

Kapturing Kung Fu – Future proofing the Hong Kong Martial Arts Living Archive

Hing Chao (International Guoshu Association), Matt Delbridge (City University Hong Kong/ University of Melbourne), Sarah Kenderdine (University of New South Wales), Jeffrey Shaw (City University Hong Kong), Lydia Nicholson (University of Tasmania)

Introduction

There are intangible cultural heritage benefits associated with the capture, documentation and preservation of Kung Fu practices in Hong Kong. An international collaborative project between the School of Creative Media, City University Hong Kong and the International Guoshu Association, the Hong Kong Martial Arts Living Archive (HKMALA), encompasses an analysis of a comprehensive digital strategy of archiving and annotating Hong Kong's diverse and rich Kung Fu styles and traditions using state-of-the-art motion capture data. By using high-definition and high-speed capture sequences, the activity of preservative annotation is transformed. The HKMALA challenges the established tradition of transference and record, to include motion data to visualize speed, torque, torsion and force (momentum and acceleration). Framing the HKMALA as a cultural heritage project also significantly shifts focus from annotation to preservation, enabling the provision of benchmarking in the use of extensive analytic tools for future generations. This approach enables a revitalized method of capture and subsequent transference never undertaken within this discipline. When traditional organisations like the International Guoshu Association embrace tools of Digital Humanities research, they become part of a broader community of intangible cultural heritage archival projects. This active association teaches us about the documentation and preservation of heritage internationally, enabling a richer strategy for future research and preservation projects.

Project Background

Chinese martial arts have a long history dating to the beginning of Chinese civilisation. In origin these martial arts were methods of combat and self-defence, but since at least the Zhou dynasty they have acquired a humanistic dimension, becoming instruments for education and 'the rites'. Confucian pedagogy defines a gentleman's education in terms of the 'Six Arts' – rites, music, archery, chariotteering,

literature and mathematics – which cover the gamut of intellectual and moral training in ancient China. Within this scheme martial arts are represented not only by ‘archery’ and ‘chariotteering’ but also the ‘rites and ‘music’. In ancient China archery rite was one of the most important Confucian rituals, and dance (*wu* 舞) was often used synonymously with martial arts (*wu* 武). From an early period in Chinese history, martial arts were considered an essential part of a colloquial ‘whole-person education’ and continued to develop in tandem with other aspects of Chinese culture until modern times. For this reason, ‘literature’ (文) and ‘martial arts’ (武) were considered the twin pillars of Chinese civilisation. Under this idealised scheme a Confucian gentleman embodies both literary and martial qualities as encapsulated in the sayings, “文武雙全” (“possessing both literary and martial qualities”), “文武兼修” (“well cultivated in literature and martial arts”) and “文通武備” (“thoroughly versed in literature and possessing martial preparedness”).

According to the *Book of Rites* (200BC), a thorough-going humanistic reevaluation of Chinese martial arts took place after Emperor Wuwang of Zhou defeated the preceding Shang dynasty, and made the practice of archery and swordsmanship an essential way to cultivate correct moral values.¹ In time, civilian Chinese martial arts absorbed and became embodiments for Chinese philosophical thinking, intersecting with Buddhism, Taoism, neo-Confucianism, Islam, as well as heterodox creeds, to give birth to multiple, complex expressions where the body became a multi-layered text for diverse cultural discourses.

While Chinese martial arts or “kung fu” are frequently thought of as a singular style in the west, the truth is that Chinese martial arts are extremely diverse and may best be understood in terms of regional systems. Within each system are a plethora of empty-hand and weapon practices, and a bewildering range of styles and schools. The formation and development of regional styles are framed by administrative as

¹ 《禮記：樂記》

well as geographical boundaries, and shaped by socio-political dynamics at the time, which might either be of a local or national character.

Within this context Hong Kong emerged as a regional hub for South Chinese martial arts in the first half of the twentieth century, as its role as a major port and trading centre under colonial Britain attracted migrants from Guangdong province. Hong Kong became a gateway for western ideas and institutions to enter China and vice versa, while its existing network and connection to Guangdong through trade, lineage ties, and well-established migration routes facilitated a wholesale transfer of martial arts knowledge, human resources and institutions from the turbulent years of the mid Republic onwards.

Republic China sought to construct a new national identity through reform and modernization of traditional culture, which led to the 'Guoxue' 國學 (literally, 'National Studies') movement. Nationalism also fuelled reform in traditional martial arts, which gathered momentum after 1928 – the year Central Guoshu Institute was established to promote Guoshu as a national physical education and sports system. This provided an opportunity for martial artists seeking upward social movement and many flocked to urban centres. The metropolis of Canton, one of the first Chinese cities to industrialise during the 1920s and 1930s, attracted rural labourers from throughout Guangdong province (and beyond), and its prosperity also drew in accomplished martial artists.

