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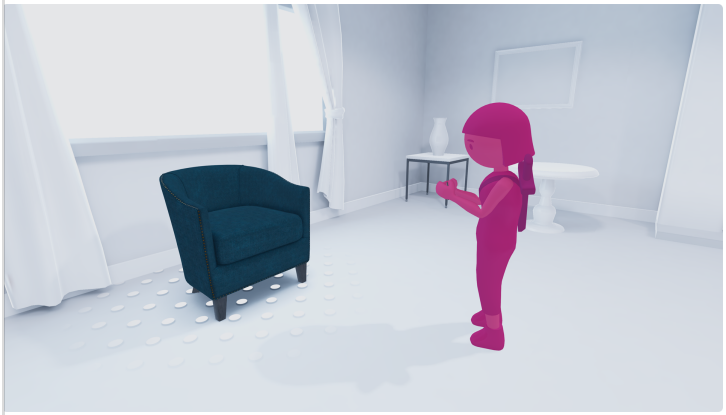
Introduction



Augmented reality (AR) lets you add virtual content to the real world. that enhance the way people see and interact with the world.

ARCore is a platform for building AR apps. It harnesses the power of Android phones

- motion tracking
- environmental understanding
- light estimation

ARCore collects that information and uses it to integrate virtual content with the real

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ARCore works in 2 ways

It tracks the position of your phone in the real world, and it builds an understanding o floors in the environment.

This spec was created using internal research and analysis of AR experiences in edu can use this spec to design practical, innovative, and magical mobile AR experiences

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Content Placement

Plane discovery

Finding a Surface

In order to find a plane, ARCore searches for a wall, ceiling, or floor by finding several

Show users how to find a surface using their phone. Use illustrations or animations t help users understand to hold their phone toward the surface that they're trying to de circular motion, and to search for surfaces that aren't too dim or too bright.

As users move their phones, give instant feedback to show they've successfully dete

Show users clearly how to scan for surfaces

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Vertical surfaces

Vertical surfaces can be harder to detect than horizontal surfaces.

Vertical surfaces reflect light, and they're often painted a single color, both of which c

ARCore is able to detect vertical surfaces. In certain cases, though, they might take a

Vertical surface detection

Confirm surface detection

When a user successfully finds a surface, tell them what to do next.

You can give them an object to place, encourage them to explore the space, or somet

To encourage the user, build their confidence, and reduce frustration:

- **Design seamless transitions.** When the user moves quickly, ARCore might lose its between surface finding and detection.
- **Aim for visual consistency.** The visuals used for instructions, surface detection, a single consistent look. Aim for visual harmony in all parts of your experience.
- **Use progressive disclosure.** Let users know about changes in system status in a or displaying text to help communicate that a surface has been successfully dete

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Use surface visualization to help users with object placement

Highlight surfaces that have been detected and are ready for object placement.

Visually highlight only the surface that the user is viewing or pointing at. Avoid highlig visual distinctions between different planes.

Communicate error states clearly and help users recover quickly

Provide feedback when something has gone wrong, and give the user an actionable p Walk the user through correcting the error state, one step at a time.

Error states can include:

- Trouble detecting a surface
- Trouble scanning a surface
- If the phone isn't moving to enable detection
- If the user isn't moving the phone properly to detect surfaces

Optimal placement range

The optimal placement range is where you can place a virtual object at the most com

Placement Range

Design your scene so it's easy for users to perceive the depth and distance of objects.

The limited field of view on a phone screen can make it challenging for a user to perceive depth, scale, and distance. This may impact users' experience, as well as their ability to interact with objects.

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A user's depth perception often depends on how objects are placed in the scene. For example, placing an object too close to the user can be startling or alarming. Placing large objects close to the user may cause them to step backward, bumping into or tripping over real-world objects behind them.

When you create your experience, consider the importance of depth. Think about how users will see your content, and whether or not they'll be able to access it. Think of the scene in 3 distinct regions: downstage, upstage, and center stage.

- **Downstage**, closest to the user: If an object is placed unexpectedly close to the user, it forces the user to move back, since it's harder to see the full object. This is useful when you want the user to look down or examine something closely. However, be careful never to encourage the user to move backward! They could trip on real objects behind them.

- **Upstage**, farthest from the user: If the object is placed upstage, it's difficult for users to see the difference between a very small object and an object that's sitting far away. It's useful to encourage exploration and movement, but can create a visually confusing experience.

- **Center stage:** This is the most comfortable viewing range for users. Objects here are optimal for users to interact with.

Note that the positioning of the three stages is relative to the viewing angle of the phone.

