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A Study for analysis of Inverse Kinematics system to Character Animations & Motion Graphics education

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Abstract

Today, 3D softwares have become an essential tool in all areas of Video, including Movies, Animations, CFs, Motion Graphics and Games. One of the most commonly used fields is the 3D character video part. However, these 3D character animations and motion graphics softwares are difficult to learn and too much to learn, making it difficult to learn them all in a university education with a limited time of four years. In this paper, many Inverse kinematics tools, which are essential in the 3D character animations and motion graphics field, compare and analyze the strengths and weaknesses of each tool, focusing on Bone, Character Studio, and Character Animation Toolkit, which are most commonly used in work fields. And use Delphi techniques for 3D experts to secure objectivity. Therefore, for universities that require large amounts of teaching in a limited time, I propose an analysis of which of the above three Inverse Kinetics tools is advantageous for students to select and focus on for efficient education.

Keywords: 3D Character Animations, 3D Character Motion Graphics, Inverse Kinematics Systems, Contents Education, Delphi Technique

1. Introduction

1.1 Background and Purpose of Study

Today, 3D software has become an essential tool in the field of video content. There are also various 3D fields used in videos, games, and various contents, and one of the most commonly used and utilized fields is character animations and character motion graphics. Character animations and motion graphics are literally meaning that making videos using characters. Instead of special-dressed actors, characters made with 3D software appear as real actors, or in full 3D animations or games, they appear as main characters and other extras, and they are in charge of storytelling. Character animation and motion graphics hold a very important position in the current field of video, games, and content, as the character industry is increasing every year around the world and in Korea.[1] In order to implement these character animations and motion graphics, it is necessary to acquire various functions of the software. However, unlike other CG software, 3D software has a

lot of new features to learn, and each year, new features to be upgraded are rapidly increasing, making it difficult to learn just the core functions of 3D software with just four years of college education. Even if college teaches 3D-related functions to college students, the gap between university education and working-level work increases, so new employees who are employed cannot be put into practice immediately. Therefore the company is re-training new employees or recruiting only experienced employees. Therefore, in order to reduce the gap between these industries and universities as much as possible, this study will explore which tools in the fields of 3D character animation and character motion graphics are effective in intensively learning at universities.

1.2 Scope and method of the study

Basically, Inverse Kinematics (IK) is used to animate 3D characters. There are several types of IK systems, with the industry's most widely used and performance-proven bone system, Characters Studio, and Characters Animation Toolkit (hereinafter referred to as CAT) selected to analyze the tool's developers, features, and strengths and weaknesses. Because it is difficult to secure objectivity through simple analysis, Delphi techniques were used through expert groups. A survey of Delphi techniques, which leads to a total of three rounds, will draw conclusions on which of the three IK systems would be good to select and educate intensively at the university.

2. ANALYSIS OF CHARACTERISTICS AND STRENGTHS AND WEAKNESSES OF EACH IK SYSTEMS

2.1.1 Bone System

Bone system is a revolutionary system that works in conjunction with IK to make it very easy to implement 3D character animation. These features have been implemented for the first time in the world since Softimage Creative Environment 2.5 (1991, former name of Softimage), and IK and Bone, which implemented them, have been recognized as the source technology for 3D character animation. As a result, 3D character animation can make great progress, and this Bone system is a basic feature provided by 3D softwares except for CAD 3D softwares because it is became at the core of character animation.[2]

2.1.2 Advantages of the Bone system

First, using Bone system allows precise adjustment and high level of freedom for each situation. If you know all kinds of script and animation menus, there is no character who can't set up with Bone system. Second, compatibility is outstanding because it is a key function and basic function of character animation. In the past, when exporting bones made by each 3D software to another 3D software, some of them were not compatible with other software, but these days, it is easier to link using version-up FBX files. Especially if you use Autodesk product line, you can maximize compatibility by using Motion builder, the software of the same company.