In 1929 the first National Guoshu Examination was held at Nanjing. Among those in attendance was Li Guangji 李廣濟, the governor of Guangdong. He was much impressed by what he saw and immediately invited Wan Laisheng 萬賴聲, a young martial art master who distinguished himself at the examination, together with several other "Guoshu" masters, to set up the Guangdong and Guangxi Guoshu Institute. As it happened Li Guangji only stayed in power for a short period of time before being overthrown by Chen Jitang 陳濟棠, who replaced him as military governor of Guangdong. The provincial Guoshu branch did not endure beyond Li's

term, but Chen Jitang was in turn a patron of the martial arts and took the Guoshu masters under his wing, while also recruiting local martial artists. Hung Kuen master Lam Sai Wing 林世榮, Shaolin master Gu Ruzhang 顧汝章, Lam Yiu Gwai 林耀桂 of the Dragon Style, Cheung Lai Chun 張禮泉 of Pak Mei, and others congregated under Chen Jitang, working as personal bodyguards and martial art instructors to his army. This group of martial artists eventually became the backbone for Hong Kong's martial arts community as many of them moved to Hong Kong after Chen Jitang lost his position.

Arguably the most influential martial artist during this time was Lam Sai Wing, whose reformed style of Hung Kuen became the most well-known martial art school in Guangdong. Lam Sai Wing was an instructor at Chen Jitang's Army, and also gave private instruction to Chen Jitang's family. During this time it is said that Lam Sai Wing was invited by the Hong Kong Meat Association to open a school. He continued to travel between Canton and Hong Kong in the 1920s and 1930s before eventually making a permanent move to Hong Kong. Lam Sai Wing's influence was largely behind the emergence of the Wong Fei Hung film phenomenon, which dominated kung fu cinema from the 1960s through to the end of the century, with a franchise of over seventy films. Lam Sai Wing was survived by his nephew and adopted son, Master Lam Cho, who inherited and continued his teachings. Lam Family Hung Kuen is now one of the most influential Chinese martial arts styles in the world and Hong Kong remains its spiritual centre.

After 1949 Hong Kong became a safe haven for refugees throughout China. Its population swelled from around 100,000 to over 2 million in the years after the war. Among the new arrivals were martial artists from different provinces, not only Guangdong but also from Fujian, Zhejiang, Hebei, Shandong and elsewhere, bringing with them knowledge of a wide range of styles including Fujian Yongchun White Crane, Liuhebafa, various styles of Taijiquan (particularly the Yang family and Wu family styles), Pigua, Praying Mantis, Xingyiquan, Bagua, and many others. As Mainland China was closed to the west for the next few decades, Hong Kong became

the most important bridge for East-West cultural exchange. Since the 1970s Hong Kong has continued to export a large volume of Kung Fu films in the wake of Bruce Lee, and continues to be a major supplier of these incredibly popular movies. It is not an exaggeration to say that global perception of Chinese martial arts was, and continues to be, largely filtered through Hong Kong. Equally important, as Mainland China experienced the catastrophic purge of the Cultural Revolution from 1966-76, with a devastating impact on all forms of traditional culture including the martial arts, Hong Kong remained a safe haven for all forms of traditional cultural practices.

Since the 1990s, there has been a gradual decline in public interest and community participation in martial arts in Hong Kong. This is due to a combination of factors including: rapid urban development; population increases; import of foreign cultures and pastimes; and importantly that Chinese martial arts have remained largely un-institutionalised. The significance of Hong Kong's martial arts legacy cannot be overstated, as many martial arts, lost in Mainland China (particularly from the Guangdong province), are still preserved in Hong Kong. Equally, this intangible cultural heritage has become fragile as fewer young people participate in the martial arts. A number of traditional styles are already in danger of being lost due to a lack of young practitioners and the aging master population. The only viable solution is a modern documentation strategy able to preserve this tradition before lost for all time.

Intangible Digital Cultural Heritage Documentation using Motion Capture

The need for preservation of Intangible Cultural Heritage was first recognised by UNESCO in 1972 and has been gaining particular momentum since 2001 when 19 international 'Masterpieces' of Intangible Cultural Heritage were identified. This has been explored fully in Richard Kurin's detailed critical appraisal of UNESCO's 2003 Convention on the *Safeguarding of Intangible Cultural Heritage*, outlining some of the limits and challenges of intangible cultural heritage (ICH) preservation (Kurin 2004). Yola de Lusenet provides a similar critical reading of UNESCO's *Charter on the Preservation of Digital Heritage*, highlighting how digital heritage and ICH can sometimes blur into one another (de Lusenet 2007). For consideration of ICH in a

particularly Chinese context Helen Rees discusses the shift in attitude towards ICH in China from a twentieth century climate of occasional active destruction to a twenty-first century approach of major preservation (Rees 2012) and Zhang Liu describes the cross-cultural nuances of the concept of ‘intangible’ cultural heritage in China – intangible translating more accurately as ‘spiritual’ (Liu 2015).

