基于智能交互的景观体验增强设计

APPLICATION OF INTELLIGENT-INTERACTION-BASED LANDSCAPE EXPERIENCE AUGMENTATION

https://doi.org/10.15302/J-LAF-20180204　收稿时间 RECEIVED DATE / 2018-03-20　中图分类号 / TU98, TP18　文献标识码 / A

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摘要

自20世纪90年代中后期起，人工智能和可穿戴交互技术不断革新我们和环境交互的方式，而在未来，这种影响将会愈加深远。可穿戴设备和移动终端主要从感知、理解和控制三个方面增强人对于环境空间的体验。本文围绕智能感官增强、智能认知增强，以及智能反馈增强三个方面，介绍了美国华盛顿纪念碑现场增强音乐项目、由麻省理工学院媒体实验室城市科学研究团队的学者为非专业用户提供智能决策辅助的“城市视景”项目，以及基于地理位置服务的“自然控”自然社区营造实景增强现实游戏应用程序设计等若干创新研究和实践探索，并展望了未来智能交互背景下空间环境规划设计领域可能面临的机遇和挑战。

关键词
智能交互景观；可穿戴设备；体验增强；增强现实

ABSTRACT

Since the mid- to late 1990s, both Artificial Intelligence and wearable interaction techniques have dramatically changed the way how humans interact with the exterior environment, as such influence will be greater and greater over time. Wearable devices and mobile terminals have enhanced humans' experience on spatial environment by improving their perception, understanding, and ability of control towards certain places. This paper centers on the advanced efforts of the augmentation technologies in intelligent sensing, cognition, and feedback, by introducing several innovative applications, including 1) the live-audio augmented project for the Washington Monument; 2) the CityScope project, developed by the MIT City Science Lab, which provides intelligent decision-making aid for non-professional users; and 3) Nature-X, an augmented reality application that creates nature community scenes based on Location Based Service. All these studied cases of spatial and environmental planning and design look into the future opportunities and challenges in the context of intelligent interaction.

KEY WORDS
Intelligent Interactive Landscape; Wearable Device; Experience Augmentation; Augmented Reality

基金项目
住房和城乡建设部科学技术计划与北京未来城市设计高精尖创新中心开放课题资助项目（编号：UDC2017010521）
中央高校基本科研业务费专项资金项目（编号：22120170016；编号：22120180084）
同济大学高密度人居环境生态与节能教育部重点实验室基金项目

Research Funds:
Ministry of Housing and Urban-Rural Development of the People's Republic of China and Beijing Advanced Innovation Center for Future Urban Design Open Program (No. UDC2017010521)
Fundamental Research Funds for the Central Universities (No. 22120170016; No. 22120180084)
Tongji University Key Laboratory Funds of Ecology and Energy-saving Study of Dense Habitats by Ministry of Education of the People's Republic of China

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1 引言

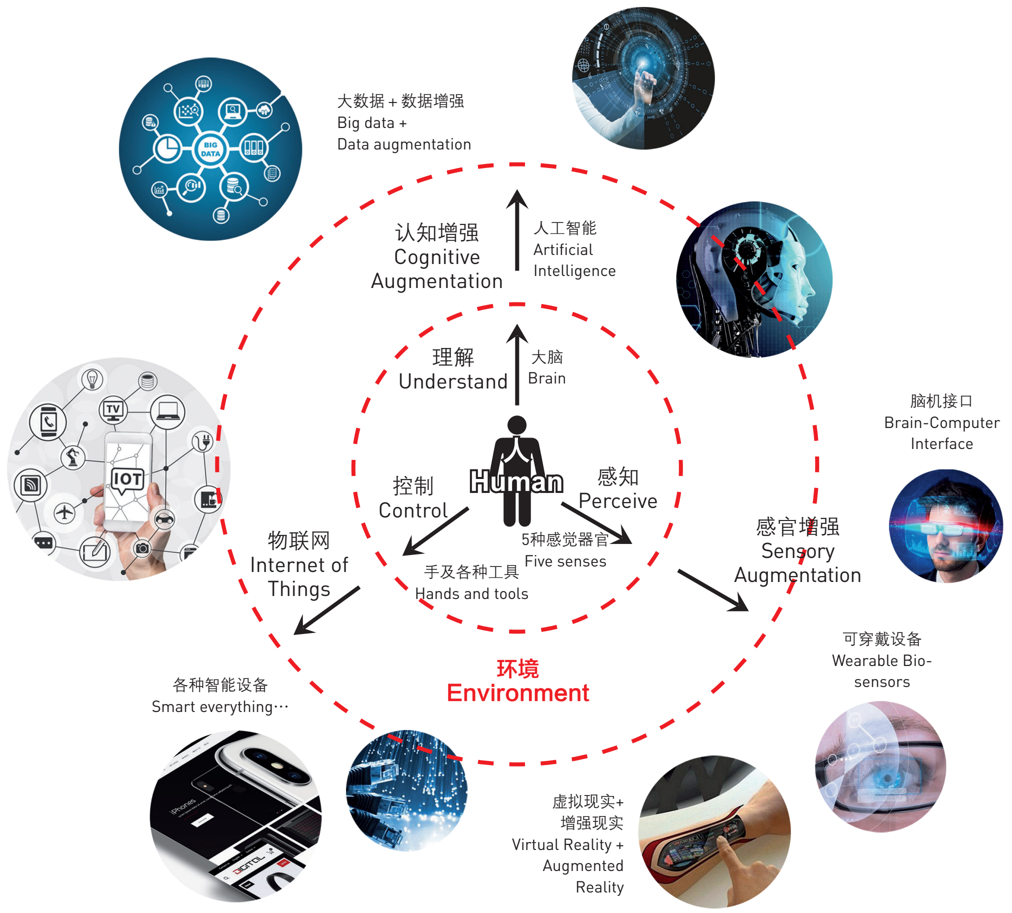
景观（landscape）是对“造景”和“观景”过程中环境与人的角色关系的考量。景观设计，以及更加广泛的空间环境规划设计领域，从某种意义上可以看作是以物质空间为对象的一种特殊交互设计。