2.1.3 Disdvantages of the Bone system

Although it is a bone system with excellent compatibility and freedom, it is difficult to use it. In case of Biped or CAT, the basic Bone setting (such as "IK solver" or various "constraints" commands which are based on the 3DS MAX) is available for use right away, making it easy for beginners to create character animations. On the other hand, Bone system has the inconvenience of having to set everything from the beginning, as well as the difficulty of using commands when setting them unless they are skilled in 3D animation. In addition, when fine-tuning or high-level adjustments are needed, the script language built into each 3D software should

be used, and teaching the script language in a typical university courses is practically very difficult.[3]This is why it is relatively late to produce results when making character animations with Bone in college education than when making with Character Studio or Character Animation Toolkit.
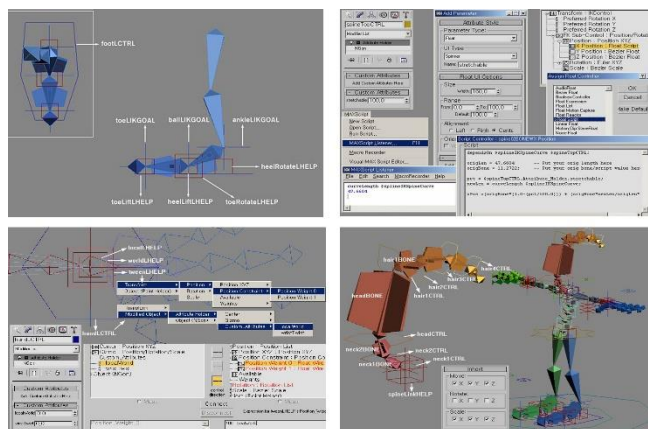

Figure 1. Bone system setting process

2.2.1 Character Studio

Characters Studio is a plug-in dedicated to 3Ds Max that helps make character animation easier. Since then, it has been included as a basic function since 3Ds Max 5.0, and has reached the present. Compared to Bone system, it has an advantage that is very easy to set, and features that help perform various character animations are built in, making it easy for designers to set character animations and produce animations using them. The advantages of this Characters studio were   the driving force behind the spread of the 3Ds Max.

2.2.2 Advantages of the Character studio

First, unlike the typical Bone system, Characters Studio provides a human-shaped skeleton which is name 'Biped' feet. Since Biped already has basic IK and basic animation settings, it can be used immediately by adjusting arm length, leg length, and location according to the situation. Therefore, Biped can gain many time advantages when producing character animations over the bone system. It also has the advantage of being able to implement character animation easily even though it does not know complex script or 3D animation-related commands. Second, it has built-in functions that help animate various characters. The most basic and difficult thing in character animation is making a character's walking motion. In Characters Studio, there is a command called Footstep to create basic action for characters, which allows beginners to easily create animation for walking characters. And Biped's Balance factor is adjusted to help the character's movements realistically when lifting or pushing objects. Other built-in features are helping beginners to use realistic character animations to some extent. Third, file compatibility between Characters studios is easy. Biped's body type files are '*.FIG' and the animated files created with Biped are stored as '*.BIP' and are easily imported, modified, and stored in each Characters studio, making it very easy for Characters to interact with.
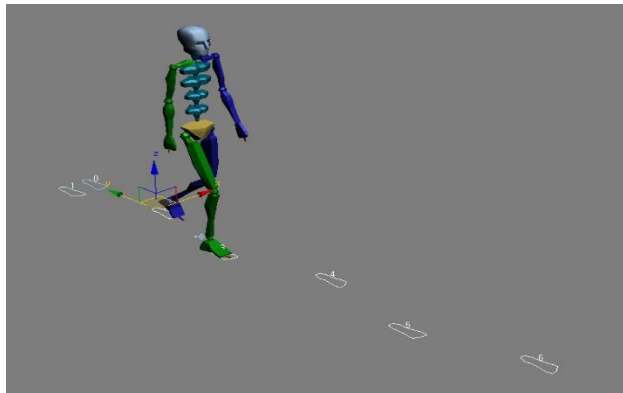
Figure 2. Biped and Footstep of Character Studio

