The Toby Foliage Engine - Light

Version 1.0.0

Documentation

Toby Fredson

florianalexandru05@gmail.com

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Product Overview

Introducing the Toby Foliage Engine (TTFE), the innovative single-pivot vegetation system that attempts to simulate multiple pivots per mesh, similar to Pivot Painter. These Amplify shaders provide a comprehensive solution for achieving realistic wind and plant shading. Its seamless integration and user-friendly interface make applying it to any mesh easy. There is **no need to worry about conversion** or any cumbersome steps as the shaders streamline this process.

TTFE is an automatic feature that works in conjunction with PBR shading. The wind physics is affected by internal mesh-based vertex position volumes. You can control the size of your volume to mask out wind in your material settings. Similarly, you can modify the behavior of your wind through the material settings.

These shaders are designed to provide optimal performance and quality for game foliage. They are created using the **Amplify Shader Editor** to be **simple and efficient**.

*** Please note that the light version includes only the essential features and only one basic wind type is available!**

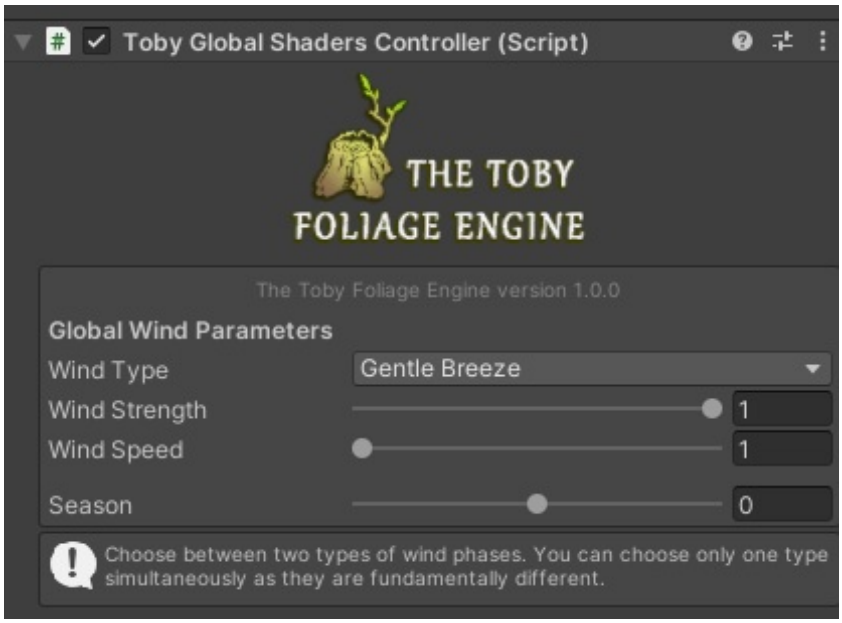
*** Amplify shader functions are not available, you can only open the shaders in code.**

Grayed-out features will be labeled as unavailable. *Example, very light gray.

(TTFE) Global Controller

This gizmo changes material settings for all shaders simultaneously. You can drag and drop the "(TTFE) GLOBAL CONTROLLER" prefab in the scene to do so.

You can find the prefab located in: Assets\Toby Fredson\The Toby Foliage Engine\(TTFE)_Core\Resources\(TTFE) GLOBAL CONTROLLER



Global Wind Parameters

- **Wind Type**

  Choose between two types of wind phases. You can choose only one type simultaneously as they are fundamentally different.

  - **Gentle Wind**
    Generate a gentle and realistic wind effect based on pivot rotation. This effect mimics the subtle rotations of plants growing in clusters, such as wheat fields. It will affect grass and trees but does not include directional trunk bending in trees. However, the branches will still be affected by the wind.

    *(Most performance friendly) -6 FPS, 1.5 ms

  - **Strong Wind**
    Intense wind pulse is driven by a 2D texture noise (3 vector RGB). Affects grass and trees.

    *(Most performance intensive) -10 FPS, 2.5 ms

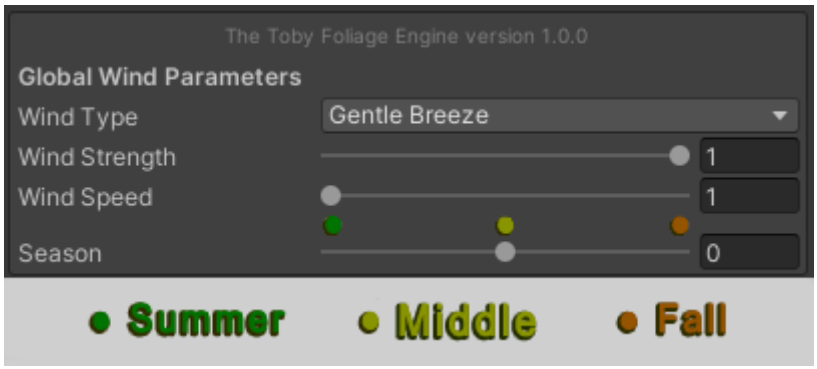
  - **Wind Off**
    Turns off the wind completely via a static switch.

    *(Saves performance) -0 FPS

- **Wind Strength**
  Wind intensity can be controlled and set to 0, but it's not the same as "Wind Off" and may affect performance.

- **Wind Speed**
  Controls the wind speed.

- **Seasons**
  Use the slider to adjust the season from summer to fall. You can customize more options in the material via the "Season Settings" of the shader. Adjusting these settings will largely influence the appearance of your leaves in different seasons.



The color change will be reflected in the global gizmo.

Known Bugs

- If after adding new vegetation prefabs to the scene, the sliders don't seem to influence the wind, don't worry, this is just a default glitchy behavior. To fix this issue, copy and paste a new controller into the scene or reload the scene again. This should help resolve the problem.

- When opening a new scene, the wind might default to one phase or another, and the leaf and bark material will mismatch settings. To fix this, move the sliders or change the wind type.

- When saving the scene, the wind defaults to another phase. This is a glitch. Saving your scene first is recommended, make changes in the wind gizmo after, and don't save. The wind settings will be stored in the gizmo.

