For discussion
on 19 December 2018

Legislative Council Panel on Home Affairs

**Virtual Reality/Augmented Reality/
Mixed Reality Research Laboratory in
the Hong Kong Academy for Performing Arts**

Purpose

       This paper briefs Members on the funding requirement and timeline for setting up a virtual reality/augmented reality/mixed reality (VR/AR/MR) research laboratory in the School of Theatre and Entertainment Arts of the Hong Kong Academy for Performing Arts (HKAPA).

Proposal

2.   HKAPA proposes to set up a VR/AR/MR research laboratory in the School of Theatre and Entertainment Arts with an estimated cost of $16 million.

Justifications

3.   HKAPA is the only higher education institution in Hong Kong dedicated to professional training of performing arts practitioners, and its graduates are the pillars of Hong Kong's performing arts sector. To fulfill its mission, HKAPA needs to keep abreast of the world trend and maintain its capability to nurture graduates equipped with the skill sets that can best meet the prevailing requirements of the arts and culture sector. The School of Theatre and Entertainment Arts of HKAPA provides training to students in design, technology, and management of the performing arts. Alumni work in a variety of fields relating to performing arts and entertainment industry, such as stage management, lighting, costume, and set design, etc.

4.   VR/AR/MR are fast-emerging technologies in the digital media field.   Their adoption in interactive design, gaming, and domestic usage is now more common than before and the relevant technologies have become more affordable for use in live performances.   HKAPA believes that the arts and culture sector is experiencing a paradigm shift with the increasing adoption of VR/AR/MR technologies on stage, and the use of technologies would gradually become world standard.   Therefore, HKAPA considers it important to set up a VR/AR/MR research laboratory with the necessary digital media equipment on campus at the earliest opportunity.

5.   The VR/AR/MR research laboratory is part of the strategy to enhance the learning of the students of the School of Theatre and Entertainment Arts.   The School has set up the Department of Media Design and Technology in Academic Year 2018/19.   It plans to offer new courses in digital media, and two specialisations, namely "Projection Design" and "Interactive Media", to students, and will make use of the new facility in the VR/AR/MR laboratory for teaching in future.   The proposed equipment in the laboratory may also inspire new creative work involving different arts disciplines, which is essential for nurturing modern day professional artists.

6.   Apart from teaching, the equipment would also be used for conducting practice-based research which is distinct from traditional research as the former focuses on the practical application in performing arts, and undergraduate students and teaching staff can both participate. A few examples of possible new projects that HKAPA may be able to undertake with the new facility are listed at **Annex A**.

7.   Without the support of up-to-date equipment instrumental to the course delivery, HKAPA would not be able to apply new technologies and interactive media to performing arts education to meet the needs, and to launch new specialisations for the benefit of students.

8.   At present, the VR/AR/MR facilities in higher education institutions in Hong Kong are often found in disciplines relating to

gaming industry and media art installation practices[1]. The proposed new facility in the School of Theatre and Entertainment Arts is unique as it will be dedicated to the education and research in performing arts. HKAPA expects that the facility will be gainfully utilised upon their installation at about 1 500 hours per academic year (September to May).

Project Scope

9. The new laboratory will provide a comprehensive immersive audio, video projection, lighting and digital media facility on campus. The core objectives of this laboratory are -

(a) to promote and support the development of cutting edge technologies in live performances through interdisciplinary researches and collaborative projects;

(b) to facilitate the launch of digital media courses as part of the specialised studies;

(c) to enable student initiated projects and innovative experiments; and

(d) to remain supportive to teaching and learning of existing specialisms of sound and lighting by means of the basic building blocks of the laboratory facility, which provides compatible and complementary support to undergraduate study courses in sound and lighting.

To achieve the aforementioned purpose, HKAPA proposes to convert and re-configure an existing studio/laboratory space of about 120 net assignable square metres in the Theatre Block on its Wan Chai campus with the provision of the equipment as listed at **Annex B**.

10. The scope and purpose of the proposed new laboratory is different from the five new laboratories located in the annex building of the On-Campus Expansion. Uses of the five new laboratories are set out at **Annex C**.