As part of situating the HKMALA in an ICH and digital heritage context, it’s necessary to locate the beginnings of this project within a brief history of movement notation and documentation. In *Writing for the Body: Notation, Reconstruction, and Reinvention in Dance* (2011) Mark Franko explores the history of dance notation and documentation, charting shifts from: written coded steps; to non-word tracking systems; to images of dancers and a focus on a dancer’s body rather than their technique or movement through space; to the development of Labanotation; the use of video; and finally the advent of the digital, placing motion capture at the forefront of the dance documentation timeline. In doing so he highlights the fundamental difference between “what might have happened” – the movement according to the choreographer’s choices – as opposed to “what did happen” – how the dancer performed in that particular performance.

Other contemporary projects documenting ‘what might have happened’ – in a notation context - can be seen in Eugenia Kim’s research into ChoreoSave, a digital documentation tool for emerging choreographers, and El Raheb and Ionnidis’ Labanotation Based Ontology for dance databases (Kim 2011, El Raheb and Ioannidis 2012). El Raheb and Ionnidis’ work highlights the difficulty of classifying and cataloguing movements in a database context, which presents as a constant challenge throughout much of the work that contextualises this project outside of martial arts. Contemporary work documenting “what did happen” can be seen in Pietrobruno’s analysis of UNESCO’s use of YouTube in preserving ICH – an example of an informal archive, based on classification and cataloguing of existing content rather than developing content specifically for the project (Pietrobruno 2013). There are also a number of official texts by institutions on the current best practice documentation and preservation of dance (Johnson and Snyder 1999, Smigel 2006,

Schmitz 2015). These progressive movements in the capture and subsequent enabling of dance analysis provide the most logical frame to place around similar problematics associated with the capturing of Kung Fu.

Whilst most literature on documentation and archiving of movement is focussed on dance, there is a limited amount of existing (western) scholarship about Kung Fu. Acavedo (2015) and Judkins (2014) stress the importance of teacher-student transmission in Kung Fu, in that it is (much like dance) not traditionally taught through notation or documentation. However, in his analysis of the appropriateness of the term 'Kung Fu' Judkins does describe a variety of documentation materials, particularly in the context of disseminating Kung Fu outside of China. These documentation materials are primarily for the purpose of transmission, rather than preservation, and Kennedy and Guo explore in more detail the practice of martial arts notation for training purposes in their analysis of historical Chinese martial arts training manuals (Kennedy and Guo 2008). A variety of researchers, critics and practitioners have also written about the documentation of martial arts in film and television, however this is usually in the context of entertainment and technological advancements in film-making, rather than as an archival process (North 2005, Yip 2014).

Motion Capture technologies are playing an increasingly natural role in ICH preservation. Historically it is used widely in humanoid robotics research (Zhao, Huang et al. 2004, Huang, Peng et al. 2005, Ou, Hu et al. 2015), sports medicine (Charbonnier, Kolo et al. 2011, Klonova, Klonovs et al. 2011, Schwartz, Hazee et al. 2012), film-making (Gadassik 2010, Whissel 2010), video games (Pronost, Multon et al. 2008, Deng, Leung et al. 2011) and now contemporary dance and performance-making (Birringer 2002, deLahunta 2002, Delbridge 2014, Dils 2002, Ebenreuter 2005, Kahn, Keil et al. 2012, Kahn, Keil et al. 2013, Barber 2015). Given the capacity to enable the capture of movement using an 'omniscient frame' generated by the capacity of a Motion Capture system's camera array to 'see within a volume, to capture not just the height and width of the 2D frame, but to capture depth (via

movement) as well' (Delbridge 2015). It is the perfect solution for an unbiased record of Kung Fu.