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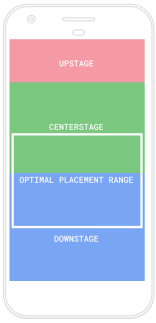

3 regions of the screen

Maximum Placement Distance

Guide users as they place objects in the scene.

Help them to avoid placing objects at an uncomfortable distance.

You can set a maximum placement distance for objects. This helps to make sure that users will place objects at a comfortable viewing distance. It also guarantees that the object will stay at a realistic scale as the user continues to move it.

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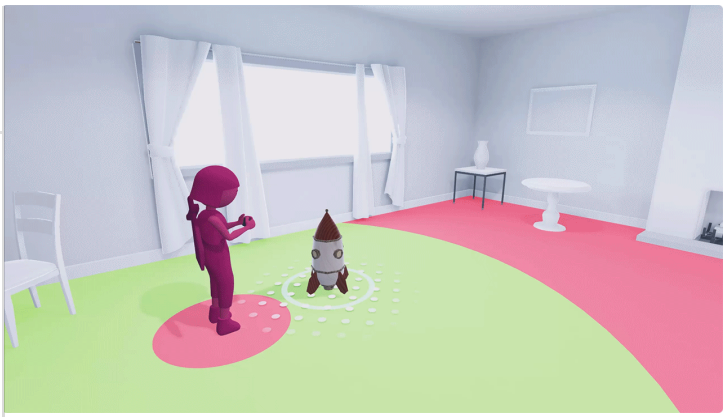
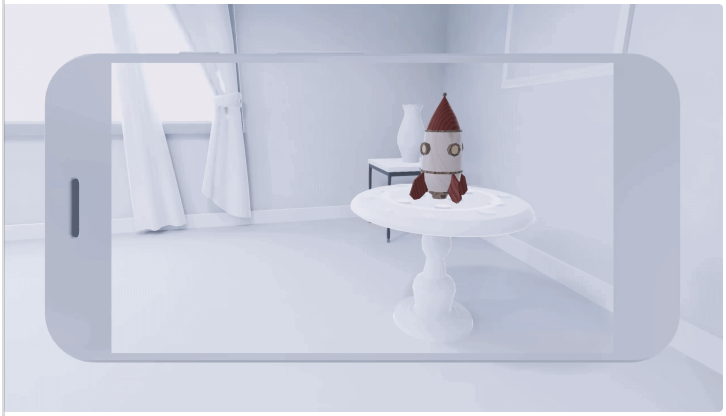


Set a default maximum distance, and don't let users place an object beyond it.

Destination Point

The destination point is where an object will eventually be placed.

Use visual indicators to guide users as they place objects. Shadows can help indicate the destination point and make it easier for users to understand where an object will be placed on a detected surface.



You can use the surface visualization, or the shadow of the object to indicate the destination point

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Placement

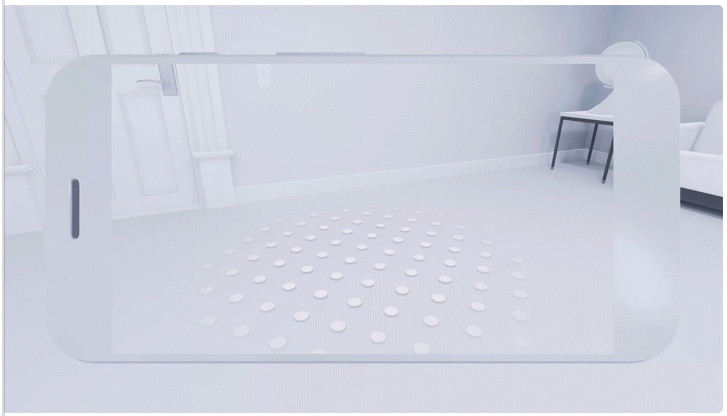
ARCore lets you drop any virtual object into a real-world space. Objects can be placed

Automatic Placement

It's possible for the app itself to populate a scene. Once a surface is detected, the ap

Automatic placement works best when:

- A virtual environment is added, without any user input, into the real-world space
- There's no interaction, or minimal interaction
- It doesn't matter if objects appear in exactly the right spot
- AR mode is crucial to your experience
- AR mode starts when the experience is launched



Virtual objects populating a scene

Manual Placement

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Users can manually add virtual objects to a scene and move them around.

