HairStudio doc

HairStudio is everything you need to get beautiful and realistic hair in Unity. Author the hair style inside the editor, tweak the physic simulation and render tens of thousands of individual hair strands in milliseconds.

Here is some documentation to easily get started.

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HairDressing script

Allows the creation of a hair dressing directly inside Unity editor.

The game object this component is attached is called the scalp. The hair roots will follow the scalp's translation and rotation (changing scalp scale is not supported). In most scenario, the scalp game object will therefore be the head bone of the character rig.

Authoring is made in three steps:

- paint roots onto the scalp,
- generate the hair guides,
- dress the guides.

General information

Scalp game object should be situated in the approximate center of the scalp volume. This allow roots' lines and new guides being oriented in a convenient way.

When the scalp is selected (and HairDressing component is expanded), roots and guides become visible and the mouse pointer act as a brush.

You can change the brush's size and strength by holding control key and move the mouse (left/right changes size, up/down changes strength).

Note that the brush won't work through any collider. In many situations, it may be useful to place a collider to brush only a part of the hair dressing.

Properties

Hair density

The number of generated hair strand will be the number of roots multiplied by this value. So 3,000 roots lead to 30,000 strands with a density of 10.

Clumping

An effect to pull hair strands in direction of their closest guide upon generation, leading strands to clump around guides. The pulling along the strand is defined by the clumping multiplier curve. Typically, the clumping start at 0, become negative, then goes to 1 using a sigmoid curve.

For each strand, a clumping value is randomly chosen between min and max values.

Waviness

An effect to randomly move the strand segments upon generation to simulate waviness.

The amplitude defines the distance a segment can be moved from its ideal position. An amplitude multiplier curve can be set to control the amplitude along the strand. Typically, the amplitude will dramatically strengthen at the tip.

The frequency defines the randomness of the noise. 10 leads to long waves, 100 leads to short waves, 1000 leads to a non-combed effect.

Max segment count

The number of segment of a hair strand is dependent on the number of segments of its guide(s). You can limit this number by setting a value different from zero here. Limiting the number of segments has the following effects:

- strands have more angles,
- physics simulation will be faster and more stable,
- collision may fail if the segment is longer than the collider size.

Random seed

An arbitrary value used by the random number generator to ensure the strands to be generated exactly the same way each time. Changing that value to another arbitrary number can help in fixing some rare randomly generated artifacts, especially when using interpolation.

Roots

Roots are placeholders where the hair strands will be generated. Roots are only visible during dressing.

When the root tab is selected, the root brush is active. Drag the mouse (with left button pressed) to paint roots on the surface. Drag while holding shift key to remove roots.

ScalpCollider

The only requirement of HairDressing is a MeshCollider. This collider is used as a hit surface to paint the roots on. It can be disabled or deleted once the roots have been painted, but remember that this collider may help preventing other brushes to work through the scalp.

Note that roots won't follow this collider if it moves. It can be on any game object with no hierarchical relation with the scalp.

RootRadius

Defines a circle around the root in which a hair strand may be generated. The radius is also used by the root brush to correctly space the roots.

Zones

Root zones are used to prevent interpolation between some hair strands. When using interpolation, generated strands will only interpolate using nearby guides situated in the same zone. This is mainly used to part hair.

There are three zones A, B and C, and three intermediate zone AB, BC, and CA. A strand in an intermediate zone will interpolate with both compatible zones. Intermediate zones are used to smoothly end a parting in the middle of the hair dressing.

See interpolation below.

Guides

Guides are samples of hair used to shape the hair style. They are used to generate actual strands when the simulation starts. A single guide can be used to generate hundreds of surrounding strands.

Combing brush (when the guide tab is selected, this brush is active by default)

Drag the mouse to comb the guides. Note that guides are always combed orthogonally to the camera, so combing generally requires a lot of camera orbiting, using the tool at different strength.

Trimming brush.

Drag the mouse to trim the guides. Hold shift to make the guides grow.

Selection tool.

Click on a guide to toggle selection (select or unselect it). Unselected guides are ignored by combing and trimming brushes, allowing to work only on part of the guides at one time.

