증강현실

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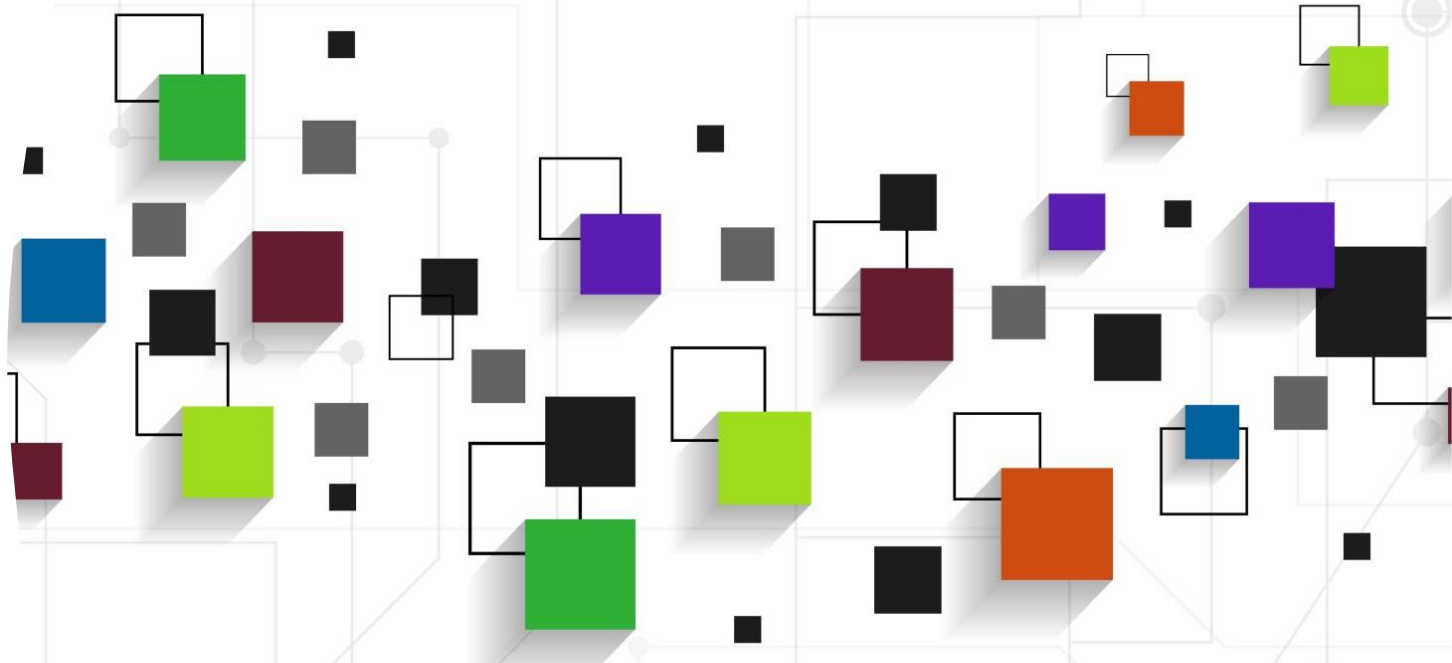


Spatial Augmented Reality

Introduction

✓Spatial Augmented Reality (SAR) is a technology that enhance users' perception of the physical world with augmented virtual content

What is Spatial Augmented Reality?

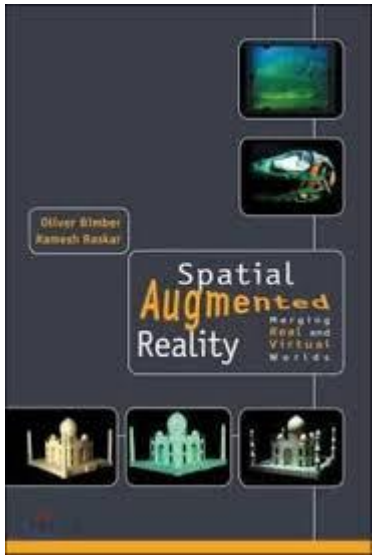
- ✓Spatial Augmented Reality (SAR) is a technology that enhance users' perception of the physical world with augmented virtual content
- ✓SAR overlays virtual content directly onto physical objects or spaces, aligning them precisely
- ✓Example: Projecting architectural designs onto physical models