然而，在“景观”中，人作为“观”之行为主体的创造价值尚未得到充分挖掘。社交化、地点化、移动化智能媒介技术为人与环境的交互带来了新的机遇：在多种媒介融合的情境下，“人-机-环境”形成全新的智能增强生态链，依托物联网技术，人类与环境可以形成超越物质空间及时间限制的强黏性关系；人们对“风景”及“场景”所抱持的功能需求及相应设计观念从以景观物理逻辑为中心，向以人类行为逻辑为中心转变；人们观察景观的时空、方式、频率及视角因观察媒介的多样性而产生个性化偏好；景观形态及体验场景因感知技术的大众化普及而呈现数字化发展趋势；智能服务降低了景观营造的认知门槛，公众参与景观共治的趋势渐长。景观设计师需要全局思考场地作为融合人、时间、空间、信息及媒介的事件发生器的价值。

在过去，人们主要通过视觉、听觉等感官系统来感知世界；大脑会对感受到的信息进行加工，从而形成对世界的理解；而双手及各种工具的使用，则让我们能够去塑造这个世界。自二三十年前开始，人工智能和可穿戴交互技术不断革新人与环境交互的方式，而在未来，这种影响将会愈加深远（图1）。首先，可穿戴传感器技术可实现智能感官增强的效果。一些能够直接被直觉脑加工的增强现实和虚拟现实技术可以直接读取大脑意识信号，捕捉我们的运动控制感知以及前额叶等高级认知活动的脑机接口，从而实现多模态数字信息融合，使人

1. 新的交互技术对人和环境交互方式的影响

1. The influence of new technologies on the human-environment interaction



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1 Introduction

The term “landscape” implies the roles of environment and humans in both the processes of creating and viewing scenes. Landscape design, and other spatial and environmental planning and design, somehow can be considered as a special interactive design that shapes and defines the physical world.

Yet, humans' role and creativity in interacting with landscapes have been less discussed. The socialized, locationalized, and mobile intelligent media technologies are offering new opportunities for the interactions between human and the exterior environment: a brand new “human-machine-environment” interaction network is forming with the support by the Internet of Things, which makes the human-environment relationship strongly adhesive, beyond spatial and temporal limits; people's demands and understandings on “landscapes” and “scenes” are undergoing a focus shift from physical logics of landscape towards human's behaviors in landscapes; The emergence of a wide range of observation media supports the diversity of people's temporal and spatial preferences and methods, frequency, and perspectives when viewing a landscape; The broader promotion of sensing technologies is facilitating the digitalization of landscape configuration and experience; Smart applications and programs make landscape creation more easily cognized by the public, and encourage public engagement of landscape management. Landscape architects are expected to comprehensively consider the importance of a place being an event container that integrates people, time, space, information, media, and other elements together.

In the past, people cognize the world with our own sensory systems like vision and hearing, understanding the world based on the processed sensing information in brains, and managing the world with hands and tools. Since two or three decades ago, Artificial Intelligence (AI) and wearable interaction technologies have brought a revolution on the ways we interact with environment — It can be foreseen that such influence will be greater and greater over time (Fig. 1). First, nowadays wearable sensor technologies can wonderfully generate sensory augmentation effects. Related technologies, including the augmented reality (AR) technologies and the virtual reality (VR) technologies which can be processed by humans' intuitive brain, can directly read signals from human brains and capture our motion control sensations and the brain-computer interfaces of human brain that are highly developed and control the regulation of complex cognitive, emotional, and behavioral functioning (such as prefrontal cortex), to integrate multi-mode digital information and offer us diverse visual experience. In

获得更为丰富的视觉信息。此外，通过实时皮电阻等技术，一些电生理信号将比我们人类自身的意识更迅速、更准确地识别出精神压力及情绪变化。

其次，智能认知增强能够帮助我们更深刻地理解每个使用者的行为偏好和需求——许多使用者在体验智能认知增强之前，很可能从未意识到自己具有某种偏好和需求。智能认知增强的实现方式主要基于通过社会计算[1]、城市计算[2]、情感计算[3]等工具对个性化行为数据和生理数据进行挖掘。

再次，新的人机交互方式和物联网的诞生使我们控制外部环境的方式更加多样化，甚至可以通过机器读取人类手势、表情、动作、意念等进行无接触远程控制[3]。值得注意的是，通过认知增强挖掘智能感官增强所提供的海量个性化实时数据，物联网可以助力更为智能地实现环境对于个体需求的实时响应。

人工智能和交互技术从感知、理解和控制三方面拓展了景观体验。由于其涉及环境设计、心理、神经认知、信号处理、微电子等多学科知识，因此要求空间设计者不局限于某个学科领域，而应积极开展跨学科合作。本文从智能感官增强、智能认知增强和智能反馈增强三方面介绍人工智能和交互技术拓展景观体验的跨学科研究和实践探索，以期帮助空间设计师加深对于人工智能和交互技术的可能性的理解。

2 智能感官增强

人们借由感官获取环境信息，并通过对信息的加工理解，在大脑中重建对环境的认知。在获取环境信息的过程中，人并不能像照相机、录音机一样完整、无损、真实地进行记录；人对于印象深刻的信息（如美丽壮阔的风景、沁人心脾的香气等）往往会比那些司空见惯的信息有更强烈的情绪反应，这一过程被称为情绪唤醒[4]。对于那些会触发强烈情绪唤醒的环境，人们的记忆会更加深刻，并更倾向于依赖这些令人印象深刻的信息去建立对于空间场所的认知。

景观体验增强设计是指景观设计通过激发并强化空间场所的情绪唤醒，从而实现场所景观体验的增强。例如，新媒体音乐人莱恩·哈勒代运用了一种带有地理标签的音乐生成技术来强化场所体验[5]。其灵感来源于环境艺术家克里斯托·亚瓦杰夫和珍妮-克劳德·德·高依本的知名艺术装置作品“门”——“门”项目通过在纽约中央公园内设置一系列门帘状的橙色布幔，不仅以亮眼的色彩丰富了冬季室外空间、增加了场所活力，更重要的是它强化了中央公园的道路结构，突出了公园原本的空间设计理念，加深了人们对于公园的空间场所体验（图2）。哈勒代及他的弟弟在华盛顿纪念碑附近运用类似的手法，以现场音乐强化空间的仪式感，增强了人们对于华盛顿纪念碑的场所

addition, some electrophysiology signals, such as the real-time skin conductance technology, can identify people's stress or emotional changes faster and more accurately than ourselves.