Known Issues

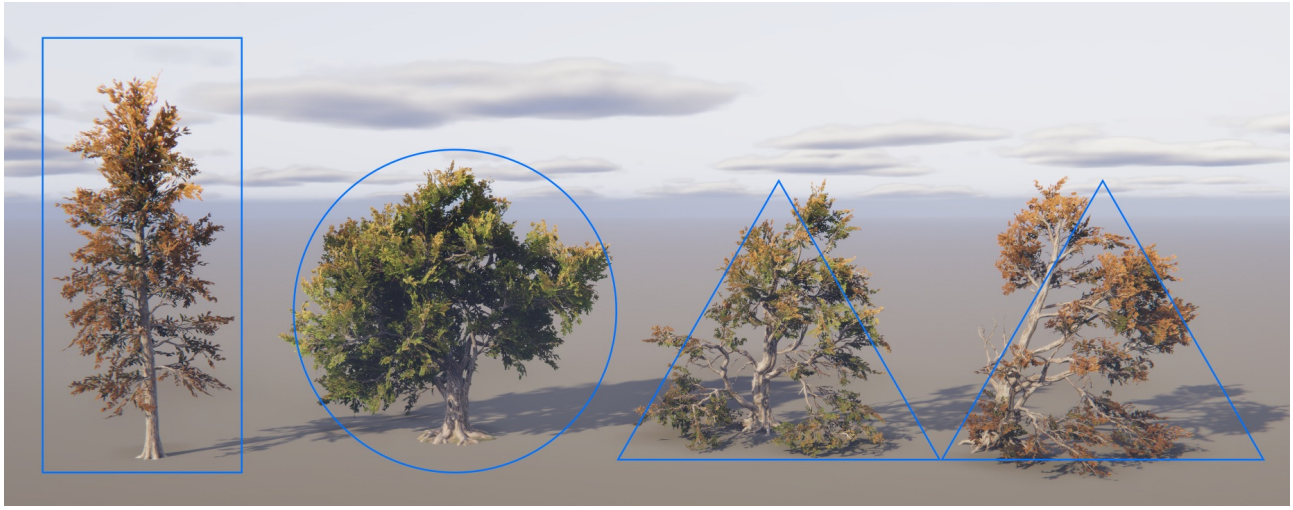
It has been observed that moving sliders in the global controller of a larger scene might appear to be laggy. Although the exact reason for this is unknown, it is strongly assumed that it could be due to the controller handling more than four shaders at a time. It is worth noting that this issue might be resolved in the future, and it's not yet suitable for real-time use in large scenes.

Shaders Overview

To effectively adjust TTFE shaders to fit specific requirements, it is paramount to possess a comprehensive understanding of their strengths and limitations. The shaders are capable of handling various shapes of trees, however, the wind effect applied to the trees will behave realistically based on their size and height. It's possible that this may not produce the desired outcome in some cases, so you may need to make some adjustments yourself.

The main tree shapes are as follows:

1. Simple tube - Tall trees and pines.
2. Round - Broccoli-like trees that can also have a thick base.
3. Irregular - The most difficult type of tree, branch bending would be impossible without Pivot Painter.



When creating a tree in your 3D application, consider atlasing your textures based on the tree's shape, as different shapes require different settings and materials, because the wind mask must correlate with the trunk thickness.

The bottom image depicts how the wind mask can vary across different trees (Fig. A).

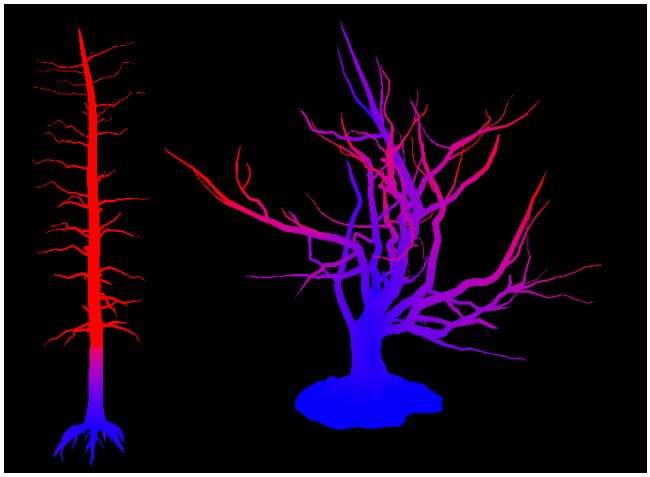


Fig. A

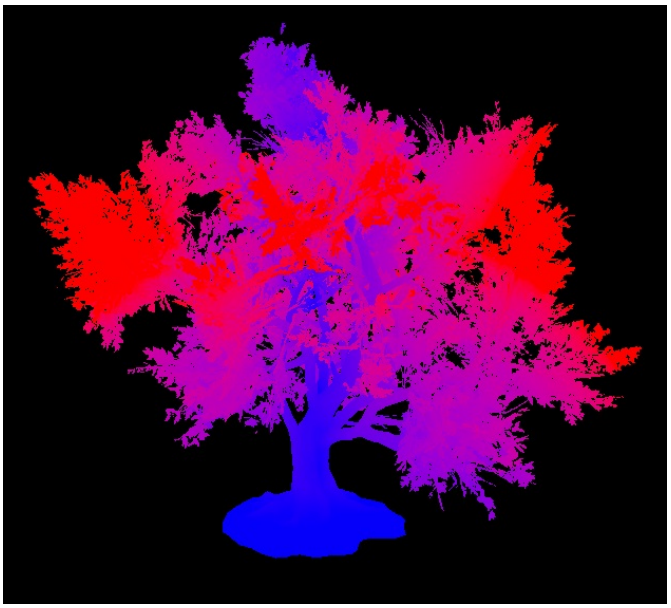


Fig. B

It's important to ensure that **bark and leaf materials** have **the same mask and wind** settings to avoid mismatch (Fig. B).

How it Works Behind the Hood

TTFE uses a series of vertex position nodes multiplied by UV texture coordinates, vertex normals, and tangents to rotate the entire mesh based on its point of origin. It does this in more than a few phases giving the illusion of more complex bending.

Inside the shader, the wind system is divided into 3 sections; Trunk wind, branch wind, and leaf wind which contains all the various leaf noises for cards.

