Apparatus: Extended Guide

In this second tutorial, we will talk about using the Apparatus plugin inside Unreal Engine 5 in a deep. We will create a full fireman game. The goal of the player is to put out at least half of all the wood blocks until his house wouldn“t burn out. We will add music and other features like a menu, and finally, we will publish our mobile game on Google Play!

Just before going any further, make sure you have read (or saw) our previous tutorial.

Technical task

Before creating a new game, a developer should clearly understand the features he“s going to add to the product and the workload he“s going to implement. We will create a list of all our objectives, so everyone will know the purposes of the tutorial, but we will not do anything else that is not included in the list (to save our time):

- Create a menu with 3 buttons: `levels`, `settings` and `quit`. A button click should navigate the player to the according widget (except for `quit`, which must shut the game down).
- Settings widget must contain 3 sliders:
  - the volume of music,
  - the field of view,
  - the controller sensitivity.
  - Plus the `back` button that will navigate the player back to the main menu.
- In the `levels` widget, there must be 3 different levels. We will not save information about completed levels, so at the game first start, the player could select any level he (or she) wants. Click on the level button should immediately start a level.
  - Plus the `back` button that will navigate the player back to the main menu.
- The level consists of different things, logics and mechanics:
  - The player can move around by using a joystick. Also, there are buttons like `jump` and `snuff out`.
  - The level is just a grass plain with a huge fence around and a wood building constructed with blocks at the center of the area.
  - The player is spawned in the building on the most top floor. While the player is spawned, a random wood block is lighted it up.
  - A Burning block causes nearby blocks to light up after several seconds of permanent neighborhood. Here some fire particles should be used.
  - After several seconds of burning, the block will be destroyed, which could cause the building to collapse.
  - The player should go through the building, find the epicenter of the fire and snuff it out.
  - If a certain percent of all wood blocks are destroyed (say, 50%), then the level is failed, - we should show the fail widget to the player and navigate him (her) back to the main menu.
  - The player should use the fire extinguisher to stop the fire, after several seconds of the using fire extinguisher on the block, the block will stop burning.
  - If all blocks have stopped burning, then the player completed the level. Show the win-widget to the player and navigate him (her) back to the main menu.
- Music and sound design:

    - There should be 1 main menu music, and one game (level) music.
    - When the sound of fire kicks in (the player is close to the fire), then the level music is disabled (until the level end).
    - There must be sound space, so the player can find the fire by listening to sounds.
- Finally, publish the game as a beta version on Google play.

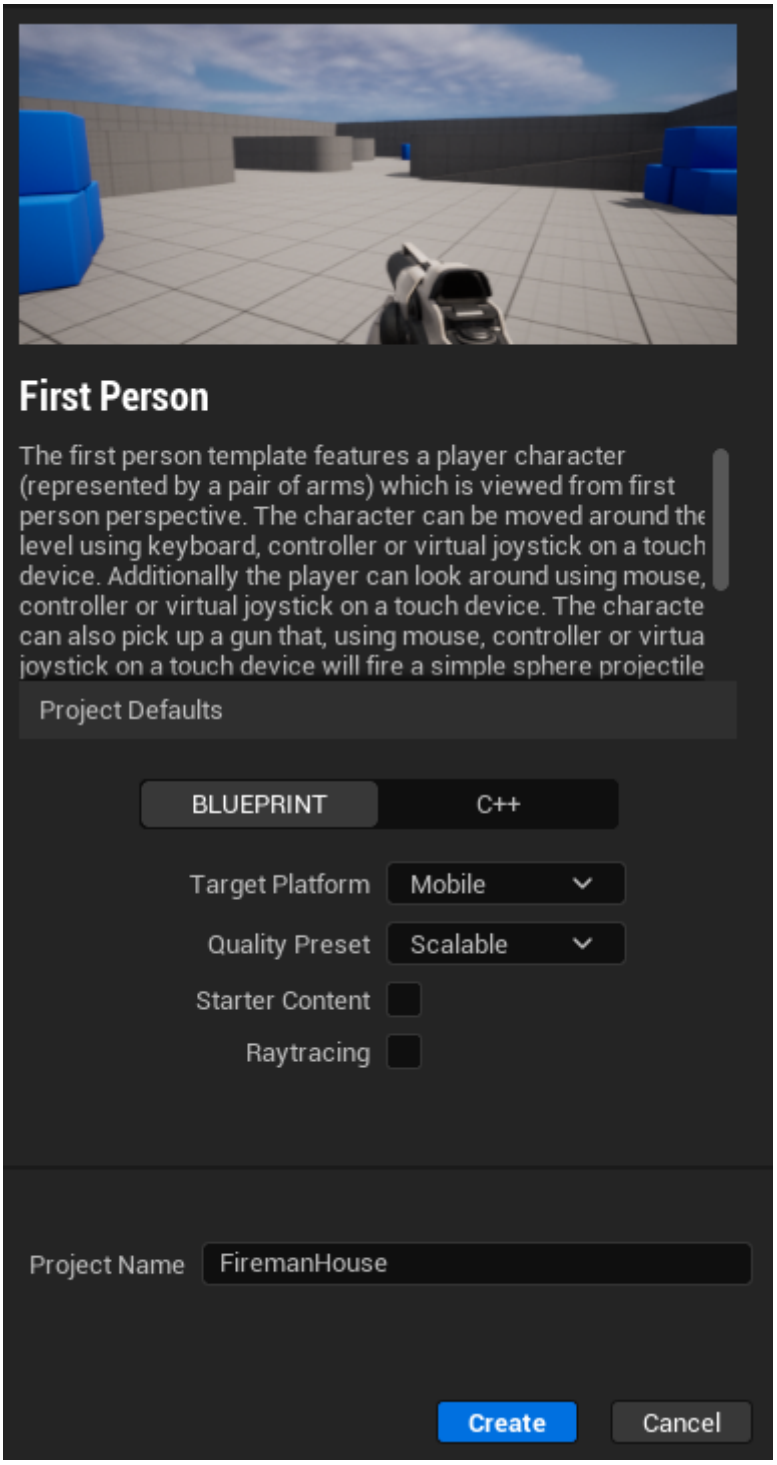
Wood block parameters

- `Ignition factor` - initially is set to `0.0`. Every tick the block is contacted with the burning one, this counter will be increased. After the parameter has reached the `1.0` value, the block become burning.
- `Fire health` - initially is set to `100.0`. While the block is burning, this value is decreased, so, when the counter reaches the `0.0` value, the block is destroyed. When there become many destroyed blocks, the level will fail (as described earlier).
- `Extinguishing counter` - the player can affect this parameter by using the fire extinguisher only when the `Ignition factor` is greater than `0` (so the player can snuff out only blocks that are going to burn). This value is initially set to `0.0`. Every tick the user use the fire extinguisher on the block, this value is increased, so, when it reaches the `100` value, the block is no more burning (i.e. if it was burning, then it stops, if it was not, then it will never start).