Secondly, intelligent cognitive augmentation helps us better understand people's individual behavioral preferences and needs — quite a few users even have no ideas about their preferences or needs before using this application — Cognitive augmentation is largely supported by the mining of individual behavioral and physiological data through social computing[1], urban computing[2], affective computing[3], and other computing approaches.

Thirdly, the newly emerging human-computer interfaces and the Internet of Things offer humans more options on approaching and managing the reality environment. Remote operation becomes possible through machine reading on human's body languages, expressions, movements, and minds[3]. It is noteworthy that cognitive augmentation can dig and further process massive individual real-time data collected by the intelligent sensory augmentation, and the Internet of Things would help people's individual real-time demands get responded by the exterior environment in a smarter way.

AI and interactive technologies have enhanced people's experience on landscapes by improving their perception, understanding, and ability of control towards certain places. Landscape architects and other spatial designers are expected to develop interdisciplinary collaborations since the operation of such interactive technologies requires knowledge of environmental design, psychology, neuro-cognition, signal processing, micro-electronics, etc. This paper introduces the current research and practice of AI and interactive technologies from the aspects of intelligent sensory augmentation, intelligent cognitive augmentation, and intelligent feedback augmentation, in order to help spatial designers explore future potentials of AI and interactive technologies.

2 Intelligent Sensory Augmentation

Humans obtain information from the exterior environment with sensory systems, and our understanding on the world is based on the processed sensing information in brains. When people obtain information from the environment, their receiving cannot be completely intact or objective; Instead, people tend to remember the objects or things that strongly affect them (such as a beautiful scenery and a pleasant fragrance) — the process is known as affective arousal[4]. Such impressing information often becomes the materials that build

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2. 环境艺术家克里斯托•亚瓦杰夫和珍妮-克劳德•德•高依本的艺术装置作品“门”强化了纽约中央公园的道路结构。

2. The Gates, an outdoor installation designed by environmental artists Christo Yavacheff and Jeanne-Claude de Guillebon, highlighted the path network of the park.

体验。当游客从周围广场沿小路逐渐走近纪念碑时，耳畔首先响起一段简单的电子琴独奏，之后会听到小提琴的泛音。游客距离纪念碑越近，听到的音乐越高昂。当游客到达纪念碑时，音乐也达到高潮，恰好与游客的情绪形成共鸣。当游客逐渐远离纪念碑时，整个音乐的顺序也会反过来，使游客的情绪从激动变为平和。直至游客离开广场，音乐会减弱至无声。

3 智能认知增强

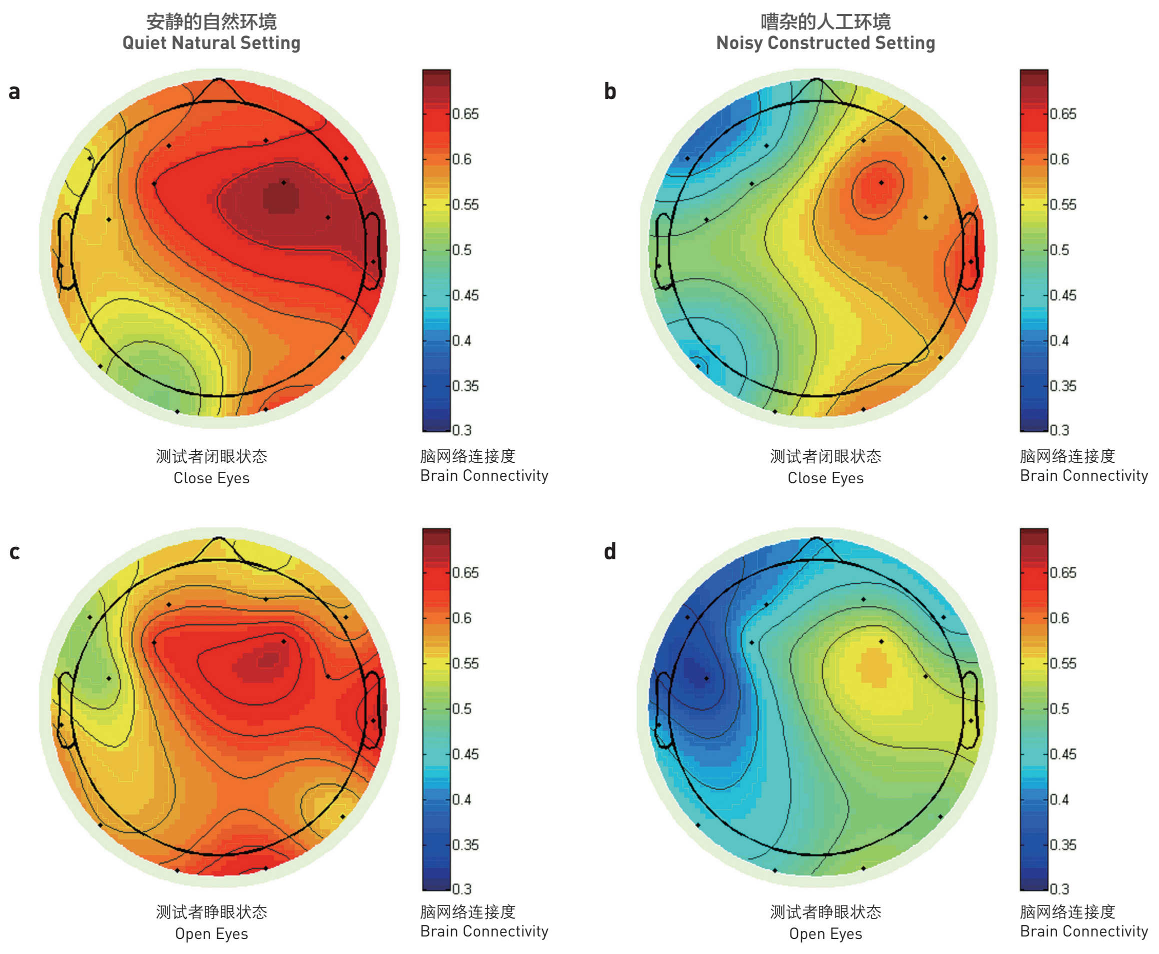
大脑重建对环境认知的过程，并非完全真实客观地再现环境的每一处细节，因为我们对于环境空间的认识往往建立在对抽象理解的简化认知上。认知心理学家认为，人类大脑简化加工信息的方式有两种：一种是处理速度较慢的逻辑脑，一种是处理速度较快的直觉脑[6]。在关乎生存等急需做出迅速判断的情况下，对于环境信息的加工处理在很大程度上依赖于直觉脑[7]。但因为这种直觉加工常常是由潜意识所决定的，所以我们的感觉往往很模糊（如放松快乐或反感恐惧），但同时我们也并不能十分准确客观地指出究竟是为什么。而这种为什么，以及引起上述情绪唤醒的原因恰是环境设计的关键。如何利用认

our cognition and perception to a particular place or spatial environment.

