

Automatic Rigging/Skinning Script

Maya Python Scripting Master Thesis

Rahul Lakakwar
i7834921
MSc CAVE, Bournemouth University
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Introduction

The animation industry is expanding day by day. Many Hollywood movies, advertisement TV series are using animation extensively now a day. Animation studios have lot of work and less time to finish their job. To achieve their target they generally automate their work. Through scripts, plug-ins or store the library of their work. So whenever they need similar kind of work they can reuse their library.

Imagine a TV series or movies were we have similar kind of characters. Rigging each one of those character would take huge amount of time. Rigging is a process which consumes lot of production time. Adjusting joint position, creating controls, establishing connection between them, skins the mesh all these processes take huge amount of time.

Rigging is the process of creating a control setup for character to perform animation. This process can be broadly divided into 3 parts creating joints, creating controls and skinning. Creating joint setup is processes were we have to create joint for deforming a character. Creating control setup is a process where we create a controller which will control those joint. Skinning is a process of painting a weight map on mesh which helps to get proper deformation of body.

Most of these processes are repetitive, like establishing connection, creating control etc. If we automate these three processes we can save production time. It will also help to generate every rig in same manner which means better quality of rig and easy to understand the rigs. It will also help to transfer an animation from one character to another as their hierarchy and naming convention will be same. These scripts are very useful for production. They save production time and headaches. They increase production quality of studio and also help to keep track of assets.

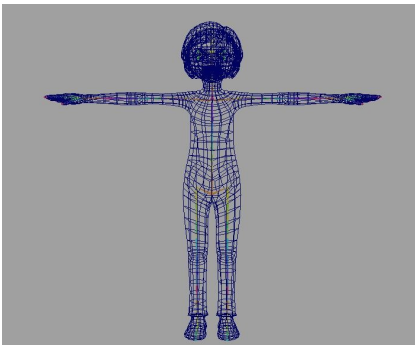


Fig 1: Joint setup [1]

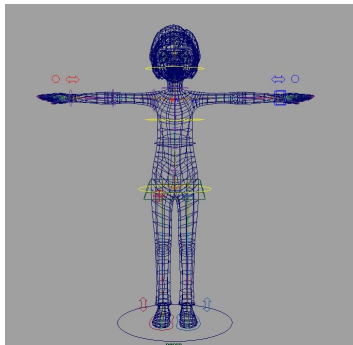


Fig 2: Control Setup [1]

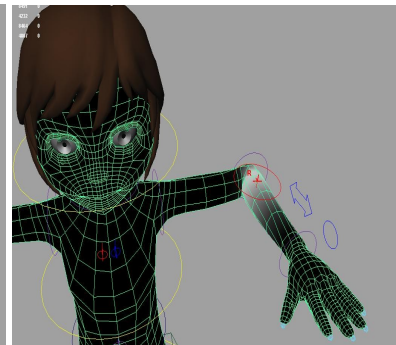


Fig 2: paint skin weight [1]

Research Background and Related Work

There has been a lot of work done in the field of rigging. Initially a rigger has to create a joint setup for a character. But it was hard to animate through joints. Then they create control which drives joints. Later they develop complex control setups but it uses a lot of time. Then they scripted it out to make whole processes auto-maze. These auto rigging and skinning script is very useful script for production studio. It will help to generate a good quality rig in a very short period of time. It will be very useful for secondary and crowd characters. It can be used to rig biped, quadruped, imaginary creature and props. It will automatically do the naming of joints and controls, which will help to transfer animation from one character to another.

1: Rig-o-matic

The Rig-o-matic [2] is a MEL script which reduces the time spent rigging bipedal characters. It has a good GUI interface to select various options required for bipedal characters. The rigger has to create a joint setup for one side of the body. The script will create all the controls for hands and legs for both sides. It also creates controls for spine, eyes and tails. It gives options for stretch and switch between IK/FK. It also gives an option for distributed joints which means we can have more joints in between two main joints to get smooth deformation. We can specify if we need no fingers, 4 or 5 fingers, it will create joints and controls for fingers.

It is based on broken hierarchy, where hands, legs, spine and other controls are created separately but they all will be under one master control. The best part of the script is that it maintains its own naming conventions followed by character name, which helps to transfer animation from one character to another.

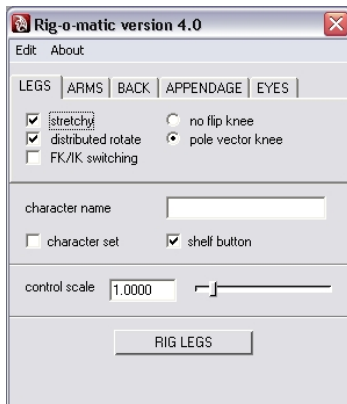


Fig 4: Rig-o-matic GUI [2]

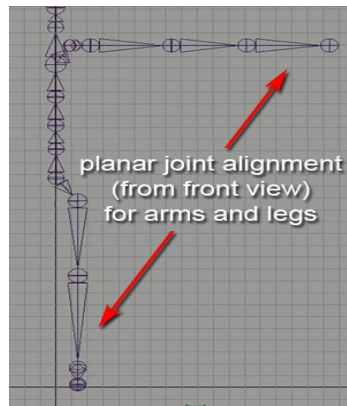


Fig 5: Basic joint setup [2]

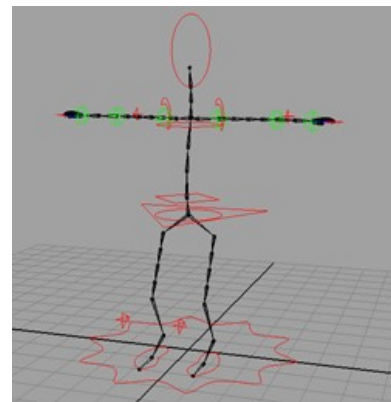


Fig 6: Final control setup [2]

Pros:

This script is very useful as it gives us a fast rig. It also saves production time. And it is very useful for a better workflow of the production pipeline and managing assets.