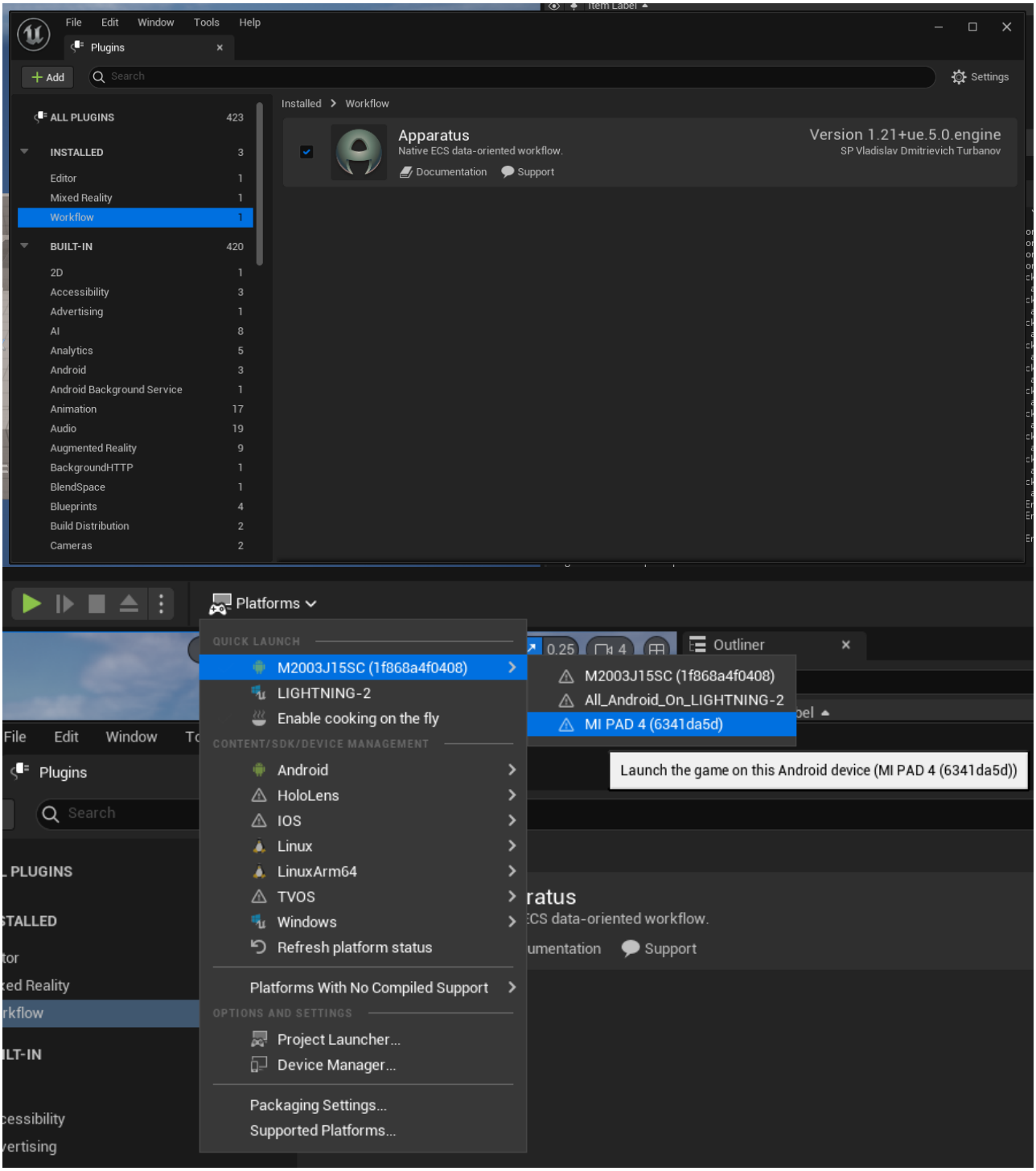
Project initialization

Before doing anything else, make sure you have Apparatus installed on your UE 5 (see previous tutorial for details). In this tutorial, we will use UE version `5.0.2`, but you can actually use any 5.0+ version you already have, because they do not have significant differences.

- Let“s create a New Project. Click the «Games» section on the left menu in Unreal Project browser. Select «FirstPerson» template, target platform should be «mobile», let“s set the new project quality to «scalable», **disable** «Started content» and name the new project anything you want, but we will use «FiremanHouse», like this:

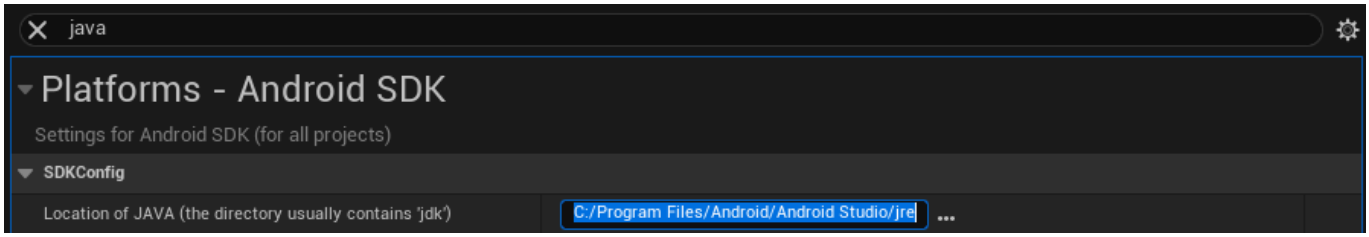


- After project creation, **enable Apparatus plugin** (via «Edit» → «Plugins» → «Installed» → «Workflow» → «Apparatus», then restart Engine as it claims to). If you want to use your android phone for project test, plug it to the computer, enable USB debug, make sure that you have installed Android studio. Go to platforms and under the section «Quick launch» select the device you want the game to run on:



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If you got the `java.lang.NoClassDefFoundError: Could not initialize class org.codehaus.groovy.vmplugin.v7.Java7` error while launching the game on the device, then just go to the project settings and manually select the `location of JAVA` setting to the location of JDK that was installed with your Android Studio (in our case it is `C:/Program Files/Android/Android Studio/jre`).



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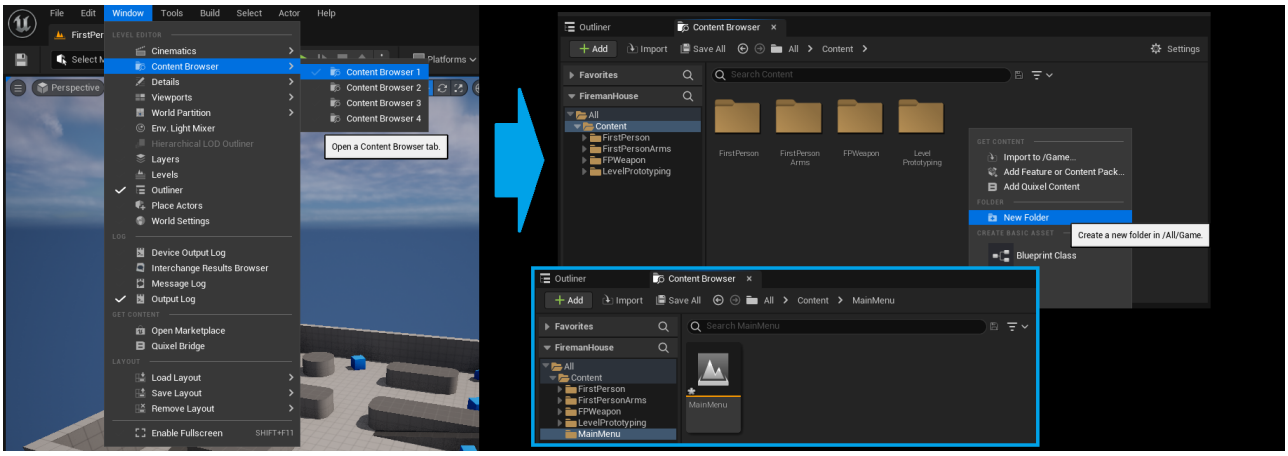
Creating background for main menu UI

Ok, the next step we need to implement is, obviously, the IU for players. Basically, we need to create the main menu, as described above. For the menu, we need several features:

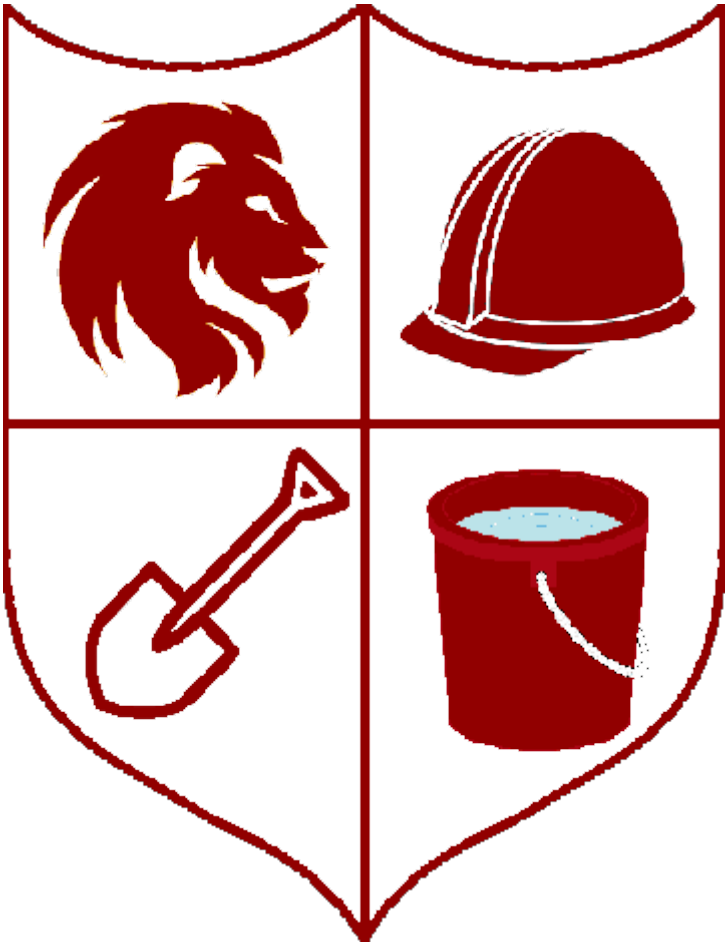
- Logo of our game.
- The level for main menu. (actually, the background for the UI)
- HUD class object that will manage our widgets via Mechanism.
- 3 widget classes: for main menu itself, for settings and for levels.
- Settings must be stored across different levels, what can be achieved by using the `Game Instance` class. So we need to create one.

In this paragraph we will complete tasks **1** and **2**. Let"s pour in the development process by completing these several steps:

- Firstly, let"s pin the `Content Browser` window and create a new level called `Main Menu` in the new folder with the same name.



