

Engineers' Role in the Construction of the Metaverse 工程師對元宇宙發展的貢獻

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Neil Stevenson, a science fiction author, coined the term "Metaverse" in 1982 to refer to a 3D virtual world that protagonists may join to flee the totalitarian reality, and was later introduced to the corporate world. From niche startups to tech giants, all Metaverse advocates are trying to set foot in the virtual realm. Broadly speaking, Metaverse contains both virtual reality, as defined by persistent virtual environments, and augmented reality which blends features of the digital and physical worlds. The Metaverse is currently in its early stages, and there is no framework in place for how visuals should be constructed and how Metaverse should be explored. There is one thing that is certain - Metaverse has its roots in computer graphics. It offers a paradigm that describes how graphics, interaction, and visualization techniques support visualization and user-centric exploration in Metaverse.

According to Dr. Ray Cheung, an Associate Professor in the Department of Electrical Engineering, City University of Hong Kong, the cornerstone of the virtual world stems from computer graphics technology, which involves a wide range of subjects like computer vision and human computer interaction before outputting analysis results or generating objects on screen. These technologies weave together and function in a way that stimulates visions of humans and presents art and visuals in a variety of desirable ways.

「元宇宙」一詞於一九八二年面世，科幻作家 Neil Stevenson 在他的小說中形容元宇宙為一個三維的虛擬世界，書中的角色們為了逃離極權主義，紛紛到元宇宙中尋求庇護。此書亦為美國矽谷的科技從業者提供靈感，讓元宇宙正式走進我們的現實。

香港城市大學（下稱「城大」）電機工程學系副教授張澤松博士認為，元宇宙與電腦圖像處理技術的發展唇齒相依。電腦圖像處理技術為建構虛擬世界的根基，過程當中需要運用人機互動或機器學習等專業知識，才能成功將影像投放在畫面上。不同的技術領域互相協作，對人類的視覺感官做出刺激，使內容媒介以我們喜歡的方式展現。為了實現真正的虛實結合，各界的工程師正不辭勞苦地鑽研能提高解析度的技術。張博士主張元宇宙的發展進程將極度依賴科技對觸覺、視覺、聽覺、嗅覺和味覺的刺激，然而以現時的技術水平而言，元宇宙設備暫時只能滿足視覺刺激。

Engineers and developers play an important role in powering the application of Metaverse. Engineers around the world have put a lot of effort into research and development to pursue higher resolution in all forms of visual outputs, striving to advance the technical environments to the point where viewers are no longer able to differentiate actual and virtual scenes.

Dr. Cheung emphasizes that satisfying the five primary human senses - touch, sight, hearing, smell, and taste - is essential to bring these goals to fruition in the Metaverse environment. The majority of these senses have been translated to virtual space, while the remainder are still undergoing continual advancements. Regrettably, only "sight" is being advanced, successfully giving viewers the feeling of depth for example, with existing computer graphic technologies. With fresh entries and investments into the industry, the human senses problem in the Metaverse should be resolved shortly.

Understand Metaverse as an Engineer

Technically speaking, anything made in the virtual world is essentially a "digital twin" of the individual or thing made in reality. In order to demonstrate how the Metaverse is a futuristic concept for an alternative universe, or a twin earth, Cheung makes reference to NVIDIA's Omniverse, also known as Earth 2.0. NVIDIA is an American multinational technology company specialized in creating interactive graphics technologies, and its Earth 2.0 schemes makes thorough data investigation and analysis possible through GPU-accelerated computations and calculations supported by artificial intelligence (AI) models. Government officials, academics and decision-makers could now investigate what-if scenarios by gaining access to enormous types of data, which is difficult to perform with conventional modeling tools hence actionable feedback is absent. The setbacks with Omniverse that most engineers would face are compliance amongst situational applications, reigniting the debate on how the needs of various user groups and stakeholders should be balanced and how their respective needs could be fulfilled.