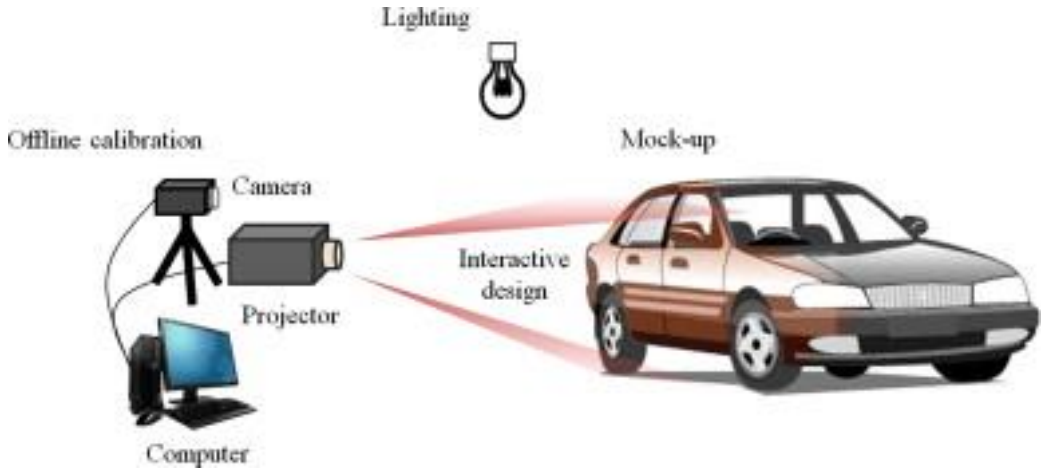
Spatial Augmented Reality

✓Project onto irregular surfaces

- Geometric registration
- Projector blending, high dynamic range

✓Book: Bimber, Rasker “Spatial Augmented Reality”





SAR Characteristics

- ✓Precise Alignment: Augmented content is accurately aligned with physical objects
- ✓Static Environment: SAR works best in controlled, stable environments
- ✓Projectors and Cameras: It often involves projectors and cameras for tracking

Key Components of SAR

- ✓Projectors: Devices that project virtual content onto physical surfaces
- ✓Cameras: Capture the physical world for alignment and interaction
- ✓Calibration: Precisely aligns virtual and physical elements
- ✓Display Surface: The physical object or space where content is projected

Projectors in SAR

LG ProBeam BU70QGA Projector ($5,499)

- ✓Projectors are the workhorses of SAR, responsible for projecting virtual content onto physical objects or spaces
- ✓Different types of projectors offer various advantages and are chosen based on specific requirements
  - Digital Light Processing (DLP) projectors
  - Laser Projectors

Samsung The Freestyle Portable LED Projector ($799)

DLP vs. Laser Projectors: Differences

- ✓Brightness: Laser projectors are often brighter than DLP projectors
- ✓Image Quality: DLP projectors offer excellent image quality, while laser projectors excel in color accuracy
- ✓Lifespan: Laser projectors typically have a longer lifespan
- ✓Application: Choose the type based on specific SAR requirements, environment, and budget

Integrating Projectors in SAR

- ✓Projector Placement: Proper projector placement and alignment are crucial for accurate content rendering
- ✓Calibration: Calibrate projectors to ensure precise alignment with physical objects or surfaces

Cameras in SAR

✓Cameras are integral components in SAR systems, enabling the tracking and alignment of virtual content with physical objects

The Significance of Cameras

- ✓Cameras capture the real-world environment, providing critical input for SAR systems
- ✓Responsible for tracking and aligning virtual content
- ✓Making it appear seamlessly integrated with the physical world

Types of Cameras in SAR

- ✓Various camera types are used in SAR, RGB and depth cameras being the most common
- ✓RGB (Color) cameras
  - Capture color information from the environment
  - Provide a visual representation of the physical world
  - Used for image recognition, object tracking, and providing realistic color to virtual content
- ✓Depth cameras
  - Capture not only color but also depth information
  - Create a 3D map of the environment, allowing for precise depth perception
  - Vital for aligning virtual content with physical objects and surfaces

Challenges in Camera Tracking

- ✓Low Lighting: SAR can struggle in low-light conditions without proper illumination
- ✓Occlusion: Tracking may be disrupted when physical objects block the camera's view
- ✓Environmental Variability: Changing lighting conditions and object movement can pose challenges

Calibration in SAR

- ✓Precise alignment is fundamental in SAR for a seamless and convincing augmented reality experience
- ✓Calibration corrects any discrepancies between the virtual and physical worlds

