Nreal Light Design Guide

A quick and simple guide aimed at providing fundamental design knowledge as well as establishing some common standards for user interaction in Nreal mixed-reality apps. The guide is broken down into four principle sections: Displaying, Controlling, Interacting and Navigating.

Displaying

This section explores ways of conveying visual information within the mixed-reality world, which can be less obvious compared to traditional screen based app designs.

Sizing

Object sizing can also be complicated in MR. A good way to think about this is by thinking about objects in real life. When working with objects in MR, always keep a reference on their size and distance from the camera with real life objects. For example, an apple is on average 8 centimeters in diameter and your hand resting on a table is usually around 40 centimeters away.

Colors

In mixed reality, **Whiter = Occludes more of the background (user's environment)** and **Black = Transparent**. Therefore, if you want the users to see the object, make it brighter. On the contrary, if you want to hide something, you can play with shadows and black. An easy way to visualize this is by trying out the "lighten" overlaying effect on adobe photoshop or by picturing how ghosts are usually depicted in films like the Harry Potter series.

Vibrant colors look great in the Nreal Light. However, for higher quality visual effects, it is recommended to stay away from an overuse of gradients.

Text

Due to the higher brightness and pixel density, text displayed with Nreal Light can be significantly easier to read when compared to most other head mounted MR devices. However, text is still tricky business in MR design and should be considered carefully.

Text Size

One of the major influences in text readability is font size. A good rule of thumb is to always keep the the size of text above 14px when it is at a distance of two meters away from the user. However larger text sizes are advisable when content is few, as this ensures minimum eye strain for the users.

Font

Simple and clear fonts in the family of san-serif is recommended as it requires less pixels for the same readability as the serif type phase.

Interactable Objects

Most apps are made up of a series of interactable objects that can be summarized with two large categories: selectable objects and movable objects. When using only a single type from the category, almost any combination of hover and select would be enough to satisfy the needs for visual feedback. However, when considering using both at the same time, more thoughts should be put on picking different feedbacks before and during the target and select process.

Selectable Objects

Selectable objects are unmovable objects that can usually be hovered on and selected to execute a command.

Selectable Effects in 3D	**Exemplar Scenarios**
Enlargement / Pulsing	Useful for any floating objects that are not in direct contact with another object.
Brightening / Change in Color	Functional in almost all situations, hence good for standardized feedbacks. Can however be viewed as unnatural or boring in some circumstances.
Object Animation	Vivid and lively especially with organic elements like plant, animal and food.
Colors and Effects on Ray	Serious scenes where objects should remain static and realistic.

Selectable Effects in 2D	**Exemplar Scenarios**
Brightening / Change in Color	Much of the 2D content will come directly from a native android / windows application, this will remain the most commonly used effect for target and select that users are used to.
Bounding box	Clear and easy to implement. Can be difficult to make artistic and interesting.

Movable Objects

Movable objects can be held and dragged or double-clicked and attached to the end of ray for more complex manipulation done via the trackpad. This section considers the visual feedbacks on scenarios where both selectable (non-movable) objects and movable ones co-exist. Therefore the movable method should be distinguished from the non-movable ones.

Movable Effects in 3D	Exemplar Scenarios
3D Bounding box	The 3D bounding box is the most straightforward way to signify movability. As it communicates configurability in many UI.
3D axis arrows, rotation circle and enlargement cube.	This is the best choice when the users are used to 3D modification programs, and when the application features complex object transforming and requires UI examples of what users can and cannot do during their current selection mode(s).
Different Animation	Vivid and lively especially with organic elements like plant, animal and food.

Movable Effects in 2D	Exemplar Scenarios
Make the Object's UI Pop Out From the Background	The current method for helping users distinguish movable objects from selectables in 2D environments is to make the UI different or by juxtaposing it so it pops out from the "background" of other selectables.
Broken Bounding Box	The standard method for configurable objects in 2D.

Organizing Objects

Plane Table

Organizing objects on planes is typically done in a table-like fashion, grouping objects in horizontal rows and arranging these groups vertically. With this setup, scrolling vertically shuffles through rows of grouped objects, which can be scrolled horizontally to go through each individual object.

There are two main ways to scroll through plane tables: dragging the objects vertically or horizontally in the opposite direction or simply swiping in that direction on the trackpad. For the current version of Nreal Light, the second method is more recommended although both methods can be implemented at the same time.

