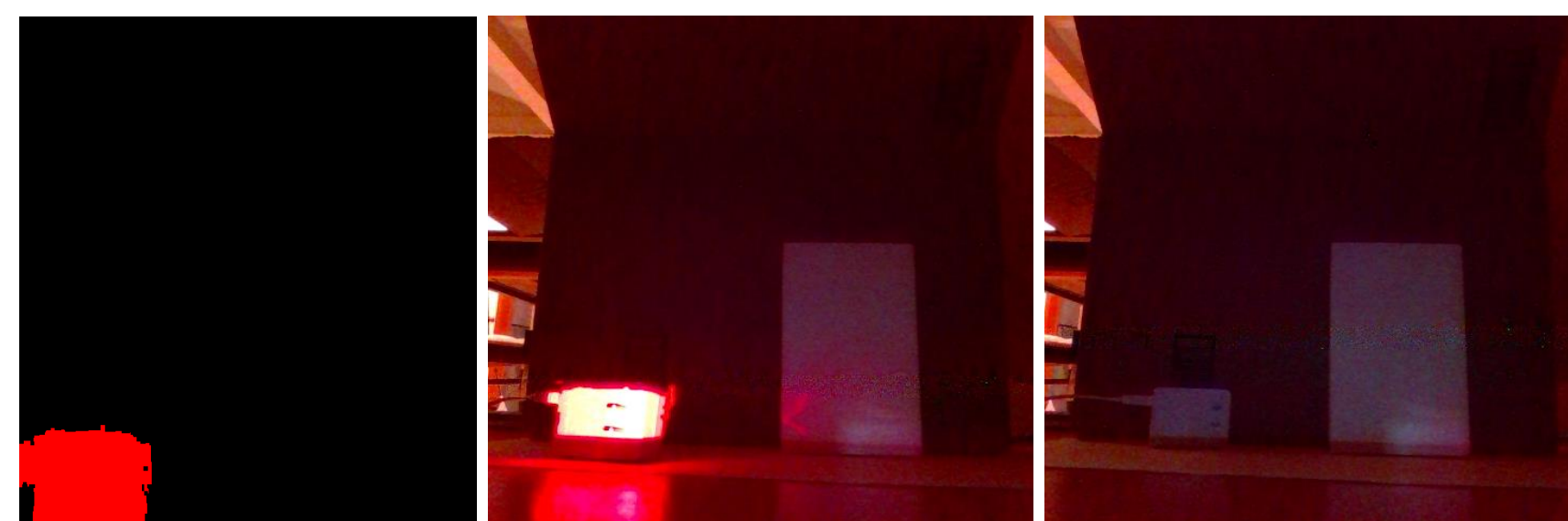
Demos and Results

Scene Geometry

Project object layout onto scene using captured and processed depth map

"Privacy" Zone

Define region in the scene in which objects are not "allowed" (colored red)

Jetson SAR	Other Work
Rectangle Disparity: 2-3 pixels	Projector Disparity: .3-2 pixels [4]
Max theoretical FPS: 20	Scan time: 30 minutes [2]
Achieved: ~5.5 fps	Real-time update [3]
Form Factor: **120mm x 117mm x 40mm**	Form Factor: 177mm x 127mm x 38.1mm + **computer** [4]

Perspective Transform Computation

- Find 3x3 matrix M that maps imaged rectangle points from camera coordinates into projector's FOV
- For all points (x,y) in new image, compute:

$$\text{dst}(x,y) = \text{src}\left(\frac{M_{11}x + M_{12}y + M_{13}}{M_{31}x + M_{32}y + M_{33}}, \frac{M_{21}x + M_{22}y + M_{23}}{M_{31}x + M_{32}y + M_{33}}\right)$$

References

[1] Bimber, Oliver, et al. "The Visual Computing of Projector-Camera Systems." *Computer Graphics Forum*. Vol. 27. No. 8. Blackwell Publishing Ltd, 2008.
[2] Raskar, Ramesh, et al. "Shader lamps: Animating real objects with image-based illumination." *Rendering Techniques 2001*. Springer Vienna, 2001. 89-102.
[3] Mistry, Pranav, and Pattie Maes. "SixthSense: a wearable gestural interface." *ACM SIGGRAPH ASIA 2009 Sketches*. ACM, 2009.
[4] Raskar, Ramesh, et al. "RFIG lamps: interacting with a self-describing world via photosensing wireless tags and projectors." *ACM Transactions on Graphics (TOG)*. Vol. 23. No. 3. ACM, 2004.