Manual placement works best when:

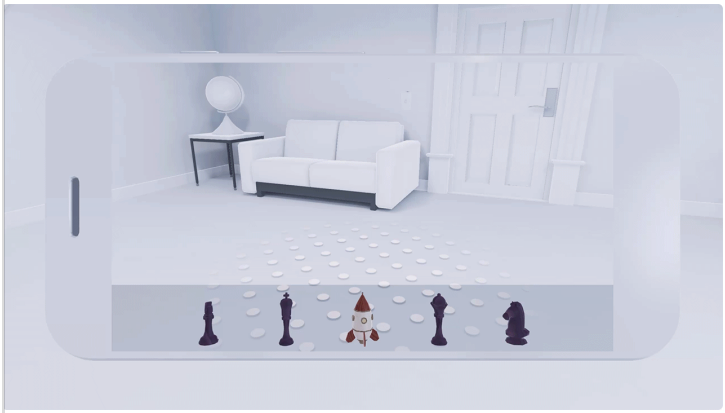
- The experience is fully interactive, such as a jigsaw puzzle
- Object placement needs to be precise, such as a furniture selection app

Tap to place an object

A user can drop a virtual object by tapping a spot anywhere in the scene. Tapping generally feels natural to the user, and works best when:

- The virtual object doesn't need to be adjusted or resized before it's placed
- It should be placed quickly

Tapping doesn't work when multiple objects appear in the scene. When tapped, multiple objects can pile on top of each other.



Tap to place interaction

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Drag to place an object

After selecting a virtual object by touching it, users can drag the object into their scene. Many users might not know how to drag. Give clear instructions, and walk them through the process of dragging step by step.

Be sure to tell users how to place an object before they pick it up! Dragging doesn't work as well when the user is not informed about the placement gesture in advance.

Dragging works best when:

- The object needs to be adjusted or transformed
- The object needs to be dropped precisely in a certain place

Drag to place interaction

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Anchoring

When you anchor an object in AR, you lock it firmly in a specific spot. Even when the anchored.

Anchoring is different than simply placing an object in the scene. Ordinary objects ca the other hand, an anchored object will stay locked in place until the user moves it.

Anchors are most useful for pinning objects that the user will keep returning to, such anchor objects that contain other assets, like game boards.

Anchoring an object doesn't mean it's stuck in place forever! You can let the user mo

Do.

It's helpful to anchor objects that contain other assets, like a chess board

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Don’t.

There's no need to anchor static objects that stay in the same spot through the whole experience

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Content Manipulation

Selection

Let the user select a virtual object in order to identify, manipulate, and

Make it easy for users to spot interactive objects and then interact with them. Interac
combinations, glowing outlines, or other visual highlights to let users know. This is es
can be selected.

Take care not to visually overpower your virtual objects. Above all, they should still lo
With a little added touch, you can encourage users to unlock the secrets of those obj

Outline or highlight selected objects

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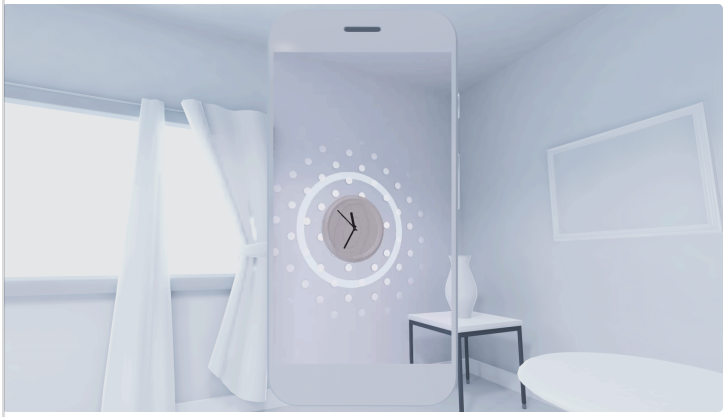
Translation

Translation is the process of moving a virtual object along a surface, or moving it fro

To start moving an object, the user selects it. They can either drag the object along th
actual phone, and the object will follow.

Select and drag to move an object



Move objects on horizontal or vertical planes

Multiple Surfaces

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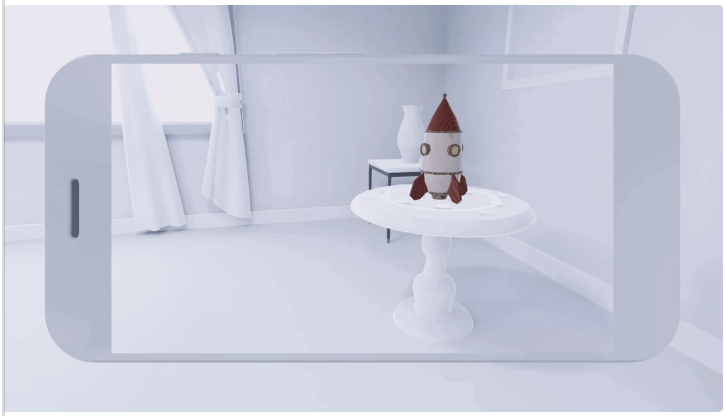
Encourage users to move a virtual object from one surface to another.