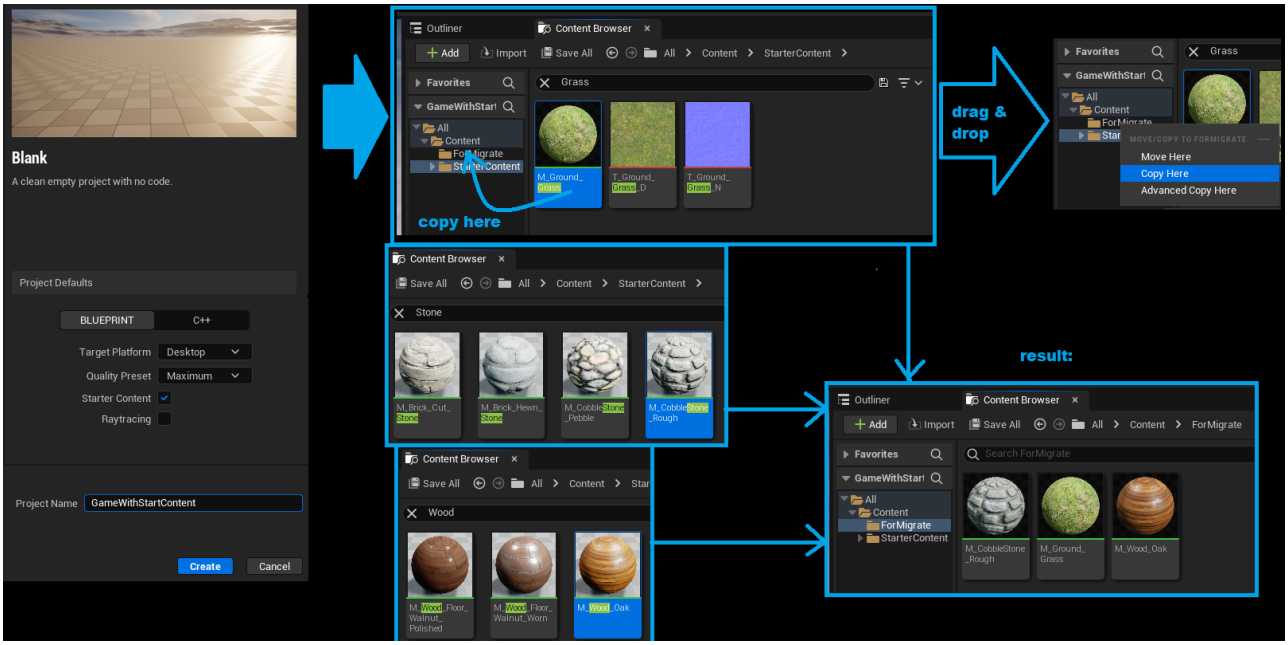
- Save created item and open it by double-click. If the Engine has asked you to select the content to save in a pop-up window, just click `Save selected`.
- The next thing we are going to do in a new level is to create a simple stone wall with the logo of our game. Of course, we will have to add some lighting to the scene. So, open any bitmap picture editor you have installed and create a simple logo for fireman organization, like this:



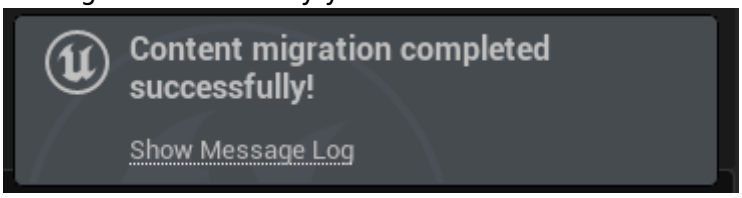
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The output file extension should be `.png` or `.jpg` (not `.svg`). </WRAP>

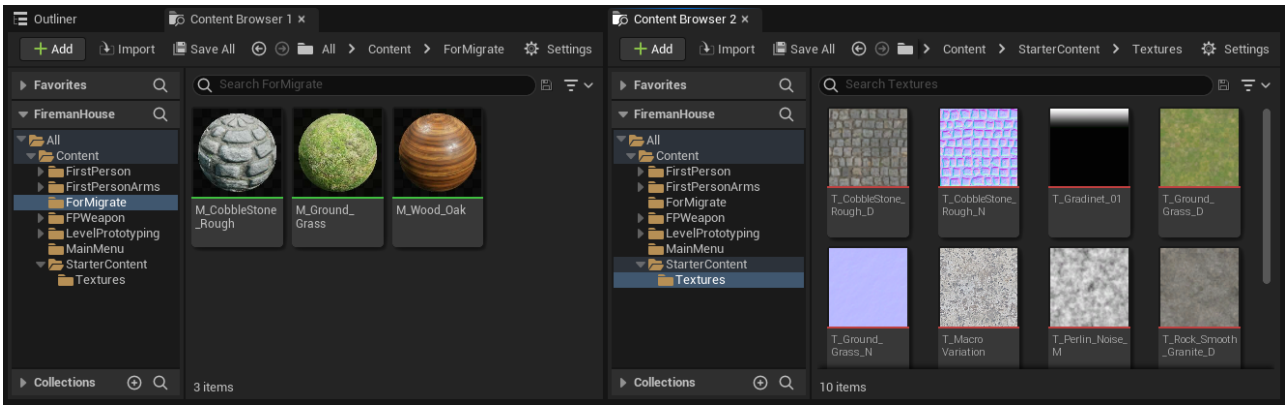
- Then, we need a material of wood, of stone and of grass. These materials are available in a Starter Content in every new Unreal Project. But we have disabled Starter Content, because its size is too big for a mobile game. So, to access the materials, we need to migrate these assets from another UE project, that has Started Content included. So, open your another UE project via UE Project Browser that has Starter Content. If you do not have any other UE projects with Starter Content, then just create a new one. We need to migrate several assets, that means, we need to select them what is not quite comfortable while searching. So, create a new folder called `ForMigrate` in the root folder of your project (we will delete it after this step). After that, open `Starter Content` folder. Search for each material in turn, drag & drop it to the `ForMigrate` folder and select `Copy`. The process should be like this:



- Now go to the `ForMigrate` folder and select all 3 materials. Right mouse button click → «Asset Actions» → «Migrate...». The Engine will show you the `Asset Report` window, so you can find the other items (textures etc.) that will be migrated with the assets. Just click `OK` button. Then a new window will be opened, called `Choose a destination Content folder`. Now we need to select a UE project that we need to migrate our assets to. To do it, you need to find a location of the tutorial project and navigate into its content folder. In our case, the correct location should be `C:\Users<UserName>\Documents\Unreal Projects\FiremanHouse\Content`. Select this folder in your operating system file explorer. Engine will perform the migration and notify you about task result.



- Delete the `ForMigrate` folder in the current project and navigate back to the tutorial project. In the «All → Content» folder, there must appear `ForMigrate` and `Starter Content` folders. In the first one you should see the materials, but in the second one should appear textures. Like so:



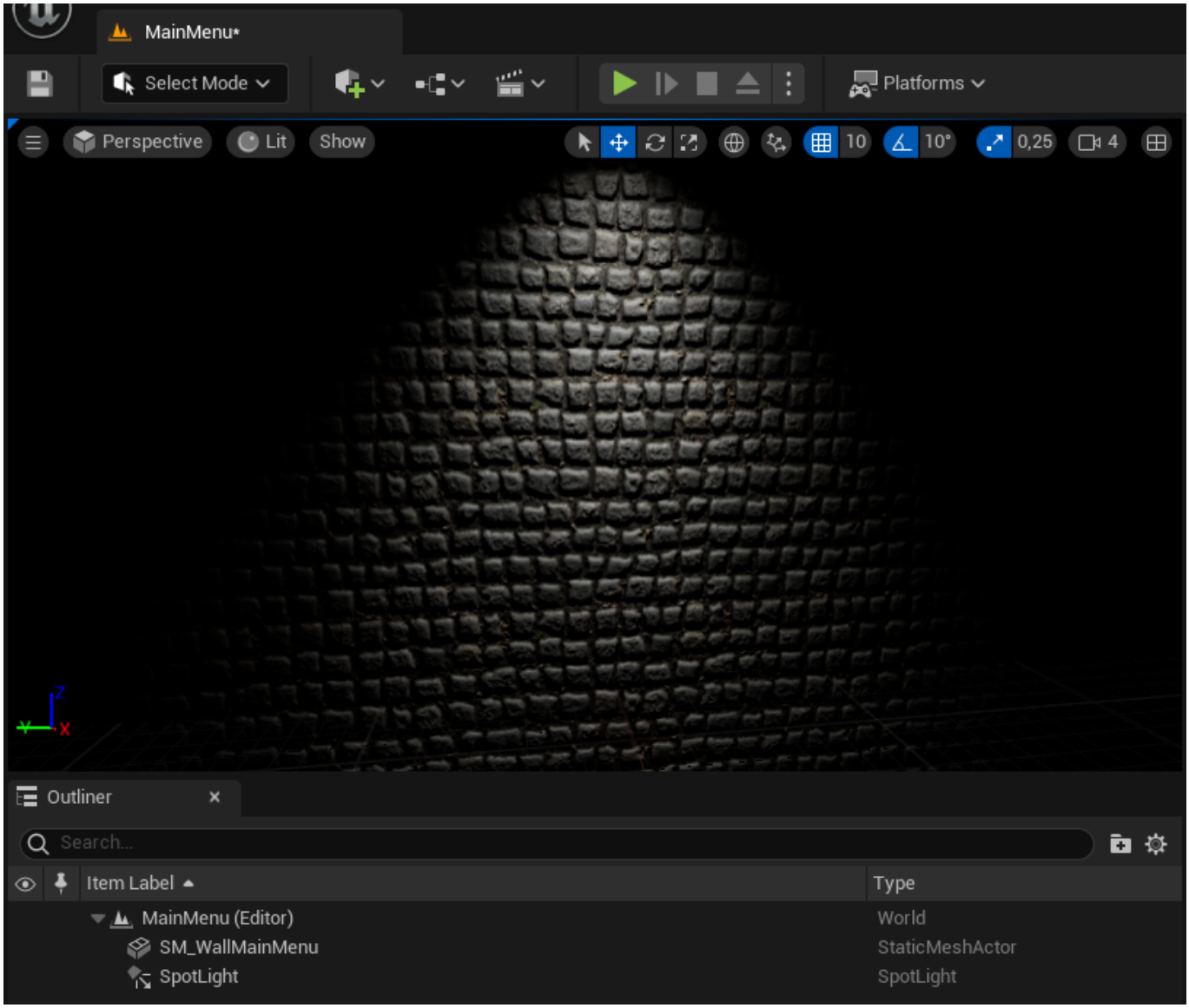
- Nice, we have just added some materials in our game, so, it is time to create a first scene for main menu. Before that, let"s select levels the Editor should use as a first game scenes. Go to the project settings and under the `Maps & modes` section find `Default Maps` options. Make `Editor Startup Map` and `Game Default Map` to be `MainMenu`. Rename folder `ForMigrate` to `BasicMaterials`. Run Ctrl+Shift+S to save the project settings.
- Open the `MainMenu` map. Open window Place actors via «Window» → «Level editor» section → «Place actors». In the panel, select `Shapes` kit, so you can access different basic shapes like