The traditional computer system begins by stating an input, then a device or process, and ultimately the system feedback is generated as an output. This might be used to explain the history and mechanisms of the Internet we used to experience. In Web 1.0, users can input an internet address, and the computer or the device will output the page they requested. As Web 2.0 develops, users can create content, then processed by a device and ultimately made available to other online users. During the Web 3.0 era, AI is being used in a growing number of applications. Machine learning is used as an input, inspiring human creativity to provide a more connected and interactive online arena for all users. The growing accessibility of quicker and more affordable internet services, together with advancements in data power and storage have all contributed to the remarkable resurgence of AI in the past few years. The responsibility of the engineers today is to branch and corroborate the computing system by incorporating and perfecting technologies such as AI, augmented reality (AR) and virtual reality (VR) in the Metaverse framework.



以技術層面剖析元宇宙

任何在虛擬世界中被創造的物品和人都屬於其在現實生活中的投射，工程學領域將此現象視為「數位雙生」技術。張博士指出，NVIDIA 旗下的元宇宙平台 Omniverse 正說明業界如何透過創造「地球 2.0」印證數位雙生技術的成果。在「地球 2.0」上，每個被創造出來的物品都與現實並存。Omniverse 的面世使政府官員、研究人員和決策者能運用更多數據模擬不同的情境，畢竟在傳統的模式下為大數據進行分析是項非常艱巨的工作。對工程師而言，如何平衡各方利益和使用情景的需求成為了為最大的挑戰。

用戶輸入指令、裝置從中轉換指令並輸出結果是大多電腦系統運作的流程。在此框架之上，每階段的網絡發展也展現了不同的特色。在網絡 1.0 的時代，用戶在輸入網址後由電腦生成結果，再向用戶顯示相應的頁面。踏入網絡 2.0 的階段，用戶可以在網絡上創造不同的內容，上傳到裝置後，其他的用戶也能觀看這些內容。網絡 3.0 的世界更以人工智能技術主導，機器學習技術取代用戶角色並向裝置輸入資料，進一步加強網絡與用戶之間的連結。工程師的角色加速了電腦的進化，讓系統框架能容納更多的運算空間予人工智能、擴增實境、虛擬實境等技術。事實上，這些技術已在市場上已發展了好幾十年。近年的互聯網服務均追求更快的速度和提供更便宜的服務，數據分析和儲存的技术亦相繼取得不少突破，為人工智能技術提供了理想的孵化環境。



Similarly, the human brain's computational structure akin to the internet. In cognitive psychology, the terms "input", "device", and "output" are used to describe the information that is processed by our five senses, our nerve system's cognitive functions, and our behaviors respectively. It's crucial to build a system with AI revolving around the creation of multisensory experiences that can emulate and imitate the human mind. How we perceive the world have long been shaped both online and offline through digital Web 2.0 experiences and in-person activations. However, with Facebook taking the lead and being laser-focused on its Metaverse ambitions since 2021, Metaverse might give humanity an entirely new world in which to create multisensory experiences, reshape norms and perceptions.

Contrary to Albert Einstein's famous dictum that "time is relative," Metaverse is capable of having its own independent space and time. Likewise, a wide array of opportunities can be recognized and accomplished if space and time are no longer creating a boundary for expansion and evolution. As the COVID-19 pandemic spreads, demand for conventional online activities to interpret and mimic multisensory experiences are on the rise. Cheung reiterated that by optimizing the analytical power featuring the five senses in each output stage, more opportunities and room for collaboration will arise for engineers and participants across industries, hence creating an immersive and coherent virtual living space. Blockchain technologies and its legislations could also be included to harness the potentials for cross-industry collaboration.

What Metaverse's Future Holds?

Cheung suggested there will be three key breakthroughs in the engineering sector. As digital titans like Microsoft, Meta and NVIDIA push the development of the Metaverse, legal regulation is unavoidably falling behind. There is little doubt that the decentralized structure of Web 3.0 technology will make investigating infringement and breaches, determining laws and jurisdictions and enforcing the law more complex, as we have started to witness enforcement actions relating to the misuse of NFTs lately. In order to address societal implications brought by Metaverse, more joint initiatives and collaborative efforts between participants from the science field and the law field are expected. For instance, the Faculty of Electrical Engineering and the Faculty of Law at CityU recently collaborated on an interdisciplinary conference to discuss how laws and policies might be used to foster the growth of the Metaverse in Hong Kong.

