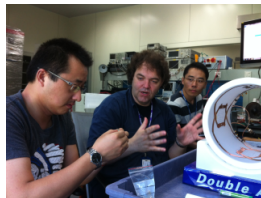


Visualization for *AR* & *Surgical Robotics*

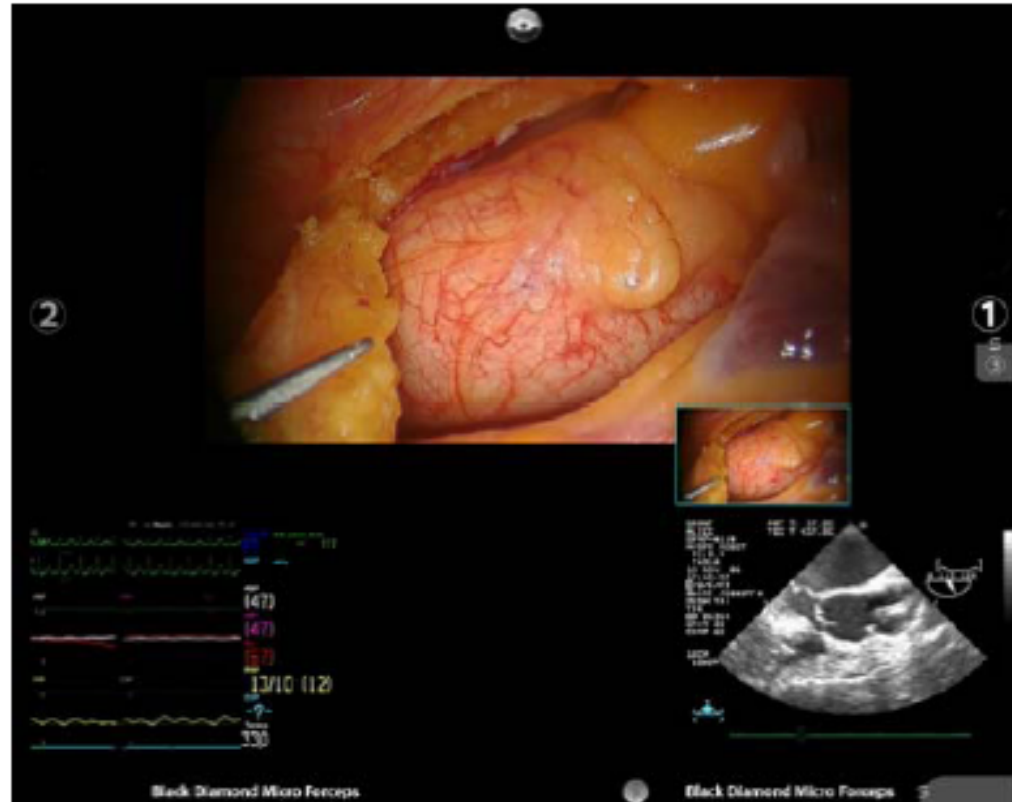
Visual Clarity & Imaging & Human Physiology