Cons:

Although it is a very useful script, it has some drawbacks. In this script we have to create

joints manually. We can not undo the process of rig generated by this script. Once the rig is created we have to do manual skinning, which takes lot of production.

2: Anzovin Studio - The Setup Machine 2

The Setup Machine 2 [3] is a standard Maya plug-in used for producing high-quality automatic rig and also provide basic automated skin weighting. Blue Zoo Productions [4] and Studio 100 [5] has used this plug-in in their projects.

This script use innovative construction-set approach. In this script we use pre rigged proxy model and fit it inside the original mesh. The script will create control setup which is flexible enough to achieve extreme position.

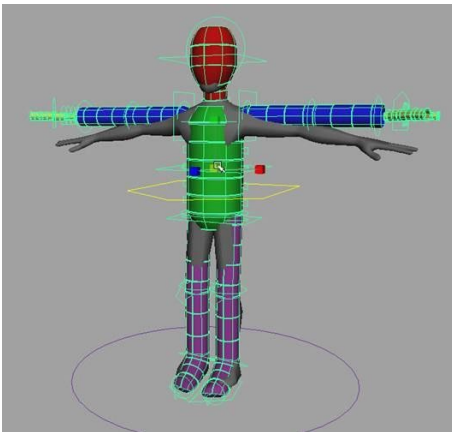


Fig 7: Fitting proxy mesh inside main mesh [6]

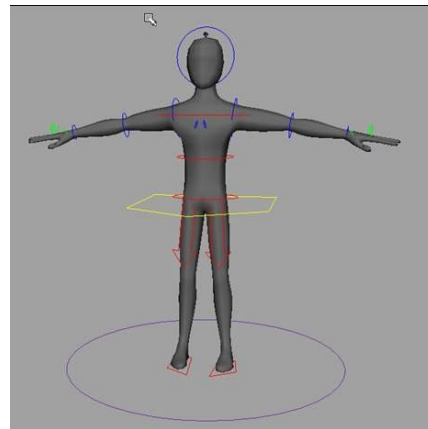


Fig 8: Control setup using Setup Machine [6]

It also includes the technique like No-flip FK-IK switching of arms and leg with stretchiness. This script also binds the mesh according to the nearest vertex position from proxy mesh. This script will also allow modifying the skin weight using vertex selection or Maya skin paint tool.

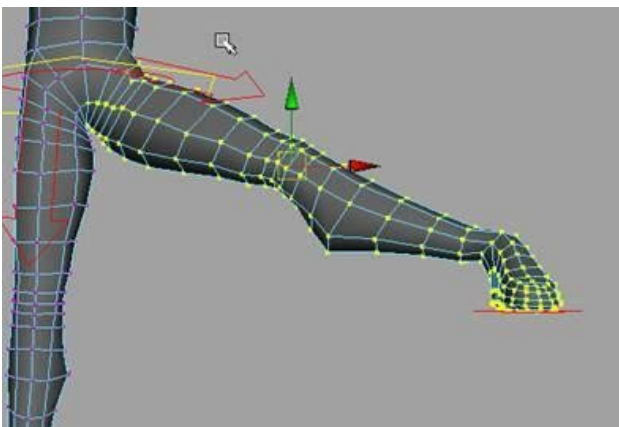


Fig 9: Skin weight using vertex selection [6]

This plug-in will also support quadruped rig. The whole process is same as biped character.

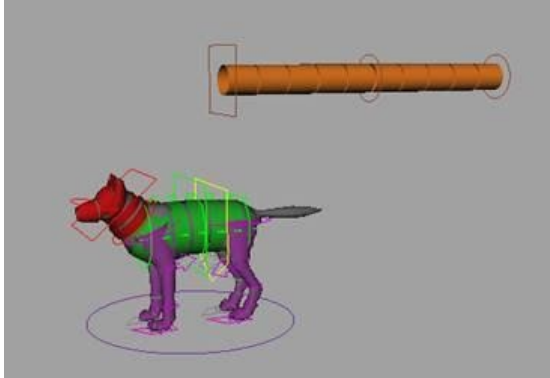


Fig 10: Fitting proxy mesh inside Quadruped mesh [6]

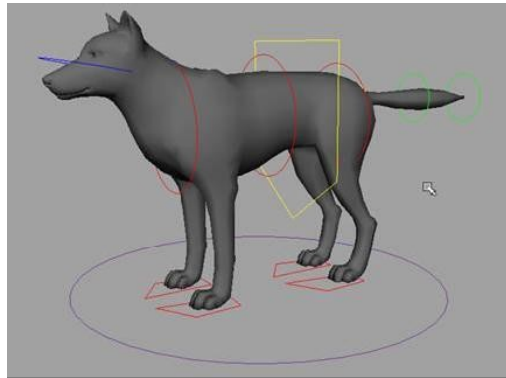


Fig 11: Control setup for quadruped [6]

One of the important features of this plug-in is that we can switch between proxy mesh and original mesh. You can select proxy mesh and perform animation. These will help animation to see animation in real time.

