Institution: University of Surrey

Unit of Assessment: UOA 13 Electrical and Electronic Engineering, Metallurgy and Materials

Title of case study: From Satellite Control to Film and Computer Animation

Spin Out - IKinema

1. Summary of the impact (indicative maximum 100 words)

Inverse kinematics mathematics developed at Surrey for satellite control is being commercialised for motion capture, film animation and for real-time animation in computer games through IKinema, a University of Surrey spin-out company. Ikinema is the most advanced full-body IK solver and has been used in films such as *X-men First Class* and *Wrath of the Titans 2*; it is embedded in Luxology's modo-601, and is used by major film studios including 20th Century Fox, Disney, Lucas Film, ILM, and visual effects specialists and game developers such as Framestore, Square Enix, and AudioMotion. IKinema currently employs 6 staff and is profitable, with 80% of sales revenues generated by export.

2. Underpinning research (indicative maximum 500 words)

IKinema technology originates from research undertaken by Dr. Pechev at the Surrey Space Centre while he was researching on singularity avoidance in control Moment Gyroscopes used in satellites.

A novel solution to a known problem that exists in areas such as robotics, spacecraft control and computer animation was developed. The new method is a computationally efficient numerical tool that solves the inverse mapping problem, also known as the inverse kinematics problem.

Surrey's new method vastly reduces the time it takes to compute the solution and as a result more degrees of freedom (hence more complex systems) can be handled in real-time. Computational complexity in previous solutions increased to the power 3 with increasing degrees of freedom whereas the new solution increases linearly with increases in the degrees of freedom. Real-time computer animation for games and virtual environments was a logical first step to commercialise the findings due to the necessity for solving highly complex systems in real-time and the size of the commercial market. The algorithm can potentially also be applied to the problem of protein folding for fast drug design, an area that is still to be explored.

The research findings have been considered novel by the research community and, quite independently, the step change that the solution offers in both the robotics control area and the area of spacecraft control received these very encouraging comments:

The author presents an insightful take on the singularity avoidance problem for CMG steering. This work is one of the first innovations in single-gimbal CMG singularity avoidance in roughly the past decade (reviewer, American Institute of Aeronautics and Astronautics, Journal of Guidance Control and Dynamics

The paper presents a novel and elegant solution to the problem of inverse velocity kinematics, a topic that has not seen much innovation in the past fifteen years. As such, it is a pleasant surprise (associate editor for the IEEE Robotics and Automation)

3. References to the research (indicative maximum of six references)

The underpinning mathematics technology that originated in the area of satellite control was first published here;

1. A. Pechev, Feedback based steering law for control moment gyros, AIAA Journal of Guidance Control and Dynamics, Vol.30, 3, 2007.
2. Alexandre Pechev, Inverse Kinematics without Matrix Inversion, 2008 IEEE International Conference on Robotics and Automation (ICRA), Pasadena Conference Center, Pasadena, CA, USA, 19-23 May, 2008

The IP is covered by a number of granted and pending patent applications, and trademarks have been granted;

Patent Number	**Country**	**Date**	**Status**
EP(FR)2188685	France	31/01/2012	Granted
EP(GB)2188685	UK	22/02/2012	Granted
EP(DE)2188685	Germany	31/01/2012	Granted
Patent Application Number	**Country**	**File Date**	**Status**
CN200880113784.1	China	28/02/2010	Pending
IN1255/DELNP/2010	India	28/02/2010	Pending
JP2010-522436	Japan	28/02/2010	Pending
US12/660447	United States	28/02/2010	Pending
Trademark	**Country**	**Date**	**Status**
US3989122	United States	28/06/2011	Granted
UK008379679	Community Trademark	22/02/2010	Granted

4. Details of the impact (indicative maximum 750 words)

A major success of the University of Surrey's cross disciplinary Knowledge Transfer discovery programme was making the connection between research in spacecraft control and its application to the acceleration of animation software.

The technology embedded in IKinema represents a revolution in computational efficiency and is the first really new advance in the field of animation for many years. It creates a paradigm shift in the computer game and film industries and will enable any company that controls it to gain significant strategic advantage over its competition. Previous animation technologies have been "straight-jacketed" by their huge code size and processing requirement, and their inability to run in real-time on any platform; IKinema's technology frees them from all of this with its small code size by enabling very fast, very computationally efficient, runtime animation on any platform. The technology which runs equally well in a browser, has created opportunities for new business models and revenue generation, protected by patent filings.