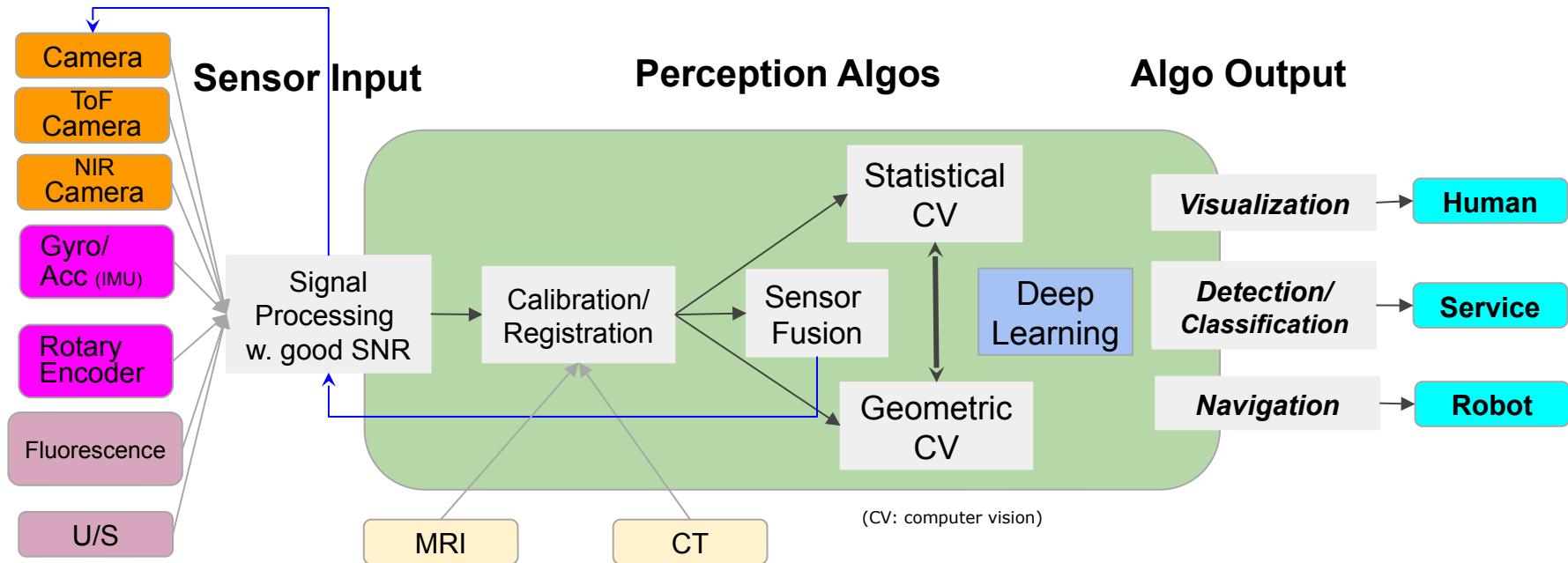
Wenyi Zhao
2020



Visualization in Practice: Important Info for Human Eyes



Machine Perception (AI): Wenyi's Systems Perspective



Product Development Cycle (**Systems Perspective**)

Simulation & Analysis

Systems Architecture

Compute Architecture

Hardware Development

Software Development

Manufacture/Calibration

Visualization: Three Topics for Today

visualization noun

2. the act or process of interpreting in **visual terms** or of putting into **visible form**

Basic Visualization → Beyond Human Vision → Presentation to eyes		
Visual Clarity	Imaging the Unseen	Display To Human
<i>Create images that reveal important features</i>	<i>Convert invisible info into visible images</i>	<i>Create visual presentation fitting human eyes</i>
<ul style="list-style-type: none">• Visualization Pipeline• Image Super-resolution• Computational surgical imaging	<ul style="list-style-type: none">• ICG imaging• Tissue-specific Fluorescence imaging• MRI scan• Ultrasound• CT scan• Photo-acoustic imaging• Narrow band imaging	<ul style="list-style-type: none">• Stereoscopic/3D Display• Eye Tracking for Near-Eye display• Low latency rendering