In landscapes, experience augmentation is to trigger people's affective arousals through specific design in order to offer the viewers a more impressive experience of the site. The new media musician Ryan Holladay employed a geo-tagged audio creation technology to augment visitors' spatial experience in one of his projects[5]. He was inspired by The Gates, a well-known outdoor installation designed by environmental artists Christo Yavacheff and Jeanne-Claude de Guillebon, who set a series of curtain-like bright orange flags in the Central Park, New York. The artwork not only decorated the winter scenery of the park and attracted a lot of visitors, but also highlighted the original design concepts on the path network and spatial layout of the site, bringing a unique experience for the visitors (Fig. 2). In Holladay's project, he and his brother created a gripping, dramatic immersing experience around the Washington Monument by playing an audio of live-music at the site. When visitors approach the monument, they would hear a short keyboard solo, followed by a harmonic over the violin. The closer they get to the Monument, the louder music they will hear. When visitors finally stand in front of the Monument, the audio gets the climax, resonating their feelings the most. When they leave, the audio would be played reversely, allowing the visitors pacified from the softer and softer tune. When they completely get out the area of the site, the audio would be mute.

3 Intelligent Cognitive Augmentation

Our cognition to a certain place or a spatial environment would not be exactly in accord with the conditions of the site, but a simplified, abstract impression. Cognitive psychologists believe that human's cognition is generated through two approaches: the logic brain that processes information relatively slower, and the intuitive brain that processes information faster[6]. Human's response to surviving demands is mostly decided by the intuitive brain which can evaluate the current situation, process relevant information, and instruct our reactions[7]. However, such intuitive processing is often subconscious. This is why we usually have a vague feeling of a particular experience — pleasure or horror, for example — but cannot exactly or objectively figure out the reason why we feel that way. But, the ways we feel and the reasons triggering affective arousals are key to environmental design. Cognition science would help designers methodically understand the



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3. 利用便携式多导生物传感器探究人们如何加工不同环境的信息，以及从这些环境刺激中恢复。研究显示，在自然环境中，人脑网络连接度明显较高，而在嘈杂的城市环境中，人脑网络连接度则较低，这一点在前额叶区域体现得尤为突出。

3. Portable biosensors are used to study how people respond to and cognize different environmental scenes, and how people recover from sensory stimulations. Related research reveals that the brain connectivity in natural environment is higher than that in noisy constructed settings. The changes in the prefrontal lobe are most obvious.

知科学更系统地理解人们对于环境信息的加工方式，可以帮助我们设计出更加照顾使用者情绪的空间场所。

智能交互下的可穿戴传感器装置通过与机器学习技术结合，可以极大地帮助我们理解人对于环境的直觉感受。我们可以利用便携式多导生物传感器（如脑电、皮电阻、表情肌肌电、心电、眼追踪等），研究实景环境中多感官刺激如何诱发不同的大脑认知活动。通过记录并测量不同的环境（包括优美的绿色自然环境和嘈杂的人工城市环境等）对实时大脑活动的影响（图3），我们发现相对于嘈杂的人工环境，在安静怡人的自然环境下，大脑可以通过更小的能耗实现更高效的功能链接及信息传递，从而让大脑得以更充分的休息，因此自然环境有助于人恢复注意力、提高认知效率[8][9]。

交互装置的使用能够极大地提升人类对于复杂信息的认知及处理效率，并有利于降低试错成本，从而赋能非专业人士参与专业决策、优化沟通媒介及推动利益共同体民主化决策等。例如，在美国众多市政工程项目中，由于无专业背景的美国民众无法在项目初期理解或参

information processing system in human brain, which would better inform spatial planning and design that takes care about the users' moods when experiencing the places.

The combination of wearable sensor devices with Machine Learning technologies would significantly improve our understanding on human's intuitive feelings about the exterior environment. Portable biosensors (such as electroencephalography, skin conductance, facial muscle electromyography, electrocardiogram, and eye tracking) were used to study the cognitive activities in human brain through real multi-sensory stimulation. By recording and measuring people's real-time brain reactions to different stimulations, including beautiful natural sceneries and noisy built urban settings (Fig. 3), it is found that the brain works at a higher efficiency on functional linking and information conveying with lower physical consumption in pleasant, quite natural environment, which allows for brain rested, helps attention recovered, and improves cognitive efficiency[8][9].