Cube, Sphere or Cone. Drag and drop Cube shape to the empty level. As there are no any lighting in the map, you will not be able to see it in the viewport (because everything is just dark). In the Place actors window select Lights kit and add Spot Light to the map. You can use Outliner window to select added cube or light source and a Details panel to manually set the location. We will use:

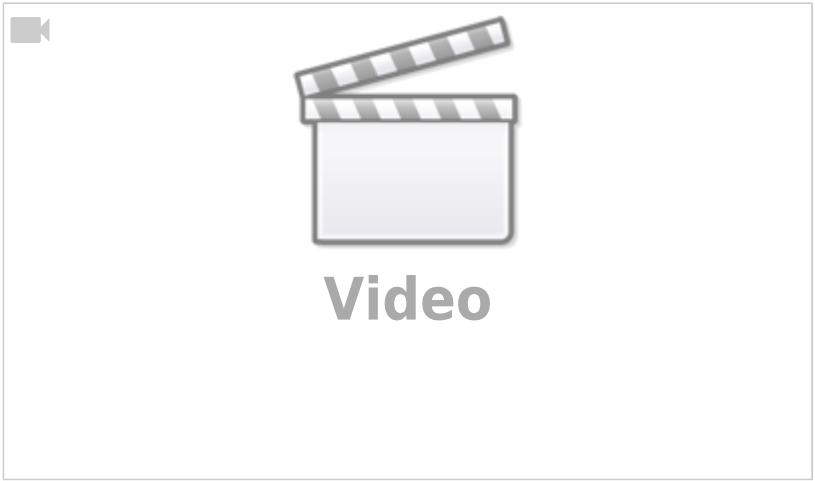
- Cube relative location: (X=-70.000000,Y=0.000000,Z=0.000000)
- Cube relative scale : (X=0.500000,Y=9.000000,Z=6.250000)
- SpotLight absolute location: (X=10.000000,Y=0.000000,Z=283.000000)
- SpotLight absolute rotation: (Pitch=-90.000000,Yaw=-107.002370,Roll=107.002370)
- You can copy and paste this values from the tutorial text to your editor, like it was described in the first tutorial (see step 8)

- Drag and drop the M_CobbleStone_Rough material from the BasicMaterials folder in the Content Browser to the cube in the viewport. As you can see, the scale of the texture is a little huge. We will solve that by creating a new static mesh via Engine brush editing mode for geometry. So, firstly, in the viewport click Lit to select other view mode - Unlit. This will help you to see all objects on the map even without lighting. Then in the Place actors window select Geometry kit and add a Box to the map.<WRAP center round tip 60%>

Note: if you has selected the correct material in the Content browser before placing the box, the material will be applied to the mesh. </WRAP>In the up menu in level editor change Select Mode to the Brush Editing Mode. Then select box facets and move them to fit the geometry box to the scaled cube we have placed before. You can use details panel to manually set the location of the geometry box (just copy it from the Cube location data). After you fit the cube, delete the last one, but the geometry mesh should be converted to the static mesh via «Details Panel» → «Brush settings» → «Advanced» → Create static mesh. The Editor will ask you the folder for the new asset and the name for it. Just select Content folder in the project, but we will name the new static mesh as SM_WallMainMenu. Run Ctrl+Shift+S to save all changes. Go back to the Lit view mode and Select Mode in your viewport to check for result.



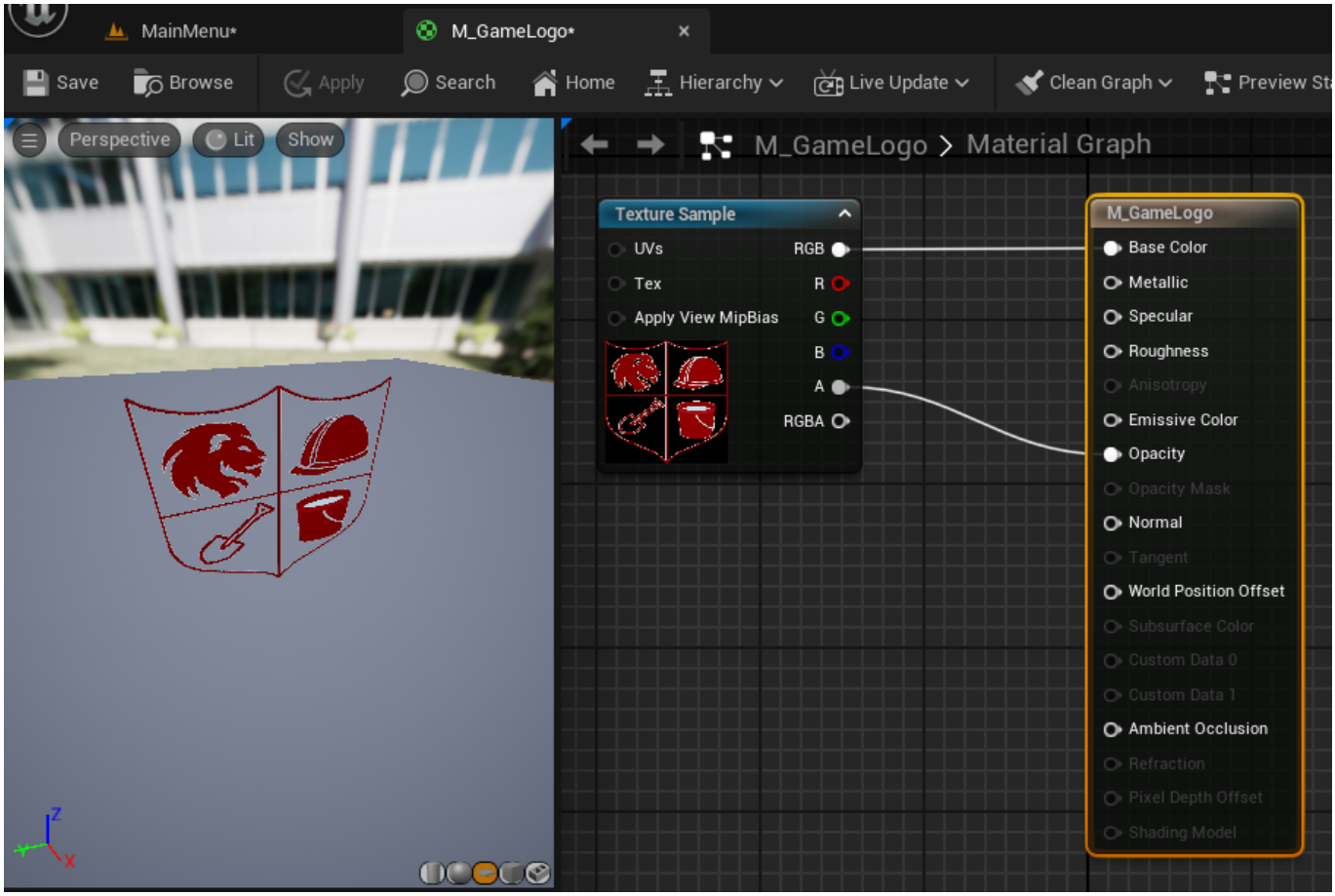
If you have any troubles in this step, just check our short video that explain, how to create a new static mesh via UE geometry.