Due to the employed method, ***visible stretching*** *may occur in the trunk and branches. Adjust the material settings until the desired outcome is achieved.*

Limitations

- TTFE is designed to work with instancing, static batching is not supported.
- TTFE is slightly more expensive for mobile but can be optimized by removing features.
- Shader Model 4.5+ capable devices are required (Desktop / High-End Mobile).
- While Mobile is supported, the scenes are intended for performance testing and will not be suitable for mobile devices (performance-intensive scenes).
- Only the latest LTS Unity versions are officially supported.

Vertex Colors

The TTFE feature is functional without the implementation of vertex colors. However, green vertex color is necessary for the "flutter feature" to work on leaves but grass does not require any vertex colors. Vertex colors Red (self-shading/Ao and seasons) and green (leaf flutter) are used.

Note that other features, such as seasonal color changes and self-shading, work without vertex colors, but the presence of vertex colors enhances the overall effect.

You can debug vertex colors by enabling “[DEBUG] Compute Vertex Colors”.

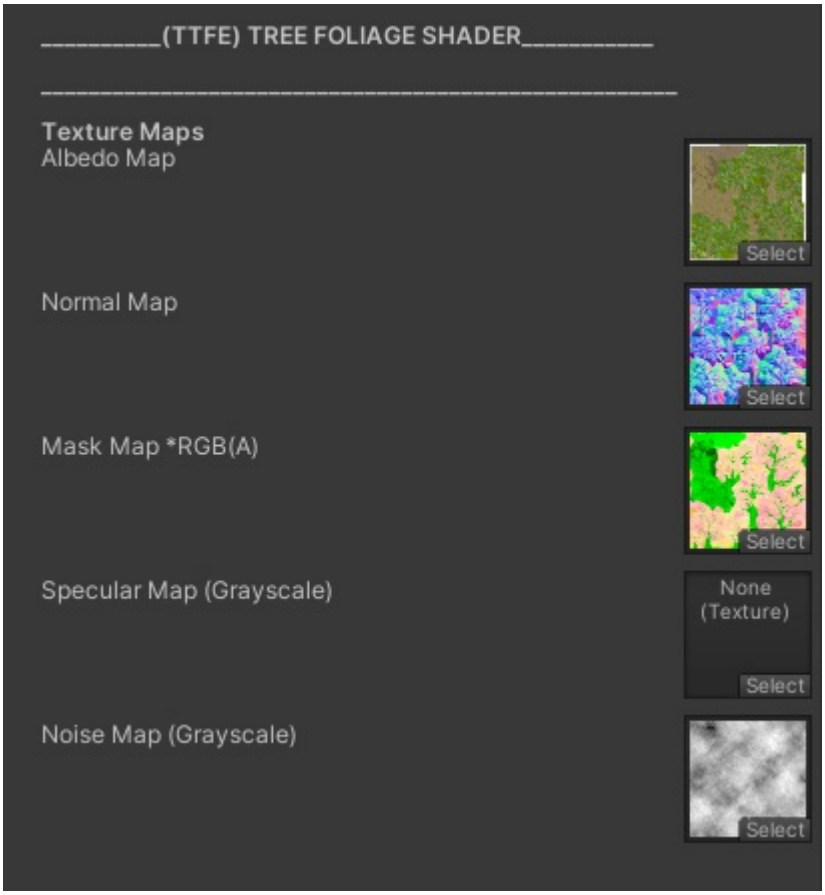
Shader Settings

TTFE includes six shaders:

1. (TTFE) Grass Foliage
2. (TTFE) Roots
3. (TTFE) Tree Bark
4. (TTFE) Tree Foliage
5. (TTFE) Tree Billboard
6. (TTFE) Uber Cliff

We'll go over some of the settings below. For the sake of simplicity, only the relevant settings will be documented.

Texture Packing



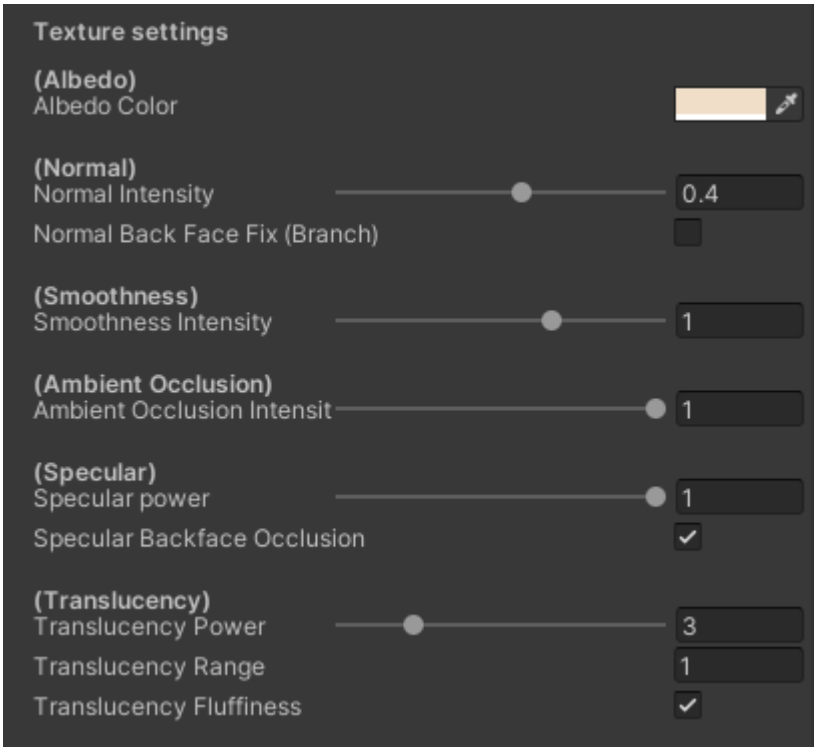
- **Mask Map *RGB(A)**
  - R - Branch mask (masks out non-leaves in the texture and prevents them from changing color with seasonal change).
  - G - Ambient occlusion.
  - B - Translucency.
  - (A) - Smoothness.

- **Specular Map**
  (Grayscale) - White is specular, black is not specular (Works only with "Specular Backface Occlusion" on).

  * Only supported in URP

- **Noise Map**
  (Grayscale) - Used as a texture mask for season color.

Texture Settings



- **Normal Back Face Fix (Branch)**
  This branch shading is used for cards with dead or dry branch textures. It corrects the normal map on the backside by flipping the Z channel.

