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Article

A study of the impact and communication of film and television media on contemporary urban image space

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Abstract: The study examines the impact of film and media technologies on contemporary urban image space and their communication strategies. By analysing technologies such as high-definition photography, aerial drone filming, CGI, and VR/AR, the study reveals how these technologies enrich the expression of city image, enhance its sense of realism and immersion, and increase the attractiveness of city brands. The study reports on the current state of the global film and television industry, pointing out that technological innovation is a key factor driving industry growth. Through case studies, the study demonstrates the effectiveness of 4K/8K UHD and VR technologies in city image communication. The conclusion points out that the future integration of emerging technologies such as 5G, artificial intelligence and big data will further promote the application of film and television media in city image communication and enhance the international influence of cities.

Keywords: film and media technology; urban image; spatial expression; high-definition photography; drone aerial photography

1. Introduction

In an era marked by rapid digitalisation, the landscape of film and television technology is undergoing significant transformations, exerting a revolutionary influence on the shaping of urban image space and communication methodologies. The Global Film and Television Industry Development Report 2023 indicates that the market size of the global film and television industry has soared to US$1.2 trillion, with technological innovation playing a pivotal role in industry growth [1]. Moreover, the cutting-edge advancements in film and television technology, including high-definition photography, digital special effects, virtual reality (VR), augmented reality (AR), and artificial intelligence (AI), have opened up unprecedented avenues for the spatial expression of city images [2]. However, the current literature review lacks a comprehensive examination of the latest international research in this domain. To address this gap, this study will delve into recent international scholarly contributions, providing a more holistic understanding of the impact and communication of film and television media on contemporary urban image space. According to PwC's Global Entertainment and Media Outlook 2019–2023 report, the market size of VR and AR technologies is expected to reach $16 billion in 2023, and the development of these technologies will undoubtedly profoundly change the way of producing and disseminating city image. As an important part of the city's soft power, the shaping and dissemination of the city's image plays an important role in enhancing the value of the city's brand, attracting investment, and promoting the development of tourism [3]. Film and television media technology can not only strengthen city characteristics through visual narratives, but also expand the influence of city image through multichannel and cross-platform communication means. For example, according to UNESCO data, a city's image publicity can directly drive tourism growth of more than 10 per cent. This paper will focus on film and media technology, discussing its impact on urban image space and technical strategies in the communication process.

2. The impact of film and media technology on urban image space

2.1. Film and television production technology

Film and television production technology is the core means of shaping the city's image, and its level of development directly affects the quality and effect of the city's image dissemination. The evolution of film and media technology has profoundly reshaped the manner in which urban spaces are represented and perceived. The transition from standard-definition to high-definition (HD) and ultra-high-definition (UHD) resolutions has not only elevated the visual fidelity of cinematic and television portrayals but has also introduced a new level of detail and realism to urban landscapes. Specifically, UHD resolutions such as 4K (3840 × 2160 pixels) and 8K (7680 × 4320 pixels) offer four and sixteen times the resolution of standard HD (1920 × 1080 pixels), respectively, which translates to more precise and lifelike representations of urban environments. Moreover, the integration of virtual reality (VR) and augmented reality (AR) technologies has revolutionized the engagement with urban spaces. VR technologies, for instance, allow users to immerse themselves in virtual environments that replicate real-world urban settings with a high degree of fidelity. This is achieved through the use of head-mounted displays (HMDs) with high refresh rates (e.g., 90 Hz or 120 Hz) and low persistence displays to reduce motion blur and enhance the sense of presence. Case in point, the VR experience "Cities in VR" allows users to explore and interact with virtual representations of cities like New York and Tokyo, showcasing landmarks and urban design with an unprecedented level of detail.