It is important to give visual cues to unfinished columns and rows where users can still scroll to unveil new objects. These can include faded edges, arrows or other icons indicating unread content.

Cylinder Arrangement

By wrapping the plane table horizontally around the user, one essentially ends up with a cylinder. This is an easy way to make the plane table experience more three-dimensional and fun. However, cylinders that are fully enclosed or have a radius that is less than two meters from the user can cause discomfort.

Sphere Arrangement

When objects are not necessarily grouped by logic, one can use a 3D ball model for organization. The ball should be around five meters in diameter and two meters away from the user. It can spin freely on the angle the user has last released their ray or finger on. This method of object collection gives the users greater freedom and is more complex three-dimensionally.

Clipping Objects

Nothing distracts the user from the MR world like clipping. Although Nreal has a forced clipping distance that is only a few centimeters away from the camera, clipping is still inevitable in some situations.

There are ways to smooth out the effects of clipping. For example, instead of the sharp clipping lines on the force clipping area, one can use effects like disintegrating pixels that start fading before the clipping lines and disappear steadily.

Controlling

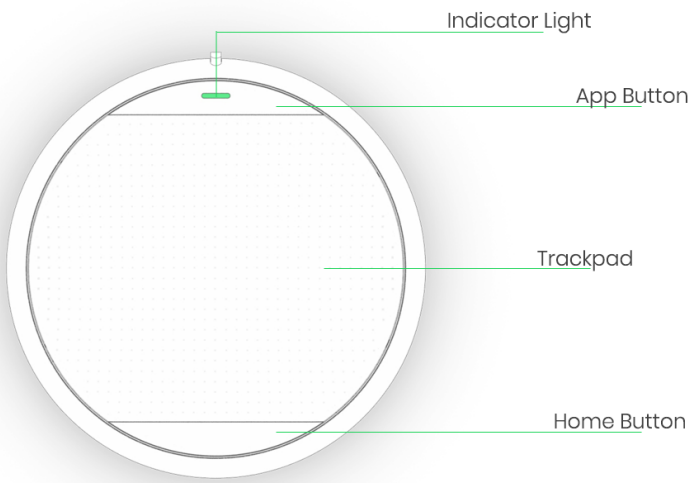
This section will explore mediums users can use to convert their thoughts and actions (input) into the mixed-reality world.

As of the current version, there are two 3 Degree-of-Freedom hand-held controllers as well as the 6 Degree-of-Freedom head position gaze. Other means of controlling, like 6DoF controllers, voice and hand gesture input are being actively worked on and will be made available in the near future.

Nreal Light 3 DoF Controller

Controlling with a light and minimal disk shaped controller that measures self rotation but not its own position.

Features



- 3 DoF (rotation) hand tracking
    - Suitable for most ray based selection and manipulation when the ray center does not have to be controlled by hand.

- 6 DoF head tracking-based ray center
    - You can translate and rotate the controller's ray center by moving your head.
- Pressable buttons

Button	Action	Example Use Case
Track pad	Click Hold Double Click	Select Manipulation - Drag Manipulation - Lock-on
Home (Bottom)	Click Long Press	Back a step Return to launcher
App (Top)	Click Long Press	Ray reset Switch ray center left and right
Left	Click	Last item to the left
Right	Click	Next item to the right

- Gesture compatible trackpad

Gesture	Example Use Case
Swipe from bottom to top	Shuffling menu items to the top [on Hover] Rotating objects to face up [Locked-on] Moving objects further away
Swipe from top to bottom	Shuffling menu items to the bottom [on Hover] Rotating objects to face down [Locked-on] Moving objects closer
Swipe from left to right	Shuffling menu items to the right [on Hover] Rotating objects to face right [Locked-on] Enlarging objects
Swipe from right to left	Shuffling menu items to the left [on Hover] Rotating objects to face left [Locked-on] Shrinking objects