2.2.3 Disadvantages of the Character studio

First, it is impossible to set various complex characters other than human types with only Characters Studio. Biped which is the basic framework provided by Character Studio, is for characters with two feet, so setting characters with multiple arms and legs is impossible with only Biped. So Making theses characters with Character Studio need additional links should be made to Biped using a bone systems and scripts. And the basic function of Characters Studio is not possible to create double joints, extend length of arms and legs, or bend the opposite way. In other words, there is a disadvantage that the degree of freedom is lower than that of Bone systems. Second, precise animation control is a bit tricky. Previous versions of Characters Studio were unable to use curve editor, a core technology of animation these days, and had no choice but to modify character animation movements with only TCB contoller made in the past. Many people in the field still misunderstand that curve editors are still not available in character studio. Unlike other Bone systems, it is difficult to control script only partially in Biped, and making detailed and specialized animations. Third, it's not compatible.   Characters studio itself cannot be used in 3D software other than 3D Max because it is implemented only in 3D Max and not in Plug-in form in other softwares.

2.3.1 Character Animation Toolkit (CAT)

Character Animation Toolkit (CAT), which was originally intended for Softimage, was a plug-in form that supported 3Ds Max, but from the 2011 version of 3Ds Max, it is a character animation tool built with basic functionality.

2.3.2 Advantages of Character Animation Toolkit (CAT)

CAT has the advantages of both Bone and Characters Studio. CAT not only provides basic frameworks like Characters Studio, but also parametric working to control various layer synthesis and walking elements, and controls posture and motion to create realistic character animations, making it easier for beginners to animate characters, but it also has the flexibility that Characters Studio does not have. Unlike Biped, CAT can create high-freedom skeletons such as creatures with more than eight legs, such as crabs and centipedes, and animations with extend length of arms and legs are also possible. And double-joints are possible, which are very helpful when animating mechanical characters which does not have muscle contraction and relaxation like organisms. Like this, CAT can make character animation with no limitations and high degree of freedom like Bone system. In addition, CAT can use various Wire Parameter and Expression commands that are not

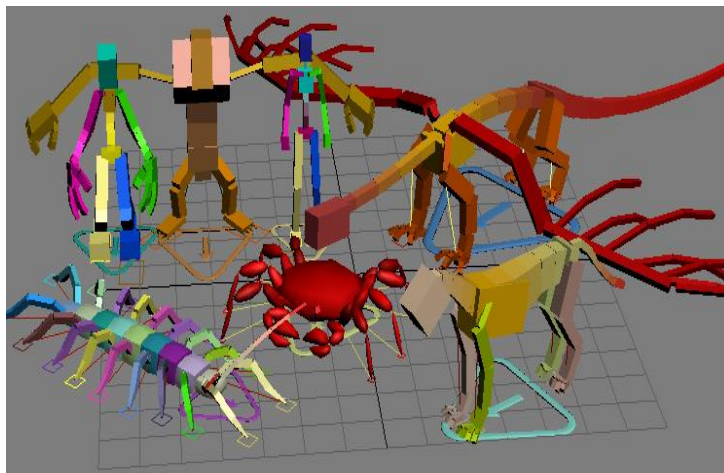available in Character Studio for more precise control.

Figure 3. Various forms of Bones provided by CAT

2.3.3 Disadvantages of Character Animation Toolkit (CAT)

The first disadvantage is that the CAT has convenience and freedom, but there are as many errors due to bugs as there are due to the opposite salary. Second, since it was supported in plug-in format and became a basic function from 3DS MAX 2011, there are not many users who use CAT in Korea compared to the number of users who use Bone system or Character Studio. On top of that, it was originally used for Softimage, but since Softimage was discontinued and used only in 3D Max, it is not compatible, and there is a vicious cycle that there is little inflow of users. As the number of CAT users are so small, the lack of university instructors who can teach CAT is also a factor in the disadvantage.

3. EXPERIMENTS AND RESULTS

In addition to the analysis of each basic system, the Delphi technique was used in this study to secure objectivity. The Delphi Method is a technique developed by the RAND Institute in the early 1960s that eliminates physical face-to-face processes and promotes more objective consensus through free expression and feedback that guarantees anonymity from experts.[4]
The sample criteria for the Delphi survey used were for professors in related departments and 3D character animation part workers. The survey was conducted by E-mail.