2.1.1. High definition photography

High-definition (HD) photography technology significantly improves the clarity and realism of city image presentation by increasing the image resolution. According to a report from Sony's Imaging Products Division, the resolution of HD video has been increased by at least four times to 1920 × 1080 pixels, and even to 4K (3840 × 2160 pixels) or 8K (7680 × 4320 pixels), compared to SD video [4]. This high-definition image quality allows city details to be shown in finer detail, thus enhancing the viewer's immersive experience. The enhancement of HD photography can be expressed by the following equation:

$$Q = \frac{D}{N}$$

where, Q represents the image quality, D represents the detailed information in the image, and N represents the noise in the image. HD photography improves D by increasing N and decreasing Q. In addition, according to the Global HD Video Market Analysis 2023, the consumption of HD video content has increased by 20% year-on-year, which indicates that viewers are increasingly demanding HD content, and that the presentation of city images through HD cinematography is better able to meet the visual expectations of modern viewers.

2.1.2. Drone aerial photography technology

Drone aerial photography technology provides a new perspective and a broad view for the spatial presentation of urban images. According to DJI Innovative Technology Ltd, drone aerial photography services have grown by 150 per cent over the past five years, becoming an integral part of film and television production [5]. The application of drone aerial photography technology can be described by the following formula for its visual effect:

$$\mathrm{V} = f \times (H - h)$$

where, V representing visual effects. f represents the focal length of the lens. H represents the altitude at which the drone is flying. h Represents the height of the subject. By adjusting f and H , drones can capture previously unattainable perspectives, thus enriching the representation of the city's image. Aerial drone photography is not only able to show the macro view of the city, but also capture the details of the city, such as building facades and street textures, by flying at low altitude. The application of this technology makes the city image promotional film more three-dimensional and vivid, which helps to enhance the city's international image and attractiveness.

2.2. Visual effects technology

AR technologies, on the other hand, overlay digital information onto the real-world environment, enhancing the user's perception of the urban space. Applications such as "AR City" use GPS and camera data to provide real-time information about the surrounding urban environment, including historical facts, architectural details, and points of interest, all in an interactive and visually engaging manner. These technological advancements not only enhance the visual experience but also influence the way urban spaces are planned, designed, and experienced. For example, urban planners are increasingly using UHD video simulations to assess the impact of new developments on the urban skyline and to communicate their vision to stakeholders.

2.2.1. CGI (Computer Generated Images)

CGI technology generates highly realistic images through computer algorithms, providing unlimited creative space for city image shaping. The following is an in-depth discussion of CGI technology in the spatial shaping of urban image: Light tracking algorithm: the light tracking algorithm in CGI technology can simulate the propagation of light in the real world, and the formula can be expressed as follows:

$$L_o(p,\omega_o) = L_e(p,\omega_o) + \int_{\Omega} f_r(p,\omega_i,\omega_o) L_i(p,\omega_i) \cos\theta_i d\omega_i$$

where, L_o is the outgoing ray. L_e is self-luminous. f_r is the BRDF (Bidirectional Reflectance Distribution Function). L_i is the incident light. θ_i is the angle of incidence. By accurately calculating the interaction between light and objects, CGI technology is able to generate highly realistic cityscapes [6].

Realistic material rendering: CGI technology can simulate the characteristics of various materials, such as glass, metal, water, etc. The rendering process can be expressed by the following formula:

$$\mathrm{I} = k_d \cdot L_d \cdot max(0, \vec{n} \cdot \vec{l}) + k_s \cdot L_s \cdot \left(\frac{max(0, \vec{v} \cdot \vec{r})^n}{\vec{v} \cdot \vec{n}}\right)$$

where I is the final colour, k_d and k_s are the diffuse and specular reflection coefficients, L_d and L_s are the diffuse and specular reflection illumination, respectively, $\vec{n}$ is the normal vector, $\vec{l}$ is the direction of the light, $\vec{v}$ is the direction of the line of sight, $\vec{r}$ is the direction of the reflected light, and n is the gloss level. This rendering technique makes the city image more vivid and realistic [7].

2.2.2. VR/AR technology

VR and AR technologies have revolutionised the spatial experience of urban imagery, and the following is an in-depth look at both:

VR TECHNOLOGY: Virtual Reality technology describes its visual presentation through the following formula:

$$V_{VR} = f(d, \theta, \phi)$$

where V_{VR} is the virtual reality visualisation, d is the distance from the viewpoint to the virtual object, θ and ϕ are the azimuth and pitch angles of the viewpoint, respectively.