Early martial arts motion capture involved highly restrictive wearable sensors with limited data capturing capabilities (Heinz, Kunze et al. 2006, Kunze, Barry et al. 2006). Whilst the data captured in these early projects was somewhat useful to evaluate the gaps in skill between novices and masters, it lacked precision and detail and was not initially considered in an ICH preservation context. In Thailand a 2009 project capturing Muay Thai postures using 42 marker mocap suits with 9 cameras was developed into short animations for ICH educational and showcasing purposes. A subsequent 2011 project, using the same system and marker set, contributed to the development of a Nintendo Wii game based on Thai Sword Dancing (Phunsa, Potisarn et al. 2009, Kovavisaruch, Wisanmongkol et al. 2011). The latter project was developed in the spirit of ICH preservation, but with the major aim of encouraging revival and new audiences who might be interested in learning Thai Sword Dancing.

Other similar international motion capture projects are informing strategy development for the capture and preservation of the Kung Fu data. These cover Folk Dancing, Chinese Opera, and Artimuse (a project that captures hand gestures central to music and handicrafts). The folk dance project comes from the University of Cyprus' Computer Graphics and Virtual Reality Lab where researchers are using motion capture to archive and document Cypriot folk dance. Unlike Kung Fu (and other forms of ICH), Cypriot folk dances are always engaged within social contexts and taught informally with a great degree of variation between regions and individual style. This means that the specifics of capturing them differ significantly to the HKMALA. As the project has progressed a strand of Laban Movement Analysis (LMA) has been added as a documentation tool alongside the motion capture. Whilst motion capture documents the 'geometry' of the dance, it is clear that it is unable to capture the 'nuance' – the emotion, intention or interaction with the environment by the performer (Aristidou, Stavrakis et al. 2014). This point is of particular significance when related back to the necessary nuance required in the capture of Kung Fu. Using LMA allows an assessment of the motion-captured dances in terms of

Body, Effort, Shape and Space. Including LMA notation is similarly used for guiding cues in the training game – for example alerting students how to make changes to a particular sense of *Effort* which might improve technique, rather than giving targetted feedback on angle or technical movement (Aristidou, Stavrakis et al. 2014). MoCap doesn't capture the dance itself, just one aspect of its documentation, which highlights the importance of situating the data within a rich database of other media – video, audio, photographs, drawings and text in order to create an accessible folk dance archive which can be used for future research (Aristidou, Stavrakis et al. 2014). Similar recommendations are made by Mallik, Chaudhury et al. (2011) in developing an ICH archive (albeit without purpose-captured mocap data) for classical Indian dance, drawing on traditional texts and images as well as audio, video and photographs.

ArtiMuse is another multidisciplinary project exploring gesture recognition methodologies in musical and handicrafts interactions. It seeks to identify, record, analyse, model and recognise these gestural skills for their preservation (Manitsaris, Glushkova et al. 2014). The project uses a human-computer interface called "Art Orasis" for gesture capture, modelling and recognition, based on data capture from wireless inertial sensors. A sample case study focuses on the capture of pottery experts at work from the Macedonian Region of Northern Greece and Cote d'Azur in France. This project is a prototype for a long-term collection strategy, recording and classifying wheel throwing pottery gestures. Future directions include increasing precision of finger movements, finding ways to record finger pressure on clay, and developing systems to assist with the knowledge transmission of these gestures. In the interrogation of associated projects and literature this was the only one to specifically discuss pressure, which plays an important role in the HKMALA.

Zhou and Mudur (2006) have conducted research projects on Chinese Opera, or *Kunqu* – one of UNESCO's first ICH 'Masterpieces,' using motion capture of contemporary opera performers and 3D scans of faces to create virtual opera performances which can be synced with archival audio of opera masters. This concept of a virtual ICH experience is also explored by researchers like Li, Choi et al.

(2013) who used motion capture to recreate the Yamahoko Parade in the Kyoto Gion Festival for a real-time virtual reality user experience and Yang, Peng et al. (2006) who recreated an ancient Chinese palace and court dance scene. Delbridge and Tompkins (2012) similarly use motion capture in a more ICH research-focused context – as opposed to a re-enactment context – exploring a virtual Rose theatre and the process of performing early modern theatre which they are also now applying to an Australian colonial context, and similarly Dunn, Woolford et al. (2012) use motion capture to test possible uses of British Iron Age dwellings based on archaeological evidence.

Achievement of the HKMALA to date

Though still in very early stages, to date the HKMALA has captured over 120 sets of empty-hand and weapon sequences, known as “*taolu* 套路”, representing 19 martial art styles have been documented so far. “*Taolu* 套路” are pre-arranged movement sequences used for learning, practicing and performing traditional martial arts.

Before the twentieth century the practice of Chinese martial arts was often conducted in secret, and it was quite rare for martial artists to commit their knowledge to writing, so movement sets / routines were created as mnemonic aids for practice. In an important way, therefore, *taolu* may be considered the primary ‘text’ for Chinese martial arts, and the learning process consists in first memorising the ‘text’, which is then subject to detailed exegesis that explains the nuances of movements and their applications.