Select all guides.

Unselect all guides.

Delete selected guides.

Toggle interpolation mode for selected guides (see interpolation below).

Add guide.

Click to manually place a guide on the surface of any collider. The current properties of the guide generator are used to create the new guide (see guide generator below)

About interpolation

Interpolation allows to generate strands according to many guides instead of one.

When interpolation is off on a guide, nearby strands will only use this single guide as reference, leading to an independent lock of hair. Clumping and waviness can offer a correct pattern but for smoother style, interpolation is required.

When interpolation is on, a strand will use many nearby guides as reference, by interpolation. This leads to perfectly smoothed strands in the space between guides (clumping is still applied, pulling the interpolated strand to the closest guide).

As the strand will be the interpolated result of many guides' shapes and length, it may lead to unexpected results if interpolation is made between guides that are very different. Parting the hair using root zones can help preventing this issue, as well as adding more guide in the area, with intermediate shapes and lengths.

Colliders

The sphere colliders used by the combing and trimming brushes. Note that the scalp collider is not used here.

Scalp spacing

The minimum distance the start of a guide can approach the colliders, when using combing and trimming brushes.

Scalp spacing at tip

The minimum distance the tip of a guide can approach the colliders, when using combing and trimming brushes. Can be used to enforce volume in the hairstyle, forcing the tip away from the head.

Guide generator

Guides are generated randomly on the roots when you use the guide generator. 500 guides for a single hair style is considered a maximum.

Number of guides: The number of guide to generate. If set to zero, the density will be used instead.

Density of guides: The number of guides to generate in relation to the number of roots.

Segment count per guide: the number of segments guides have.

Segment length: the length of the guide's segments. Shorter segments will offer smoother curves, at the cost of physic simulation performance and vertices count.

Notes

Hair strands are generated once when the game starts. Most of HairDressing properties change won't affect the hair dressing in play mode and will require a restart.

HairSimulation component

Physic simulation of hair

With HairStudio, every single strand of hair is simulated. Many forces are working together to provide a realistic simulation while keeping animation in control. HairSimulation script contains the parameters to achieve your specific needs in the matter.

General information

HairSimulation is a physic simulation. As such, it uses the physics parameters of the Unity project, like gravity or fixed timestamp, and runs during the fixed update.

An additional de-penetration step occurs in the rendering update, to prevent strands penetrating the colliders if more than one rendering is produced between two physic steps (as colliders may have moved without physics being update). This de-penetration may lead to unrealistic physics.

The simulation is performed whenever the object and component are active, even if they are not visible in the scene or behind the camera. In many situations, it is good practice to force stop the simulation to save performances.

Physics

Collision distance

The physical thickness of hair strands, meaning the minimum distance it can approach a collider. Note that only the strand's nodes are concerned. If the collider is small enough, or your strand's segment long enough, penetration can occur.

Weight

The gravity force applied. This should be a small value, except for particular cases like wet hair. No gravity at all is also acceptable in most short hair dressings.

Drag

A dumping force applied. Drag will slow the hair velocity. There should be at least a little drag to avoid erratic motions. Too much drag will cause the hair to be late and over behind during fast motion. A drag bigger than 2 should only be used for specific situations like underwater simulation.

Stiffness

Stiffness allows to preserve the hair style and shape. There are two different systems to achieve that goal.

Local stiffness

This represents the stiffness of the hair. More specifically, each hair segment related to the previous segment. This effect will preserve the shape of the second half of the strand, even if the first half has moved from its original position. A large value will lead to unstable simulation and can be solved with more iterations (see below).

Local stiffness is an important effect for long hair, as it will provide a good shape preservation even far from the scalp.

