Puppetry-inspired animation: A midair hand gestures manipulation for 3D character animation

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Bringing together keyframe and motion-timing can be very difficult to control especially when manipulating body parts of a character animation. Both seem are 'detach' in their event as keyframe is physically visible, while timing is imperceptible and merely appears as substance of a sequence of keyframes. This paper presents an overview of my doctoral research, which focuses on an approach to create a puppetry-like animation technique in computer animation that provides an embodied interaction between user and animated character. The proposed project investigates how character animation acquires direct response from the user hand-centered direct manipulation using Leap Motion. Such midair motion-sensing device is used to automate keyframes that create motion timing for character animation based on the timing of a user's movements.

Character Animation, Motion Timing, Motion-sensing, Hand/fingers Movement, Puppetry, Embodied Interaction

1. INTRODUCTION

Creating animation is an intriguing activity that involves making an inanimate object animate. But the process can be very time consuming and tedious when it involves animating a character using the keyframe technique. The complexity of movement requires detailed observation imagining continuous real-time movement into fragmented keyframes that are used to construct movement in computer animation. It is due to the nature of animation itself that, movement is *created* and not occurs fortuitously. Although movement is the key element underpinning every animation, animation remains blunt and movement merely a movement without imbuing the beauty of timing. A precise timing provides 'believability' that conveys meanings to every movement without it necessarily being a realistic representation.

Synthesising keyframe and motion-timing can be complicated to control a character, particularly involving body parts. Keyframe is something that physically visible, whereas timing is a substance of keyframe and imperceptible in its physical form but heavily relies on how keyframes are constructed. During keyframing, we set a key pose on a frame followed by another frame on different frame after changing body parts to different poses. The timing is depends on the distance and spacing given when we set the keyframes. The process monotonously goes forwards and backwards repeating the procedure creating a sequence of frames in order to produce timing that determines a movement. Animators can only see the timing of the animation once the keyframes have been set and they play the animation back. There is no direct feedback about timing during the process of setting keyframes. The 'detach' between setting keyframes and anticipating timing, give the manipulation process seems indirect. Indirect in this sense is when keyframing and timing process are not integrated as one component of movement. In other words, we are unable to see what is created and what we will get as a result.

Others may take a different approach by using motion capture to record real time movement but this replicates realistic movement and does not allow for stylised animation.

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In this research project, I proposed a work-in-progress seeking a novel approach to animation techniques based on hand gesture movement using a motion-sensing controller, Leap Motion. It investigates the depiction of motion timing through the device that detects hand/fingers and gestures moving in midair. This technique is expected to provide a full hand-body embodied interaction, which allows direct manipulation and immediate response between the user's hand control and a 3D character.

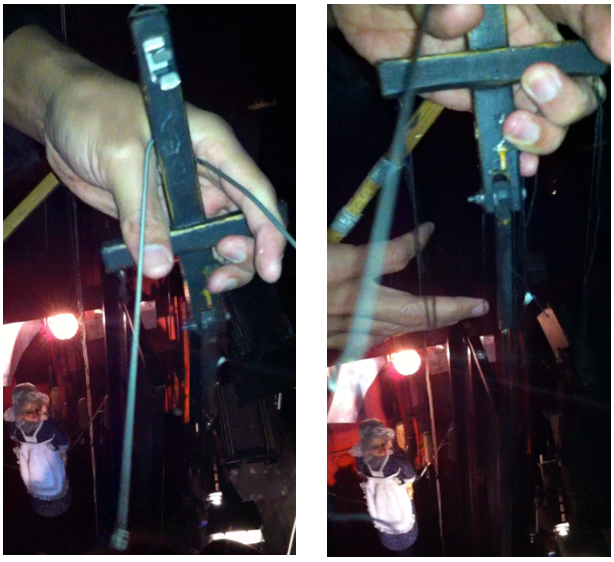

***Figure 1:** Hand gestures controlling a traditional marionette puppetry on rods and strings*

An inspiration for this technique is based on handling traditional marionette puppetry where the motion timing in the puppet is knowingly generated by the puppeteer hand gestures manupulating rods and strings (Figure 1). Through a similar concept, the interface allows the timing of a 3D character's movement to be influenced by the user's hand/finger controls; while it concurrently automates the keyframes directly. The technique aims to improve the principle of creating motion timing in computer animation, which the existing linear keyframing makes hard to achieve.