Feedbacks

- Controller vibration

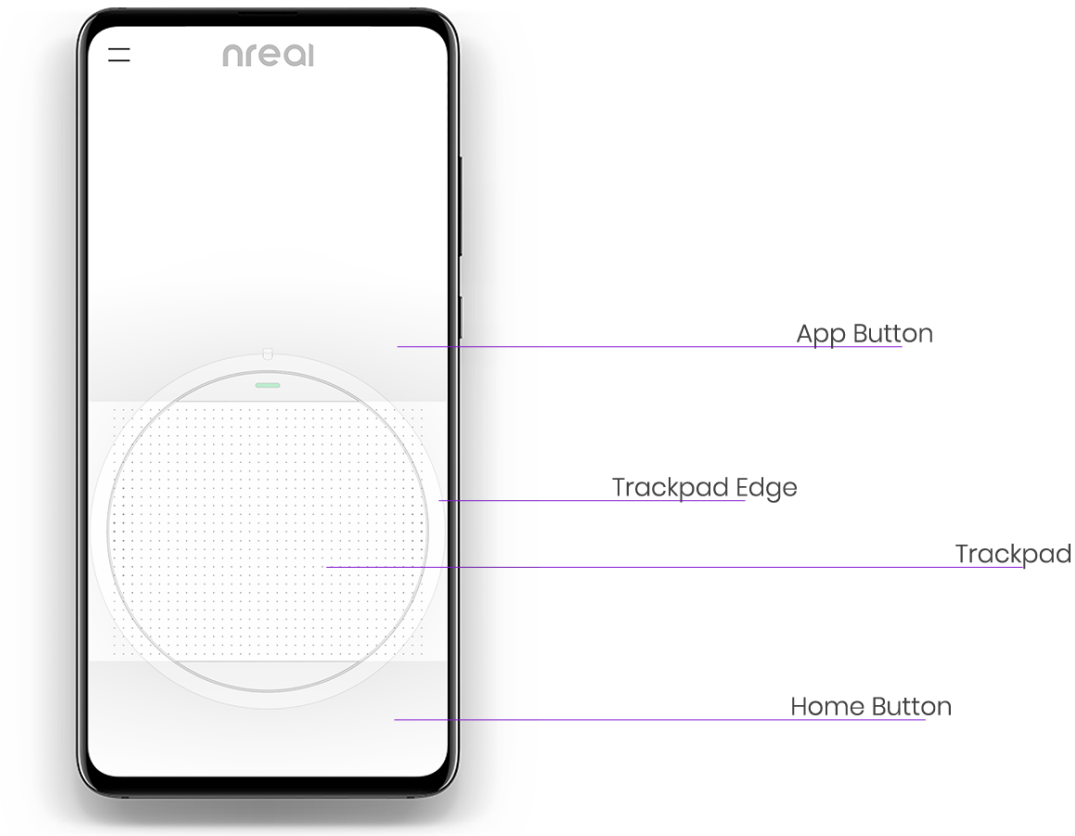
Common Use Case	Action	Vibration Count	Vibration Duration
On entering a selectable object	--	single	short
Select	On release	single	short
Step backwards	On release	double	short
Ray reset	On press	single	long
Returning to launcher	On hold On execution	single single	on hold short
Selecting an adjacent object through swipe or click	On execution	single	short
Object manipulation via swipe or circle drawing	On finger movement	multiple	very short

- Common visual feedback
  - on hover - possible feedbacks include subject enlargement, change in color, animation from static, and bounding box.
  - on select - possible feedbacks include subject pulsates in size, brightness, and bounding box color.
- Common auditory feedback
  - on enter
  - on select
  - on step backwards
  - on ray reset
  - on manipulation through trackpad swipes

Phone as a 3 DoF Controller

You can use the phone as a 3 DoF controller that is essentially identical to the previously mentioned disk shaped 3 DoF controller. To make controlling even easier though, the phone utilizes its extra space for a few added swipe gestures.

Features



- 3 DoF (rotation) hand tracking
    - Suitable for most ray-based selection and manipulation, when the ray center does not need to be controlled by hand.
- 6 DoF head tracking-based ray center
    - You can translate and rotate the controller's ray center by moving your head.
- Gestures compatible touchscreen