Global stiffness

This is a non-realistic effect that will bring the hair back to its original position, relatively to the scalp. Also known as root stiffness, it will ensure the stability of the first part of the strands. This effect is

mandatory in most situation, to avoid hair to come in front of the face, to keep locks stuck behind the hear, to add stability to the upper hair…

Global stiffness applies at full strength on the root side, and weakens linearly in direction of the tip, thanks to both parameters “start” and “end”, for example:

- 0/1 leads to a locked root and free tip,
- 0/0.5 leads to a locked root but no global stiffness farther than the half of the strand,
- 0/0 leads to no global stiffness at all,

Note: if Global stiffness start is equal to 1, strands are locked in position from the root to the tip. In this specific case, the whole physic simulation will be turned off to save performances. This is useful for hair styles that does not require simulation at all (short, shaved, less important characters).

Global stiffness end is ranged from 0 to 2, which is not intuitive. As the global stiffness is decreasing linearly, a value of one will still allow the tip to be completely free. Increase the value beyond 1 to add global stiffness to the tip.

Simulation

Length iterations

The number of iterations made to resolve the length of each segment. Two iterations are enough in most situations. A bigger value can be used if the simulation requires fast accelerations.

Stiffness iterations

The number of iterations made to resolve the local stiffness. The longer the hair, the more is required. A bigger value will lead to a more stable simulation if local stiffness is strong, at the cost of performances.

Colliders

The colliders used during the simulation. For now, only sphere colliders are allowed.

Note that the colliders used in the HairDressing component are not used at all during the simulation.

Friction

This hair-to-hair effect simulate the friction between hair, by using the nearby hair velocity to move the segments together. This is mandatory for long hair with large motion amplitude.

Repulsion

This hair-to-hair effect will simulate fluffiness by pushing hair away from neighbors. Useful in rare situation like:

- Simulating a sudden fear,
- Hair inflation after hair drying,
- Simulating an electrocution,
- Etc.

HairRenderer

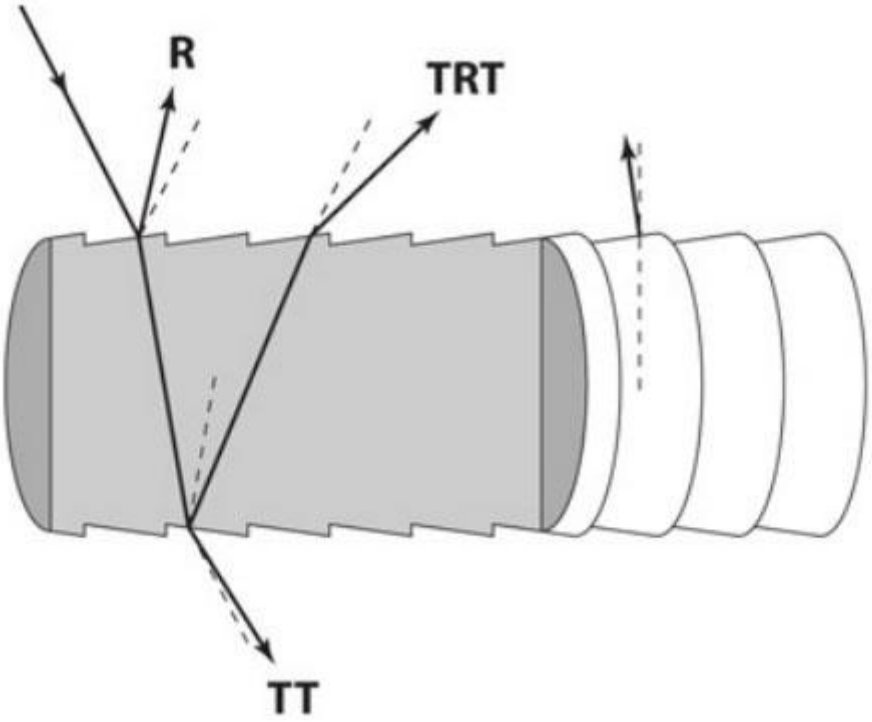
Draws the hair for each camera

Hair rendering is a complex topic due to the very nature of hair. Light comes into the hair, transmit and bounces from strand to strand, grabbing a subtle color in its path before leaving the hair volume back to the camera. A solution must be found to approximate these interactions, allowing believable but fast rendering for real-time applications.