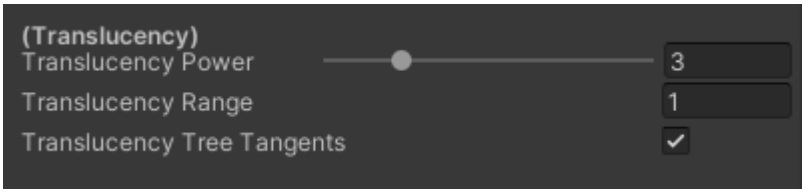
- **Specular Backface Occlusion**
  Attempts to remove the specular from the backside by recalculation vertex normals. An additional specular map can be added for more control (works with the “Specular Map” channel).

  **In Built-in, this is an expensive feature and should be avoided if possible.*
  **In URP, this feature has been removed but the specular map is still used to mask out specular.*
  **In HDRP, this feature has been completely removed.*

- **TTFE Translucency**
  New and Innovative deferred translucency that gets automatically occluded in shadow by a feature called “Translucency Ao”. Works in Built-in, URP, and HDRP (only additional to the diffusion profile In HDRP).

  - **Translucency Power**
    Adjust translucent intensity.
  - **Translucency Range**
    Adjust translucent thickness offset.
  - **Translucency Fluffiness**
    Used on grass to make it appear more lumpy.

- **Translucency Tree Tangents**
  Used on trees for better and more encompassing lighting.

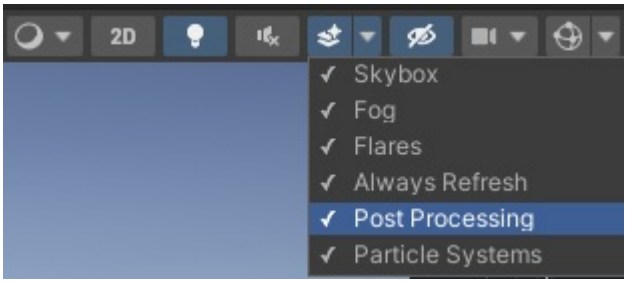


Limitations

TTFE translucency requires one directional light to work as it’s “light direction based”. Omni lights are only partially supported as they will be locked to the sun's direction.

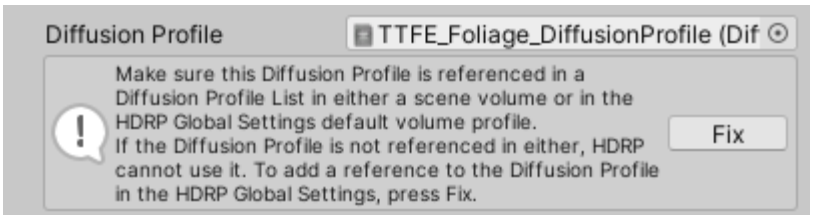
Known Bugs

If you notice glitching, toggle the “sky and fog” button in the editor. This is just an editor glitch.

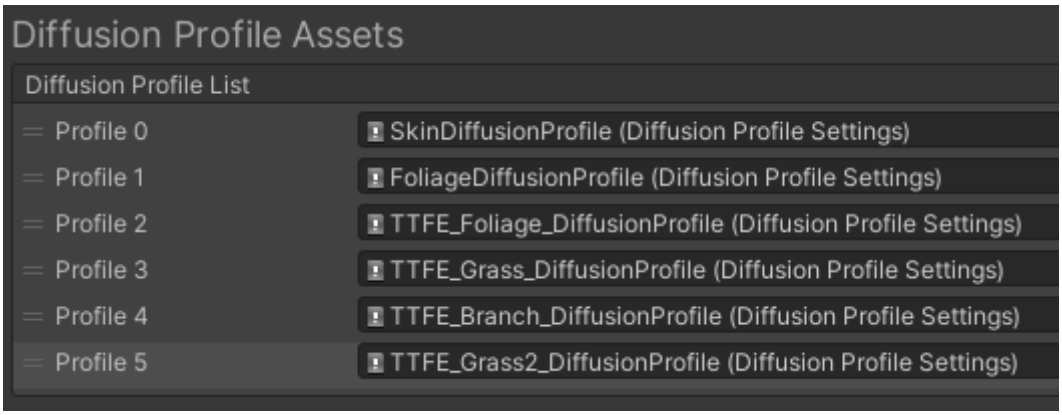


High Definition Render Pipeline (HDRP)

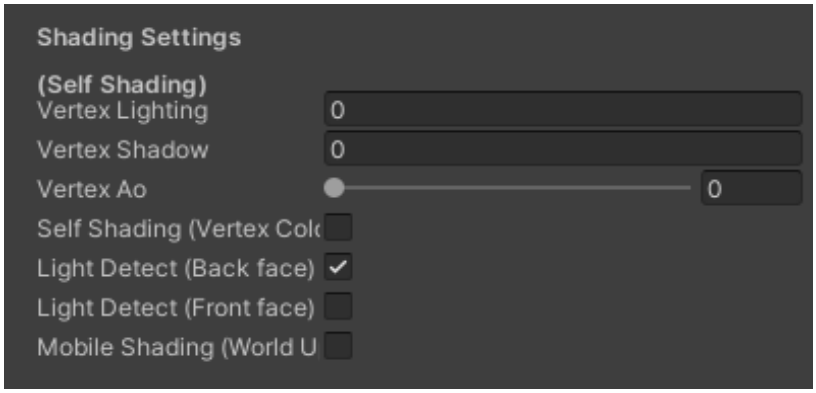
The models in the scene appear unnaturally green or pink. This issue is caused by a diffuse profile yet to be added to the HDRP asset. You can quickly fix it by selecting the material in question. When selected, you will see a warning window under the diffusion profile field in the inspector, simply click the “fix button” to add the supplied profiles to your project.