Types of Calibration in SAR

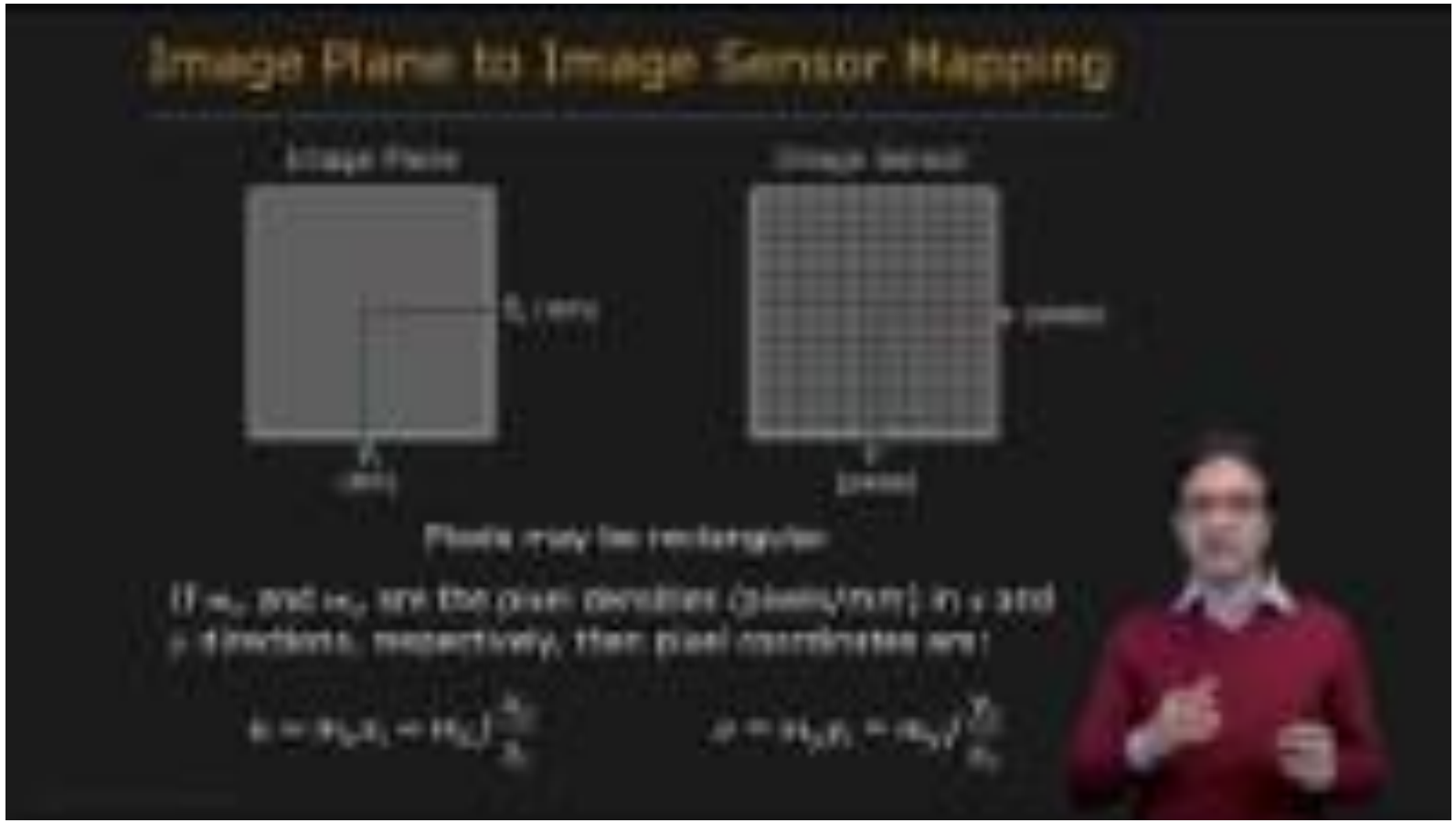
✓Intrinsic calibration

- Fine-tune the camera's internal parameters
- Parameters include focal length, lens distortion, and image sensor characteristics
- Ensure accurate image capture

✓Extrinsic calibration

- Establish the spatial relationship between cameras and projectors
- Determine the position and orientation of each projector relative to the cameras
- Align virtual and physical spaces

Calibration



https://youtu.be/qByYk6JggQU?si=ADLOGcEnqyW2zQ3p (2021, 19:44)

Display Surfaces

- ✓SAR can be applied to a range of surfaces, each with unique possibilities and challenges
- ✓Common surfaces include walls, floors, tables, and stages