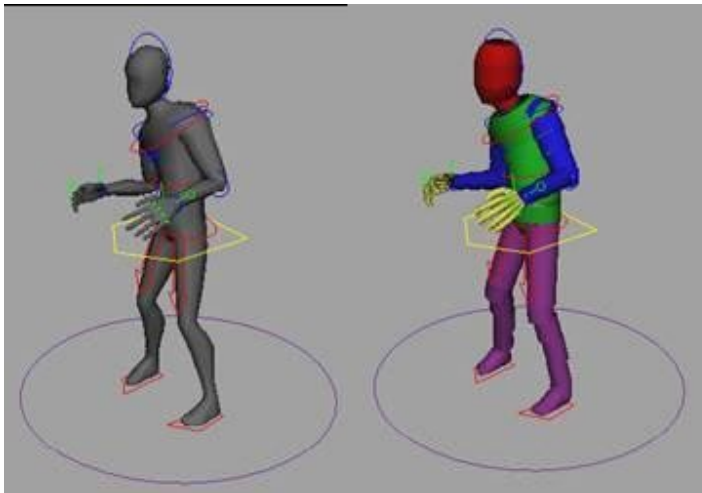


Fig 12: The final result of Anzovin Studio – The Setup Machine [6]

Pros:

This plug-in generate fast and high quality of standard rig. Switching between proxy and main mesh is new feature which helps to see animation in real time. Automatic Skinning is an important benefit on these plug-in which save lot of time.

Cons:

Although it give you a stander rig but it has some disadvantages also. It's hard to modify rig. Also it does not support some feature like bendy setup.

Zv auto rig

Paolo Dominici Character TD at Animation Lab had a different approach toward the construction of rig. He used mesh based rig. In his script he fit a proxy mesh inside the main mesh. And run the script to generate the control

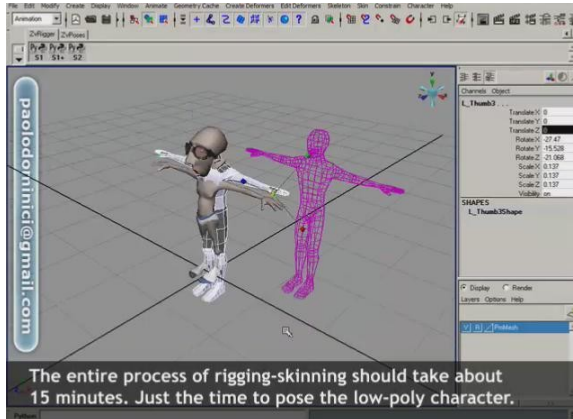


Fig 13: Fitting Proxy mesh in to main mesh [7]

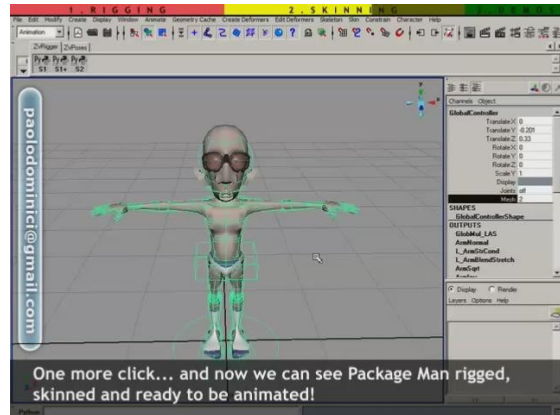


Fig 14: Control setup [7]

. It will adjust the proxy mesh according to original mesh. We can animate the proxy mesh. This script also gives option to customize the control. We can switch between proxy mesh and main mesh. The important feature of this script is that it take the skin weighting of the proxy mesh and copy it original mesh. This script will automatically bind the mesh with joint depending on distance from proxy mesh. It will take main mesh vertex and apply it same skin weighting value as the proxy mesh. This will do major of skinning work. We can later modify skinning weights using Maya paint skin weights tool.

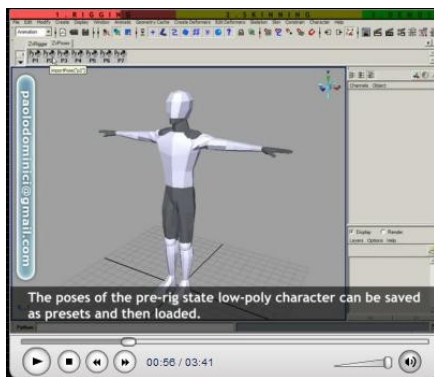


Fig 15: Proxy mesh for biped [7]

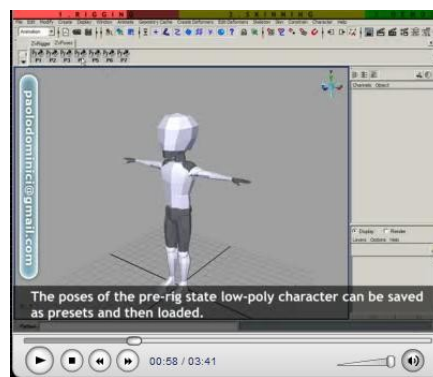


Fig 16: Proxy mesh for biped [7]

Auto Rigging Setup Tool

As per the background research we can say that the rigging process has change a lot over the period of time. It's an art of getting realistic or imagery deformation. My idea is to provide an auto rigging and auto skinning tool which can help to generate good production quality rig in fast and easy way. There has been lot of method for rigging. I have decided to choose proxy mesh method because it is as fast as other rigging method, also it give you a proxy mesh of character so you don't have to on load heavy mesh every time, in addition to that proxy mesh can also be used to transfer the skin weight from proxy mesh to main mesh. This will give you a complete skin character within few minutes.

The script is written in Maya python scripting language. Python is a platform independent language also it is supported by all major 3D animation packages. Python is extensively used in animation industry. My auto rigging tool is a collection of 12 python file. I have one main file main.py and 11 other python file which the main file is importing. I have divided my script in different classes to keep the thing clean, easy to understand and I can import the function of one class into another class. I have kept each setup in a separate file so that it can be modify at any time without affecting other files. It's easy to add new function to existing setup.