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[1] For example, Creative Media programme in the City University of Hong Kong and Digital/ Media programmes in the Polytechnic University of Hong Kong.

Expected Benefits

11.　　HKAPA expects that the new equipment would provide the necessary hardware to enhance production, teaching and learning, practice-based research, and achieve collaborative development and interdisciplinary activities with other academic streams such as drama, dance, Cantonese Opera, music via a series of major Academy Productions on an annual basis.　The VR/AR/MR technologies will provide enriching experience for designers and performers through visualisations and exploring the altered reality in creating performing arts. Such technologies also introduce other new ways of performing arts related development, such as performer gestural analysis, associated motion graphics and animation content generation, and facilitating safe and information-rich learning of theatre technology.　For example, by simulating an outdoor working environment in VR where equipment (e.g. loudspeakers) hung 10 metres above ground is swayed by wind, students can be prepared for those environmental conditions where they have to work at height.

12.　　The laboratory can further develop industrial engagement and research by applying the VR/AR/MR technologies in performances in Hong Kong.　It would help HKAPA to achieve its goal of nurturing media artists, designers and technicians for the 21st century performances, as well as forging engagement with the industry in adopting various applications in live theatre and entertainment.

Financial Implications

13.　　It is estimated that the proposed equipment will require a total non-recurrent expenditure of $16 million.　Estimated cost of the equipment and their major functions are set out at **Annex B**.　The required cash flow is estimated as follows –

Year	$ million
2019-20	11.4
2020-21	4.6
Total	16.0

14.   Due to rapid technological evolution in recent years, which is expected to continue, HKAPA estimated that the normal serviceable life is five years for wearables and computers, and eight to 10 years for other equipment such as loudspeakers, lighting fixtures, and video projectors, subject to availability of parts from manufacturers and support from service providers.

15.   HKAPA estimated that the additional recurrent expenditure would be about $650,000 per annum. HKAPA will fully absorb the expenses arising from the operation of the laboratory within its existing level of annual subvention.

Implementation Plan

16.   It is expected that the new laboratory would be fully commissioned around mid-2020.   HKAPA plans to install the equipment according to the following schedule –

Activity	Target Completion Date
Tender invitation for the first batch of equipment	March 2019
Award of contract for the first batch of equipment	May 2019
Delivery for the first batch of equipment	July 2019
Installation and commissioning for the first batch of equipment	August 2019
Tender invitation for the second batch of equipment	September 2019
Award of contract for the second batch of equipment	December 2019
Delivery for the second batch of equipment	April 2020
Installation and commissioning for the second batch of equipment	May 2020

Background

17.   Established in 1984, HKAPA is a government-subvented tertiary education institution providing training and education in performing arts and related technical arts.   The core of HKAPA's teaching is its full-time programmes from certificate to undergraduate levels in Dance, Drama, Film and Television, Music, Theatre and Entertainment Arts, as well as Chinese Opera.

18.   The School of Theatre and Entertainment Arts was established in 1986.   As at the end of September 2018, there are 53 teaching staff working in the School.   Its publicly-funded academic programmes and current student enrolment are set out as follows –

Publicly-funded Academic Programmes	Total number of students at the start of Academic Year 2018/19
Fast Track Intensive Training Programme (Two levels of intensive learning, 16 weeks in each level)	18
Fast Track Vocational Certificate (One-year full-time)	32
Bachelor of Fine Arts in Theatre and Entertainment Arts (Four-year full-time)	178
Total number of students enrolled in publicly-funded programmes in the School of Theatre and Entertainment Arts	228
Total number of students enrolled in publicly-funded programmes in HKAPA (excluding Junior Music and Gifted Young Dancer Programmes for teenage students)	858

Advice Sought

19.   Members are invited to note the content of this paper and to advise on HKAPA's plan on the new VR/AR/MR Research Laboratory. Subject to Members' view, we will seek the necessary funding approval from the Legislative Council in accordance with established mechanism.