China has a tradition of documenting martial arts in the form of written manuals for over two thousand years. The earliest martial arts literature appeared in the Han dynasty, during which time specialised treatises on swordsmanship, archery, and empty-hand combat were composed. A rich literary tradition meant that a sophisticated technical language was developed early on to describe and annotate martial arts. Later, textual descriptions were accompanied by illustrations. Sometimes the manuals also include diagrams, which show the pattern of footwork to guide practitioners through routine performance. The illustrated manual became

the norm by the Ming dynasty at the latest. The advent of photography did not replace the illustrated manual as the primary medium to document martial arts, but simply replaced hand-drawn illustrations with photographs. The arrival of motion pictures around the same time provided an alternative, and more accurate medium to record martial arts, but significantly, it did not replace the manual, which continues to be the most widespread (and popular) means for documentation. Significantly, none of these conventional tools are able to represent precise movement in three-dimensional space.

Motion capture is poised to transform how Chinese martial arts are documented and, eventually, how they are taught. For the first time in history, we now have a tool that is able to precisely capture intricate movement for prosperity but also subsequently translate and revisualise this to the screen. It was not until recently that this technology has reached the point of sophistication and accuracy able to meet the technical demands of this project. In 2009 the International Guoshu Association had its first trial with motion capture, at the time using facilities at Cyberport in Hong Kong. The motion capture equipment available in Hong Kong at the time was unable to capture (and replay) Chinese martial arts' high-speed movements, due to insufficient image resolution, the capture speed of the camera, and inefficiencies with suit and markers. Worse still, the technology available in Hong Kong at that time was simply unable to sufficiently record joint movements of the hands.

These issues will be resolved in the near future by contemporary optical motion capture systems. The speed of movement is no longer an issue for cameras that capture motion at a rate of 120 frames per second, while the quality of the data is such that they can be displayed also in real-time and at life-size. Even the issue of capturing complex hand movements, which was the major stumbling block in previous experiments, is now overcome (at least in respect of capture). However, challenges in motion capture persist and, even though our current studio with a 24-camera Motion Analysis system at the motion capture lab at City University of Hong

Kong is sufficient for data capture, there are many areas we seek and welcome improvement.

The difficulties encountered so far for the HKMALA capture cycles are not uncommon to other (similar) projects. Research done by Li, Horain et al. (2009) using markerless motion capture technology to explore the cataloguing and classification of 3D gestures into a database library, identified ongoing issues with the accuracy and efficacy of the data captured. Key issues in the use of motion capture seem to be recurrent (throughout practice and associated literature in the field). These problematics are not dissimilar to the early stages of capturing data for the HKMALA and include: the difficulty of translating high dimensional data to low dimensional latent space; modulating gesture variability; the benefits of using biomedical constraints as 'rules'; the process of syncing and evaluating captured data with existing library data; and the difficulty of choosing appropriate capture technology to suit the project – in the case of Li, Horain etc all, the struggle was with depth ambiguities from using only a single camera, but with the HKMALA the most serious problem is to do with the effective capturing of hands.

Hand movements have so far presented the most serious problems in terms of equipment, templating, and necessary accuracy. When we started the project in 2013 the gloves available in the market were unable to meet our requirement so we used markers instead (18 on each hand). This setup enables us to document hand movements fairly accurately. However, during the data capture process the joints and hands sometimes overlay each other. When multiple markers intersect this creates a lot of problems to the software, generating considerable "noise" which can only be cleaned up manually. The manual clean-up is exceptionally labour-intensive, such that one minute of data requires up to several weeks of a dedicated personnel to clean up (depending on complexity). At present, we are seeking a technical solution and have been experimenting with new motion capture gloves and the ability to co-capture hand gesture in a separate (but synched) data stream.

A final problematic (yet to be resolved), is that the technology we use is unable to capture human textures, like expressions, skin movement, and other nuances. This means motion capture is unable to replace more conventional means of documentation altogether. While it offers accurate 3D data motion capture data it also diminishes aspects integral to the identity of the martial artists, and the performance itself. For this reason, we aim to use an alternative set up using high-definition video capture as a parallel tool for documentation co-located within the archive.

The HKMALA is an ambitious project that builds capacity and expertise in the use of techniques and technologies traditionally based in film production and animation to facilitate cultural heritage preservation. In doing so it makes a lasting, necessary and meaningful contribution to a reassessment of the conditions for Intangible cultural heritage preservation. The HKMALA future proofs the important place Kung Fu occupies in Chinese identity and permits us to reconsider many aspects of original Kung Fu practices whose purpose has altered radically since first constructed, and whose traditions face the risk of being lost. Internationally, the use of Motion Capture technology is currently undergoing a significant turn, generating unforeseen cultural heritage experiences in the form of open environments and interactive cultural experiences. It is anticipated even at the early stages of this project, it will preserve the tradition and generate significant opportunities for the scholarship and practice of Kung Fu into the future.