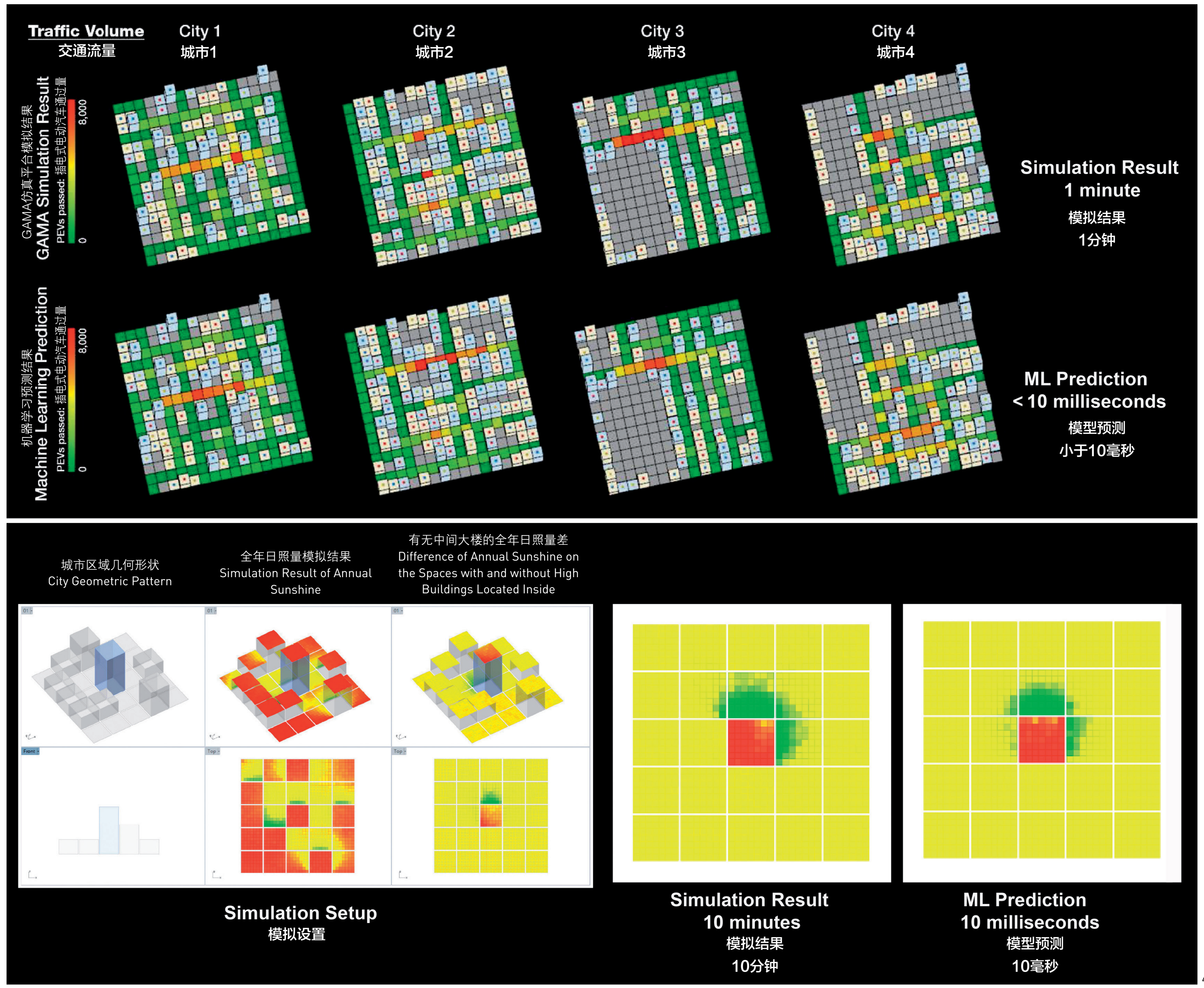
The use of interactive devices can greatly improve humans' efficiency to cognize and process complex information and

4. CityScope项目引入了机器学习方法，使计算耗时从原来的分钟量级变成毫秒量级，大大提高了实时决策效率。上图对比了分别通过自主行动者建模模型模拟及机器学习预测模型生成结果的时长（图片来源：参考文献[9]）。下图左半边为太阳辐射模拟结果，右半边则体现了两种模型预测结果的高匹配度（图片来源：参考文献[12]）。

5. CityScope项目原型针对专业及非专业用户决策辅助的有效性测试（图片来源：参考文献[9]）。

4. CityScope can greatly reduce the required computing time from a few minutes to shorter than ten milliseconds that significantly enhances the efficiency in the decision-making process. The top diagrams show a comparison between the required computing time of ABM (Agent-Based Model) simulation and Machine Learning prediction (Source: Ref. [9]). The bottom-left diagrams show the simulation results of solar radiation through the two mentioned approaches, while the bottom-right diagrams demonstrate that the high matching of the two results (Source: Ref. [12]).

5. Tests on the availability of the CityScope prototype for providing decision-making aids for professional and non-professional users (Source: Ref. [9]).



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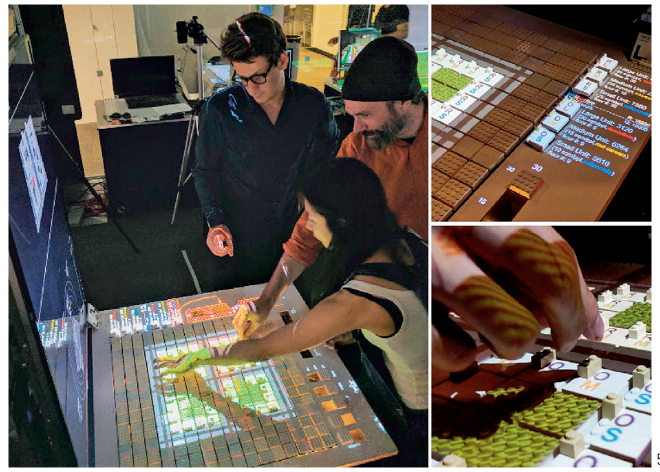
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reduce trial-and-error costs, which allows the public to participate in professional decision-making process, optimizes communication interfaces or agencies, and promotes democratic procedure among stakeholders. For instance, quite a few civil projects in the United States move slow or have to be halted because the ordinary Americans could hardly understand the releasing results of urban planning and design in forms of CAD drawings or graphics generated by other cartographic softwares, or

与决策那些政府利用AutoCAD等传统制图软件制作的城市设计方案，加之沟通媒介的欠缺极大地阻碍了民主决策的效率，最终导致工程推进迟缓，并已造成总额高达3.7万亿美金的资金僵套[10]。为应对这一问题，来自麻省理工学院（MIT）媒体实验室城市科学研究团队的肯特·拉尔森等学者创立了"城市视景"（CityScope）项目[11]，旨在创建更智能、更直观、更友好的城市智能决策辅助平台（图4，5）。为了降低平台的认知门槛，鼓励人人参与，设计团队从三个层面引入对"人因"智能交互装置设计的考量。

第一个层面是可触界面。平台采用设计语言更直观的交互界面，并且通过乐高组件增强交互界面的可触性，以进一步提升交互参与的可理解性及直觉性。

第二个层面是实时认知计算。区别于传统的城市模拟计算平台，CityScope强调了在沟通过程中进行实时计算的必要性。随着城市计算模型的复杂化及多元数据量的激增，模拟系统的计算时间可能呈指数递增（例如，一个高精度模拟预测可能需要耗费数天时间），这将极大地阻碍利益相关方决策的连贯性，因而迫切需要高效的模拟系统来优化讨论效率。CityScope团队采用深度神经网络算法，根据20 000余座城市的全年日照及交通数据建立数据分析模型，并将数据用于机器学习训练。经测算，该平台预测数据准确率可达85%~90%，而局地性计算预测耗时可缩短至1毫秒以内。虽然可视化结果存在一定的偏差，但其精确度足以支持实时的智能决策[11]。