It's a fun way for virtual objects to interact with the real world. During the translation f transitions or changes in scale.

When both surfaces are virtual, make sure there's a visual distinction between the tw

Try to avoid sudden transitions that might create the illusion of changes in scale. Wh directions at once, it may appear to be shrinking or growing.

Moving objects in AR can feel less realistic then simply looking at them. Make it easy object is being moved, highlight the surfaces where the object can be placed.



Translation Limits

Add a boundary to show users how far they can move an object.

It can stop users from translating the object so far away that it becomes impossible t

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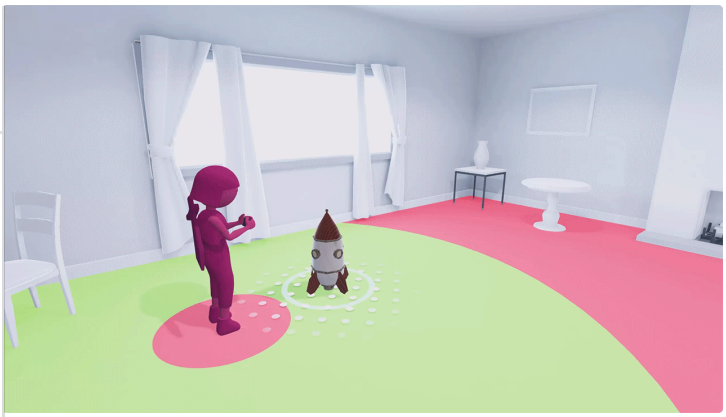

Use translation limits to keep objects close enough to interact with

Rotation

Rotating a virtual object lets the user orient the object's position in any direction. Obje automatically.

Manual rotation

Support both 1-finger and 2-finger gestures for manual rotation.

- To avoid conflicts with scaling, 2-finger rotation should only happen when both fin axis.
- To avoid conflicts with translation, 1-finger rotation should only happen when the

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Rotate by twisting an object with two fingers, or by swiping off the selected object

Auto-rotation

Avoid auto-rotating an object unless it's an intentional part of the experience. Persiste users.

Scaling

Scaling lets the user increase or decrease the size of an object. It's most often perfor

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Pinch to scale an object

Minimum and maximum scale

For an optimal experience, add a minimum and maximum scale limit. The more preci you can control the composition of the scene.

Consider adding a bouncing effect to indicate the object has reached maximum and once it's achieved the desired scale.

Add minimum and maximum limits to keep an object visible. Use a bounce effect to communicate to the user that they've reached a limit.

Scale and gameplay

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Playing with scale can add an unexpected aspect to an experience. Being surprised b
intention, can be either hilariously surprising or absolutely terrifying. Depending on yc
you can use surprise as a tool to evoke different emotions, whether a horror game or

You can also communicate scale with sound effects. Alter the scale and pitch of a sc
experience.

Surprise or delight your users by playing with scale

Gestures & proximity

Similar gestures or overlapping objects can make it difficult for the user to select an

Proximity

Consider the sizing of touch targets to allow for easy interactions.

Precise handling may prove to be challenging to users for objects that are small or di

When your app detects a gesture near an object, assume that a user is attempting to
targets despite the object's small size.

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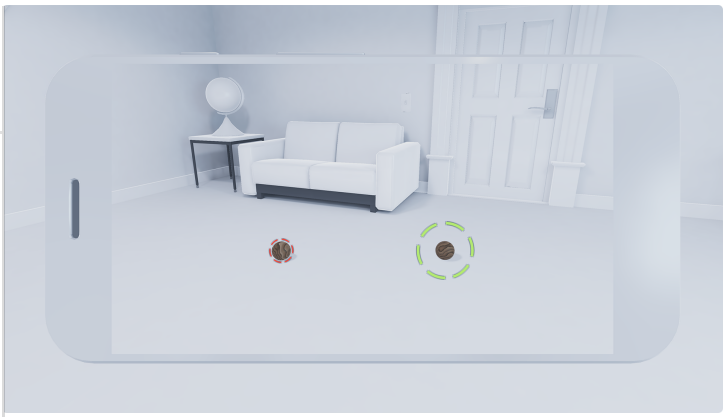

Provide touch targets that are big enough to tap, like the example on the right

Accommodate various two-finger gestures

Two-finger gestures are commonly used to rotate or scale an object.

These can include:

- Rotating an object with index finger and thumb (on the same hand)
- Touching the screen with thumb and index finger, holding your thumb still on the c
- Rotating an object with two thumbs (using two hands)

Include these touch interactions as a part of two-finger gestures.