2. LITERATURE REVIEW

Much of the keyframe technique and timing are based on the traditional methods of 2D animation and exploits Disney's Animation Principles within the animation production (Lasseter, 1987; Kunder-Gibbs, 2009; Montgomery, 2012) as well as a learning instrument among novice learners in the animation, these formulated basic principles have become an important tool among animators in 'understand[ing] how things move in the real world' (Montgomery, 2012). This notion is rather unspecified when the principles themselves according to Disney are intended to enhance 'believability' (Thomas and Johnston, 1981) in the movement of animated characters. Parent (2010) classified these principles into four 'types of motion quality' (2010). He manages the principles in such a systematic manner as to provide user with thematic understanding that help them not to see principles randomly.

Many 3D character animation references written by practitioners tend to explain practicality of the mechanics of each principle and how it should be applied to a character. Collectively, the tendency is to provide a complete-course and step-by-step lesson of how principles are operated in particular software using available functions and command controls such as in Montgomery (2012), Lapidus (2011), and Hess (2011). Similarly, Steve Roberts (2011) and Webster (2005) provide basic understanding of the principles that emphasise on the required technical skills at creating motion for character in both methods 2D and 3D animation. The approach is rather a guided tutoring of character locomotions and poses. The main concentration is given on selected important of principles as suggested by Parent in his 'type of motion quality' of 'Simulating Physics' and 'Designing Aesthetically Pleasing Actions'.

3. STATEMENT OF THESIS AND GOALS

The primary concern of this project is to research how the user is able to create motion timing in animated character without having to engage with frame-by-frame setting process. It can be a very laborious process that one has to manage.

It is known that keyframing technique is commonly used, as it is a method that can easily be found in any given 3D animation-related software. A set of keyframe exhibits the accuracy of motion-timing that we attempt to create for animation. But deciding how much or less frames needed and simultaneously resolves timing issue can be problematic due to the 'indirect' manipulation keyframe technique that occurs between user and the character. In this research I propose a direct manipulation approach to keyframe animation, which allows motion-timing data input is directly derived from the user's hand controls. This research attempts to address the following questions:

(i) What other techniques than keyframe animation are able to impart interaction and develop performativity?

(ii) How is motion-sensing tool able to transform keyframing animation technique and influence the way we animate?

(iii) How is 'believability' achievable through devising hand/finger as direct controls and as a source of motion timing?

These questions aim to fulfill the following goals:

(i) Explore Leap Motion that can contribute to the development of full embodied interaction between user and character animation;

(ii) Examine the relationship and mapping between motion-sensing tool, hand/fingers technique and character animation in order to automate the keyframes;

(iii) Design and evaluate a prototype that is feasible to receive hand/fingers input data from the Leap Motion to generate the character in 3D software;

(iv) Formulate a concept of hand/fingers gesture animation technique that provides direct manipulation and instantaneous motion timing onto character animation.

4. DISSERTATION STATUS AND METHODS

I am an MPhil/PhD in Art and Computational Technology at the Department of Computing, Goldsmiths, University of London, in the second year (20 months) of the programme. To date, my research is revolves around addressing an understanding of the essence of animation that is, timing. Some primary and secondary sources of literatures are identified to form different sections namely from the related issues of traditional keyframe method, motion captures to inventive techniques using motion-sensing related devices. As a requirement of practice-based research, some practices are also explored such as using frame-by-frame technique and performing motion capture. Prior to the current investigation, a Wii remote was used for a similar endeavour to animate a 3D character and automate keyframes.