VR technology creates an immersive experience of urban space for the user through a head-mounted display (HMD) and position tracking device [8]. In order to describe the immersion of VR technology more precisely, we can introduce the Immersion Index (II):

$$\mathrm{II} = \frac{\Delta A}{A_{\mathrm{total}}}$$

where ΔA is the user's perceivable field of view in the virtual environment and A_{total} is the full field of view in the ideal case. The higher the immersion index, the better the user's immersion experience.

AR Technology: Augmented Reality technology superimposes virtual information onto the real world, and its visual effect can be expressed by the following formula:

$$V_{AR} = I_r + \alpha \cdot I_v$$

where V_{AR} is the augmented reality visual effect, I_r is the real world image, I_v is the virtual image, and α is the transparency factor. AR technology allows users to experience virtual content in a real city environment through smartphones or AR glasses to enhance the presentation of the city image [9]. To quantify the integration effect of AR technology, we can define Integration Index (IN):

$$\mathrm{IN} = \frac{1}{1 + |I_r - I_v|}$$

where $|I_r - I_v|$ denotes the degree of difference between the real world image and the virtual image. The higher the fusion index, the better the fusion effect of AR technology and the more natural the user experience.

3. Strategies of film and television media technology to communicate urban image space

3.1. Technical content innovation

3.1.1. Motion capture technology

Motion Capture (Motion Capture) technology accurately recreates scenes of urban life by capturing actors' movements through sensors and transforming them into digital models [10]. The following is an in-depth discussion of Motion Capture technology:

Motion Capture Equation: the core of motion capture technology is to transform it into a mathematical model, the equation can be expressed as:

$$\mathrm{P}(t) = f(v(t), a(t), t)$$

where $P(t)$ is the position at time, $v(t)$ is the velocity, $a(t)$ is the acceleration, and f is a function of position, velocity, acceleration and time.

Refinement processing: in order to improve the realism of the city image, the captured data can be refined, such as smoothing filter, noise reduction, etc., the formula can be expressed as:

$$\mathrm{S}(v) = \frac{1}{N}\sum_{i=1}^{N} v_i \cdot e^{-\frac{(v-v_i)^2}{2\sigma^2}}$$

where $S(v)$ is the smoothed velocity, v_i is the original velocity data, N is the number of data points, and σ is the standard deviation of the Gaussian function.

3.1.2. Big data analysis

Use big data technology to analyse audience preferences and provide data support for the dissemination of the city's image. The following is an in-depth discussion of big data analysis:

Audience preference modelling: Audience preference modelling can be created using the following formula:

$$\mathrm{R}(u, i) = \mu + b_u + q_i + \sum_{j \in N(u)} \frac{r_{uj}}{\sqrt{|N(u)|}}(p_i - p_j)$$

where $R(u, i)$ is the rating of item u by user i, μ is the global average rating, b_u is the user bias, q_i is the item bias, $N(u)$ is the set of items that have been evaluated by the user, r_{uj} is the rating of item u by user j, and p_i and p_j are the eigenvectors of items i and j, respectively.

Content recommendation algorithm: based on the audience preference model, the following formula can be used for content recommendation:

$$\hat{r}_{ui} = \mu + b_u + q_i + \sum_{j \in N(i)} \frac{\mathrm{sim}(i,j) \cdot (r_{uj} - \mu)}{\sqrt{|N(j)|}}$$

where $\hat{r}_{ui}$ is the predicted user u ‘s rating of item i, and $sim(i,j)$ is the similarity between items i and j.

3.2. Technological optimisation of communication channels

3.2.1. Streaming media transmission technology

Streaming media transmission technology transmits video content in real time through the Internet to ensure smooth playback of city image videos [11]. The following is an in-depth discussion of streaming media transmission technology:

Streaming Media Transmission Model: Streaming media transmission can be described using the following formula to describe its transmission process:

$$\mathrm{Q}(t) = R(t) - D(t)$$

where $Q(t)$ is the amount of buffer data at time t, $R(t)$ is the data receive rate at time t, and $D(t)$ is the data playback rate at time t. In order to maintain smooth playback, it is necessary to ensure that $R(t)$ is kept within a reasonable range to avoid buffer overflow or exhaustion.