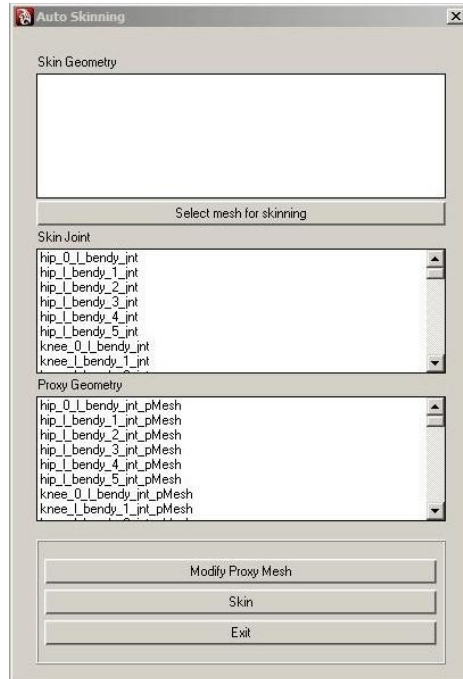


Fig 17: Proxy mesh for biped

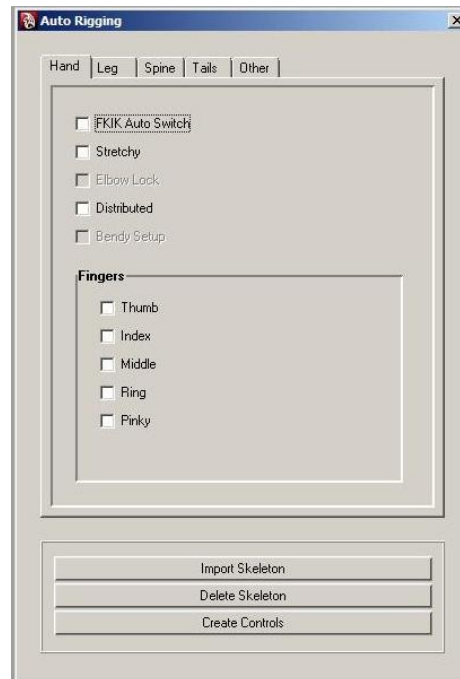


Fig 18: Proxy mesh for biped

The main.py file has two GUI one for rigging and another for skinning. When we run the script it will start the Auto Rigging Setup Tool, where I can choose option for hand finger, leg, spine etc. The GUI gives lot of option to choose. Different type of hand setup, leg setup, spine setup it also give option to include tails, eyes, jaw, tongue. Once I choose my option I can import skeleton. The GUI will pass this value to import skeleton. We get the skeleton according to our option. Then we have to adjust the skeleton according to character. You can delete the skeleton and create a new one. Once the joint placement is over, we can create the controls. It will create control according to the option selected in GUI. Auto Rigging Setup Tool is good and fast way too create production quality rig.

Over the period of time there have been a lot of new techniques. All these techniques are used to achieve extreme poses and better deformation. I have included a few techniques in my script. I have created basic FKIK switch. On top of that, I have given an option to include extra features. It's always good to have those techniques as an option. Because it depends on the character which techniques to be followed. Here I would like to describe the technique I used in my script.

FK/IK autoSwitch

The script will generate basic IK and FK control. When we switch between IK to FK, it will change the constraint weighting. Result, the hand will move from IK control position to FK position. Then we have to match the position of FK with IK and start animation from that new position. But some time there will be a difference between IK and FK position, which can be seen as a sudden shift in position. Again it will take a lot of time to adjust the same position to get free flowing position.

What if we don't want the hand to move toward control, instead of that control should move to match the position of hand. While doing animation there should not be any sudden shift between hands. Auto switch does the same job. Maya has a command called scriptJob which runs the function on some event like selection of some control or changing of attribute. I have defined scriptJob, on change of attribute FKIKSwitch for FKIKSwitch control. It will check for the value of attribute is it FK or IK. If it is FK then it will rotate all FK control to match with IK control. This can be done by adding a temporary aim constraint and orient constraint. If the value is IK, then it will add a temporary parent constraint to IK control to match position.

Stretchy

If you have a cartoon character that can stretch his arm or some time to achieve a pose we might require stretchy hand or leg. This script supports stretchiness for hand and leg. It also gives separate stretch options for upper part and lower part. For hands and legs stretch there are three attributes: auto, upper and lower.

In auto your whole hand gets stretch where as in upper or lower it will stretch upper or lower. It finds the minimum distance between wrist and shoulder, if IK control goes below that it will not affect the stretchiness. But if it goes more than minimum distance then stretchiness depends on each stretch attribute.

Elbow lock

Elbow lock is another new feature which is being used quite extensively now a day. Elbow lock is a feature where elbow or knee position is locked with pole vector when you move IK control your elbow will not move. If we switch on this option it will find a distance between shoulder and pole vector and a distance between pole vector and wrist. If the option is off it will take minimum distance as distance between wrist and shoulder. If the option is on it will take the distance as distance between shoulder and pole vector and distance between pole vector to wrist.

Distributed joint

Distributed joint is another good feature, where you get good deformation in hand and leg. In a normal hand joint system we don't have any joint in between elbow and wrist, so when we rotate wrist control, it just rotates wrist joint, there will be no proper falloff of weights, which doesn't look natural. But if you switch this option on, it will create new elbow joint and add 5 new joints in between wrist and elbow. Then it will apply IK Spline and it will connect the wrist rotation value to twist value of IK Spline. When you rotate the wrist it will rotate the rest of the 5 joints which give you a natural deformation.

