
UCL
MACHINE LEARNING
FOR 2D ANIMATION
NOGHOST

Introduction

The Problem

The process of creating 2D animation consists of a number of steps, some of which are highly labour intensive. These steps which require lots of manual labour can constitute a large portion of an animated project's budget, often up to 50%. The 2D animation industry is underserved in general when it comes to innovation in creative tools. RnD involving AI is often looking to replace a manual process wholesale, rather than enhance the creative abilities of a master artist.

A lot of the machine learning research in the animation industry has gone into the 3D field - leaving 2D animation relatively underserved. There has been work done in frame interpolation, but this has not been done with the consideration of how it could fit into the existing 2D animation pipeline, or making the process more accessible to novice users, as such, is not of much use to a real world production. What sets our approach apart is that we want to design it around the capabilities and creative talent of a master animator, to allow them to take a shot from start to finish, keeping creative control the whole way. With our research, our proposed toolset will allow one animator to complete the work that it takes 5 people to do now.

Why focus on 2D Animation?

2D animation has unique stylistic possibilities that have wide appeal for feature film, animated series and advertising. The hand-drawn aesthetic is one of many styles that 2D animation can take, and the tactile nature of 2D animation is what helps it to appeal to a wide audience. From a creative perspective, the artist making the animation has total control over all aspects of the final image, there is no baked lighting, fluid, fur or muscle simulations that you might use in 3D animation.

Improving the efficiency of content creation for 2D animation could have a huge effect on the industry as a whole - especially when it comes to episodic content. The time and money savings that we believe we'll be able to achieve using these kinds of tools open up massive opportunities for 2D animated series to increase the quality and quantity of work done. For content creation tools, research is heavily focused towards 3D animation, so there is an opportunity to make a big difference to the 2D animation process as not a lot of work is being done in this area.

The Process

Existing workflow

2D animation is produced in stages, usually in a large project it is segmented like so;

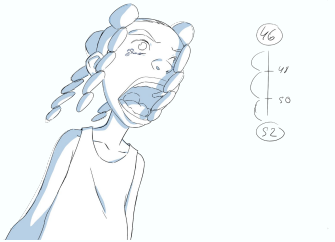
Key Poses/Layout - Also called pose to pose drawings, these are the start of the animation process and just sets out the major actions and placement in the scene.

Roughs/Inbetweening - This is often a two stage process where the lead animator will add timing notes for the Inbetweening artist in the form of frame charts that show how the drawings should be distributed in time.

Cleanup/Inking - From the rough stage the lines then need to be refined to the final inked drawings, there are many different styles that can be used from animation to animation, and different line effects that can be used to exaggerate motion.

Colour/Mattes - With the final linework all that is left is to fill in the colour, shadows and highlights of the image.

Layout



Roughs

Cleanup

Colour

The Process

How we plan to Improve it

The current workflow for creating 2D animation involves various processes that are very labour intensive. For a lead animator, the current workflow requires that the creative input be front-loaded between the initial roughs through to the pose drawing stage. Beyond these stages, the work of creating in-betweens, mattes, line and colour passes are much more laborious and labour intensive, and are delegated to other artists. The master animator does not have direct control or creative input during these stages, and they cannot get an accurate preview of how the final animation might look at the early stage where they are creating the basis for the characters' movement.

Where Machine Learning comes in

Using a machine learning based approach, we plan to create tools that will fundamentally enhance and speed up the process of creating 2D animation for a master 2D animator. Combining different disciplines of machine learning, we want to explore how we can make tools that not only increase efficiency, but also adapt to expand the creative options for the animator. We want to work across the 2D animation pipeline from the roughs stage onwards, creating algorithms that not only interpolate between hand drawn keyframes, but offer the artist intuitive options in both movement and style.