***Figure 2:** The midair hand gestures manipulation technique using Leap Motion and LeapStreamer*

My current development is focused on the application of preliminary prototyping software (Figure 2) that complements the entire framework. This is to explore calibrations of left and right hands movement and its synchronised input/output data to a 3D character in Maya. This experiment includes the navigation of hands distance, orientation, translation, location and exertion within the Leap proximity.

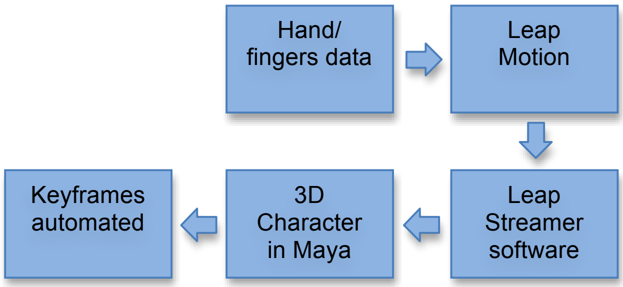

***Figure 3:** The diagram shows the process of the technique*

The above diagram shows a flow of how the entire system works (Figure 3). It consists of three basic components: a Leap Motion device, a LeapStreamer[1] software, and 3D animation software; for this purpose I use Maya. The process is when user moves his hands, motion data from the hands gestures are received by Leap Motion through its sensory tracking feature. The raw data is received by LeapStreamer and is used to identify the movemet of the left and right hand and fingers. This data is converted to commands in MelScript which can be understood in Maya and then sent via a network socket to Maya. Within maya the hand movement data is mapped to a 3D animated character. In this preliminary experiment, I use a 3D character called AndyRig[2] with full basic skeleton rigging.

In order to receive output data from the user's hands, we assigned Set Driven Key (SDK) onto the character's IK controllers. A Set Driven Key consists of a driver and driven objects; the former is a handle that controls values on key attributes (i.e. translate and rotate X, Y, and Z), and the latter is the object whose translates and rotates are determine by the attributes from the driver/handle. For example, in this experiment, we connect Andy's left hand on translate Y to the SDK handle's leftHand translate Y attribute. We do the same to translate X and Z on Andy's both hands. Consequently, the character's hands moves on Y

[1] LeapStreamer is a software developed by Marco Gillies in collaboration with this project, using openFrameworks in C++. It is for connecting, and sending/receiving input/output data from Leap Motion and Maya.

[2] AndyRig is a freeware rig-ready 3D character created by John Doublestein in 2007 for his students use for various animation purposes.

axis as the data is received by the Driven Key's handle. This function makes the animation process easy to animate as the keys are set within the value range preset in the attributes. Driven Key allows to have more control over data mapping onto the character. In particular many different mappings are possible. For example, there is no need for the user's left hand to be mapped to the character's hand, we have also mapped users' hands to the hips, legs and head, to simulate the practice of puppeteering.

Both hands are need to be calibrated in LeapStreamer by selecting left and/or right hand function in order to be able the character recognise the sending data. When the character's hand is moving, keyframes are automatically added to the timeline; in concurrent, spacing of the keyframes that occurred indicate the timing, in which it is detected from various pressures put by the user onto his hands. That concludes the process.

The next development is to mapping the details of each hand and finger translations, rotations and identity to different body parts of the character's IK handles moving on X, Y and Z coordinates, followed by evaluating the technique through producing a short animation. The prototype will also be used and tested to a group of participants to improve its interaction and feasibility of hand/fingers gestures.

5. EXPECTED CONTRIBUTIONS

It is known that users who deal with keyframe animation struggle to animate objects in 3D particularly character animation due to the complexity of skeleton joints and keyframes. The alternatives are MoCap and Kinect, which provide an immediate bodily-captured movement but the techniques are likely to replicate realistic action.

By developing a midair dexterity approach to mapping motion timing for skeletal-based animation, it would be easier for user to automate keyframe and reduce the tediousness of animating process. As a result, another novel approach to stylizing movement for character animation will be introduced and incorporates a new concept of learning experience that the existing interfaces exclude from enabling embodied interaction.

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