Home Affairs Bureau
December 2018

**Possible Projects that can make use of the Virtual Reality (VR) /
Augmented Reality (AR) / Mixed Reality (MR) Research Laboratory**

Topic/ Project	**Virtual Reality Dance Performance**	**Augmented Content in Theatre**	**Cross-modal Research to Investigate Head-tracking Impact on Performers**
Outline	Two or more performers are wearing VR goggles and fitted with motion capture sensors; the movement of each is captured and rendered in VR as their avatars, and the entire dance performance is presented virtually.	Live performance but audience wear AR headsets with which they are provided additional information, commentary, transcripts, or subtitles.	Sound and visual representation in virtual environment often induces user discomfort and sometimes nausea in prolonged use. This effect is rarely examined with performers.
Expected outcome	Audience can experience performances at any arbitrary viewpoint inside the virtual space. This will extend performances beyond physical space.	New ways of designing performance and audience experience can be experimented and deployed.	The study can help staff and students to identify potential risks of exposure in highly interactive environment. It can help the investigation of new approaches in devising appropriate performance duration due to physiological responses against virtual environment.
Type of equipment to be used	All listed in Annex B, except Audio	All listed in Annex B	All listed in Annex B

Proposed Equipment for Virtual Reality (VR) / Augmented Reality (AR) / Mixed Reality (MR) Research Laboratory

	Types of Equipment	Proposed equipment items and major functions (Pictures of selected equipment are shown in **Annex B(1)** and the picture number bracketed in italics is marked against each selected item below)	Estimated cost		Major Functions
			2019-20 ($ million)	2020-21 ($ million)	
1.	Infrastructure	• Fibre-optic audio and video signal distribution network • Enterprise-grade core switches and other routers • Conduits and connector panels for fibre-optic receptacles and other sockets • Power distribution across the laboratory	1.34		High bandwidth AV signal transmission between devices to enable multi-stream of 4K Ultra High Definition (or higher in video resolution) routing to and from multiple nodes in the laboratory and across other labs. The network shall support common communication protocols like Open Sound Control, Digital Multiplex, Music Instruments Digital Interface, etc.

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			2019-20 ($ million)	2020-21 ($ million)	
2.	Video	• Trackable 4K camera system *(1)* • 3-dimensional (3D) scanning camera system • Aerial filming device • Camera based motion-capture system *(2)* • 360-vision-camera acquisition system with functions of multiple-streams of panoramic, flexible cropping, stitching and optical correction	6.21		To enable precision video capture, 3D scanning of human-size objects and aerial footages, as well as 3D capture of buildings and landscape to produce realistic scenes in VR.
		• Laser projector array • Hologram modular projection kit *(3)* • Portable LED-video wall package *(4)*			To provide panoramic projection, holographic and other flexible reproduction configuration inside the laboratory for various VR production scenarios.

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		2019-20 ($ million)	2020-21 ($ million)	
3. Lighting	• LED-based studio and robotic lighting fixtures (and necessary portable dimmers where required) *(5)* • Programmable lighting control console		0.80	To provide illumination for video shooting, motion capture and other artistic lighting effects.
4. Audio	• Multi-channel sound field synthesis system • Bone conduction/ vibrational actuators • Real-time digital audio signal processor/ renderer		2.00	To provide immersive audio experience, with sound source localisation, automation and acoustical simulation for VR
	• Ambisonic capture device • Soundfield microphones • Binaural capture with tracking information *(6)*			To acquire precision and trackable 3D soundfield recording.

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			2019-20 ($ million)	2020-21 ($ million)	
5.	Interactivity and advanced programming	• Wireless head-tracking • Bio-sensing *(7)* • Motion-tracking systems	1.15		To provide spatial and other bio data for registering locational and gestural information in interactive applications.
		• Programming platforms for interactive design			To enable customised computer coding in languages such as HTML5, Andriod OS, iOS, WebApp, Open GL.
6.	Rendering engines	• External graphics processing unit		1.10	High-resolution real-time video rendering engine to support true interactivity in live theatre.
7.	Biometric monitoring	• Biometric measurement apparatus (e.g. Electroencephalo-graphy (EEG) monitoring, heart-rate monitoring, etc.)		0.20	To enable studies in perception to support qualitative researches through subjective testing methods.