Gesture	Exemplar Use Case
Tap on trackpad	Select
Press and hold on trackpad	Manipulation (Drag)
Double tap on trackpad	Manipulation (Lock-on)
Tap on home (bottom) Swipe from either edge towards the center	Back a step
Long press on home (bottom)	Return to launcher
Tap on app (top)	Ray reset
Swipe from left to right	Shuffling menu items to the right [on Hover] Rotating objects to face right [Locked-on] Enlarging objects
Swipe from right to left	Shuffling menu items to the left [on Hover] Rotating objects to face left [Locked-on] Shrinking objects
Swipe from bottom to top	Shuffling menu items to the top [on Hover] Rotating objects to face up [Locked-on] Moving objects further away
Swipe from top to bottom	Shuffling menu items to the bottom [on Hover] Rotating objects to face down [Locked-on] Moving objects closer

Feedbacks

- Phone vibration

Common Use Case	Action	Vibration Count	Vibration Duration
On entering a selectable object	--	single	short
Select	On release	single	short
Step backwards	On release	double	short
Ray reset	On press	single	long
Returning to launcher	On hold On execution	single single	on hold short
Selecting an adjacent object trough swipe or click	On execution	single	short
Object manipulation via swipe or circle drawing	On finger movement	multiple	very short

- Common visual feedback
    - on hover - possible feedbacks include subject enlargement, change in color, animation from static, and bounding box.

    - on select - possible feedbacks include subject pulsates in size, brightness, and bounding box color.
- Common auditory feedback
    - on enter
    - on select
    - on step backwards
    - on ray reset
    - on manipulation through trackpad swipes

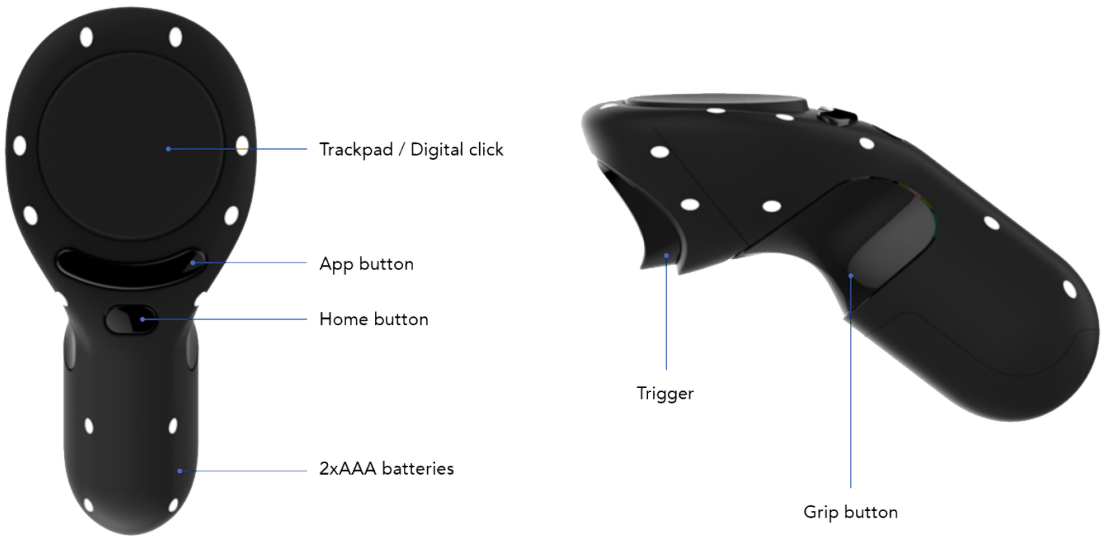
Finch as a 6 DoF controller

By utilizing the FinchShift™ controller from Finch Technologies, nreal supports 6 DoF controlling on both hands. This provides enough interactive features to make nreal compatible with most VR or MR apps.

Apps utilizing the 6DoF controller must inform users to connect to the controller on start if they are not yet connected to their FinchShift™. Failure in doing so may result in users not being able to perform necessary interactions within the app.

Note that the FinchShift™ controller is not provided in-the-box with the Nreal Light and is sold separately as an add-on. This means that it is possible that some users will not have the 6DoF controller capabilities. It is therefore recommended to provide a '3DoF mode' by reducing interaction features within your app so it supports 3DoF controllers when 6DoF controllers are not accessible to the user.

Features



- 6 DoF hand tracking
    - Suitable for complex ray based controls with the ray center following the controller's hands.
    - Suitable for mimicking physical objects held by the user's hands including but not limited to guns, cold weapons, rackets and bats.
- 6 DoF hand tracking on both hands
- Suitable for mimicking physical objects held by both hands of the user.
- Hand mode
    - Recreate the user's hands in virtual space with the use of 6 DoF hand tracking in conjunction with the trackpad, trigger and grip buttons.