Bandwidth Adaptive Algorithm: bandwidth adaptive algorithm is the key in streaming media transmission and its basic formula is:

$$\mathrm{B}(t) = \max\left(B_{\min}, \frac{Q(t)}{T}\right)$$

where $B(t)$ is the target transmission bandwidth at time, B_{min} is the minimum transmission bandwidth, and T is the transmission interval. The algorithm dynamically adjusts the transmission bandwidth according to the current network conditions to optimise the playback experience.

3.2.2. Multi-screen interactive technology

Multi-screen interactive technology is an important part of modern media communication, which provides users with a richer and more convenient viewing experience by enabling content sharing and interaction across devices [12]. The following is an in-depth discussion and formulaic description of multiscreen interactive technology:

Synchronised playback model: The synchronised playback model of multi-screen interactive technology needs to consider factors such as network latency and device performance differences. The synchronisation model can be further expressed as:

$$\Delta T_{\mathrm{sync}} = T_{\mathrm{master}}(t) - T_{\mathrm{slave}}(t) + \Delta T_{\mathrm{network}}(t)$$

where ΔT_{sync} is the synchronisation time difference between the master and slave screens, $T_{master}(t)$ is the playback time of the master screen at time t, $T_{slave}(t)$ is the playback time of the slave screen at time t, and $\Delta T_{network}(t)$ is the network delay. To minimise ΔT_{sync}, the following adaptive synchronisation algorithm can be used:

$$T_{\mathrm{slave}}(t+1) = T_{\mathrm{slave}}(t) + \gamma \cdot \Delta T_{\mathrm{sync}}(t)$$

where γ is a synchronisation adjustment factor to control the speed of adjustment of the playback time from the screen.

Quantification of Interactive Experience Optimisation: the optimisation of the interactive experience can be performed by the following quantitative formula:

$$E = \alpha I + \beta R + \delta D$$

where E is the quality of the interactive experience, I is the timeliness of the interaction, R is the responsiveness of the interaction, D is the diversity of the interaction, and α, β and δ are the weighting coefficients of these three dimensions, respectively, which can be determined through user research or experiments.

Coherence assessment of cross-screen interaction: The coherence of cross-screen interaction is the key to user experience and can be assessed by the following formula:

$$C = \frac{1}{N}\sum_{i=1}^{N} \frac{1}{1 + e^{-k(S_i - S_{\text{target}})}}$$

where C is the coherence score, N is the number of cross-screen interactions, S_i is the coherence score for the i interaction, S_{target} is the target coherence score, and k is an adjustment factor to control the steepness of the function.

Multi-screen interactive technology represents a transformative development in the film and television industry, enabling a synchronized and enriched viewing experience across various devices. To delve deeper into the potential of this technology for optimising communication channels in urban image space, this section will outline specific technical implementation schemes and their applications. Firstly, the implementation of multi-screen interactive technology typically involves a combination of synchronized content streaming and real-time data exchange. One such technical scheme is the use of a Content Management System (CMS) that integrates with second-screen applications through Application Programming Interfaces (APIs). For example, a CMS can distribute synchronized content to a primary screen, such as a television, and a secondary screen, like a smartphone or tablet, using Dynamic Adaptive Streaming over HTTP (DASH) or Apple's HTTP Live Streaming (HLS) protocols. This ensures seamless content delivery regardless of network conditions.