References

- Acavedo, J. (2015). *The Craft and Geometry of Martial Arts*. Prince's School of Traditional Arts, London, Pachi Tanglang Martial Arts Institute.
- Al Kork, S. K., A. Jamard-Hakoun, M. Adda-Decker, A. Amelot, L. Buchman, O. Chawah, G. Dreyfus, T. Fux, C. Pillot-Loiseau, P. Roussel, M. Stone, K. Xu and B. Denby (2014). *A Multi-Sensor Helmet to Capture Rare Singing, an Intangible Cultural Heritage Study*. 10th International Seminar on Speech Production (ISSP 2014), Cologne, Germany.
- Aristidou, A., E. Stavrakis and Y. Chrysanthou (2014). "Cypriot Intangible Cultural Heritage: Digitizing Folk Dances." *Cyprus Copmuter Society Journal*(25): 42-49.
- Aristidou, A., E. Stavrakis and Y. Chrysanthou (2014). *LMA-Based Motion Retrieval for Folk Dance Cultural Heritage*. 5th Internation Conference, EuroMed 2014, Limassol, Cyprus, Springer International Publishing.
- Aristidou, A., E. Stavrakis and Y. Chrysanthou (2014). *Motion Analysis for Folk Dance Evaluation*. 12th EUROGRAPHICS Workshop on Graphics and Cultural Heritage (GCH), Darmstadt, Germany.
- Barber, T. E. (2015). "Ghostcatching and After Ghostcating, Dances in the Dark." *Dance Research Journal* **47**(1): 44-67.
- Birringer, J. (2002). "Dance and Media Technologies." *PAJ: A Journal of Performance and Art* **24**(1): 84-93.
- Charbonnier, C., F. C. Kolo, V. B. Duthon, N. Mangenat-Thalmann, C. Becker, P. Hoffmeyer and J. Menetrey (2011). "Assessment of Congruence and Impingement of the Hip Joint in Professional Ballet Dancers: A Motion Capture Study." *American Journal of Sports Medicine* **39**(3): 557-566.
- de Lusenet, Y. (2007). "Tending the Garden or Harvesting the Fields: Digital Preservation and the UNESCO Charter on the Preservation of the Digital Heritage." *Library Trends* **56**(1).
- deLahunta, S. (2002). "Virtual Reality and Performance." *PAJ: A Journal of Performance and Art* **24**(1).
- Delbridge, M.J. (2014). *Motion Capture in Performance: An Introduction*. Palgrave Macmillan, Basingstoke, UK

Delbridge, M. J. and J. Tompkins (2012). *Reproduction, Mediation, and Experience: Virtual Reality, Motion Capture and Early Modern Theatre*. SPACE-EVENT-AGENCY-EXPERIENCE. online, Centre for Practise as Research in Theatre, University of Tampere.

Deng, L., H. Leung, N. Gu and Y. Yang (2011). "Real-time mocap dance recognition for an interactive dancing game." Computer Animation and Virtual Worlds **22**: 229-237.

Dils, A. (2002). "The Ghost in the Machine: Merce Cunningham and Bill T Jones." PAJ: A Journal of Performance and Art **24**(1).

Dimitropoulos, K., S. Manitsaris, F. Tsalakanidou, S. Nikolopoulos, B. Denby and S. Al Kork (2014). *Capturing the Intangible: An Introduction to the i-Treasures Project*. 9th International Conference on Computer Vision Theory and Applications. Lisbon, Portugal.

Dunn, S., K. Woolford, L. Barker, M. Taylor, S. J. Norman, M. White, M. Hedges, H. Bailey, M. Fulford and A. Clarke (2012). Motion in Place: A Case Study of Archaeological Reconstruction Using Motion Capture. *Revive the Past: Computer Applications and Quantitative Methods in Archaeology*, Beijing, Pallas Publications.

Ebenreuter, N. (2005). "Dance Movement: A Focus on the Technology." IEEE Computer Graphics and Applications **25**(6): 80-83.

El Raheb, K. and Y. Ioannidis (2012). *A Labanotation Based Ontology for Representing Dance Movement*. Gesture and Sign Language in Human-Computer Interaction and Embodied Communication. E. Efthimiou, G. Kouroupetroglou and S.-E. Fotinea, Springer Berlin Heidelberg.

