BU STUDENTSHIPS 2014
PROJECT DESCRIPTION

PROJECT DETAILS

Project Title

Robot Controllers for Character Animation

Project Summary

The goal of this project is to perform research into the development of new controllers for the simulation of virtual characters. By applying new techniques from robotics to this problem domain, the student will explore methods of creating controllers for character locomotion.

RATIONALE

The simulation of animated characters is vital to the digital economy, in particular the visual effects industry, allowing virtual characters to perform stunts that are either too dangerous or physically impossible for a real person to achieve. A 2011 survey found that 72% of households in America played video games and in 2012 computer games sales accounted for worldwide revenue of over $20bn, with nearly all of the top selling titles relying heavily on the animation of human characters. The real time simulation of character motion is vital to UK based games companies which rely on simplified physical models and motion capture to simulate believable characters.

The results of using these systems is well known: the range of motions available to a character is fixed to the scope of the motion database, which is data intensive and time-consuming to construct. Animation artefacts are visible in even the most high profile titles: characters in the Assassins Creed series, a game renowned for the exceptional quality of animations, will judder and walk unrealistically when they collide with other characters or objects, which negatively affecting the players experience. By improving this experience this research aims to deliver a direct economic benefit to the computer games industry.

In our previous work [1] we proposed a theoretical model for locomotion adaptation which allows a simplified physics-based character to walk up stairs or walk faster, without falling over. Our method is completely physics based - it does not rely on any motion capture data or statistical techniques. This project seeks to apply these principles to the design of game controllers which are natural looking due to its biological underpinnings, while being fast enough to include in the computer game pipeline.

AIMS, METHODS AND OUTCOMES

The candidate will be expected:

1. to perform research into the development of a game controller using biological principles,
2. to implement a viable, high performance game controller for character locomotion using these principles,
3. to evaluate this controller against existing methods for character animation in terms of the evaluation criteria of performance, animation quality and viability.

ABOUT THE NCCA

The National Centre for Computer Animation (NCCA) at Bournemouth University is a recognised leader in education and research in the area of computer animation. The NCCA was in 2011 awarded the Queen's Anniversary Prize for Higher and Further Education owing to its achievements in research and education, and the National Endowment for Science Technology and Art (NESTA), in a report presented to the Minister for Culture, Communications and the Creative Industries in February 2011, described the NCCA as a "shining example" and "a global leader in education and research in computer animation and visualisation". The Prime Minister recently highlighted the importance of the digital effects and computer games sectors to the UK economy by recognising the contribution of about 60 NCCA graduates to the multiple Oscar-winning British film Gravity. 80% of graduates will find employment in Computer

Animation, with about half employed in Computer Games.

[1] Fangde Liu, Richard Southern, Shihui Guo, Xiaosong Yang and Jian J Zhang, Motion Adaptation With Motor Invariant Theory, IEEE Man, Systems and Cybernetics, 2013 Jun;43(3):1131-45

Academic Impact

Researchers in the fascinating fields of motor control, robotics and biomechanics have made countless discoveries in recent years which have had largely no impact on the realm of computer animation. Laszlo and Fiume [1] proposed a rudimentary method of locomotion control based on robotics principles, but motion is stiff and unnatural. This approach has been supplemented by incorporating motion capture data [2], but this solution is too slow for the modern games pipeline. More recently a reflex based model was introduced to the graphics community [3], but the muscle model is impractical for the simulation of multiple characters. Our approach of adapting the limit cycle based on symmetry controllers is computationally efficient and gives natural results, and could revolutionise the way in which characters are synthesized in games.

[1] J. Laszlo, M. van de Panne, and E. Fiume. Limit Cycle Control and its Application to the Animation of Balancing and Walking. Proceedings of SIGGRAPH 1996, pp. 155-162.