- Pressable buttons

Button	Action	Exemplar Use Case
Track pad; Trigger	Click Hold Double click	Select Manipulation (Drag) Manipulation (Lock-on)
Home	Click Long Press	Back a step Return to launcher
App	Click Long Press	Ray reset Switch ray center left and right
Grip	Hold	Grabbing hold of an item
Left	Click	Last item to the left
Right	Click	Next item to the right

- Gesture compatible track pad

Gesture	Exemplar Use Case
Swipe from bottom to top	Shuffling menu items to the top [on Hover] Rotate objects to face up [Locked-on] Moving objects further away
Swipe from top to bottom	Shuffling menu items to the bottom [on Hover] Rotate objects to face down [Locked-on] Moving objects closer
Swipe from left to right	Shuffling menu items to the right [on Hover] Rotate objects to face right [Locked-on] Enlarging objects
Swipe from right to left	Shuffling menu items to the left [on Hover] Rotate objects to face left [Locked-on] Shrinking objects

Feedbacks

- Vibration on controller

Common Use Case	Action	Vibration Count	Vibration Duration
On entering a selectable object	--	single	short
Select	On release	single	short
Step backwards	On release	double	short
Ray reset	On press	single	long
Returning to launcher	On hold On execution	single single	on hold short
Selecting an adjacent object trough swipe or click	On execution	single	short
Object manipulation via swipe or circle drawing	On finger movement	multiple	very short
On collision between hands and an object in hand mode	--	single	short

- Common visual feedback
  - on hover - possible feedbacks include subject enlargement, change in color, animation from static, bounding box...
  - on select - possible feedbacks include subject pulsates in size, brightness, bounding box color...
- Common auditory feedback
  - on enter
  - on select
  - on step backwards
  - on ray reset
  - on manipulation through trackpad swipes

Gaze

Controlling with the position and direction that the user is facing. It is best to use gaze in coordination with controller methods to enhance user experience. However, on rare occasions where both of the user's hands are occupied, gaze can be used to provide a dependable way for targeting and selecting.

Features

- 6 DoF Head Tracking
  - Suitable for areal attention directing
- 6 DoF Head Tracking with vision center
  - Suitable for targeting during extremely light interactions
  - Suitable for targeting when both hands are not available

Feedbacks

- Visual feedback
    - on areal attention - possible feedbacks include subject enlargement, coloration, and start of animation. This effect is created by including a "not looking" mode where the app is less pronounced when attention is not directed to it. Some apps can go to sleep when they leave attention for a given amount of time.
    - on enter - possible feedbacks include subject enlargement, change in color, animation from static, and bounding box.
    - on select - possible feedbacks include subject pulsates in size, brightness, and bounding box color.
- on dwell select - display timer over vision center.
- Auditory feedback
    - on enter
    - on select

Developing with Controllers

To learn more on the details in developing apps that utilizes controllers and even try out a sample app, check out the Nreal Controller Guide.

Interacting

Mixed reality apps are meant to be interactive. This section discusses the fundamentals of interactive apps like targeting and manipulating objects.

Targeting

Ray

The ray is the default method of selection designed for Nreal Light. It is a clear and 3D method of selection and is supported by all controlling devices currently compatible with Nreal Light.

The concept of the ray is a straight line projecting forwards from the ray origin which is often close to the user's controller holding hand. For the 3DoF controller and phone, the ray origin is by default 50 cm below the user's headphones and slightly offset to the right or left depending on the user's habitual hand. For the 6DoF controller however, the point of projection should ideally be overlapping with the user's controlling hand.

Cursor

A cursor is the point of contact of the ray with the content object and can be used with or without the ray. When used in conjunction with the ray, the cursor provides a clearer point of action and can display other visual feedbacks like hover and swiping. Using the cursor alone can also be a good way for visualizing selection in 2D applications as it removes the sometimes distracting ray in the foreground.

The cursor can have different states like "hovering", "pressed" and "swiping". It can also be used to differentiate non-selectable, selectable and movable objects when applications contain a large amount of objects with different properties.