Visualization Pipeline: Building Blocks

Endoscope

Camera
Sensors



*Intuitive Da Vinci 8.5mm
Endoscope*

Camera
Optics



Light
Bundles

Vision Tower



Video Processing

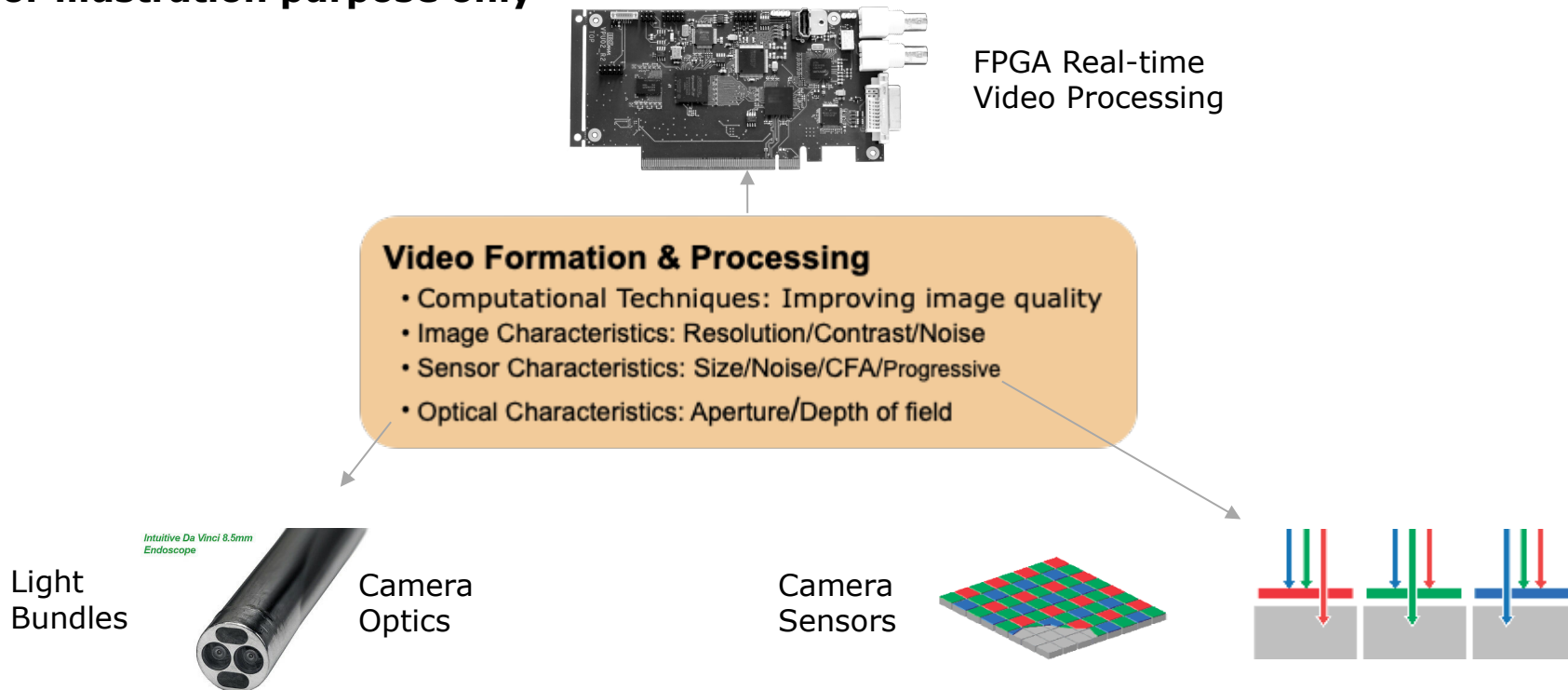
Surgeon Console



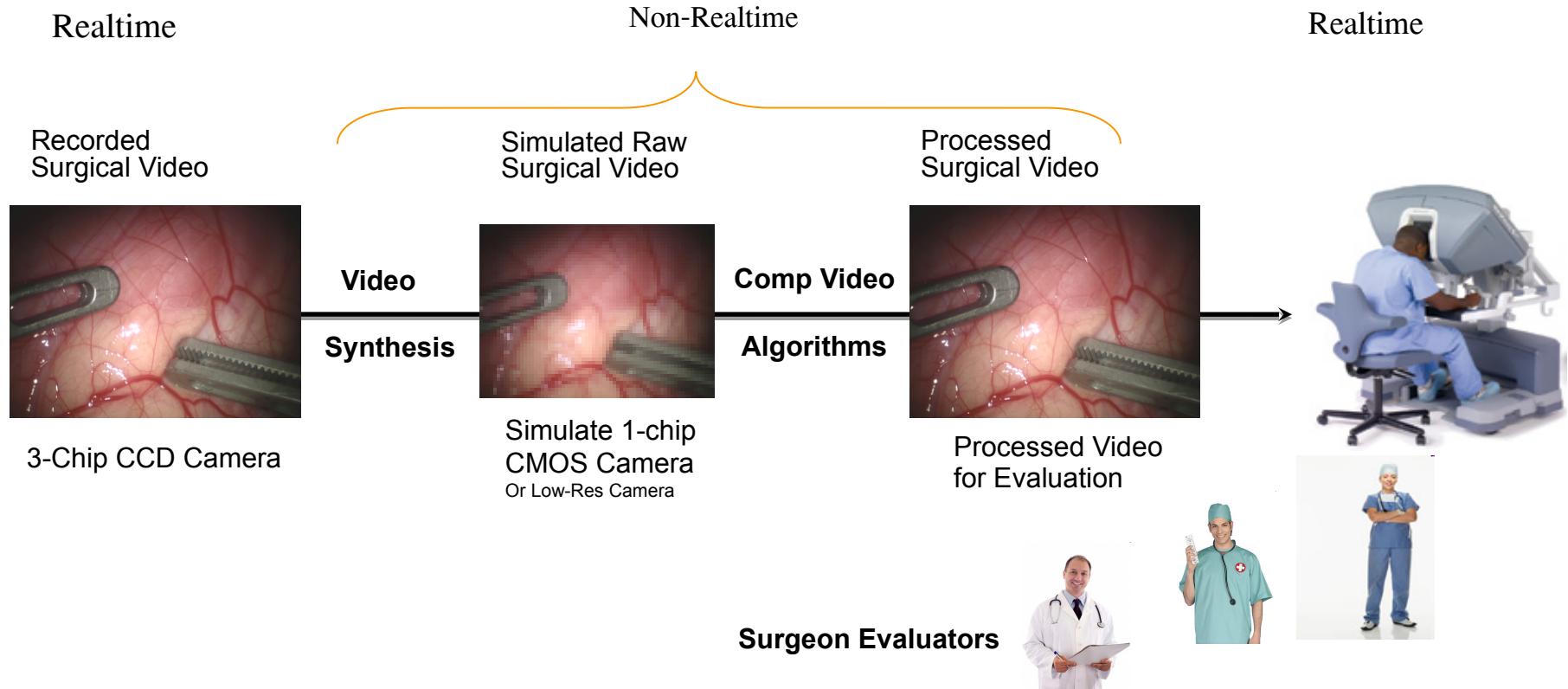
Project Video onto
Surgeon's Eyes

Key Process: Video Formation and Processing

For illustration purpose only



Simulation from Real data to Predicate Performance



Super-Resolution with Consistent Optical Flow

Image Reconstruction

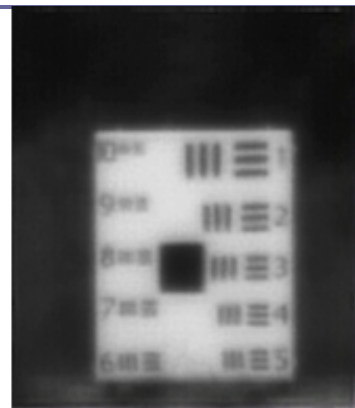
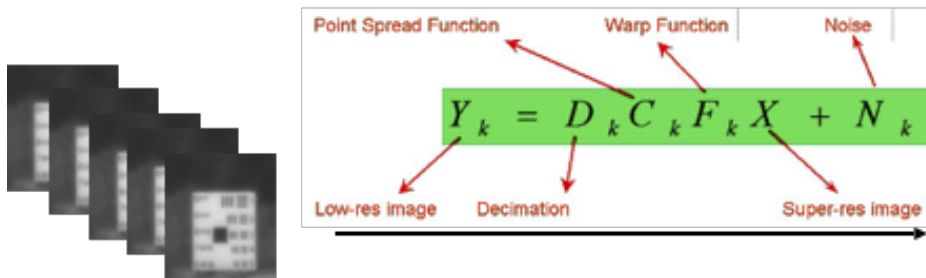
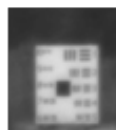


Image Interpolation