[2] KangKang Yin, Kevin Loken, and Michiel van de Panne. 2007. SIMBICON: simple biped locomotion control. ACM Trans. Graph. 26(3)

[3] Jack M. Wang, Samuel R. Hamner, Scott L. Delp, and Vladlen Koltun. 2012. Optimizing locomotion controllers using biologically-based actuators and objectives. ACM Trans. Graph. 31, 4, Article 25

Societal Impact

In 2012 computer games sales accounted for over $20b in revenue, with nearly all of the top selling titles relying heavily on the animation of human characters [1], utilizing the methods described above. Our proposed approach has the potential to significantly impact on this lucrative and growing industry:

- Our approach will yield more natural results in situations when characters collide or are required to react to environmental changes.
- By removing the dependence on extensive motion capture database for the synthesis of realistic character animation, this approach significantly reduces the costs associated with the collection and analysis of motion data.
- Our approach is considerably more computationally efficient, raising the possibility of enabling the simulation of large crowds of virtual characters.

[1] Source: http://www.theesa.com/facts/pdfs/esa_ef_2013.pdf

Training Opportunities

A student undertaking this project could originate from a rigorous computing discipline, incorporating a strong mathematical background. Some background in mechanics and engineering would be beneficial, in addition to experience in the field of character animation controllers for Computer Games. As a direct result of this research work, a successful candidate would receive valuable experience and training in the following areas:

- The mathematics of motion, in particular the topology of passive dynamic models and Lie group theory.
- The dynamics of natural human motion, and the process of capture and analysis of human motion.
- Mathematical and modelling tools required for analysis and synthesis.
- Computer animation tools for generating the final results.

In addition, a student in our group would benefit from the developmental opportunities afforded to them by being a part of the Center for Digital Entertainment and the CVGRG research group:

- Conference attendance, and the presentation of his/her work in front of a group of peers.
- The development of industrial and academic contacts through the CDE network through seminars and the CDE conferences.
- Frequent academic and industrial seminars and academic reading groups which help develop his/her exposure to other academic or industrial topics of interest.
- Extensive support in journal and conference publication preparation.
- Support and assistance in early researcher career development and grant preparation

SUPERVISORY TEAM & RESEARCH ENVIRONMENT

First supervisor	1. Richard Southern
Additional supervisors	2. Jian J Zhang
Recent publications by supervisors relevant to this project	Fangde Liu, Richard Southern, Shihui Guo, Xiaosong Yang and Jian J Zhang, Motion Adaptation With Motor Invariant Theory, IEEE Man, Systems and Cybernetics, 2013 Jun;43(3):1131-45 Slater M, Rovira A, Southern R, Swapp D, Zhang JJ, et al. (2013) Bystander Responses to a Violent Incident in an Immersive Virtual Environment. PLoS ONE 8(1): e52766. doi:10.1371/journal.pone.0052766 Xiaosong Yang, Jian Chang, Richard Southern and Jian J. Zhang, "Automatic cage construction for retargeted muscle fitting", The Visual Computer (Proceedings of Computer Graphics International), June 2012, doi: 10.1007/s00371-012-0739-3. R. Southern, S. Guo, F. Liu and J. J. Zhang. A biologically inspired latent space for gait parameterization. Poster Presentation at SIGGRAPH and CGI 2012.

INFORMAL ENQUIRIES

To discuss this opportunity further, please contact either Dr Richard Southern via email: rsouthern@bournemouth.ac.uk

ELIGIBILITY CRITERIA

All Candidates must satisfy the University's minimum doctoral entry criteria for studentships of an honours degree at Upper Second Class (2:1) and/or an appropriate Masters degree. An IELTS (Academic) score of 6.5 minimum (or equivalent) is essential for candidates for whom English is not their first language. Additionally:

A student undertaking this project could originate from a rigorous computing discipline, incorporating a strong mathematical background. Some background in mechanics and engineering would be beneficial, in addition to experience in the field of character animation controllers for Computer Games.

- Applicants must have a degree in Computer Science, relevant Engineering discipline (Mechanical or Electrical) or equivalent
- Experience with Software Engineering, especially in the Games or Film industries will be advantageous
- Experience with Robotics and Character Animation will also be considered relevant

HOW TO APPLY

Please complete the BU Research Degree Application 2014 and submit it via email to the School Research Administrator – Jan Lewis - msresearch@bournemouth.ac.uk by **Tuesday 26 August 2014**. Further information on the application process can be found at www.bournemouth.ac.uk/phd2014