第三个层面是辅助决策。CityScope平台作为一种可穿戴交互装置的延伸，可以在交互过程中了解使用者的隐性需求和决策偏好，从而帮助使用者进行决策。它沿用了"阿尔法狗"所应用的优化搜索算法，基于统计模拟算法研究，兼顾搜索的宽度与深度；根据使用者在交互操作过程中每一步的变量设置及乐高模块空间布局，实时搜索最优策略，并为决策者提供语音提示。同时，使用者也可以反馈文化、审美及政治因素等机器无法考量的决策条件，从而逐步让机器在符合讨论者共识的前提下提供最优化的情境模拟及决策辅助建议[12]。2016年，该平台初期模型已成功辅助德国汉堡政府进行叙利亚难民安置场所问题的决策。城市居民代表及城市决策者通过放置乐高模块来预测安置场所在不同情境下的优劣，最终的讨论成果综合体现了民众及市政决策的意见。难民安置后，良好的市民反馈也进一步验证了该平台辅助智能决策的价值。2017年3月，MIT媒体实验室①联合同济大学设计创意学院成立"同济-MIT城市科学实验室"，完成了CityScope四平路校区社区决策辅助平台的设计，开展了中国境内的首次实证，该案例将在后文详细论述。

4 智能反馈增强

人对环境的认知并不是一成不变的。相反，我们往往会通过反复的探索和试错来认知环境。任何一种战略决策都是将环境中的成分、约束条件和机会置于博弈论的理论体系中进行衡量的结果，即在博弈中，受到团体共同利益驱动的行为取向能够策略性地导向个体利益的激励结构[13]。2011年，美国KPCB风险投资公司合伙人约翰·杜尔提出SoLoMo概念[14]，即社交化（social）、地点化（local）、移动化（mobile）的缩写，希望将虚拟的网络世界与真实的现实世界连接起来。看似松散的用户能够在SoLoMo模式下基于地理位置、兴趣及行为偏好自动聚合，这种临时自发组成的群体很有可能成为传播的焦点社群，使社会关系网络最大化地发挥人际传播的功效，形成全新的社会化、本土化和移动化服务趋势。

智能反馈增强通过人机智能交互以及物联网拓展了人们试错的方式。同济-MIT城市科学实验室发起的"自然创生计划"旨在将政府主导的"生命城市建设"转化为一场自下而上、全民参与的自然友好活动，以助力生态景观营造及人类生态友好行动，着力营造有利于促进

① 团队成员包括张砚、艾瑞尔•诺曼、路易斯•阿隆索、阿诺德•格里纳德等。

participate in the decision-making processes, nor get well informed from the media. The lack of communication and public engagement has caused a total stuck of 3.7 trillion US dollars[10]. Kent Larson, et al. from the City Science research group of MIT Media Lab responded to this issue with an innovative project, CityScope[11], which is a slew of tangible and digital platforms dedicated to solving spatial design and urban planning challenges. It provides users-friendly decision-making aid and other intelligent helps (Fig. 4, 5). To establish public platforms accessible to all citizens, the team introduced "human factors" into the intelligent interaction design from three aspects.

First, tactile interface. The platforms adopt a more intelligible interface and allow for tactile instructions by using LEGO modules, enhancing the intuitiveness of users' interactive experience.

The second is real-time cognitive computation. Comparing with traditional urban design simulation systems, CityScope emphasizes the real-time computing as a communication agency. Since the increasing complexity of urban spatial models and the surge of the multivariate data, the time that computation requires would exponentially increase (for example, the computing of a high-precision simulation might take a few days), which hinders the coherence of stakeholders' decision-making process. To improve the computation efficiency, CityScope adopts an algorithm of in-depth neuro-network and establishes a modeling dataset that draws on the annual sunshine and traffic information of more than 20,000 cities. Through Machine Learning, the accuracy rate of prediction can reach 85% to 90%, and the required time for local computing can reduce to shorter than one millisecond. Although the visualized results do not perfectly match the reality, the accuracy is high enough to support CityScope to conduct real-time intelligent assessments[11].

The third is decision-making aid. CityScope, as an alternative wearable interactive device, can learn and predict the users' private needs and preferences, helping them better make decisions. Based on the Monte Carlo algorithm research, CityScope adopts AlphaGo's search algorithm that can fetch information from massive sources with a deeper study. According to users' variable settings and the spatial layout of LEGO modules, CityScope responds in real-time and offers optimal options, while providing voice prompts for all the stakeholders engaged in the decision-making process. At the same time, users could feed back their cultural, aesthetic, or political considerations that are beyond the intelligent scope of machines, allowing for the optimization of scenarios simulation and the consensus among the stakeholders[12]. In 2016, the prototype of this platform was employed by the government of Hamburg, Germany to make decisions on the Syrian refugee resettlement issue. By simulating different resettlement plans with LEGO modules, civil leaders and urban managers could assess the superiority and weakness of each scenario. The final decision was made respecting and responding to the demands and desires of all parties — The sound comments from the public showed the success of the implementation of intelligent decision-making. In March 2017, the Tongji-MIT City Science Lab, co-established by the CityScope team① and the College of Design and Innovation of Tongji University, developed a CityScope platform for the community building of Siping Road Campus — it was the first CityScope case implemented in China and will be discussed later in this paper.

4 Intelligent Feedback Augmentation

People's cognition on the exterior environment changes: we explore the world and alter our cognition as we interact with it. Any strategic decision is a result generated by assessing the components, constraints, and opportunities in a given context. In other words, common interests could strategically lead to an incentive structure of individual interests[13]. In 2011, John Doerr, a partner of KPCB Ventures, an American venture capital firm, proposed the concept of SoLoMo[14], i.e. the acronym of social, local, and mobile, in hope of connecting the virtual world with the realities. SoLoMo encourages spontaneous aggregate of individual users with common geographic locations, interests, and behavioral preferences. Such groups could act as the focus community of social communication, maximizing the interpersonal communication in social network, and forming a brand new pattern of socialized, localized, and mobile service.