Franko, M. (2011). "Writing for the Body: Notation, Reconstruction, and Reinvention in Dance." Common Knowledge **17**(2): 321-334.

Furusato, M., D. Hanawa and K. Oguchi (2012). *Motion Analysis of Devil Sticking by motion capture system*. Biomedical Engineering and Sciences (IECBES). Langkawi.

Gadassik, A. (2010). *Ghosts in the Machine: The Body in Digital Animation*. Popular Ghosts: The Haunted Spaces of Everyday Culture. E. Peeren and M. del Pilar Blanco. New York, Bloomsbury Publishing.

Heinz, E. A., K. Kunze, M. Gruber, D. Bannach and P. Lukowicz (2006). *Using wearable sensors for real-time recognition tasks in games of martial arts: an initial experiment*. IEEE Symposium on Computational Intelligence and Games, IEEE.

Heryadi, Y., M. I. Fanany and A. M. Arymurthy (2012). A syntactical modeling and classification for performance evaluation of Bali traditional dance. International Conference on Advanced Computer Science and Information Systems (ICACSIS). Depok, IEEE.

Huang, Q., Z. Peng, W. Zhang, L. Zhang and K. Li (2005). Design of humanoid complicated dynamic motion based on human motion capture. International Conference on Intelligent Robots and Systems.

Johnson, C. and A. F. Snyder (1999). Securing our Dance Heritage: Issues in the Documentation and Preservation of Dance. Council on Library and Information Resources Dance Heritage Council.

Judkins, B. (2014). "Inventing Kung Fu." JOMEC Journal(5).

Kahn, S., J. Keil, B. Müller and B. Ulrich (2013). Capturing of Contemporary Dance for preservation and presentation of choreographics in Online Scores. Digital Heritage International Congress 2013, Marseille, IEEE.

Kahn, S., J. Keil, M. Zoellner and B. Mueller (2012). Towards and Affordable Markerless Acquisition of Intangible Contemporary Dance Choreographies at Large-Scaled Stages. The 13th International Symposium on Virtual Reality, Archaeology and Cultural Heritage VAST (2012). D. Arnold, J. Kaminski, F. Niccollucci and A. Stork.

Kennedy, B. and E. Guo (2008). Chinese Martial Arts Training Manuals: A Historical Survey. California, Blue Snake Books.

Kim, E. (2011). "ChoreoSave: A Digital Dance Preservation System Prototype." Proceedings of the American Society for Information Science and Technology **48**(1): 1-10.

Klonova, A., J. Klonovs, A. Giovanardi and A. Cicchella (2011). "Smart motion capture system measuring movements of professional standard sports dancers in promenade position." LASE Journal of Sport Science **2**: 26-32.

Kovavisaruch, L., J. Wisanmongkol, T. Sanpachuda, A. Chaiwongyen, S. Wisadsud and T. Wongsatho (2011). Conserving and Promoting Thai Sword Dancing Traditions with Motion Capture and Nintendo Wii. Portland International Center for Management of Engineering and Technology (PICMET).

- Kunze, K., M. Barry, E. A. Heinz, P. Lukowicz, D. Majoe and J. Gutknecht (2006). Towards Recognising Tai Chi: An Initial Experiment Using Wearable Sensors. 3rd International Forum on Applied Wearable Computing (IFAWC).
- Kurin, R. (2004). "Safeguarding Intangible Cultural Heritage in the 2003 UNESCO Convention: A Critical Appraisal." Museum International **56**(1-2): 66-77.
- Li, L., W. Choi, K. Hachimura, T. Nishiura and K. Yano (2013). Presentation of Japanese Cultural Event Using Virtual Reality. Computer Vision - ACCV 2012 Workshops. J.-I. Park and J. Kim, Springer Berlin Heidelberg.
- Li, Q. L., W. D. Geng, T. Yu, X. J. Shen, N. Lau and G. Yu (2006). MotionMaster: Authoring and Choreographing Kung-fu Motions by Sketch Drawings. Eurographics/ACM SIGGRAPH Symposium on Computer Animation. M. P. Cani and J. O'Brien.
- Li, Z., P. Horain and A.-M. Pez (2009). Statistical gesture models for 3D motion capture from a library of gestures with variants. Gesture in Embodied Communication and Human-Computer Interaction: 8th International Gesture Workshop. Bielefeld, Germany.
- Liu, Z. (2015). "Indigenising intangible cultural heritage: comparison and interpretation of the concept of ICH in China." International Journal of Intangible Heritage **10**.
- Ma, MD. (2009). "Editor's Foreword". Journal of Chinese Martial Studies. Hong Kong Three-in-One Press
- 馬明達 (2015) . “倫武學與武術文獻學 (代前言) ” . 「珍本叢刊」 . 廣西師範大學出版社
- Mallik, A., S. Chaudhury and H. Ghosh (2011). "Nrityakosha: Preserving the intangible heritage of Indian classical dance." Journal on Computing and Cultural Heritage (JOCCH) **4**(3).
- Manitsaris, S., A. Glushkova, F. Bevilacqua and F. Moutarde (2014). "Capture, Modeling, and Recognition of Expert Technical Gestures in Wheel-Throwing Art of Pottery." Journal on Computing and Cultural Heritage (JOCCH) **7**(2).
- Nakamura, A., S. Tabata, T. Ueda, S. Kyofuji and Y. Kuno (2005). Multimodal Presentation Method for a Dance Training System. Extended Abstracts on Human Factors in Computing Systems, Portland, Oregon, DBLP.