You can manually assign all the diffusion profiles in the "HDRP Global Settings" by going in to: “Edit -> Project Settings -> Graphics -> HDRP Global Settings -> Diffusion Profile Assets”

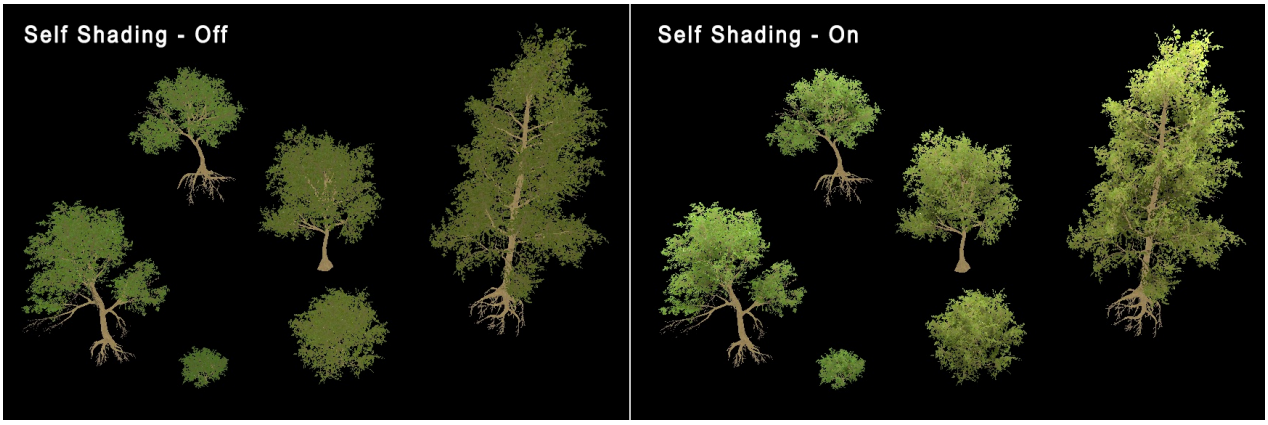


Lighting/Shading Settings



- **Self Shading**

Get some extra shading out of your foliage for a more stylized look. Vertex position scale and offset are used to shade and light the tree, in addition, you can use vertex color R for ambient occlusion.



- **Vertex Lighting**
  Adds vertex position-based lighting.

- **Vertex Shadow**
  Adds vertex position-based shading.

- **Vertex Ao**
  Uses baked ambient occlusion from the mesh vertex color R for extra shading. Bake vertex color R in your 3d modeling program.

- **Self Shading (Vertex Color)**
  Turns the self-shading On/Off.

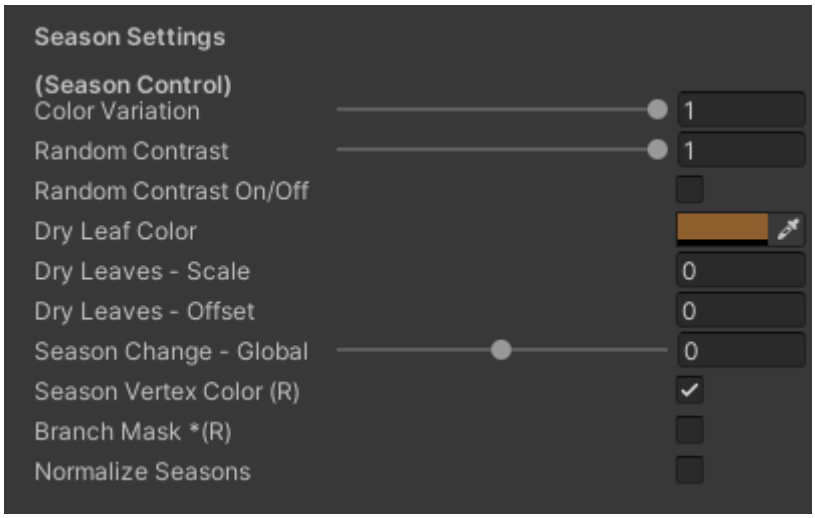
- **Mobile Shading (World Up)**
  Foliage with simple "vertex position Y shading" ("world up" toggle). Shading conforms to surfaces such as the terrain. It's usually used on grass and is more optimal for performance.

- **Light Detect (Back face)**
  Tackles the age-old problem of dark back faces in Unity by re-calculating vertex normals. This option is enabled by default.

  * Only available for trees in the “light version”.

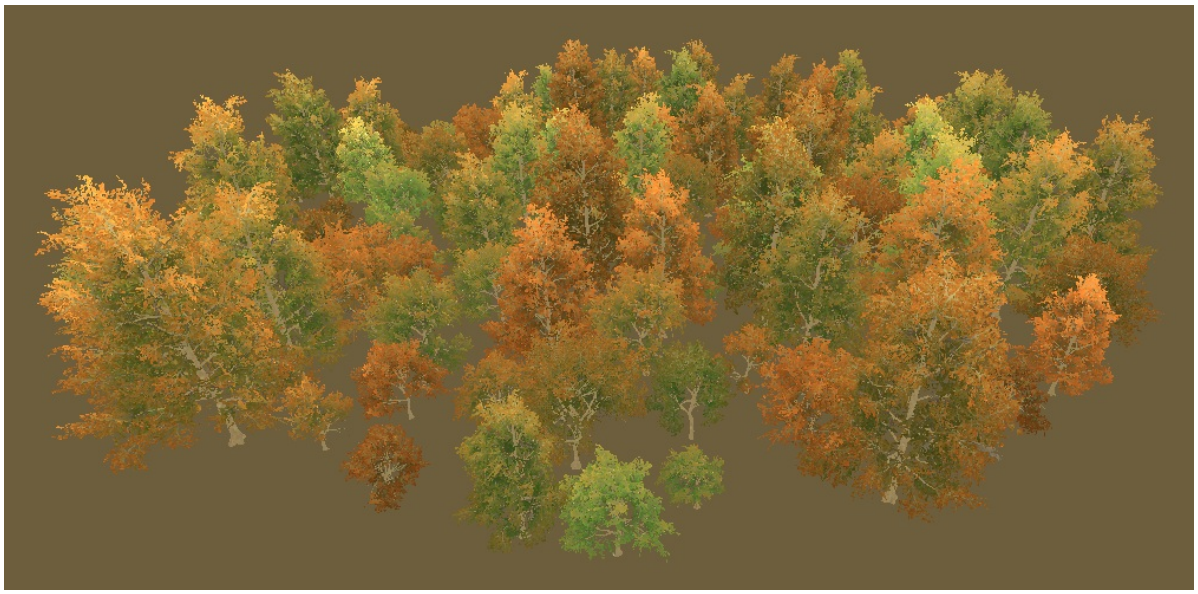
- **Light Detect (Front face)**
  Corrects the vertex shading of the front face to be identical to the default Unity shading. Can be used after “Light Detect (Back face)” has been turned on.