此外，人類大腦吸收資訊的過程就像電腦系統獲取資料一樣。從認知心理學層面分析，對人類大腦的“輸入”泛指從五官感受到的資訊，而電腦設備則可理解為人類的神經系統，而人類的行為則是生成的結果。為了能更好地讓用戶的五官獲取資訊，元宇宙設備自然需要具備模仿全方位感官刺激的功能。


愛因斯坦曾推測時間是相對的，然而元宇宙中獨立運行的時空對此給出了相反的論證。如時間和地域不再為社會活動設限，人類將實現無限的可能。張博士相信，透過工程師和社會科學家間的緊密合作，技術研發方向定會更貼合人類的五感消費需求，讓虛擬世界的體驗更具現實感。區塊鏈技術的突破、有效法律規管和行業間的緊密合作讓實現世界統一不再是空談。



未來的發展

張博士預測工程學界將依三個方向發展。第一個發展方向，是會有更多社會學科學界別和法律界別間的協作機會，共同為社會層面的影響提供解決對策。城大電機工程學系最近與法律學系舉辦了跨學界的研討會，齊聚探討該如何透過建立指引和法律支持元宇宙在港的發展。

General public still lacks understanding for coding as well as the Metaverse concept, as such education is essential to fill the knowledge gap. When education lags behind technological advances, technology, rather than educators, dictates what constitutes educational opportunity. If the digital world were to become an essential part of our lives, coding may potentially become a language that everyone must be familiar with, similar to how English must be mastered for one's to succeed in today's business setting. To meet these new prospects, we must improve how we educate children and train teachers, educators, academics, policymakers, and digital designers. According to Cheung, more schools are starting to introduce virtualization technology to their students such as traveling simulations in virtual reality. Additionally, CityU has offered a path for bringing exceptional educational practices in higher education by hosting the very first Metaverse career fair for its students. CityU ensures that youngsters have genuine human social connection while navigating in the virtual worlds. Students can attend the interview with employers and business representatives as avatars, facilitate interactions and actively take part in various informational presentations.

Third, advances in sensing, display, and optics technology are a cornerstone in the AR and VR industries. Today's headsets and devices are not sleek enough to deliver a full immersive experience. Despite billions of dollars invested in development, VR/AR glasses are still far from equipping with Dolby voice in terms of audio quality or presenting visuals of IMAX grade. Availability of gears built for Metaverse is imperative to establish better connections with all the five senses. In the long run, this would eliminate technological barriers and limits associated with lack of suitable devices, and as a result, the construction of more lifelike virtual experiences. Most industry participants feel that hardware limits will be what prevents us from realizing the Metaverse, and that companies involved in its creation will be critical in closing this technology gap. Cheung emphasizes that Metaverse solution providers should always stay enthusiastic and dedicated to improving user experiences in the opportunities that the Metaverse will provide. 

其次，為公眾提供關於編程和虛擬世界相關的知識對元宇宙的發展至關重要，然而當今社會大多缺乏對此的認知。若數碼世界成為我們未來生活的一部分，那編程語言將和英語般成為社會上通用的語言。張博士補充，越來越多的學校開始讓學生接觸虛擬世界的技術，例如在疫情之間學會如何用虛擬實境設備到訪世界各地。城大也透過舉辦首屆元宇宙招聘會呼應數位化的科技浪潮，充分體現學校與時俱進的教育風貌。學生們可使用虛擬化身與僱主互動，出席簡介會，甚至是參與面試。

最後的發展方向將從目前元宇宙設備規格不足的問題延伸，尤其是未能為五感媒介進行寫實模擬的困境。改善設備的規格和表現將有助突破元宇宙在發展路上的障礙，為用戶完善虛擬體驗的臨場感。張博士認為工程師將為元宇宙的研究投入更多科研力量，致力為用戶、為社會創造仿真、可行的元宇宙模式。 