With the development of human-machine intelligent interaction and the Internet of Things, intelligent feedback augmentation offers humans new options for trials and errors. The City Science Lab launched the Revitalizing Nature Renewal Program, as a response to the Life City Construction movement advocated by the government, with a hope to promote a bottom-up nature-friendly campaign for all citizens. The program aims to encourage biological landscape creation and eco-friendly behaviors by building both online and offline eco-communities. The Lab developed two applications, Nature-X and Succuland, both combining

① The research is developed by Yan Zhang, Ariel Noyman, Luis Alonso, Arnaud Grignard, and other contributors.

人与环境亲密接触的O2O线上与线下自然社区。在“自然控”和“多肉妙境”两个应用程序中，研发团队将“物质景观营造”与“公民博物行动”相结合，挖掘人与环境媒介相融合的景观营造场景，力图建构符合信息技术发展水平的公众参与机制，并实践景观营造的社交化、地点化及本土化发展。将社交网络的数据分析方法应用到数据动态监测中的社会化众包模式，对于人们感知、反馈、响应及学习具有动态发展特征的虚实两重“生态环境”有着不可替代的价值。

“自然控”是一款实景增强现实游戏应用程序，其以同济大学四平路校区作为基于地理位置服务（LBS）的自然社区营造场景（图6）。结合同济校园植物志及植物时空分布数据进行移动终端应用设计，作为公共社区景观的大学校园能够为亲子、青少年及大学生提供亲近自然的场所，并增强人们对聚居空间布局、植物栖息地与生物多样性关系的综合感官认知。“自然控”强化了当前校园内的植物标识系统，并通过地理信息标记优化及植物物候数据可视化，将环境教育从课堂之上引导至贯穿于整个校园生活的全过程观察之中，以提升公众关注环境、保护环境的意识，进而实现景观的社会共治。

“多肉妙境”艺术园艺应用程序以城市一平米阳台景观营造为切入点，引入智能识别及扫描建模技术。借助该程序，使用者能够将自己种植的多肉植物转化为线上虚拟多肉景观，并激活增强现实/虚拟现实的养植及智能管理场景（图7）。该营造机制赋能民众超越物质空间的限制，自主营造个性化线上多肉花园景观，为植物爱好者践行其“植物美学”创造了更多途径。基于LBS及云端智能集成社区群体数据，“多肉妙境”能够生成社区级、城市级及地区级多肉花园虚拟景

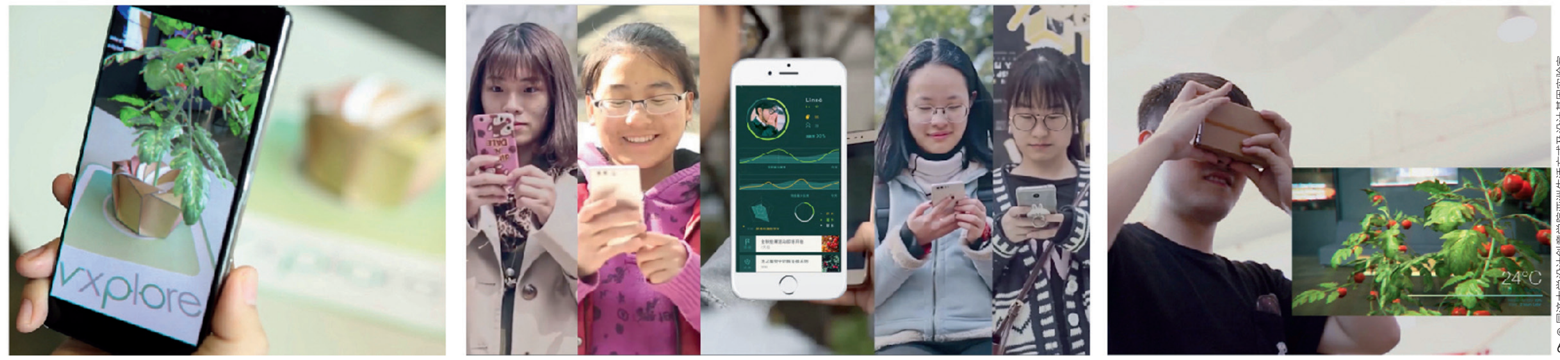
the concepts of “creation of physical landscape” and “citizen science promotion” and exploring possible landscape scenes to connect people with environmental agencies. The emergence of the two applications attempt to build a public engagement mechanism in line with the development of information technology, and to promote the socialization, localization, and mobility of landscape creation. By applying the data analysis method used in social networks into the crowdsourcing mode that is under dynamic data monitoring, it plays a significant role in people’s perception, response, and learning from both real and virtual “ecological environment” with dynamic, changing characteristics.

Nature-X, a game App featuring augmented reality, takes the Siping Road Campus of Tongji University as the empowerment case of a LBS-based natural community (Fig. 6). By mapping the historical and existing flora information of the site, the App is designed as a mobile nature museum which allows the campus to become a place for families, youngsters, and college students to access to natural environments in an entertaining way, while realizing all-sensory augmentation on the relationship of spatial layout, floral communities, and biodiversity. In Nature-X, the interpretation and signage system of the existing plants in the campus was improved, and by optimizing geo-tagging system and the visualization of the floral phenology, indoor environmental classes can be explored as a broader natural experience throughout the whole campus. It also encourages public engagement in environmental protection and landscape management.

Succuland, an App featuring urban gardening and horticultural design, takes small balconies of residential buildings in cities as the sites for landscape co-creation. It employs intelligent detection and scanning-modeling technologies that allow the users to scan their succulents and

6. “自然控”增强现实游戏应用程序
7. “多肉妙境”艺术园艺增强现实/虚拟现实应用程序
8. 虚拟的社会化关系网络与实际的地理位置共同融合于移动终端，形成了全新的社交化、地点化和移动化服务网络。

6. Nature-X, an augmented reality game App.
7. Succuland, an App featuring gardening and horticultural design.
8. Virtual social network and real geo-positioning are combined and integrated into mobile terminals, forming a brand new network that provides socialized, localized, and mobile services.