Season Settings



- **Season Control**

  Color and seasonal changes are based on vertex and world position.



- **Color Variation**
  Each plant will have a random color based on world position.

- **Random Contrast**
  Each plant will have a random contrast based on world position (Expensive feature hence it can be toggled off).

- **Random Contrast On/Off**
  Turn on or off the random contrast.

- **Dry Leaf Color**
  Leaf color in fall.

- **Dry Leaves – Scale and Offset**
  Adjust the radius of the dry leaves.

  To lock the season color so it can't be changed with the (TTFE) GLOBAL CONTROLLER, set "Dry Leaves - Scale and Offset" to "0,0" (default values are "1,1"). Is useful for having dry or different-colored trees in any season.

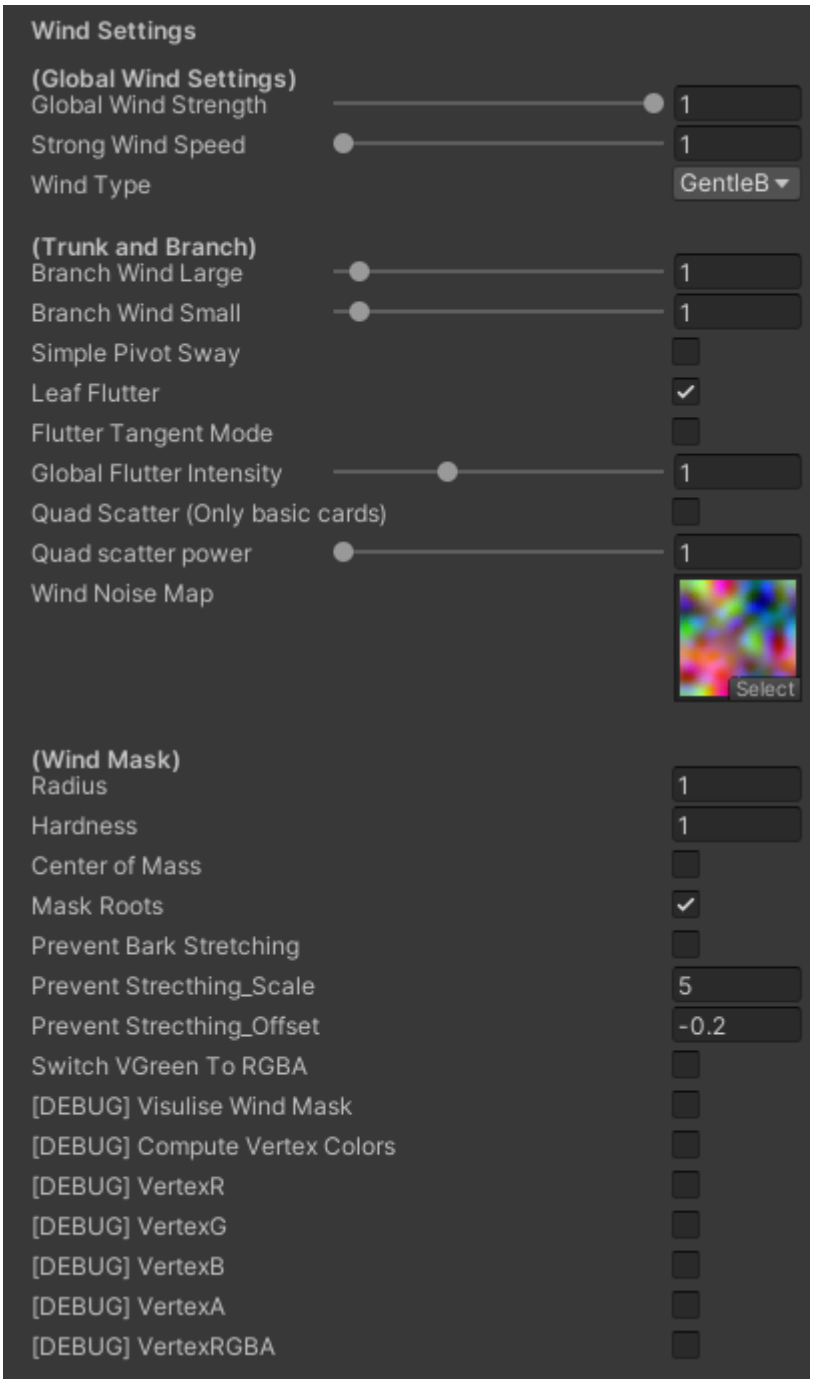
- **Season Change - Global**
  Adjust the intensity of the seasonal change. Correlates directly to the "**season**" slider of the global gizmo.

- **Season Vertex Color (R)**
  Uses the vertex color red to drive the seasonal change, instead of the vertex position.

- **Branch Mask *(R)**
  Prevent seasonal color changes in texture atlas branches with masking (R-channel).

- **Normalize Seasons**
  It prevents season colors from glitching with world position.

Wind Settings



- **Global Wind Settings**

  Correlates directly to the (TTFE) Global Controller sliders.

  - **Global Wind Strength**
    Adjust the intensity of the main wind.

  - **Strong Wind Speed**
    Adjusts the wind speed.

- **Wind Type**
  Use the dropdown to change between wind phases.

- **Trunk and Branch**

  Adjust and customize branch and leaf settings.

  - **Branch Wind Large and Small**
    Adjust the large and small wind noise of your branches. You will need to adjust your branch bending intensity according to your preference because in some cases the branch bending won't be very visible.

  - **Simple Pivot Sway**
    Best fitted for tall trees and pines with cylindrical shaped bark (prevents strange bark wobble).

  - **Leaf Flutter**
    Turns on leaf fluttering.

  - **Flutter Tangent Mode**
    Leaf flutter is based on vertex tangent rather than vertex position.

  - **Global Flutter Intensity**
    Adjust the intensity of the flutter.

  - **Quad Scatter (Only Basic Cards)**
    Random pivot motion based on vertex tangents. This is only suitable for simple cards as intersecting planes will move independently from each other.

  - **Quad Scatter Power**
    Adjust the intensity of the quad scatter.