Bendy set up

Bendy setup is used to achieve “c” or “s” position of hand. For bendy setup we need distributed joint. If we have distributed joint option on it will create an IKSpline on distributed joints and give a control to control IKSpline curve. It will connect the wrist rotation value with IKSpline twist, to give a natural deformation to hand. The distributed joint function returns a joint which is skinned with IKSpline. The bendy setup function creates a control on that joint. This control will always follow elbow joint. Similarly we can create a bendy setup in between shoulder and elbow. This feature is generally used for cartoon character.

FKIK for spine and tail

The script provides 3 type of setup for spine and tail, FK, IK, FKIK. FK option will create a control on each joint. And parent the control with the previous control. In IK setup it will create IKSpline. It will give 3 control to control IKSpline. Whereas FKIK is the combination of FK and IK. In this method I have applied IKSpline on joint and created duplicate joint chain for FK control. Then in tail parent all FK control to IK control and then parent each IK control to its near FK control. Where as in spine parent each IK control to its near FK control.

FK/IK for finger

Generally fingers have FK joint but there are few pose which are difficult to achieve like scrunches. This script gives you both controllers. You can switch between FK and IK. In addition to that it has stretchy option for both IK and FK. This script also provides you the option to choose the finger. According to your character you can choose the fingers.

Auto Skinning Setup Tool

Skinning is a tedious and slow process. It takes time to get good deformation. If we skin the mesh using Maya smooth binding, it will bind the mesh but the influence could be unexpected. Then rigger has to skin the character from scratch. Auto skinning will do the job half way.

Auto skinning is a part of auto rigging setup. In one hand we have auto rigging script which deal with all rigging issue and on other hand auto skinning will take care of skinning process. Once you create a control for character the script will open auto skinning setup window for skinning. Here you have to select main mesh and include in first list of auto skinning window. The second list is a list of joint to be skinning. And third is the list of proxy geo.

Auto skinning script helps to change the shape of proxy mesh according to your original mesh. As well as it helps to transfer skin weight from proxy mesh to main mesh. This will do the skinning job half way or even more, if proxy mesh is placed properly. It contains some good feature, which reduces the production time a lot.

Skinning joint

The script will select the entire joint for skinning according to auto rigging GUI option. So the rigger doesn't have to select the entire joint each time. It will display in the 2nd list of Auto Skinning GUI.

Proxy mesh

It will also create a proxy mesh on each joint. It will display in the 3rd list of Auto Skinning GUI. You have to resize proxy mesh according to your main mesh. You can scale it, translate it, rotate it or even you can adjust the vertex position. It should be approximately near to main mesh. Then we can run the modify proxy script which will modify the proxy mesh according to main mesh. It will take the nearest point of original mesh and snap all vertex of proxy mesh one by one. The end result will be proxy mesh which will look similar to main mesh.

Copy skin weight

Before clicking on skin button we have to make sure that we have selected proper mesh and proper proxy mesh. When we click on "skin" button, it takes all the selected proxy mesh. Make a copy of those selected proxy mesh. Combine all duplicate mesh using poly unite procedure. Merge all close vertexes to each other, so that there should not be variation in skin weight in close region. Then apply the smooth bind to both new geometry and main mesh. Then copy the weight from new geometry to main mesh. Then delete the new mesh. This will reduce the amount of time given to rigging and skinning.

Switch between proxy and main mesh

Before exiting from skinning GUI make sure to select all main mesh from GUI. When exit from skinning GUI, it will select all main mesh and apply poly smooth. The script will add an attribute to master control to switch between proxy mesh and main mesh. When the values of master control's mesh attribute is 0, it will display proxy geometry, when the value is one it will display main geometry. But when the attribute value will be 2 it will ingress the poly smooth division of main mesh

Implementation

Each character could be different from other, that's why I have generalized the setup to match most of the character requirement. The scripts are quite simple to use. Options are clear and understandable. First of all make sure you have all script in your "Documents/ Maya /script" folder. Load the main.py script and run it.

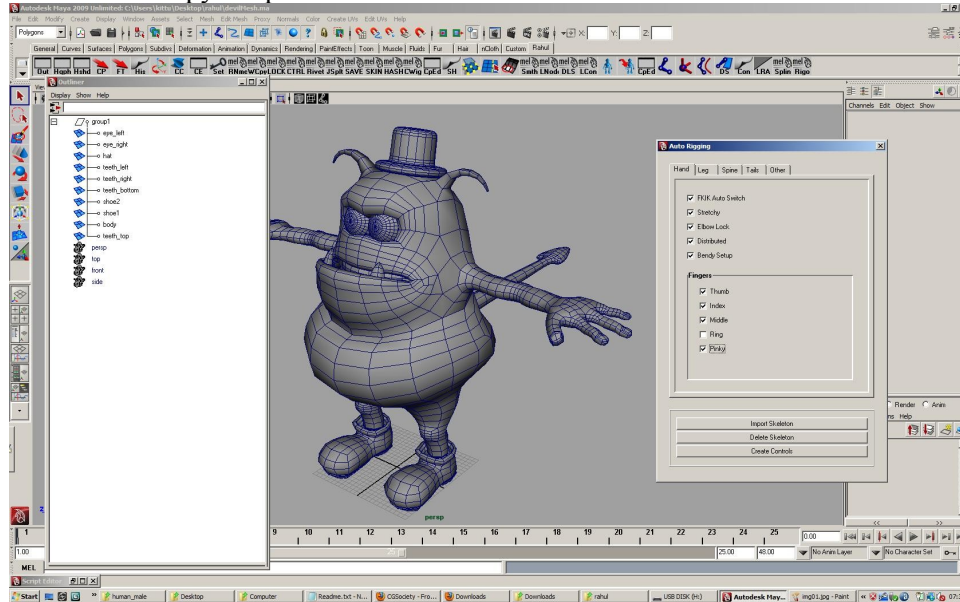


Fig 19: Proxy mesh for biped [10]

It has different tabs for different part of body. Choose the option according to your character. for example if your character is imagery character which has 3 finger and its hand and legs need stretch option you can select those option and click on button "import skeleton". Once the skeleton is imported you can notice that script had imported the skeleton according to your option. Now adjust the position of joint.