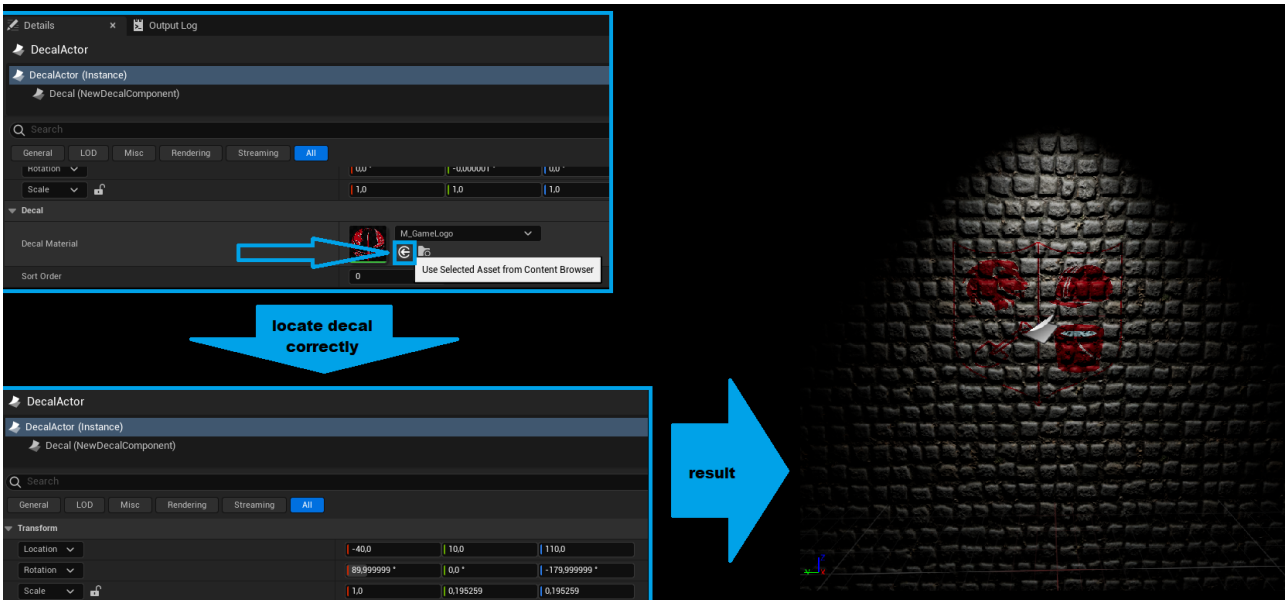
- The `SM_WallMainMenu` will be used only in the main menu, so let“s move it to the `MainMenu` folder.<WRAP center round important 60%>

When you move assets from different folders, Unreal Engine will generate so-called *redirectors*. While

it is normal for them to appear in development build, you should avoid their existence in production build, that means, you should fix them. To find out all the redirectors in the project, go to the root («All») folder in the Content Browser and in filters select «Miscellaneous» → «Redirector». After that you will be able to see redirectors in your project. Select them all, perform right mouse button click and select «Fix up». You should fix up all redirectors before creating a product, as it also specified in Marketplace guidelines. </WRAP>Perfect, now we need to add game logo to the wall. To do so, open the operating system file browser, navigate to the path, where the logo image is stored, and drag and drop the image file from the file browser to the Content Browser inside Unreal Engine to the `MainMenu` folder. Rename added texture to `T_GameLogo`. Go to `Place Actors` window and search for `Decal Actor`. Drag and drop it to the level scene. Next, we have to create a material for it. Navigate back to the Content Browser and perform right mouse button click on the logo texture. Select «Create Material». Name it `M_GameLogo`. Double click on new saved asset to open material editor. Click on the result node of the material and in details panel select material domain to the `Deferred Decal`. Make Blend Mode to be `Translucent`. Connect RGB output of the texture to the `Base Color` of the result node, but the A output (alpha-channel) to the `Opacity` parameter, as so:



- Save and apply the material. Go to the Content Browser and select the material `M_GameLogo`, then select the decal actor on the map, go to its details panel and under the `Decal material` option click the `Use selected asset from Content Browser` button. Locate the decal actor correctly, so it will be placed on the wall, like this:

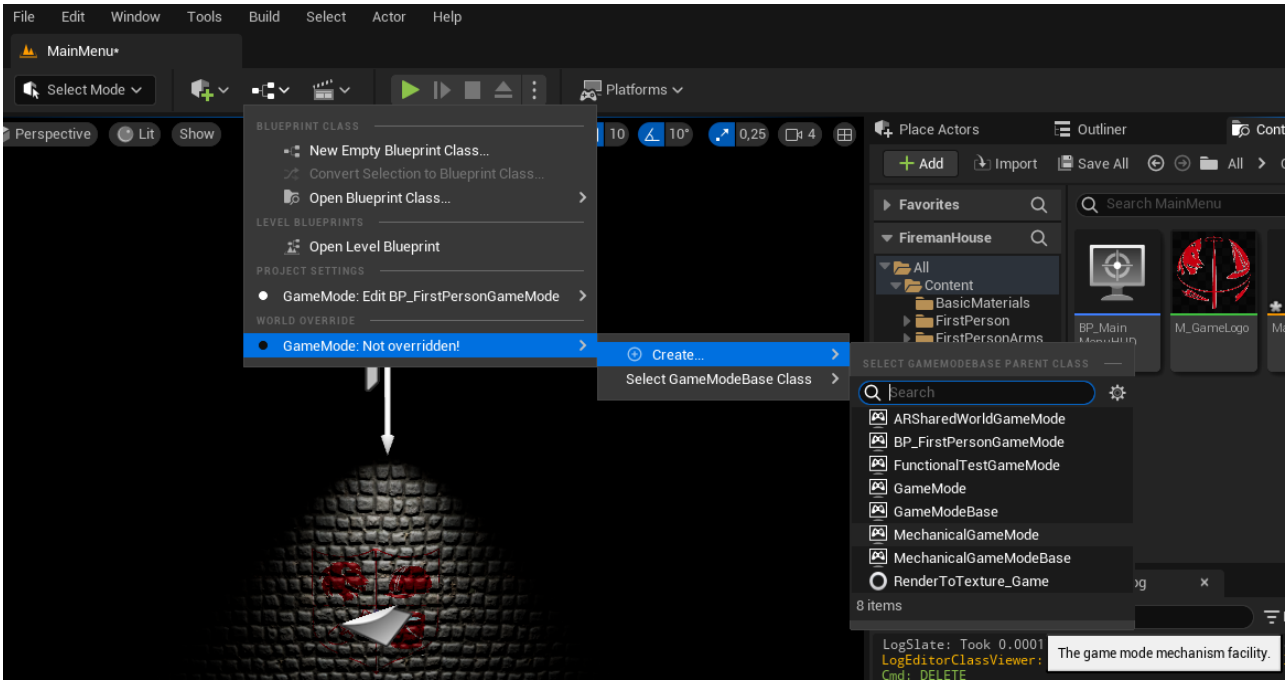


  - Location: `(X=-40.000000,Y=10.000000,Z=110.000000)`
  - Rotation: `(Pitch=0.000000,Yaw=-179.999999,Roll=89.999999)`
  - Scale: `(X=1.000000,Y=0.195259,Z=0.195259)`
- Now we have a complete background for the UI. Move the viewport view as needed, because we are going to create a camera. When you found a perfect view for the background, click on the upper-left button with 3 sticks in the viewport and select «Create Camera here» → «CameraActor». In the details panel search for activate options and for `Auto Activate for Player` select `Player 0`. Here we will also enable `Auto Activate` in the Activation section.
  - Camera Location: `(X=325.000000,Y=0.000000,Z=140.000000)`
  - Camera Rotation: `(Pitch=-5.000000,Yaw=-180.000000,Roll=0.000000)`

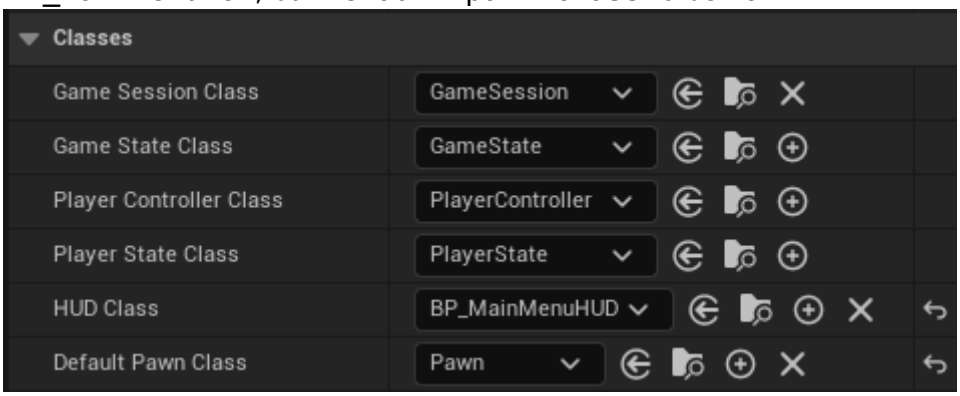
UI basic logic

Here we will solve other steps that were introduced in the paragraph above. We need to create 3 different widgets and animations for them. All the widget manipulation will be done via special HUD class. So:

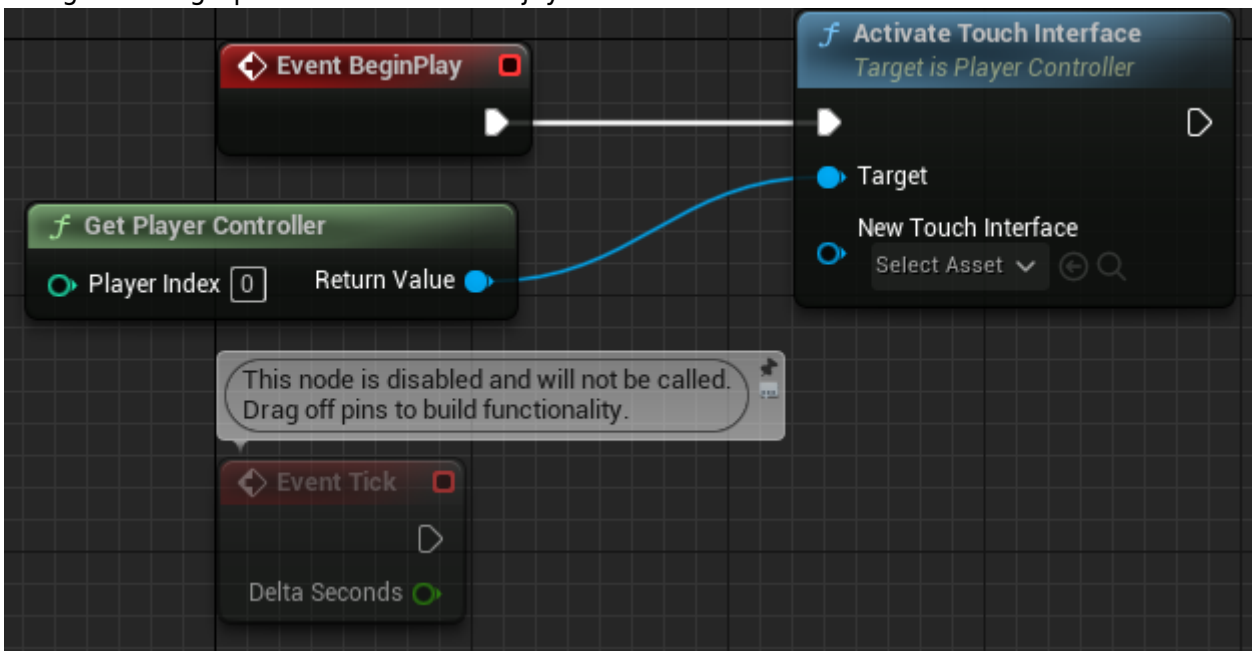
- Go to `MainMenu` folder in the Content Browser and create a new HUD class (derived from `HUD`). Name it `BP_MainMenuHUD`. Click on the diagram-like button on the up Editor menu, under «World Override» go to the «Game Mode: Not overridden!» option, select «Create» → «MechanicalGameMode».



- In the pop-up window name new created blueprint like `BP_MenuGameMode` and place it under `MainMenu` folder. In the opened BP Editor navigate to Class defaults and make `HUD Class` option to be `BP_MainMenuHUD`, but `Default pawn class` to be Pawn.

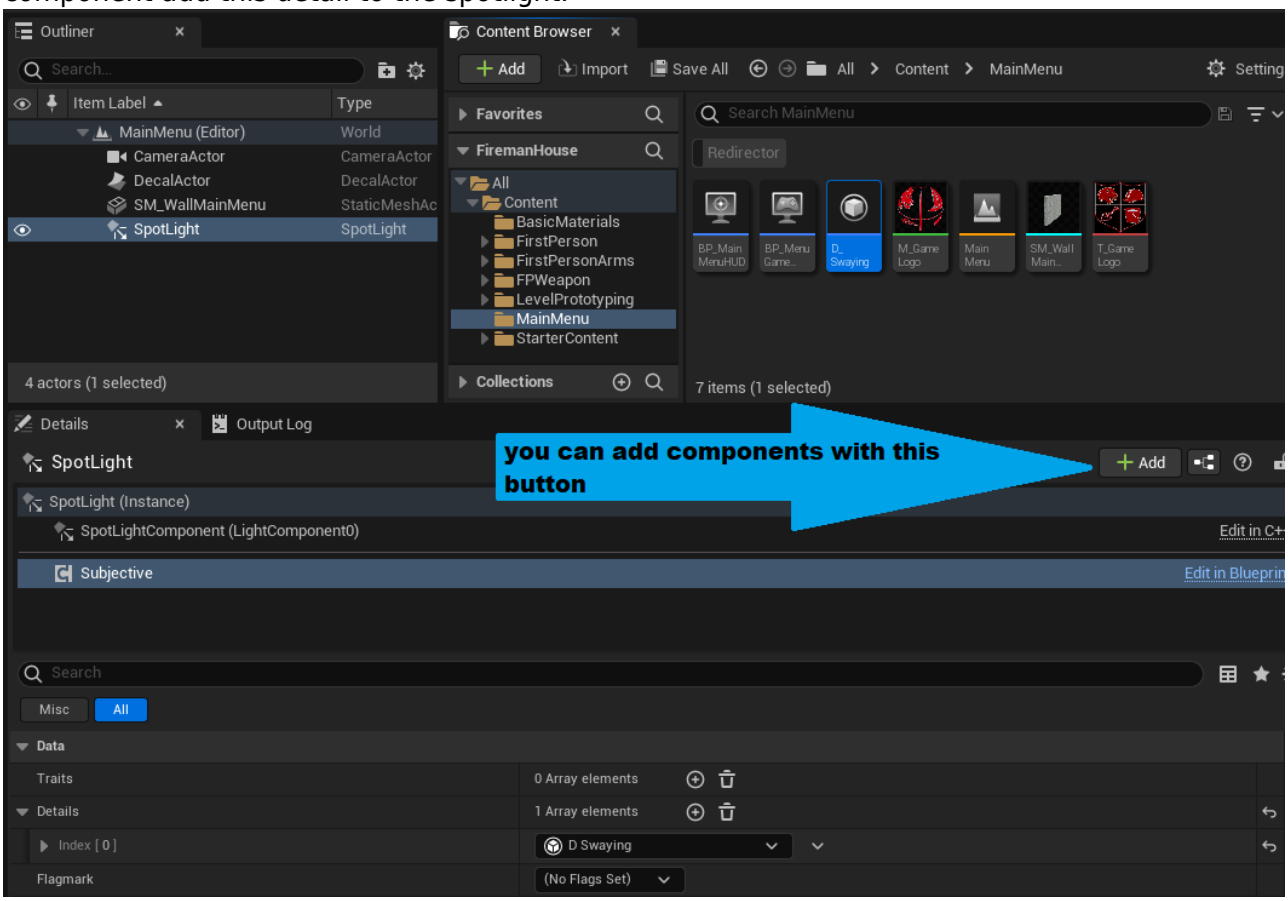


Then go to the graph editor and disable joystick like so:



- Now we need to add animation of light source swaying. We will perform this logic in the GameMode BP using ECS. Go to the level editor, select `SpotLight` object and add a `Subjective Actor` component to it via details panel. Create a new detail BP called

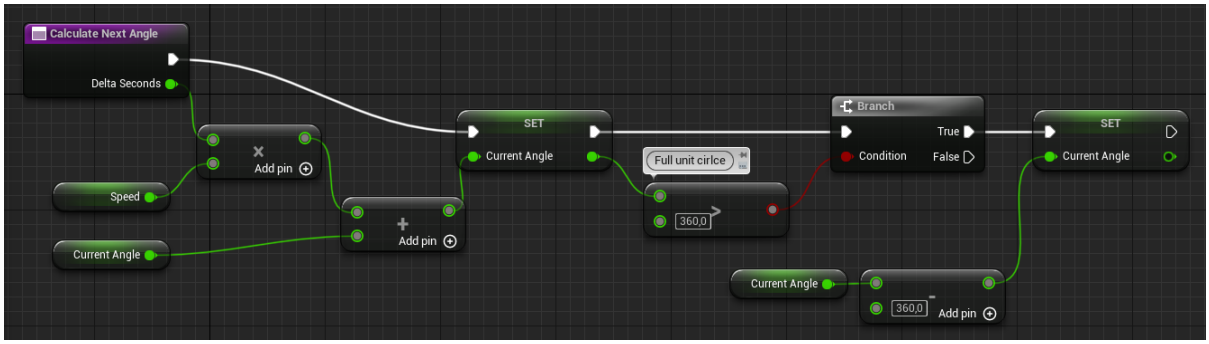
`D_Swaying` in the `MainMenu` folder. In the details panel of recently added subjective component add this detail to the spotlight.