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			2019-20 ($ million)	**2020-21** ($ million)	
8.	Rigging System	• Modular rigging truss system *(8)* • Industrial automation of tracking and/or rotation	1.50		To enable mounting of camera, lighting, sensors, microphones and loudspeakers at flexible positions, with the added function of programmable aiming and positioning.
9.	Wearables	• Wireless wearables (headsets, goggles and glasses) for VR, AR and MR *(9)*		0.50	To enable vision in virtual or augmented environments for both performers and spectators.

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		2019-20 ($ million)	2020-21 ($ million)	
10. Portable workstations and digital media softwares	• Graphic design softwares Adobe Creative Suite, Open GL, Shader • Modeling softwares Sketchup, Cinema4D, 3dsmax, Maya • Visual programmes Processing, Isadora, Max, TouchDesginer • Video mapping programmes Madmapper, Maya UV Toolkit • Interactive design programs Unity or Blender • Portable computers to support highly demanding graphics of real-time processing	1.20		To provide computer-based processing for various digital media applications in support of the courses in Projection Design and Interactive Media course works.
	Total	11.40	4.60	

Pictures of Selected Equipment for Reference

Exact items will be procured according to established procedures of the Hong Kong Academy for Performing Arts, and all product models / brands shown in the pictures below are for illustration only and the actual final purchase might be different (e.g. updated versions might be available at the time of purchase).
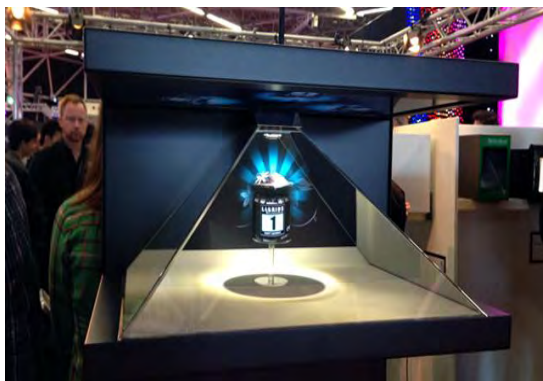
(1) Trackable 4K camera

(2) Camera based motion-capture system
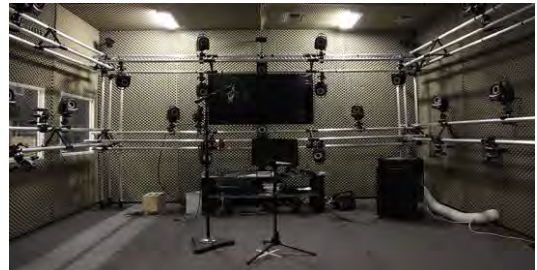
(3) Hologram projection modular kit
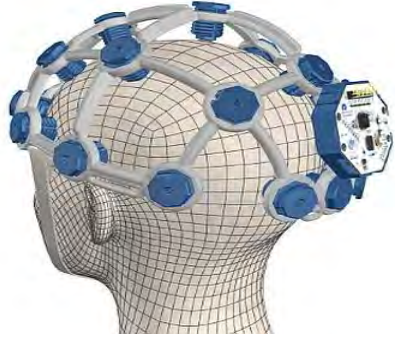
(4) Portable LED-video wall

(5) LED lighting fixtures for theatre lighting effects

(6) Binaural head-tracking

(7) Bio-sensing : video-Electroencephalo-graphy (EEG) sensing headset

(8) Circular rigging truss

(9) Wearable

**New Laboratories in Annex Building of
the Hong Kong Academy for Performing Arts**

Amongst other facilities, the following specialised laboratories have been provided in the annex building of the On-Campus Expansion project –

(a) a **dance technology laboratory** to provide teaching space for dance students to develop compositional / choreographic works;

(b) a **Chinese Opera studio** to provide the School of Chinese Opera with teaching, rehearsal cum mini-performance venue;

(c) a **drama project laboratory** to provide drama students with teaching and learning space that can replicate performance settings of industry standard;

(d) a **multi-media laboratory** to provide teaching and project space for the School of Theatre and Entertainment Arts and interdisciplinary projects; and

(e) a Theatre and Entertainment Arts **multi-purpose laboratory** to provide a computer laboratory and teaching space for theatre and entertainment arts students.