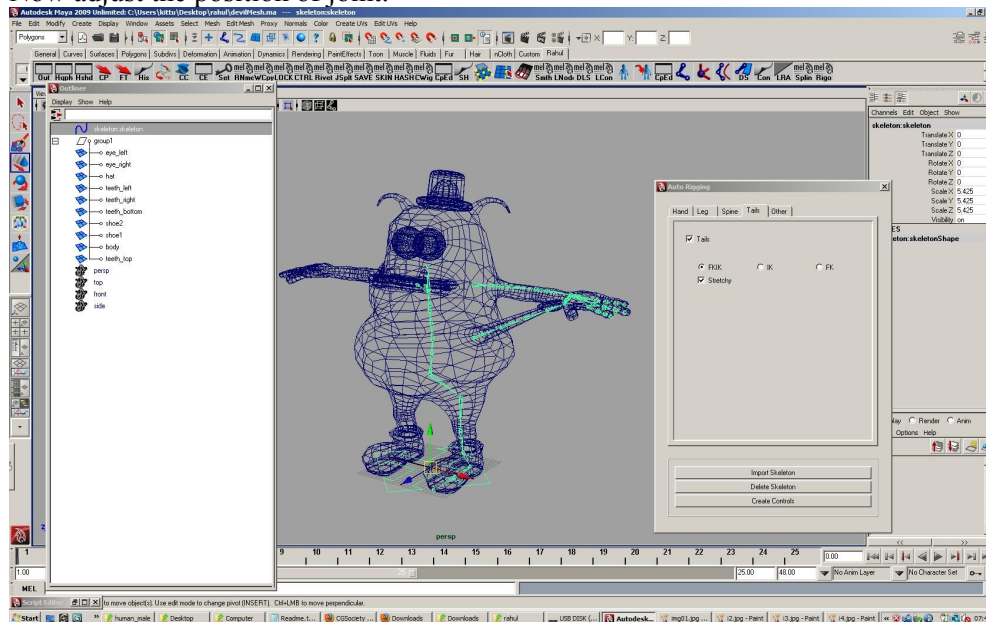


Fig 20: Proxy mesh for biped [10]

Here you need to be bit careful, you can only translate parent joint, like translate clavicle joint and only scale and rotate to other joint like elbow or wrist. You can delete the current skeleton and re-import the new skeleton. Also you can scale the main control to match the character. This is quite important because each control's size which the script will generate is multiplied by main control size. So first scale your main control size then adjust the each joint. Make sure not to break hierarchy or change the name of joint or control. Also make sure not to change the orientation of joints.

Once the joint position is set click on button "create control". It will create all the control and place it in nice clean hierarchy. If you check out the outliner you can see that it has one master control which is parent of all other control. One proxy meshes group and one untouchable group which will be invisible. This group contains all the joints and IK handle. The rig is full scalable.

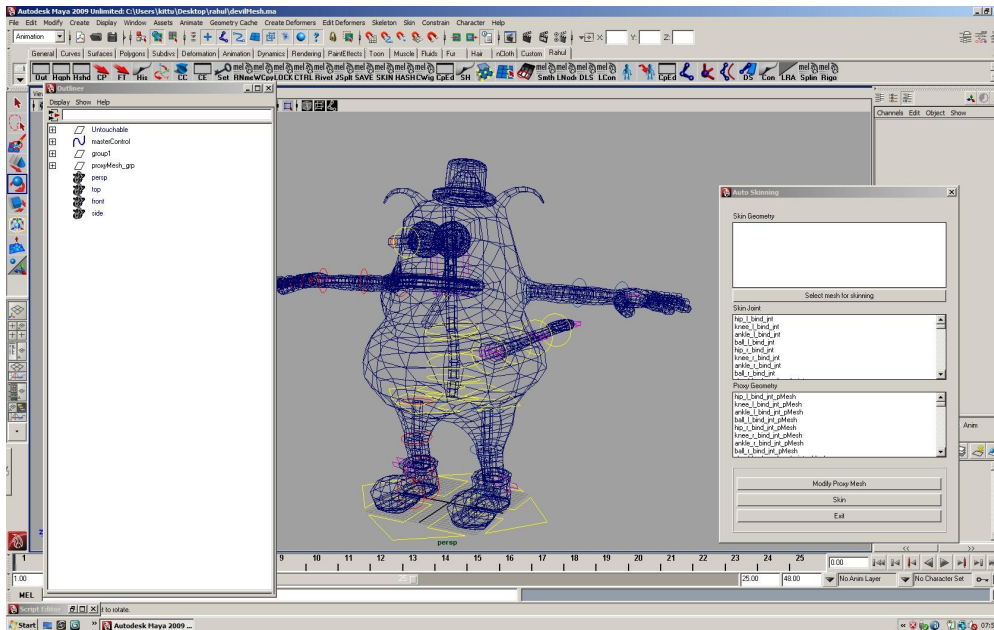


Fig 21: Proxy mesh for biped [10]

As soon as you create the controls, rigging GUI will be closed and skinning GUI will appear. It will create all the control as well as give you a proxy mesh on each skin joint will have 3 list box first is for main geometry, 2nd list box is a list of all skinning joint and 3rd is a list of all proxy mesh.

You have to select all main geometry and select them for skinning. This is another feature of the script is that it give you list of joints to be skinned and all proxy geo attach to it. Now you have to adjust each proxy mesh according to main mesh. You can match it approximately. Once it had done, then select main geometry from auto skinning GUI. And select proxy which comes under main geometry.