Gaze and dwell

Gaze alone as a selection method can still be used for less interactive applications like video-streaming or book-reading. The gaze and dwell method requires users to focus their gaze center on a selectable object for a given period of time. This means that the users, while using gaze and dwell as a selection method, can free up both hands for activities like dining or work.

Manipulation

Moving and turning objects around in 3D space is one of the most complicated interaction in MR and requires some degree of learning no matter the controlling method. It is therefore strongly advised to follow this guide for a standardized manipulation logic.

Simple Grab and Place

Simple grab and place allows users to quickly grab an object or window with the ray or cursor by holding the trackpad. In this mode, users can move the object in a spherical path around its ray origin with the object always facing the front of the user (simulating a fixed ray length). Users are also unable to change the ray length during simple grab and place. Therefore, in order to move an object forward, the user must move physically with his headphones and ray origin. For more complicated manipulations such as rotation, scaling and ray length, it is recommended to incorporate them in hover and fixed to ray modes.

Object follows ray/cursor	Change object distance	Scale object	Rotate object (ground plane)	Rotate object (side plane)
√	×	×	×	×

Fixed to Ray

To fix the object to the end of the ray or cursor, double click on the object instead of holding onto it. By fixing the object to the end of ray, users can release their finger to more freely perform trackpad gestures, which is required for object manipulation beyond simple ray following.

	Object follows ray/cursor	Change object distance	Scale object	Rotate object (ground plane)	Rotate object (side plane)
1	√	swipe up and down	×	swipe left and right	×
2	√	swipe up and down	swipe left and right	×	×

Hover Manipulation

Hover manipulation is faster than the fix-to-ray method but provides less control. By aiming the ray at the object and doing gestures directly, objects can be manipulated in a similar or complimentary way with fixing to ray. The object's center however will always remain stationary during hover manipulation.

	Object follows ray/cursor	Change object distance	Scale object	Rotate object (ground plane)	Rotate object (side plane)
1	×	×	swipe up and down	swipe left and right	×
2	×	×	×	swipe left and right	swipe up and down

Navigating

This section covers basic operations that helps the user navigate through Nreal's mixed reality system, like how to get from menus to menus, apps to apps.

Select

The default method for selecting any interactable object is by first targeting it and then performing some kind of action to select.

Means of Targeting	Selecting Action
Ray and/or Cursor	Tapping or clicking
Vision center	Dwell for n seconds, Tapping or clicking, Voice commands*
Hands (hand mode)	Mimicking pointing gesture and pressing, Mimicking grabbing gesture

Back

By default, single clicking the home (bottom) button is dedicated for returning to the app's previous view (back) on every hands-on method of controlling. This allows quick navigation in and out of different views within an app. However, for apps that are intended to be compatible with hands-free methods like the gaze and dwell, there should be an interactable object or app tray to satisfy the back function.

Closing an App

Closing an app is performed by long-pressing the home button. With the current SDK version which doesn't support multi app, this will also bring the user directly back to the launcher.

Adjusting Ray Origins for 3DoF Controllers

The ray origin is the beginning point of a ray which is stationary when rotating the controller.

Since there are no absolute positions for a 3DoF controller, one can only assume that at the moment a ray is first casted (presumably on the start of an app), the user is pointing their controller towards the center of their field of view (a natural thing to do). However, that might be wrong: the users could be pointing their controller far off from center on the moment of ray cast. In this case the ray will be misaligned, making content targeting much more difficult.

When this happens, you will have to provide a means for the user to consciously readjust the direction their controller is pointing and refresh the ray cast to their vision center. By default, this is done by clicking the app button once.

Switching Between Left and Right (3DoF Only)

Since ray origin for 3DoF controlling methods is relative to the absolute position of the user's head, it is unknown if the controller is in the user's left or right hand. Therefore, if the ray origin is offset to the wrong side, targeting would feel very awkward: almost as if the user was using a mirrored laptop!

By default, ray origin is switched to the opposite side by double clicking the app button.

App Tray

App trays provides more complex secondary actions that can be performed on an object and is customized for each individual app. This is similar to the right mouse button on the windows system. Often, the app tray is shown after a single tap on the app button. This is replaced by a long press in the Nreal Light as single tap is being used for ray re-adjustments.

Next Step

Read the Developer Guide to learn more about how to develop a mixed reality app on Nreal Light.