**Projection displays, Video see-through systems**

**Projection displays**

Projection-based AR, also known as Spatial Augmented Reality (SAR) or Projection Mapping, is a type of augmented reality that uses projectors to overlay digital content onto physical objects or surfaces in the real world. It involves the projection of computer-generated visuals onto real-world surfaces to create the illusion of interactive and dynamic augmented environments.

**What are the types of AR projection?**

**Static AR Projection:** Static AR projection refers to the use of augmented reality (AR) technology to project static or non-moving virtual content onto the real world. It involves overlaying digital images, videos, or information onto the physical environment in a way that appears to coexist with the real objects.

**Dynamic AR Projection:** Dynamic AR projection refers to the use of augmented reality (AR) technology to project interactive and moving virtual content onto the real world. Unlike static AR projection, which involves stationary virtual elements, dynamic AR projection adds a layer of interactivity and responsiveness to the augmented experience.

**What Equipment is used for Projected AR?**

Projectors: High-quality projectors are a fundamental component of projected AR. They are used to cast virtual content onto physical surfaces, such as walls, buildings, stages, or objects. Projectors with sufficient brightness, resolution, and image quality are essential to ensure a vivid and realistic augmented experience.

Calibration Devices: To achieve accurate projection mapping, calibration devices are used to align the virtual content precisely with the physical surfaces. These devices can include laser projectors, depth cameras, or dedicated calibration tools that help determine the position, size, and orientation of the projection surface.

Content Creation Software: Specialized software is used to create and design the virtual content that will be projected onto the physical surfaces. This software allows users to manipulate 2D and 3D elements, map them onto the real-world geometry, and control their behavior and interactivity.

Media Servers: Media servers are powerful computers or hardware devices used to manage and control the projection mapping process. They handle the synchronization of multiple projectors, manage the content playback, and often provide real-time adjustments for visual effects, transitions, and interactive elements.

Tracking Systems: Tracking systems are sometimes used in projected AR to enable dynamic interaction between the virtual content and physical objects or people in real-time. These systems can employ technologies like computer vision, motion sensors, or depth cameras to track the position and movements of the users or objects within the augmented space.

Physical Structures: In some cases, physical structures or surfaces may be required to create the desired augmented environment. For example, a stage setup or a specific arrangement of objects may be necessary to achieve the desired effect or interaction.

**Examples of Projector AR**

Wall Arts for events: By projecting images and animations onto the surface, users can engage with virtual objects and games by interacting with the projected content using their feet or other physical objects. This application is often seen in museums, exhibitions, and interactive installations

Mapping on Buildings: By projecting onto the intricate architectural details, projectors can create the illusion of moving textures, animations, and 3D effects that bring the structures to life. This technology is often used for art installations, advertising campaigns, and special events

Retail and Advertising: Projector AR is used in retail settings to enhance product displays and create engaging shopping experiences.

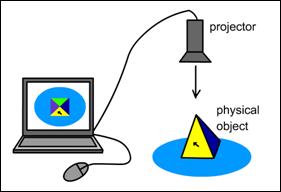
Live Performances and Events: Projector AR is often employed in live performances, concerts, and events to create immersive visual experiences. By projecting onto screens, stages, or props, artists can merge virtual elements with live performances, enhancing the atmosphere and providing dynamic visuals that respond to the music or performance.

**Advantages:**

* Large-Scale Immersion
* Realistic Integration
* Shared Experiences
* Dynamic and Interactive
* Flexibility and Adaptability
* Versatile Applications

**Disadvantages**

* Requires a dark (dim) environment — In other words, cannot be used at bright places or outdoors at daytime.
* Expensive
* Limited use cases
* As it is projection-based, it casts shadows when interacting with hands



**Video see-through systems**

Video see-through systems are a common approach in augmented reality (AR) that involves capturing live video of the real world using cameras and then overlaying digital content onto the video feed. These systems provide users with a view of the real world with digital elements superimposed on it, creating a mixed-reality experience. Here's how video see-through systems work in AR:

**1. Camera Technology:**

Video see-through AR systems use one or more cameras to capture the user's view of the real world. These cameras can be mounted on AR glasses, headsets, or mobile devices.

**2. Live Video Feed:**

The video feed from the cameras is processed in real time. It provides a continuous and live view of the user's surroundings. This live video feed serves as the base layer of the AR experience.

**3. Digital Overlay:**

Digital content, which can include 2D images, 3D objects, text, animations, and other virtual elements, is superimposed onto the live video feed. This digital overlay is generated based on the user's perspective and the context of the real-world scene.

**4. Alignment and Calibration:**

The digital overlay needs to be precisely aligned with the real world to ensure that virtual objects appear correctly within the user's view. This alignment is achieved through calibration and tracking technologies, which track the user's head movements and maintain the correct positioning of the overlay.

**5. Tracking and Interactivity:**

To enable user interactions with the digital content, video see-through AR systems often incorporate tracking technology, such as head tracking and hand tracking. This allows users to interact with and manipulate virtual objects in the scene.

**6. Display Devices:**

Video see-through AR can be experienced through various devices, including AR glasses (e.g., Google Glass), AR headsets (e.g., Microsoft HoloLens), and smartphones or tablets with AR capabilities. These devices display the combined live video feed and digital overlay to the user.

**7. Real-Time Rendering:**

The digital content must be rendered in real time to match the user's viewpoint. Advanced graphics processing units (GPUs) are used to render and display the overlay, ensuring smooth and responsive interactions.

**8. Use Cases:**

Video see-through AR systems have a wide range of applications, including gaming, navigation, remote collaboration, design and visualization, medical training, education, and more. They provide a dynamic and interactive way to access digital information within the physical world.

**9. Challenges:**

Video see-through AR systems face challenges related to tracking accuracy, display quality, and occlusion handling. Precise tracking is essential to maintain the alignment of virtual objects with the real world, and occlusion handling ensures that virtual objects appear correctly behind real-world objects.

Video see-through systems are a popular choice for AR because they offer a versatile and immersive way to blend digital and physical experiences. These systems allow users to interact with digital content in the context of their surroundings, providing endless possibilities for innovative applications and experiences.