Table 1. Characteristics and fields of panel of experts

# of people	Occupation	Position	Career (years)	Specialized field
1	Education	Professor	15	3D Animation
2	Education	Professor	7	3D Game
3	Education	Professor	7	3D Motion Graphics
4	Education	Professor	5	3D Motion Graphics
5	Video production	Representative	15	3D Motion Graphics, VR
6	Video production	Head of department	7	3D Mobile & Apps

7	3D Motion Graphics	Team leader	12	3D Motion Graphics
8	3D Game	Team leader	7	3D Character & Rigger
9	3D Game	Team leader	7	3D Animation & Character
10	3D Game	Team leader	5	3D Animation & Character

In the first round of Delphi analysis, we wanted to collect keywords that experts thought were important in each system through open surveys. The survey extracted the top 25% of the critical keywords from these three systems, resulting in the following results. (Questionnaire: Please write down all the factors that you think are important when using 3D Inverse Kinematics systems in work field and university education.)

Table 2. Composition and analysis elements of various systems (Expert Panel Round 1)

Utilization	Industry usage status, Support in Software (Compatibility), Degrees of freedom, Scalability
Ease of use	User Interface, Ease of learning, User convenience, Degree of Preference
Technical support	Controlling, Quality, Acceptance of technology, Interaction, Visual elements, Divisional labor usage, Self-directed control, Adjustment range, Stability

Based on the results of the first round, in the second round, a panel of 10 experts was given the highest score(10 points)   and the lowest score(1 point) for each item, and the total score was arranged in descending order. (Questionnaire: Please score the importance of each keyword selected in the first round. The highest score is 10 points, the lowest score is the lowest score.)

Table 3. Itemized Criticality Assessment Results (Expert Panel Round 2)

Industry usage status	82	Degree of Preference	60
Support in Software (Compatibility)	78	Quality	53
Scalability	75	Adjustment range	41
Degrees of freedom	74	Controlling	36
Ease of learning	73	Self-directed control	34
Stability	72	Acceptance of technology	28
User convenience	70	Interaction	21
User Interface	62	Controlling	15

Based on the results of the second round, seven items with an average score above 70 were selected and applied to each system (Bone system, Character studio, CAT). Each item was given a maximum score of 5 points and a minimum score of 1 point, and each item was averaged.

Table 4. Evaluation results for each itemized systems (Expert Panel Round 3)

	Bone system	Character Studio	CAT
Industry usage status	5	3.8	1.9
Support in Software (Compatibility)	4.8	2.4	1.8
Scalability	4.7	2.3	4.5
Degrees of freedom	4.8	2	4.7
Ease of learning	2.2	4.3	4
Stability	4.2	3	2
User convenience	2.5	4.3	4.3

4. CONCLUSION

All three systems have advantages and disadvantages. Although the Bone system is the best in terms of utility value, freedom and compatibility, more than a certain level of professional education and computer language education in scripts are required to control it. And it is difficult for students to learn the script language itself in current college courses, especially in design and art.

Character Studio is equipped with a variety of functions that significantly reduce the difficulty of the Bone system, and it is easy to learn. But it is not scalable and compatible, and in order to compensate for this, the Bone system must be used simultaneously. In addition, it lacks the latest features because it is a system built on a somewhat old engine.

Although CAT is the best alternative because it combines the advantages of Bone and Character Studio, there are problems with compatibility and low prevalence that it is only available on 3Ds Max and some game engines, just like Character Studio.

In this paper, the advantages and disadvantages of each system and experts' analysis through Delphi techniques concluded that: Although there are difficulties in learning, it is widely used in accordance with current industrial trends and suggests that universities provide education centered on the Bone system, which is the basis of character animation.

It is expected that the use of Bone system education proposed in this paper will reduce the time required to study other tools, enabling intensive 3D character education and fostering college students' 3D character animation production skills.

In addition, it is expected that it will be easy to adapt to actual field work by using the bone system, which is most commonly used in practice.

In the future, based on this paper, research on the degree of work adaptation of new employees employed in practice should be conducted.

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