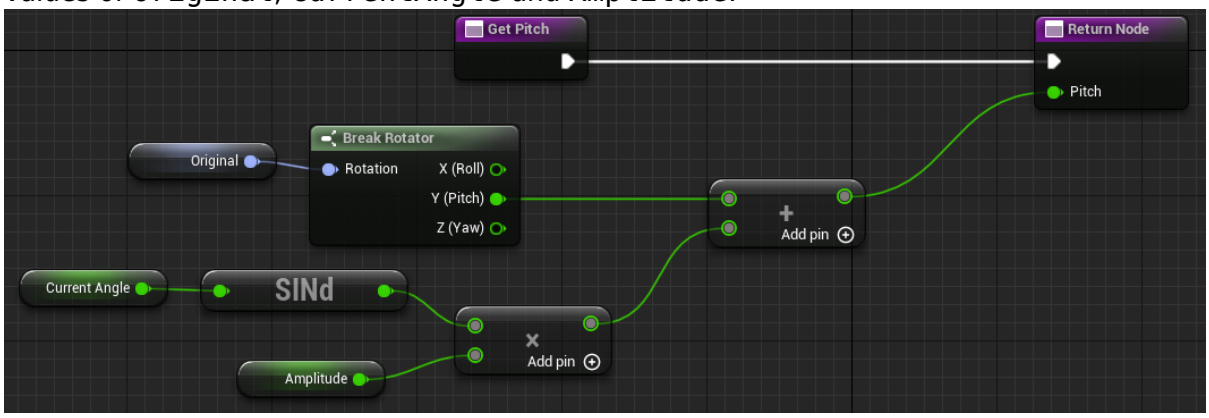
- Next, select SpotLight actor and make it moveable via details panel. Go to the newly added detail BP editor and add some variables:
  - `Original` of type «Rotator» with «Instance editable» flag enabled.
  - `Amplitude` of type «float» with «Instance editable» flag enabled.
  - `Speed` of type «float» with «Instance editable» flag enabled.
  - `CurrentAngle` of type «float» (without «Instance editable»).<WRAP center round tip 60%>

You can add description to every new variable. `Original` - is the premier rotate parameter of the spotlight, `Amplitude` is the maximum angle of which we will rotate the light source, `Speed` variable define, how fast the swaying would be, but the `CurrentAngle` is the current state of rotation. </WRAP>

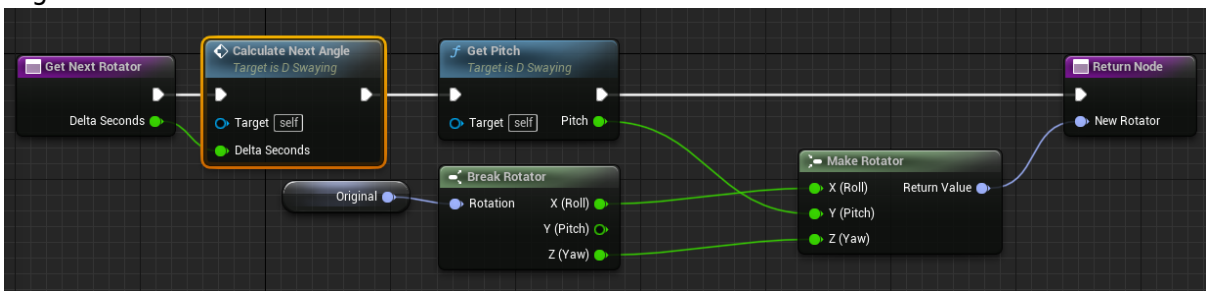
- We will perform the rotation logic like so: `CurrentAngle` is the value in degrees of the angle in the unit circle. Every tick this value is increased by `Speed` parameter multiplied by DeltaSeconds. To get the rotation of each tick, we need to get the `Roll` and `Yaw` attributes from the `Original` structure, but the `Pitch` parameter will be achieved by the math function: `Original.Pitch + Amplitude * sin(CurrentAngle)`. Easy though? So let“s create a few simple functions in the detail Blueprint:
  - `Calculate Next Angle`: Increase a `CurrentAngle` value by `Speed` multiplied by `DeltaSeconds`. If new value is greater then `360.0`, then turn it back to that range. The function must obtain the `DeltaSeconds` value as float argument.



- `GetPitch`: perform the math function above. It will calculate a current pitch based on the values of `Original`, `CurrentAngle` and `Amplitude`:

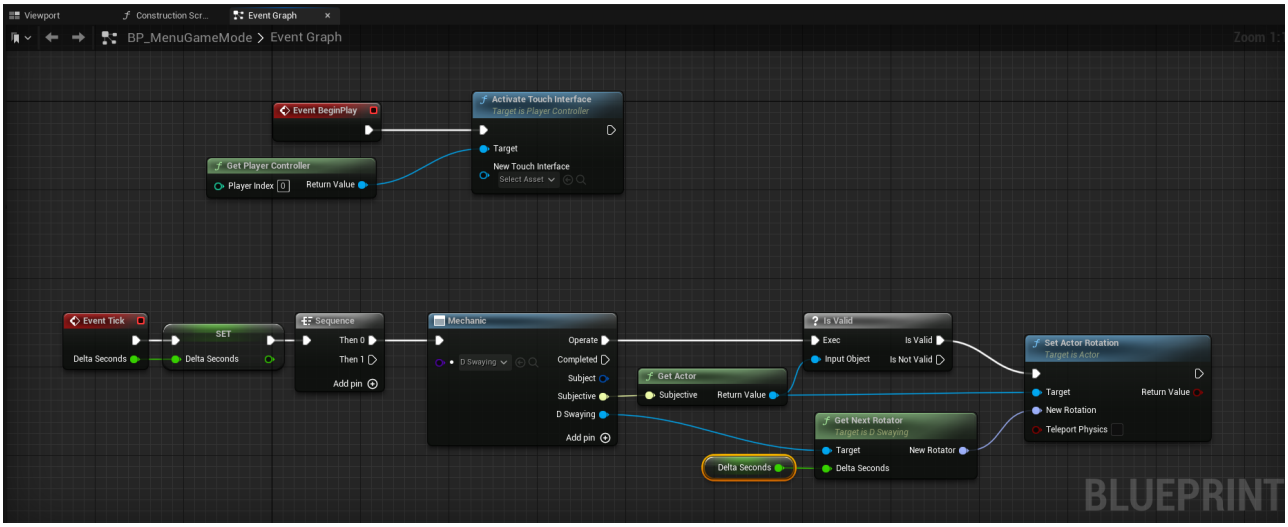


- `GetNextRotator`: the **pure** function that will use previous helpers to return a full rotator that the actor should be set to. Function must obtain the `DeltaSeconds` value as float argument:



- Please, make `GetPitch` and `Calculate Next Angle` to be private, but the `Original` variable to be «Blueprint Read Only».

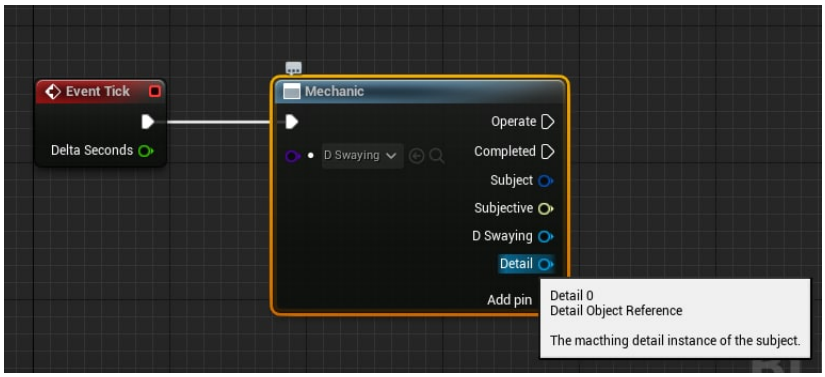
- Now let“s navigate to menu GameMode and in event graph write down our mechanic. To do so, drag pin from `Event Tick` and create a new node - `Sequence`. Find out the mechanic BP node and connect them. Click `Add pin` and in detail field select `D_Swaying`. Next, we need to get Actor reference from Subjective interface and if it is valid, then just set its rotation by using `SetActorRotation` node (`Teleport physics` flag may be empty). As you remember, the function `GetNextRotator` require `DeltaSeconds`. The last value can be accessed from `Event Tick` event. Promote it to variable, so you will not get spaghetti BP. The full GameMode Blueprint must be like this:



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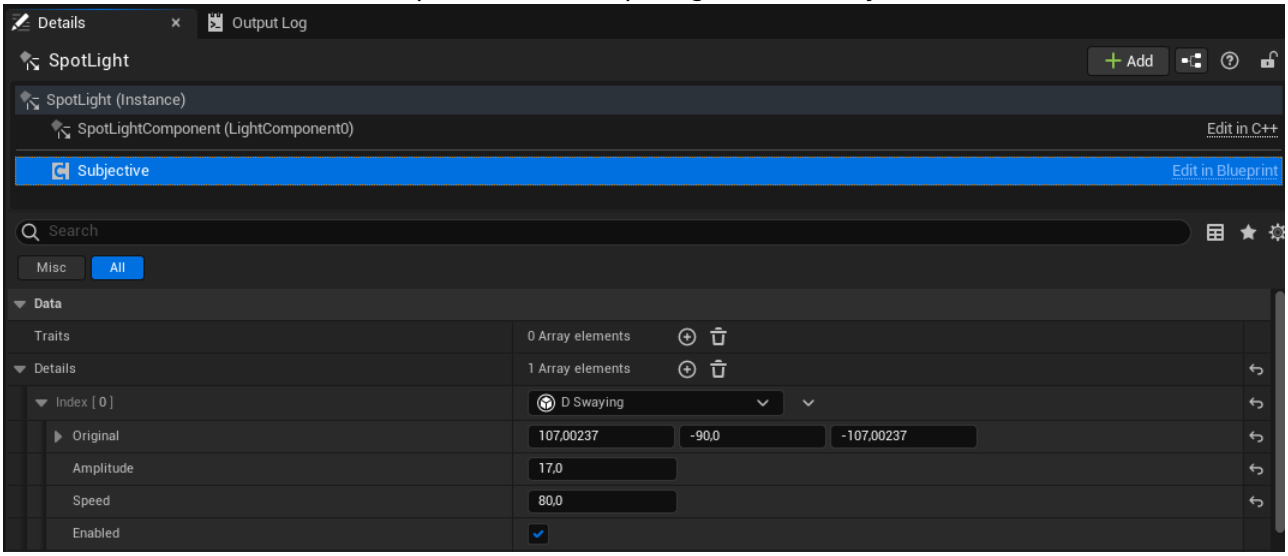
It is worth to check for the actor validity, because the `D_Swaying` detail can be added to non-actor Subjective. </WRAP>

If you have some strange extra pins on the Mechanic node like this:



Then try to reload Unreal project.

- Go to the level editor and set up detail in the SpotLight accurately:



  - Original rotator: `(Pitch=-90.000000,Yaw=-107.002370,Roll=107.002370)` (The same as SpotLight absolute rotation);
  - Amplitude: 17;

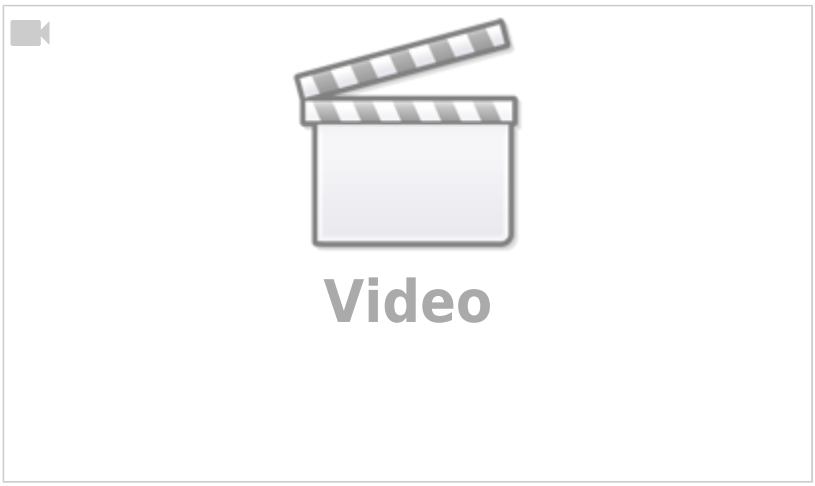
    - Speed: 80.
- Go to the project settings and in Supported Platforms remove all flags except for Android. **Find** Support Movable Spotlights and Support Movable SpotlightShadows settings and **enable** them both.
- Launch your game on the Android device (if you have one).<WRAP center round help 60%>

Here are some advices of how to launch the game on the real device, because sometimes this step is just a headache for developers:

- Before launching on the device, reopen your UE in administrator mode, as it mentioned here.
- To ensure that your device is connected to the computer, open cmd and run adb devices. You should see your device and its id in the output. The last command is included in Android Studio platform-tools, that is can be located in the path C:\Users<UserName>\AppData\Local\Android\Sdk\platform-tools. Use short USB cable, because long USB cables often useful only for device charging, not for gadgets connection.
- Go to the Android Studio SDK manager and install Android 10.0+ (R) (that is API version of 30) or Android 10.0 (Q) (API 29) and uninstall Android API 33.
- In UE projects settings find Android SDK section and set these settings: SDK API level to 29 and NDK API level to android-29 (as it suggested here).
- Go to UE project settings and configure your project for android.
- You can try other build formats (like Multi or DXT) as it mentioned here.
- To solve Failed to open descriptor file error, you can try to create a build and install the game with bat-script.
- Other solutions can be found here, but anyway, just try to find your problem in Google or write your problem to us directly.
- Check your device API level with CPU-Z application.

</WRAP>

Our result:

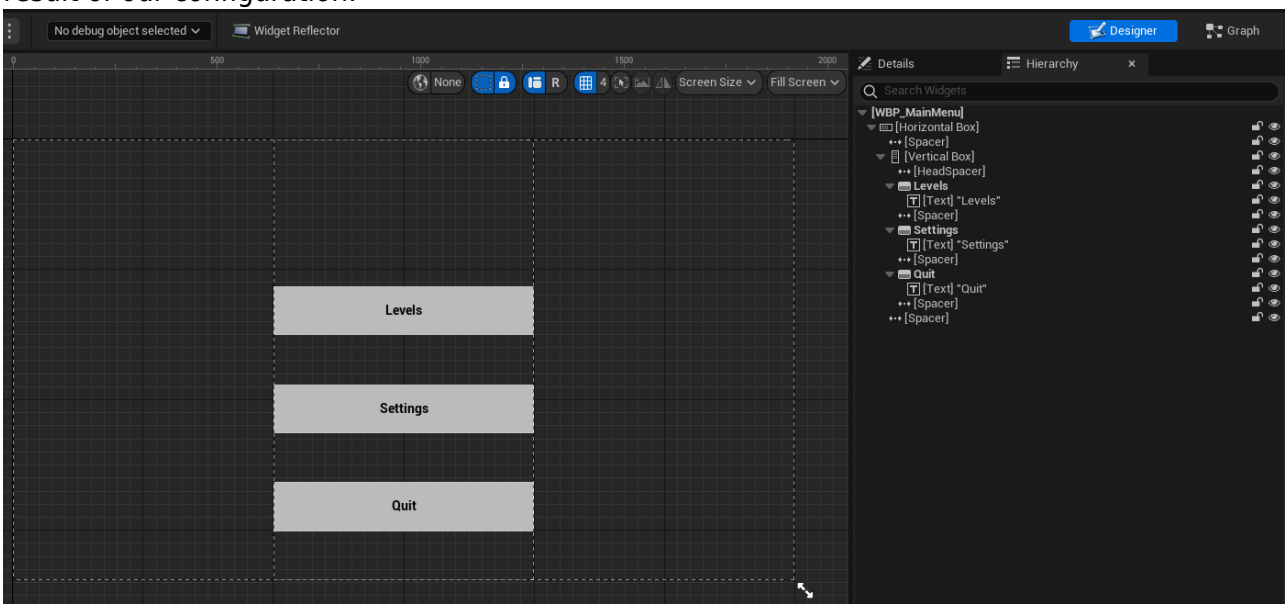


Creating Widgets

- Ok, now we need 3 different widgets for main menu, settings and level picker. Let“s create the first widget in MainMenu folder. Click the Add button with the green plus sign and select User Interface → Widget Blueprint. In the pop-up window Pick Root Widget for New

`Widget Blueprint` expand `All Classes` and select `Subjective User Widget`. We will use Apparatus to handle widgets switching. Name the new widget to be `WBP_MainMenu`. Run Ctrl+Shift+S to save all.

- Open the widget editor. Search for the `Horizontal Box` in the widgets palette. Drag & drop it to the root item (`[WBP_MainMenu]`) in the `Hierarchy`. For now you should be able to see the borders of the widget. In the palette search for `Spacer` item. Add two of them to the horizontal box. Search for `Vertical Box` and add it between spacers in the horizontal box. Then select three added items (2 spacers and 1 vertical box) in the hierarchy and in details panel in `Slot (Horizontal Box Slot)` section make `Size` parameter to be `Fill` instead of `Auto`. Now we need to add 4 spacers and buttons between them to the vertical box. Select 7 added items and, again, make `Size` parameter to be `Fill` instead of `Auto`. Select the first one spacer in vertical box and name it something like `HeadSpacer`. In the details panel you will see the float value near to the `Size` parameter in `Slot (Vertical Box Slot)` section. Make it to be `3.0`. Then rename each button to the correct name, for example, `Levels`, `Settings`, `Quit`. Add text element to each button with the proper text value (see `Content` section in details panel). Select all 3 added text items and make their `Color and Opacity` color to be black (see `Appearance` section). Save and compile the widget. Try to resize screen in the viewport so you will see that the widget we created is adaptive for any screen size. Here is the result of our configuration:



- Perfect. We will customize our appearance to be a little unique in the future, otherwise any player will find that the game is created with UE (because of buttons shapes and the default text font). But now we will create some logic for the widgets. In the opened widget go to the graph editor and check that you can access button variables.

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