North, D. (2005). Virtual actors, spectacle and special effects: kung fu meets "all that CGI bullshit". The Matrix trilogy: cyberpunk reloaded. S. Gillis. London, Wallflower Press.

O'Connor, N., Y. Tisserand, A. Chatzitofis, F. Destelle, J. Goenetxea and L. Unzueta (2014). Interactive games for preservation and promotion of sporting movements. 22nd European Signal Processing Conference. Lisbon, Portugal.

Ou, Y., J. Hu, Z. Wang, Y. Fu, X. Wu and X. Li (2015). "A Real-Time Human Imitation System Using Kinect." International Journal of Social Robotics **Online First**.

Phunsa, S., N. Potisarn and S. Tirakoat (2009). Edutainment: Thai Art of Self-Defense and Boxing by Motion Capture Technique. International Conference on Computer Modeling and Simulation (ICCMS), Macau, IEEE.

Pietrobruno, S. (2013). "YouTube and the social archiving of intangible heritage." New Media & Society **15(8)**: 1259-1276.

Pronost, N., F. Multon, Q. Li, W. Geng, R. Kulpa and G. Dumont (2008). Interactive Animation of Virtual Characters: Application to Virtual King-Fu Fighting. International Conference on Cyberworlds. Hangzhou, China, IEEE.

Rees, H. (2012). Intangible Cultural Heritage in China Today: Policy and Practice in the Early Twenty-First Century. Music as Intangible Cultural Heritage: Policy Ideology, and Practice in the Preservation of East Asian Traditions. K. Howard. UK, Ashgate.

Schmitz, D. (2015). A White Paper for the Dance Heritage Coalition. The Dance Preservation and Digitization Project: The Technology Summit and Beyond. Charlotte, North Carolina, J. Murrey Atkins Library Special Collections, the University of North Carolina.

Schwartz, C., A. Hazeel, V. Denoël, O. Bruls, J.-L. Croisier and B. Forthomme (2012). Shoulder injury prevention in sports using 3D motion capture. 11th Belgian Day on Biomedical Engineering. Brussels, National Committee on Biomedical Engineering.

Smigel, L. (2006). Documenting Dance: A Practical Guide. M. Goldstein and E. Aldrich. Washington, DC, The Dance Heritage Coalition.

Stavrakis, E., A. Aristidou, M. Savva, S. Loizidou Himona and Y. Chrysanthou (2012). Digitization of Cypriot Folk Dances. 4th International Conference in Cultural Heritage Preservation (EuroMed 2012), Limassol, Cyprus.

- Whissel, K. (2010). "The Digital Multitude." Cinema Journal **49**(4): 90-110.
- Yang, C., D. Peng and S. Sun (2006). Creating a Virtual Activity for the Intangible Culture Heritage. 16th International Conference on Artificial Reality and Telexistence, IEEE Computer Society, Washington, DC, USA.
- Yi, H. (2013). Interactive Motion Recovery of Chinese Kung-Fu for Computer Games. 2013 International Conference on Computer Sciences and Applications, IEEE Computer Society Washington, DC.
- Yip, M.-F. (2014). "In the Realm of the Senses: Sensory Realism, Speed, and Hong Kong Martial Arts Cinema." Cinema Journal **53**(4): 76-97.
- Zhao, X., Q. Huang, Z. Peng and K. Li (2004). Kinematics mapping and similarity evaluation of humanoid motion based on human motion capture. Intelligent Robots and Systems (IROS 2004), IEEE.
- Zhou, H. and S. P. Mudur (2006). On the Use of 3D Scanner for Chinese Opera Documentation. Interactive Technologies and Sociotechnical Systems. H. Zha, Z. Pan, H. Thwaites, A. C. Addison and M. Forte, Springer Berlin Heidelberg.