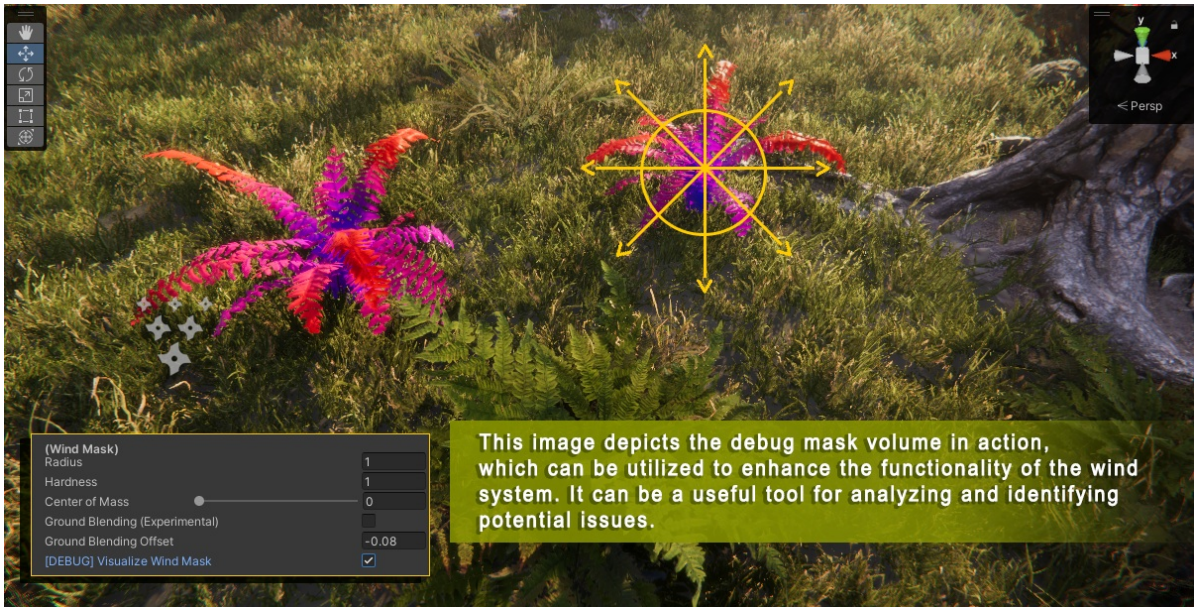
  - **Wind Noise Map**
    Internal 2D texture noise (3 vector RGB), generates an Intense wind pulse that affects grass and trees (only available for “Strong Wind” type). The effect will be turned off if this texture is missing.

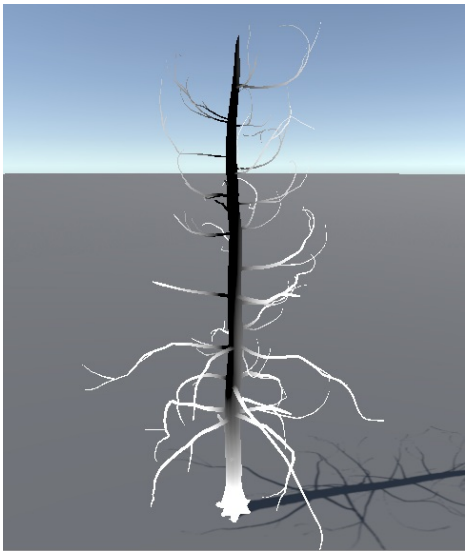
    * Only available on trees.

- **Wind Mask**

  The meat and potatoes of the Toby Foliage Engine, the wind mask is essential for customizing how your trees behave in different wind conditions. A vertex-position volume sphere, masking out the wind on your trunk and leaves. Its radius can be controlled via the material settings.

  Using vertex color as a mask might become available in future releases.





** Due to its rudimentary and limited nature, the mask isn't perfect and never will be, therefore additional options are available.*

Visualizing wind mask is not available in the light version!

- **Radius**
  Adjusts the volume size to mask wind in your material settings.

- **Hardness**
  Adjusts the intensity of the volume mask.

- **Center of Mass**
  Creates a center of gravity making the mesh less affected by wind in its center.

- **Mask Roots**
  It prevents the roots from being affected by the wind.

- **Prevent Bark Stretching**
  Helps to reduce stretching on the sides of the bark where branches connect.

- **Prevent Stretching Scale and Offset**
  Adjust settings to reduce the stretching amount.

- **[DEBUG] Visulise Wind Mask**
  Tick "[DEBUG] Visualize Wind Mask" to visualize wind physics.

- **[DEBUG] Compute Vertex Colors**
  Visualize all vertex colors available on the mesh.

Other Shaders

(TTFE) Tree Billboard

Identical to the tree foliage shader but with fewer features.

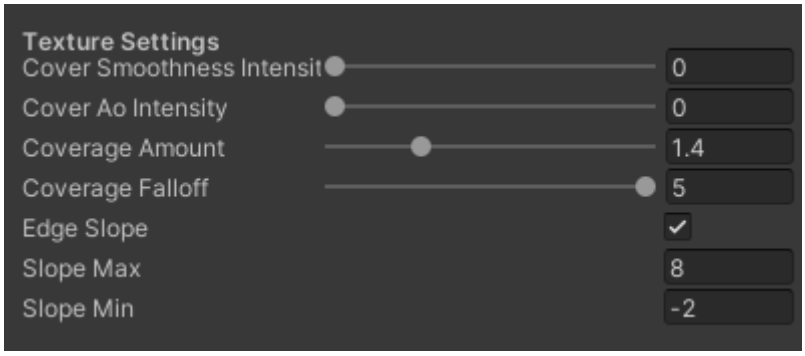
(TTFE) Roots

Basic root shader.

(TTFE) Uber Cliff

Triplanar cliff shader with grass/snow coverage and correct edge slope angle.

It contains three tri-planar material layers; “Rock Layer”, “Dirt Layer”, “Coverage Layer” and additional “Detail Texture” and Edge Normal”.



Optimization

Rest assured that each and every node in the shaders has been meticulously tested and optimized to perfection. While the scenes and models may not be ideal for mobile devices, they serve as an excellent benchmark for testing TTFE against other shaders.

Here's a list of expensive features for mobile devices that may require optimization.

- **Specular Backface Occlusion**
  ** In Built-in, this is an expensive feature and should be avoided wherever possible!*

- **Light Detect (Back face)**
  This option is enabled by default and could be expensive. “Mobile Shading (World Up)” is recommended for the best performance.