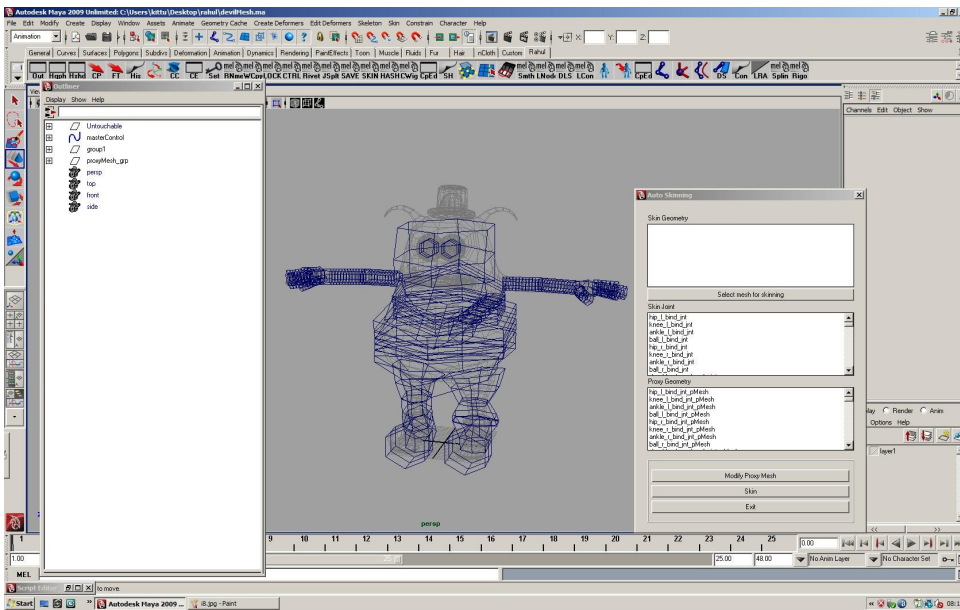


Fig 22: Proxy mesh for biped [10]

Then modify the proxy geometry by click on modify geometry. It will adjust the proxy mesh according to near position of your original mesh. Once you finish with all proxy modification select main geometry, select joint which will affect geometry and select proxy geometry relative, and click on “skin” button to transfer. It will create the copy of all proxy geometry. Merge the close vertex. Apply the smooth skin and transfer the skin weight, then delete the new geometry. Select all main mesh from GUI. When exit from skinning GUI, it will select all main mesh and apply poly smooth. The script will add an attribute to master control to switch between proxy mesh and main mesh. Select all main mesh from GUI. When exit from skinning GUI, it will select all main mesh and apply poly smooth. The script will add an attribute to master control to switch between proxy mesh and main mesh.

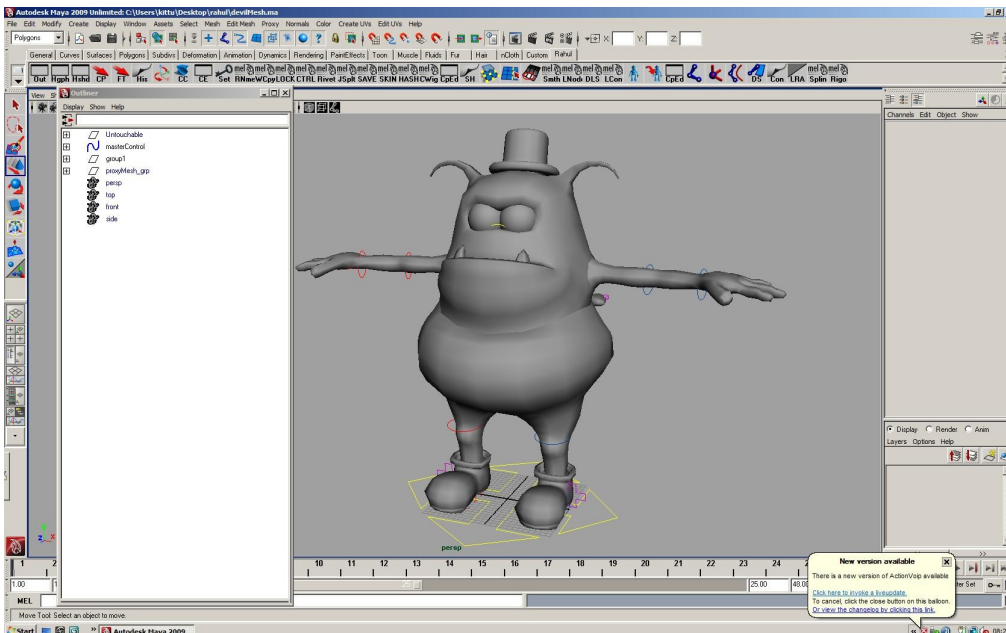


Fig 23: Proxy mesh for biped [10]

Connection Network

The script has one main.py and 11 other class from were it importing. It creates many nodes and complex node network. There is some node network which I would like to describe here

Stretchy Network

IK control for hand and leg has three attribute – auto, upper and lower. Value of these three attribute describe who much IK joints will move. In auto mode the joints will move along with IK control. Where as in upper or lower joint will move only in upper or lower part

All these three values go to multiply divide node these multiply divide node will check if the hand is right or left according to that it will set the input2x value. If it is left side the value will be 1, but if it is right side then value will be -1. Because when we mirror the joints its direction will also change, so we have to give -1 value to get proper stretch.