6 © 同济大学设计创意学院亚洲生活方式及设计基因实验室

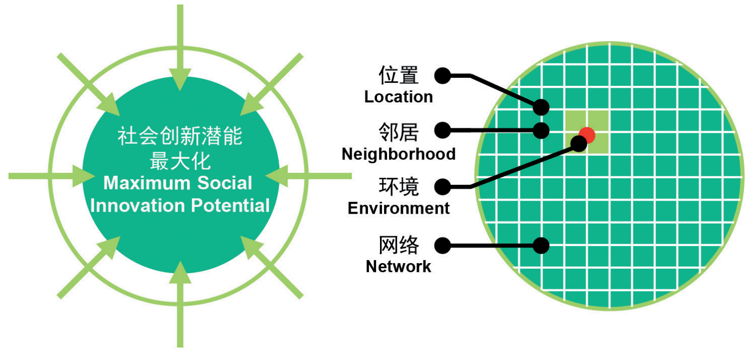

7 © 同济大学设计创意学院亚洲生活方式及设计基因实验室

观，可激发线下养植兴趣社区群落的涌现，重建亲密邻里关系，同时扩展城市人群自主接触、学习、享受和回馈自然的个体及群体交互场景。

以上两个应用程序都依托于SoLoMo智能媒介推动数据众包，使用户由被动的信息接受者变成主动的信息创造者。景观数据的众包采集、分析、智能识别、验证及群体反馈有利于建构个体与群体之间的共同兴趣，提高个人与环境交互的感知、反应、判断及学习能力。游戏化的交互设计重新赋予了地点作为事件发生容器的价值，SoLoMo

upload to this VR platform, and then generate their own virtual succulent gardens, realizing AR / VR gardening and supporting intelligent management scenarios (Fig. 7). This mechanism not only supports the diversity of users’ landscape creation beyond physical limitations, but also offers possibilities for plant enthusiasts to practice on “floral aesthetics.” Aided by the LBS and cloud data collection, Succuland could intelligently generate virtual succulent gardens at community-, city-, and regional-scales, stimulate the emergence of groups with common interests, rebuild neighborhood harmony, and provide individual or group interaction scenes where citizens could get in touch with, learn about, enjoy, and protect the natural environments in cities.

Nature-X and Succuland both rely on SoLoMo and adopt the data crowdsourcing mode, turning the users from passive information receivers toward active information providers. Crowdsourcing collection, analysis, intelligent detection, verification, and group feedback of landscape data are conducive to the emergence of common interests



8 © 曹静，何汀滢，陈筝

无限泛在的特征强化了基于地点的个体愉悦体验、身份认同及数据分享，催生了受众间地理位置、兴趣及行为偏好的自动聚合，将认知增强融入到真实世界人与环境的交往中。物质媒介与虚拟媒介的融合在物质、形式和机制上的分层，会在社会关系网络人际传播交流的过程中渐次产生影响[15]，并成为缔结城市中人与环境集体交互的纽带（图8）。

5 未来展望

人工智能时代的交互技术正从本质上改变人和环境互动的方式，从而深远地改变环境设计学科的发展前景。目前，国内外建筑、规划，以及景观设计研究前沿实验室都相继开展了一系列有关新型交互的探索，以寻求空间规划设计的新机遇。

在传统的计算机辅助设计中，计算机只是设计者解决逻辑问题及实现创意的工具。如今，计算机已经成为设计师的创意伙伴，甚或设计全过程的参与者。随着机器学习的发展，人工智能将拥有更为强大的直觉力，能进行一定的策略性思考（包括对设计需求和意图的理解），且具有强大的计算能力，从而能够独立自主地完成生成式设计。此外，神经反馈数字信号可使设计产品感知现实世界并与设计师产生智能连接，从而帮助设计师更好地进行创作。

具体到景观设计领域，人工智能能够为设计创新提供强大的技术支撑。人工智能具有强大的数据处理能力，能高效、快速地帮助空间设计者把握景观空间的尺度和功能，从而获得更科学合理的设计结果。此外，机器学习、神经网络等技术可以帮助研究者从过去的现象中推演出规律，以预测未来景观的发展方向。

between individuals or groups, improving individuals' sensing, feeding back, assessing, and learning capacities in the interactions with environment. Through such gamification that takes real places as event containers, SoLoMo emphasizes the location-based individual enjoyment, identification, and data sharing, encourages citizens' spontaneous aggregation with common locations, interests, and behavioral preferences, and applies cognitive augmentation into the real human-environment interaction processes. The material, form, and mechanism layers of the integration of the material and virtual agencies would gradually influence interpersonal communication in social network[15] and simulate collective human-environment interaction in cities (Fig. 8).

5 Related Potentials for Future Landscape Design

The interaction technologies in the age of AI is profoundly changing the way how people interact with the exterior environment, and would greatly influence the future development of the disciplines of environmental sciences. A number of efforts on new human-environment interaction have been seen in Architecture, Urban Planning, and Landscape Architecture to seek new explorations on spatial planning and design.

Traditional computer-aided spatial design provides logic aid and helps on creation. Nowadays, intelligent computing contributes to spatial design as a co-designer, or a participant in the entire design process. As the development of Machine Learning, AI will be developed with a stronger intuition and thinking ability (for example, the ability to understand design requirements and intentions), and, of course, its computing capacity will be much more improved, which supports independent automatic design. In addition, the application of digital neuro-feedback signals allows for the emergence of intelligent products that could sense the reality world and be intelligently connected with designers, informing them for better design practices.

Particularly, in the field of Landscape Architecture, design innovation can be wonderfully supported by the advanced technologies of AI. The increasingly stronger computing capacity what AI might have would efficiently help landscape architects understand landscape scales and functions and develop more reasonable designs. Furthermore, technologies like Machine Learning and neuro-networks can help researchers conduct theoretical deduction to predict the future development of landscape design.

可以预见，在未来的10~20年内，人工智能和交互技术将被更广泛地引入建筑及建成环境设计中。人工智能带给我们感官、认知和反馈方面的增强及不断推陈出新的交互方式让我们的环境更加复杂、多样，也更为美丽。新技术支持下的设计模式将成为空间设计学科的研究热潮：建筑与建成环境设计不再是简单机械建造的产物，而是在人与人工智能的配合下，按照社会需要自然生成、衍化的结果。LAF

It can be foreseen that in the next one or two decades, AI will extensively saturate into architectural and environmental design and lead us to a more complicated, diverse, and beautiful world through sensory, cognition, and feedback augmentations. In future, with new technical supports, design patterns and modes would draw more academic attention: architectural and environmental design are no longer a product of mechanical construction, but a spontaneously generated result in the collaboration between humans and AI. LAF

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