Our plan is to work with a non-destructive approach, giving flexibility to offer options, and make changes at any stage that will propagate throughout the animation process, something which is not possible with current techniques. The process will need to be tackled in stages rather than with one core algorithm. First we'll need a system to prep training data, ingesting from the client database, this will then be run through a processing stage to tag the data for use. We'll need to come up with our core models, design which blocks of processing will be put together, and work out hyperparameters to ensure we don't get into local minima. Finally we'll need to focus on optimisation, compactification, scaling, and lastly working out what we will need to sacrifice in order to work towards a realtime output.

Machine Learning

Which disciplines will be required?

Each of the different stages of 2D animation production will need its own set of techniques; for going from layout to inbetweening we will interpret the timing notes and combine them with the key poses and create every frame. Then with these rough frames the animator may want to make edits to the line work to more get the specific image they want, these will have to be able be passed back into the inbetweening process, translated back to the key pose data by minimising the difference between the regenerated inbetweens and the edit that was made. This process will require Autoencoders and computer vision techniques to extract and isolate the timing notes, for creating the inbetween frames an approach like Recurrent Neural Networks or Transformers that takes the key poses, encoded timing notes and edits could ensure temporal coherence and output to low resolution (inking is rough at this point).

The output from the prior stage can then be fed into a network with optional tagging for specific line style modifications (speed lines, ect.) and an overall line style. A GAN with recurrent feedback for frame to frame consistency would suit this stage as there is a huge datasets available for animation before and after the cleanup/inking. The matting stage would also suit a GAN for unsupervised training. These last two stages will probably need a CNN for producing the high resolution output required in a reasonable time at inference (see VQGANs).

In terms of the UX requirements of the tools, we will be trying to predict what the artist wants from their animation based on the inputs they make, and offer suggestions based on the style of the project. This will require elements of affective computing and active learning in order to achieve a satisfyingly reactive result. One of the big challenges is that this will need to happen in realtime so that the artist gets instant feedback from their actions.

R&D

Why do we need UCL?

A research project involving this level of Machine Learning integration is currently beyond our internal capability due to the wide breadth of expertise and cross-disciplinary knowledge that will be required. The unique part of our research will centre on how to really enhance the work of an “expert user”, something that has not been done before in this field. Rather than trying to replace all manual labour, we are aiming to enhance the productivity and creative capabilities of artists.

Due to these aims and requirements, there are no current off-the-shelf solutions that we can use as a basis to start from, meaning all the development will need to be built from the ground up. A collaboration with an expert from UCL would be hugely beneficial for the project, someone who is able to lend their expertise to help us work out how to combine these complex systems into cohesive user-empowering animation tools.

What skills do we have on our team?

Our capabilities in relation to this project are largely focused on the UX, and software pipeline integration. We are coming at this project from a perspective of the 2D animator, and our intimate knowledge of the workflows and requirements that the animators themselves have. Our Technical Director Jack Straw has a background in the UX and building of animation tools, optimisation and GPU Acceleration, along with Distributed Computing and Data Processing.

The Line animation have a varied catalogue of 2D animation productions under their belt, for a variety of commercial clients. Their input on this project will be twofold: firstly, providing access to raw animation data from each pass of the 2D animation pipeline, and secondly direct feedback from the animators themselves who will be testing the tools. No Ghost and The Line have collaborated in the past on multiple projects blending 2D and 3D animation. The Line have agreed to allow us access to their entire archive to use as training data for our project.

Next Steps

What are we planning?

We are applying to Innovate UK Smart Grants towards the end of October for funding to develop an initial prototype, testing our approach. We plan to build a functional version of the core algorithms, working with a dataset provided by our studio partners, The Line Animation. The scope of the prototype will primarily be to take an input of frame data, calculate the in-betweens and be able to interactively change the style of the output.

Once this prototype is completed, we will apply for further funding from a variety of sources in order to develop an extended prototype. Next we'll move towards an Alpha stage, closed and open Beta, before final release, adding features as we go.

THANK YOU

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