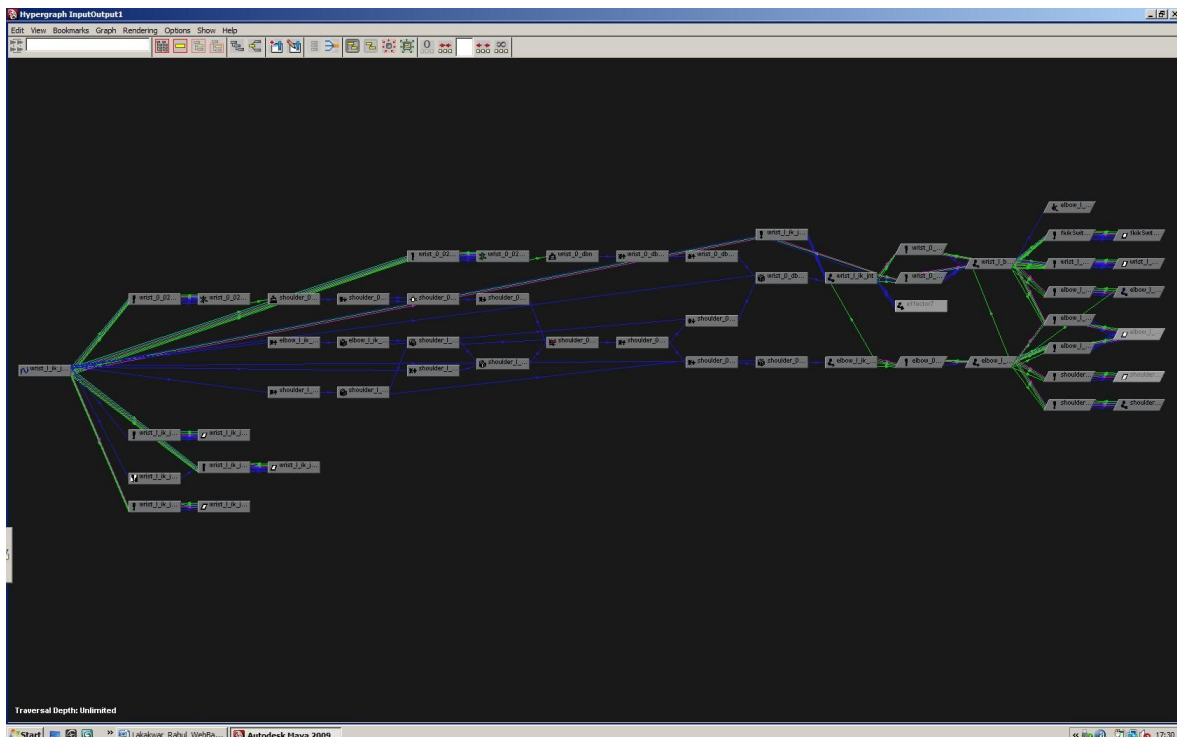


Fig 24: Proxy mesh for biped

We also have to find the distance between shoulder and wrist. This distance between nodes is connected to multiply divide node which is being divided by mater control. So that stretch network will work properly after scaling the main control. Also we have to add another multiply divide node, if it is left then input2x will be 1 , otherwise if it is right then input2x will be -1.

Now we can clamp the values. The sum of upper and lower will be the minimum value; we don't want hand to shrink. The value of auto multiply divide node will be maximum, and the distance between will be current value. This clamped value will be divided by itself. But if elbow lock is on it will take the distance between shoulder and pole vector for upper arm and pole vector and wrist for lower arm.

Elbow Lock Network

If the elbow lock is on it will stretch the elbow joint to meet the position of pole vector. For elbow lock setup we need three distances between nodes. One from shoulder to wrist, and another distance between nodes will be from shoulder to polevector and pole vector to wrist.

If elbow lock is off then first distance between will work for stretchy network, but if it is off it will take the elbow distance between and wrist distance between nodes for stretchy. If we feed this distance between values to joints they will stretch and stick to pole vector position. We have to parent locator of distance between nodes to pole vector to stick with pole vector.

Bendy setup network

Bendy setups are generally used to achieve “c” or “s” poses of hand. It takes the base joint duplicate it break it from child, then we can parent duplicate joint with base. Also we can use copyUnparentChild which almost do the same job. We can now increase the number of joint to apply IKspline; we can use joint segment script to generate it. We can apply IKspline to shoulder bendy joint and elbow bendy joint. Now we can copy the joint keep only the first, middle and last joint. Skin them with IKspline curve.

Conclusion & Future work

Rigging is the process of creating a control setup for character. It required good balance of artistic knowledge as well as technical knowledge. A rigger should understand the need of an animation and give the solution which animation can understand. For example, if a rigger creates a good rig, but if it doesn't achieve the pose easily then animator may not like the rig. Through Auto Rigging Setup Tool rigger can easily satisfy animators need.

The auto rigging setup tool is very useful script for generation secondary. It contain some advance technique like switching between IK and FK, bendy setup, elbow locking. The rig is flexible enough to achieve any kind of pose. It has clean hierarchy. . It will automatically do the naming of joints and controls. This will help to transfer animation from one character to another. All control is separate under master control. Later on we can add extra control just make sure not to break hierarchy.

The Auto Rigging Setup Tool will generate every rig in same manner which means better quality of rig and easy to understand the rigs by animators. It will also help to transfer an animation. They can save the animation library, and use library whenever needed .These scripts are very useful for production. They help to keep track of assets. Increase the production quality of studio and save production time.

There is few limitation of this script like you cannot change orientation; you cannot increase the number or joint of spine or tail. My initial plan would be adding all this features. Make it more robust. Add auto switching for fingers. Right now it's only for biped. I want to make auto rig for quadruped also. Also make script to be used each function separately for example if I need only my hand bendy setup in some props I could use it

Further I will add GUI, which helps animator for easy selection of control. GUI will take all information generated from rigging script. Also to add facial controls and to make GUI for it. Which include the functionality to store facial expression and body poses.

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