The underlying IP is relatively generic and applies to several areas, including spacecraft control, robotics, protein folding, stress analysis and computer animation. Patents are granted in France, UK, Germany and pending in US, India, Canada and China. The IKinema trademark is granted in US and Europe.

Surrey's research, now embedded in technology, is being commercialised by IKinema, www.ikinema.com a spin-out from the University of Surrey. The company, founded in 2010, employs 6 staff and is profitable, with 80% of sales revenues generated by export. There are 3 main products offered by IKinema all based on the research conducted at Surrey; IKinema Action for Maya, IKinema WebAnimate and IKinema RunTime.

IKinema motion capture technology is now used by leading studios, such as Hollywood 20th Century Fox, Disney, Industrial Light & Magic, and the firm also counts US, UK, Japan with studios such as Framestore, Luxology, Square Enix, Audio Motion and partners such as NVidia, Autodesk, Intel, Vicon, Xsens and The Foundry.

Although no users have fully quantified the benefits in monetary terms it has enabled them to speed up and improve their animation, pre-viz and motion capture pipelines.

In a pilot test Microsoft estimated that iKinema software reduced animation costs by 80%.Since animation is estimated as 50% of a game's development cost this would reduce the overall cost by 40%. The 3D modelling and animation market in 2008 was worth $237M, whilst the video games market in 2011 was worth $65B.

20th Century Fox Director CINEDEV (Cinematic Development), comments:

"I am beyond excited to integrate IKinema into my performance capture pipeline. IKinema's full body solver is unmatched in its ability to duplicate human behaviour. It allows me to quickly adjust performance capture on the fly with just a few controls. I no longer need to spend hours tweaking curves to get a result. IKinema is now an essential part of my process now and in the future."

Head of rigging at Framestore states;

"The IKinema solver is a fantastic solution for a wide range of skeleton control issues," "By using IKinema's advanced solver settings and its extremely flexible constraint system, we have been able to iteratively improve our solving solution and accuracy. With the ability to easily reproduce this same setup script on many shots, we will be shaving days and weeks off our production time."

President and founder of Luxology stated;

"Bringing IKinema tech into modo was a smooth process for us,"..... "We also found that once it was in, the flexibility of the code allowed us to adapt it to a wide range of applications, from simple-to-use posing tools to sophisticated IK support for complex character rigs. Each an essential piece of the modo 601 character animation experience."

VICON CEO and President comments:

"IKinema provides a new and exciting method of mocap data manipulation inside of Maya. This is great news for Blade users!"

Difference Engine Studios comments:

"A breeze to use. The learning curve is incredibly shallow and short, and it only took us a couple hours to be able to put together some interesting rigs with it. This looks to save us a lot of time and money, too. Amazingly, we are getting close to real-time broadcast-quality animation with this system. In conclusion, this is one piece of software that has gone from 'Interesting' to 'Must Have' in about two days."

For the quality of the invention and the potential international impact, Dr. Pechev received the 2010 Royal Academy of Engineering Entrepreneurs Award and the Royal Society of Edinburgh Enterprise Fellowship.

5. Sources to corroborate the impact (indicative maximum of 10 references)

C1. CEO of Ikinema. Contact details provided.

C2. 20th Century Fox Director (CINEDEV) Contact details provided.

C3. Framestore, Head of Rigging. Contact details provided.

C4. President of Luxology. Contact details provided.

C5. VICON CEO and President. Contact details provided.

C6. NPL http://www2.surrey.ac.uk/business/why/casestudies/KTA_Case%20Study_Ikinema.pdf

C7. UKTI http://212.137.70.163/investintheuk/whytheuk/successStory/233240.html

Related Media Articles

http://www.framestore.com/press/12pr/120330wot/index.html

http://www.cgchannel.com/2012/03/ikinema-ships-ikinema-action-2/

http://www.cgchannel.com/2011/06/99-plug-in-adds-motionbuilder-functionality-to-maya/

http://www.animationmagazine.net/vfx/luxology-integrates-ikinema-solver-into-modo-601/

http://www.eurograduate.com/lifestyle/article.asp?id=3603&pid=2

http://www.spacemart.com/reports/Smooth_moves_how_space_animates_Hollywood_999.html

Product review

http://www.3dworldmag.com/2011/06/25/review-ikinema-for-maya/

http://uk.reuters.com/article/2011/06/06us-videogames-factbox-idUKTRE75552120110606

3D and animation market http://ionpeddie.com/publications/3d-modeling-and-animation-market/#TOC