Display Surfaces

✓Walls

- Walls are a popular choice for SAR applications
- Ideal for architectural visualization and art installations
- Material properties like color and texture can impact display quality

✓Floors

- Floors offer interactive experiences in retail, exhibitions, and gaming
- Durability and slip resistance are important considerations
- Darker materials may affect brightness and color accuracy

Display Surfaces

✓Tables

- SAR on tables creates interactive workspaces, educational tools, and gaming surfaces
- Material flatness and reflectivity affect projection quality
- Touch-sensitive overlays may be added for interactivity

✓Stages

- Stages are used in theater, live performances, and events
- SAR enhances stage design with dynamic visuals
- Material properties must align with lighting and projection requirements

Display Surfaces: Non-Planar Surfaces

✓Non-planar surfaces include curved, irregular, and 3D objects

- Sculptures, statues, vehicles, and 3D architectural elements

✓Introduce complexity and creativity to SAR applications

✓Challenges

- Non-planar surfaces vary in shape and curvature
- Maintaining accurate alignment on complex surfaces can be challenging
- May involve multiple non-planar surfaces

Display Surfaces: Non-Planar Surfaces

✓Creative Use Cases

- Art Installations: Transform sculptures with dynamic visual affects
- Automotive Design: Visualize car designs on non-planar vehicle surfaces
- Museums and Exhibits: Enhance 3D objects with interactive information