- **Random Contrast**
  It has proven surprisingly expensive, most likely, because it uses a "blend node". Another one best left avoided.

- **Ground Blending (Experimental)**
  This is an experimental feature, it enables the bottom vertices to be stretched downwards. Initially conceived to fix floating grass on slopes, its performance cost shouldn't be taken lightly. Avoid this feature unless you want to use it. ***Not suitable for games***!!

GPU Instancing

Is supported in Built-in but. In URP and HDRP you will have to turn off the SRP batcher.

TFFE runs very well without instancing, so manually turn on instancing on your materials as it is disabled.

* There seems to be a bug that breaks instancing when "cross-fading" is enabled. If you experience issues make sure your prefab contains a low triangle count and "LOD crossfading" is turned off otherwise it might break instancing.

Performance Intensive Scenes

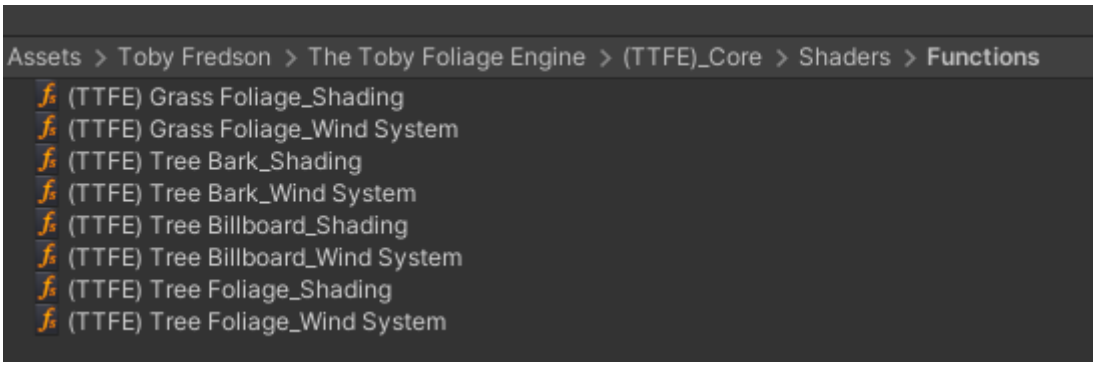
The demo scenes were created to test the performance of the TTFE shaders, which can be compared with other shaders or used for testing. For lower-end devices, you can set the "LOD bias to 1" in your "Preferences -> Quality settings".

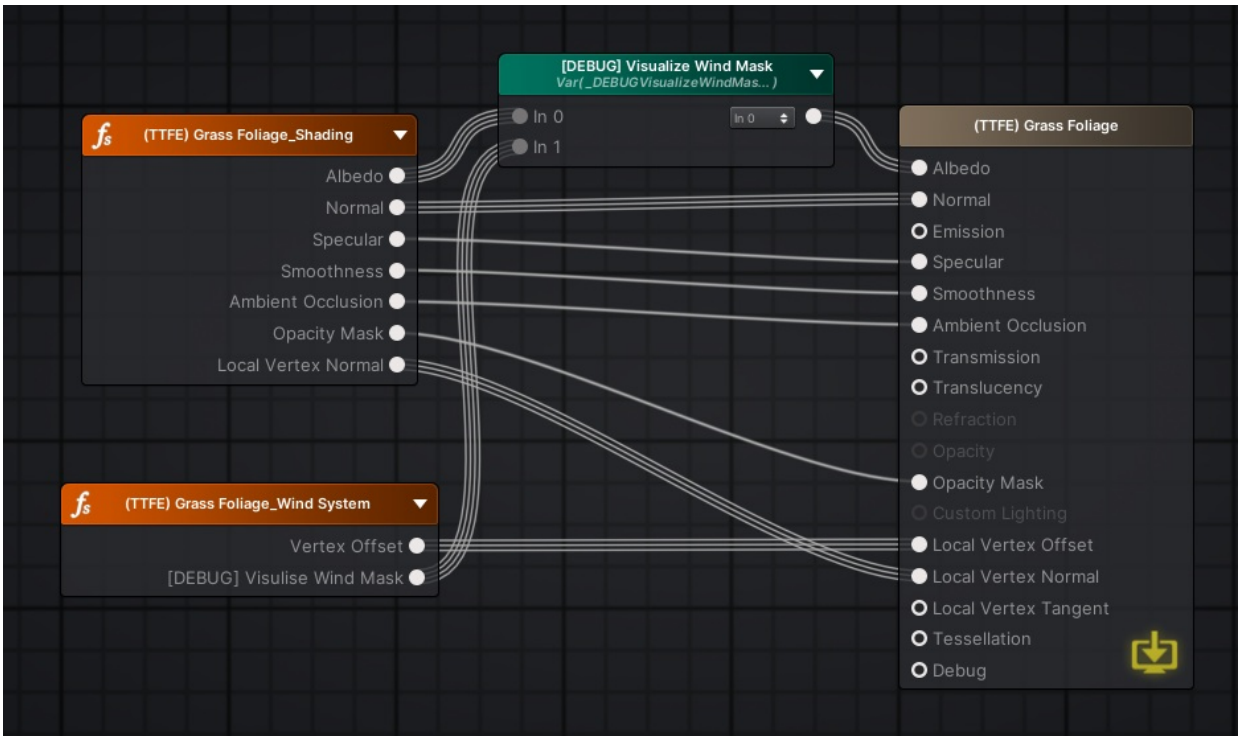
In HDRP the settings are defaulted to 1. If you want good visual quality set “LOD bias” to 2.

Amplify Shader Functions

The node systems have been methodically arranged into Amplify Shader functions, rendering them easily accessible and reprehensible to integrate with your shaders. The system is well-organized and user-friendly, providing an efficient and effective workflow for users to optimize their performance.

Foliage shaders contain 2 types of nodes, "_Shading" and "_Wind System".





Original Assets

The Toby Foliage Engine includes a range of unique art assets that are well-optimized and game-ready, all of which are original.

Credits

Credits for the “***Specular Backface Occlusion***” and “***Light Detect (Back face)***” systems go to **Hybris Factory**.

https://www.artstation.com/ivan_janik

Special thanks for helping me develop the “Translucency Occlusion” system.

Acknowledgement

Inspired from The Vegetation Engine By BOXOPHOBIC.