

PVC_StandInGeo and PVC_Billboards: LOD Stand-in Geometry Generators

By Paul Van Camp for Unity

Contact: mocha987-ustore@yahoo.com

Everyone knows that to make a 3D game run more efficiently you need to create low level-of-detail (LOD) stand-in geometry for objects that are far from the camera. But where does that geometry come from? One method is to grab a render of a portion of your scene and project that image onto simple geometry such as a plane or a grid. Well that is the principle behind PVC_StandInGeo and PVC_Billboards. They both use screen captured images and they both work in the free version of Unity.

PVC_Billboards is a free plug-in for Unity that creates a two-triangle billboard at the taking camera's near clipping plane while PVC_StandInGeo is an inexpensive plug-in that creates billboards as well as having a grid generation mode where rays are (mathematically) cast from the camera into your scene for each grid point so that the newly created grid will lie like a blanket over your geometry with a small gap between each point and the collision point. No programming skills are needed to use these tools but they are not recommended for beginners.

As your player (or players) move away from the original geometry you can use the supplied PVC_StandInGeo_Fade component to do the fading by having it change the transparency on the geometry's shader. Alternatively Unity Pro has a LOD component and there are third-party LOD solutions on the Unity Asset Store.

To see a Web Player demonstration of PVC_StandInGeo visit the site: <https://db.tt/AIZw33ey> Keep in mind that PVC_Billboards functions in the same manner for geometry creation other than lacking the grid option.

To do its magic, PVC_StandInGeo or PVC_Billboards must be added as a component onto a game object and it works while the game engine is running. When the game engine stops, the generated geometry vanishes as Unity always restores a scene to its pre-run state. However when invoked within the Unity Editor these tools save each stand-in object into your asset directory as an image, a material which uses that image, a mesh asset, and a prefab object. Simply drop the prefab objects back into your scene for your quick and easy stand-in replacement.

PVC_StandInGeo's raycasting for grid point positions only works if your objects have collider components otherwise they will not be detected. Mesh colliders provide the most accurate boundaries for objects. Invisible colliders used for triggers or movement blocking should have their layer marked as "Ignore Raycast" so they will not be detected. You may also want to add effect sources such as torches or water streams to the "Ignore Raycast" layer so they sit in front of the stand-in grid and often it is best to place thin objects such as street lamps into the "Ignore Raycast" layer as well.

Let us go step-by-step through the process of using these tools:

- Having multiple cameras in the scene can lead to confusion so it is a good idea to add a special camera into the scene for image capturing and to disable the usual player camera. When casting a grid on an outdoor scene consider using a slightly higher vantage point than what the player sees so that grid edges will be tucked away out of sight.
- The PVC_StandInGeo (or PVC_Billboards) component does not have to be attached to the camera as it will use the Camera.main specified by Unity if the object it is attached to has no camera. If the InteractiveMode parameter is set to include a dialog then a dialog will appear on screen allowing you to set stand-in capture settings which are:
 - clipping plane distances (use zero values for current camera settings)
 - Grid vs. Plane creation mode (for PVC_StandInGeo only.)
 - If grid mode then the dialog will include settings for grid dimensions, the amount of gap to add between the grid the geometry behind it, the maximum distance from the camera that geometry should sit, and the maximum number of iterations for subdividing grid quads as well as a tolerance value for determining when to subdivide. Also there is a “DiscardUnused” parameter which if enabled will result in the discarding of generated geometry whose vertices did not hit a collider when the ray tracing was done
- Note that these components have a “Material” attribute that must hold a material. This material will contain the shader that you wish the generated stand-in geometry to use. Since the captured image will already contain lighting effects you should use an “Unlit” shader or turn off diffuse and specular effects and use only emission. If you plan to fade the texture on and off or use the alpha to make background areas invisible then you will need a shader that supports transparency. A simple shader that does not respond to lights is provided with the code in the subdirectory named “Material” along with a material setup to use it.
- Other settings available are:
 - Assets subdirectory for resulting images, meshes, materials, and prefabs.
 - Base Name for resulting assets and file names. You can modify this name to reflect where the stand-in geometry is to reside in your scene.
 - A Version number which will be appended to the base name with three digit padding.
 - A Version Increment toggle which if turned on will cause the version to be automatically incremented each time geometry is created.
- If the InteractionMode parameter is set to include Keys then the Escape key will toggle between having the a dialog for selecting settings and a smaller information dialog. Also the “g” key can be used to toggle the enable state of the generated geometry which may be helpful when judging the suitability of the new geometry to your original scene.

- After stopping the game, the assets mentioned above can be found in the directory you specified for prefabs. Put the prefabs into your scene by dropping them into the Hierarchy window. (If you drop them into a Scene window an undesirable positional offset will be added.)
- The created geometry will have a PVC_StandIn_Fade component attached to it. By default it is disabled. When enabled it will control the transparency of the attached material based on how far the object is from the scene's Camera.main object. You can use this to fade the geometry on and off with the player's distance to the geometry.

A Few Usage Tips For PVC_StandInGeo:

- Often it is best to isolate objects or groups of objects before creating substitute geometry for them and then, in the final game, hide the edges with other objects.
- Use the Max Distance parameter to reduce long hallways into short representations of themselves.
- The renderer does not deal well with the long thin triangles that are created due to abrupt changes in depth. They can result in depth confusion where the renderer does not know which triangles are in front of which resulting in a shredding effect as background geometry is rendered on top of foreground geometry. Use invisible colliders to create ramps for more gradual depth drop offs perhaps even creating custom geometry for this purpose.
- Use mesh editing tools to clean up problems. Long thin triangles that are a problem can be subdivided or eliminated and, if eliminated, the holes left behind can be filled in. There are tools listed in the Asset Store for geometry editing and exporting.

A Discussion of the Subdivision Process Used by PVC_StandInGeo

When both the SubdIterMax and the SubdTolerance parameters of PVC_StandInGeo are greater than zero, grid centers will be tested against a ray cast from the screen into the scene and if the difference between those positional values exceeds the given tolerance the grid quad will be subdivided into four quads. This is an imperfect process for the following reasons:

- Since only the center point is being tested, surface details can easily be missed. However since the goal of this tool is to create geometry that will be seen from a distance it is really only edge areas that need the extra detail.
- Textures are interpolated across a polygon in a linear fashion by the renderer however this will not line up with the image captured since perspective foreshortening is not linear. In other words, even though the image is correct at the corners, features in the center tend to shift towards the rear. There are situations such as with fences and stone walls which have regular parallel lines where these distortions are not apparent with a regular grid because each grid unit is the same size as its neighbors so it shares the same distortion inaccuracy but with the irregular sizing of subdivisions the vertical lines will sway a little due to the inconsistent distortion error.

- Be careful as the amount of geometry generated by subdivisions potentially increases by a power of four with each iteration. There is a hard-coded limit of eight iterations but keep in mind that four to the eighth power is still a pretty big number.