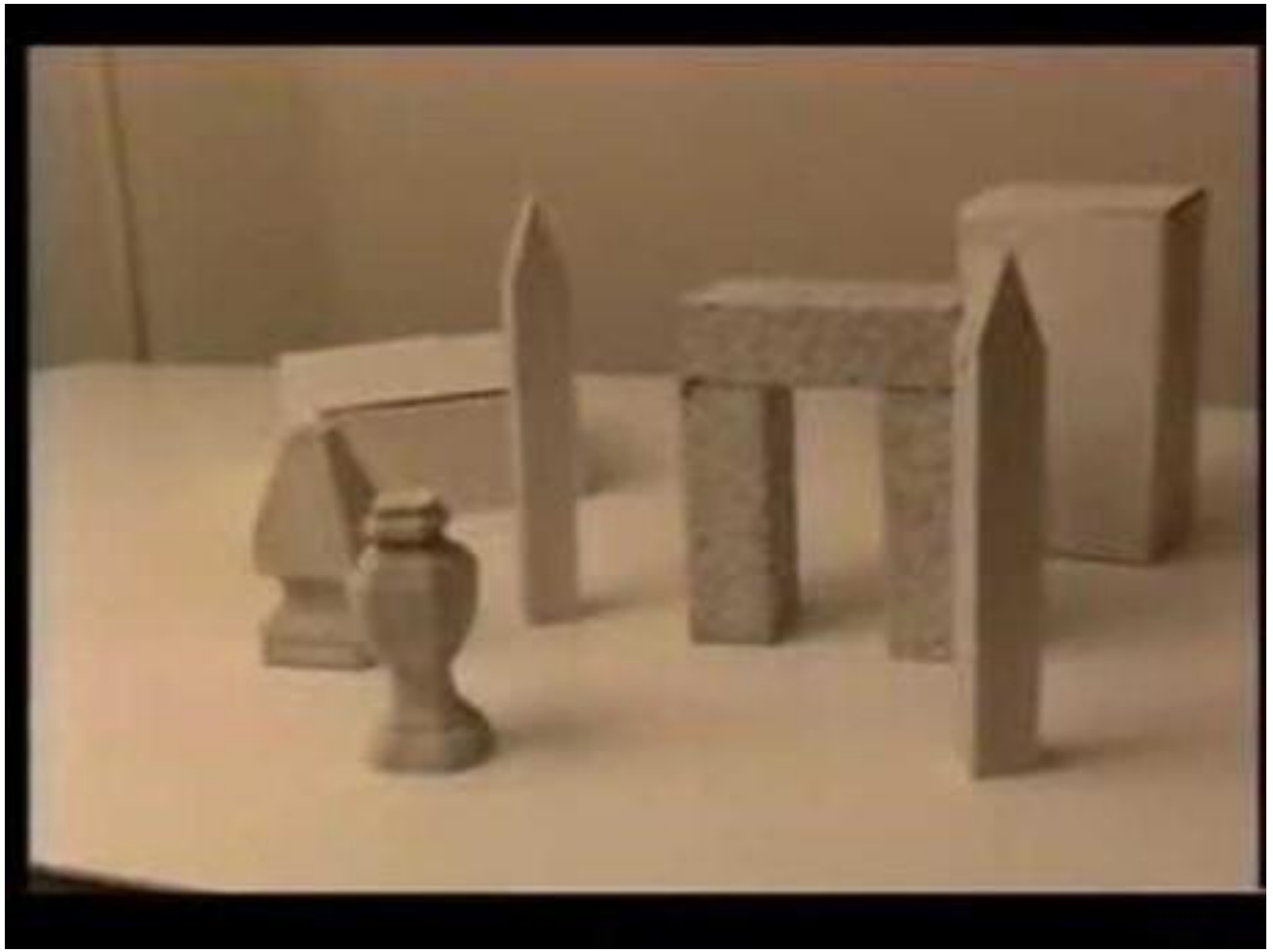
✓Benefits

- Creativity: Enables artists and designers to push the boundaries of spatial storytelling
- Engagement: Interactive experiences on 3D objects captivate audiences
- Realism: Seamless integration of virtual content with non-planar physical surfaces

Dynamic Projection: Deforming Non-Rigid Surface

https://youtu.be/-bh1MHuA5jU?si=37dvh29-FuoPfuHv (2016, 1:03)

Shader Lamps



https://youtu.be/pDexuUc7r9c

Display Surfaces: Quality

- ✓Ensure proper lighting conditions for optimal display
- ✓Address any imperfections in the surface for accurate alignment
- ✓Dust and debris can affect projection quality
- ✓Consider the material's impact on brightness, contrast, and color accuracy
- ✓Material properties
  - Material color: Dark materials absorb light, while lighter materials reflect more
  - Texture: Textured surfaces may distort projected images
  - Reflectivity: Highly reflective surfaces can cause glare

Display Surfaces: Challenges

- ✓Environmental lighting: Ensure proper lighting conditions for optimal display
- ✓Surface irregularities: Address any imperfections in the surface for accurate alignment
- ✓Surface cleanliness: Dust and debris can affect projection quality

Projected AR Workbench

https://youtu.be/N5C0a4D6PXk?si=w1G7x43aUf3gM5hJ (2020, 0:30)

SAR Examples

https://youtu.be/PKMCB5v8pt0?si=1Su76exL5AeXXPfE (2015, 2:35)

SAR vs. Traditional AR

✓Traditional AR

- Overlay virtual content onto the user's view of the real world
- User-Centric: Focus on enhancing the user's perspective and interaction
- Example: Pokémon Go

✓SAR

- Overlay virtual content directly onto physical objects or spaces, aligning them precisely
- Object-Centric: Focus on aligning virtual content with specific physical objects
- Example: Projecting architectural designs onto a physical model

SAR vs. Traditional AR: Interaction

✓Traditional AR

- User-centric interactions
- Users interact with virtual objects in their view

✓SAR

- Object-centric interactions
- Users interact with virtual objects relating to specific physical objects

SAR vs. Traditional AR: Use Cases

✓Traditional AR

- Navigation apps showing directions on the user's screen
- Virtual try-on using a smartphone or a large display

✓SAR

- Projecting virtual furniture onto a real living room for interior design
- Enhancing a physical model with dynamic architectural details

SAR vs. Traditional AR: Similarity

- ✓Both SAR and traditional AR aim to merge the digital and physical worlds
- ✓Use sensors, cameras, and tracking to achieve their objectives
- ✓The fundamental principles remain rooted in AR

Challenges in SAR

✓ Environmental lighting

- Too much or too little light can impact the visibility of virtual content
- The dynamic nature of lighting conditions can make consistent projection challenging

✓ Calibration complexity

- Calibrating SAR systems, especially on complex surfaces, can be a challenging process
- Precise alignment is essential for a convincing SAR experience

✓ Limited mobility

- SAR often requires users to stay within specific zones or with fixed equipment, limiting mobility
- Mobility constraints can affect user experience and application versatility

Future Trends

✓Explore emerging trends in SAR technology

- Miniaturization of projectors and cameras
- Integration with AR for scene understanding
- Potential applications in healthcare and automotive industries

Conclusion

- ✓SAR overlays virtual content on physical objects with precise alignment
- ✓Key components include projectors, cameras, calibration, and display surfaces
- ✓SAR has applications in design, education, entertainment, and manufacturing
- ✓Challenges exist but are being addressed by ongoing research
- ✓SAR’s future looks promising with technological advancements

Q/A