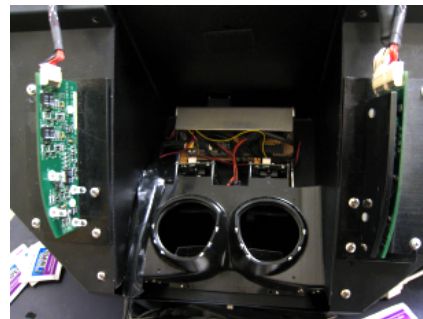
Cubic-interpolated



Why 3D Display for AR and Surgical Robotics?

To mimic the real 3D world, you create 3D display

- For AR, it is about display virtual contents as if they were real!
- For surgical robotics, 3D vision is the key advantage of robotic surgery over laparoscopic surgery

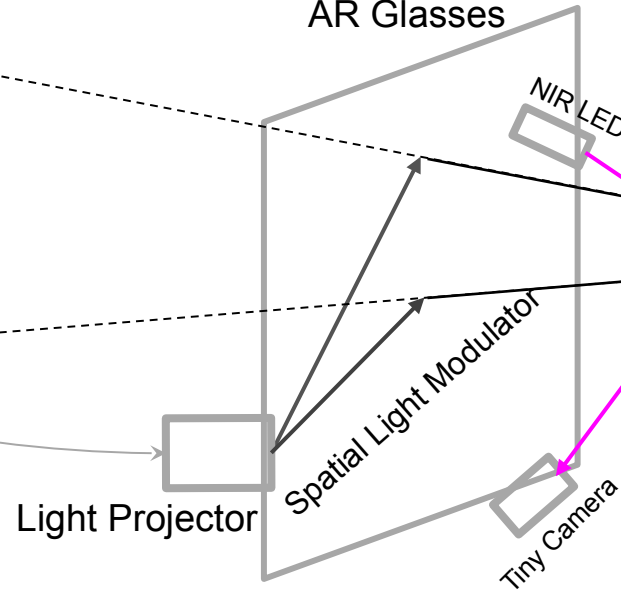


Eye Tracking For Near-Eye Display

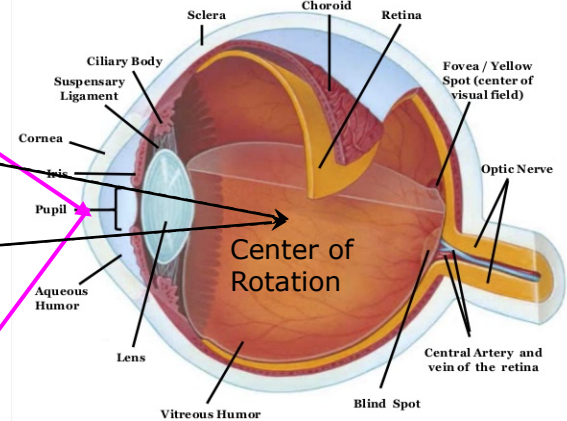
Content Rendering Engine



AR Glasses



User's Eye



ET Outputs Required

- Center of Rotation/IPD (interpupillary distance) -> Rendering Center
- Vergence -> Virtual Object Depth
- Gaze -> Interaction Applications