HairStudio relies on a Physically Based Rendering (PBR) model proposed by Marschner et al. In this model, three sort of light is managed:

- The light that bounces at the surface of the hair, with no color,
- The light that goes straight through the hair fiber, carrying the inner color,
- The light that enter the hair fiber then bounces inside, carrying more color and with more angle.

Here is a schema, courtesy of Marschner et al.



HairStudio adds a fourth light which is a simple diffuse, applied where there is none of these specular light.

HairStudio shader does the math. It only need some base parameters (see below) and most of the others will be calculated automatically. By convention, a parameter set to the minimum value of the slider will be overridden internally by the real-life value.

HairStudio also allows a more artist friendly approach, with non-realistic features. For each light feature, the artist can choose a custom, non-realistic color, specular angle, roughness and intensity. This may lead to the creation of more light than the hair receives, and should not be considered PBR anymore.

HairStudio only support this single scattering for the moment. Semi-transparent hair like blond hair will not look very realistic most of the time because light interaction from hair to hair is not supported. Real time solutions exist and this is a planned feature.

HairStudio does not support self-shadowing. The inner part of a fluffy hair style will look too bright. This is a planned feature as well.

Material

The material to use for the hair. This material must use the HairStudio shader.

Update material

For performance reasons, the material is duplicated internally and any change in the material won't be visible in realtime. You can check this option to update the material each frame, at the cost of performance.

Note that this update will never be active in a standalone application.

If you change the material values in script, you can manually call the UpdateMaterial method to make the changes effective on the hair.

Distance for min/max detail

HairRenderer supports level of detail based on the camera distance. At the distance for max detail and closer, all strands will be rendered. If the camera goes farther, more and more strands will be ignored. When the camera reaches the distance for minimu detail and further, only one strand out of 30 will be rendered.

Material

These are the properties of the hair material, once you have choosen the HairStudio shader.

Diffuse

Color D

The color of the diffuse feature. Realistic is less saturated than both second reflection and transmittance.

Intensity D

The intensity of the diffuse feature. Set the minimum value for realistic override.

Reflection feature R

Color R

The color of the reflection feature. Realistic is white as the light bounces on the surface of the hair.

Intensity R

The intensity of the reflection feature. Represent the light absorption. The sum of the intensities of all features should not be greater than 1 (or you would create light out of nowhere).

Angle R

The angle of the reflection feature. Realistic is between minus 10 and minus 5 degrees.

Width R

The width of the reflection feature. Realistic is between 5 and 10 degrees.

Transmittance feature TT

Color TT

The color of the transmittance feature. Realistic is more saturated than reflection, but less than second reflection.

Intensity TT

The intensity of the transmittance feature. Set the minimum value for realistic override (Intensity R x 3).

Angle TT

The angle of the transmittance feature. Set the minimum value for realistic override (minus Angle R x 0.5).

Width TT

The width of the transmittance feature. Set the minimum value for realistic override (Width R x 0.5).

Azimuthal width TT

The width of the transmittance feature perpendicularly to the direction of the hair.

Second reflection feature TRT

Color TRT

The color of the second reflection feature. Consider it as the base color of the hair.

Intensity TRT

The intensity of the second reflection feature. Set the minimum value for realistic override (Intensity R x 0.5).

Angle TRT

The angle of the second reflection feature. Set the minimum value for realistic override (minus Angle R x 1.5).

Width TRT

The width of the second reflection feature. Set the minimum value for realistic override (Width R x 2).

Glints G

Color G

The color of the glints. Realistic is more saturated than second reflection.

Scale G

The intensity of the glints. Set the minimum value for realistic override (Intensity R x 2).

Azimuthal width G

The width of the glints perpendicularly to the direction of the hair. Realistic is between 10 and 25 degrees.

Separation angle G

The half angle between the two glints. A higher value will separate the left and right glints.

Hair shape

Hair color nuance

A multiplier for all colors applied differently on each strand, to add noise on the overall color.

Thickness at root

The thickness of the hair strands at the root.

Thickness at tip

The thickness of the hair strands at the tip.

Thickness decrease distance

The distance from the root at which the thickness starts to decrease.