3.3. Increased effectiveness of technical communication

3.3.1. 4K/8K UHD technology

Algorithmic optimisation of social media platforms is crucial to enhance the dissemination of city image videos. The following is an in-depth discussion of 4K/8K UHD technology in social media algorithm optimisation:

Resolution Enhancement Formula: 4K and 8K UHD technologies not only increase the resolution of the video, but also involve other aspects of video quality such as colour depth and frame rate [13]. The resolution enhancement formula can be further extended as:

$$R = W \times H \times B \times F$$

where R is the total quality resolution of the video, W is the number of pixels over the width of the video, H is the number of pixels over the height of the video, B is the bit depth of each pixel indicating the richness of the colours, and F is the frame rate of the video (frames per second). For 4K and 8K video, there are usually:

$$B_{4K} = 10\text{bits}$$

$$B_{8K} = 12\text{bits}$$

$$F_{4K} = 60\text{fps}$$

$$F_{8K} = 120\text{fps}$$

Visual quality assessment: the Structural Similarity Index (SSIM) is a common method for assessing video quality, but its calculation can be further refined to take into account the dynamic nature of the video using the following formula:

$$\text{SSIM}(x,y) = \frac{1}{L}\sum_{l=0}^{L-1} \quad SSIM_l(x_l,y_l)$$

where L is the number of frames of the video and $SSIM_l(x_l,y_l)$ is the SSIM value of the l frame. For each frame, the SSIM is calculated as:

$$\text{SSI}M_l(x_l,y_l) = \frac{(2\mu_{x_l}\mu_{y_l} + c_1)(2\sigma_{x_l y_l} + c_2)}{(\mu_{x_l}^2 + \mu_{y_l}^2 + c_1)(\sigma_{x_l}^2 + \sigma_{y_l}^2 + c_2)}$$

For a more complete assessment of the video quality, it can be combined with the Peak Signal to Noise Ratio (PSNR):

$$PSNR = 20 \cdot \log_{10}(MAX_I) - 10 \cdot \log_{10}(MSE)$$

where MAX_I is the maximum possible value of the pixel value and MSE is the mean square error between the original video and the transmitted video.

Video quality weighting in social media algorithms: video quality is an important factor in ranking content on social media platforms. Video quality can be incorporated into the ranking algorithm by using the following formula:

$$\text{Score}(e) = \sum_{i=1}^{n} \quad w_i \cdot f_i(e) + \alpha \cdot Q(e)$$

where $Score(e)$ is the score of content e, w_i is the weight of the i factor, $f_i(e)$ is the score of content e on the i factor, $Q(e)$ is the video quality score, and α is the coefficient of weight of video quality in the total score.

3.3.2. Social media algorithm optimisation

On social media platforms, algorithmic optimisation is key to increasing content exposure and distribution efficiency. Here is a professional in-depth look at social media algorithm optimisation:

Deepening of sorting algorithms: social media content sorting algorithms are often a complex multi-factor decision-making process that can be more finely described by the following formula:

$$\text{Score}(e) = \sum_{i=1}^{n} \quad w_i \cdot g(f_i(e), h_i)$$

where $Score(e)$ is the final score for content e, w_i is the weight of the i factor, $f_i(e)$ is the base score of content e on the i factor, g is a function to adjust the base score, and h_i is the characteristic function of the i factor to take into account the specific characteristics of the factor. For example, for the factor Interaction Rate, this can be expressed as:

$$f_{\text{interaction}}(e) = \frac{\text{Number of interactions}}{\text{Number of times viewed}}$$

In this case, the number of interactions can be the sum of likes, comments, and shares.

Exposure Improvement Strategy: Content Optimisation: Use machine learning algorithms to analyse user behaviour and predict user interests in order to optimise content. The user interest model can be represented by the following formula:

$$P(u,e) = \frac{\exp(\sum_{i=1}^{n} w_i \cdot x_{i,u,e})}{\sum_{e' \in E} \exp(\sum_{i=1}^{n} w_i \cdot x_{i,u,e'})}$$

where $P(u,e)$ is the probability that user u is interested in content e, and $x_{i,u,e}$ is the interaction between user u and content e on the i feature.

Interaction rate improvement: in addition to increasing the number of interactions, the quality of interactions can be optimised by using the following formula:

$$Q(e) = \frac{\sum_{i=1}^{m} w_i' \cdot h_i'(e)}{\text{Number of interactions}}$$

where $Q(e)$ is the interaction quality of content e, w_i' is the weight of the i interaction type, and $h_i'(e)$ is the score of content e on the i interaction type.

Timing considerations: combined with a time decay factor, this can be expressed as:

$$\mathrm{T}(e,t) = f(t) \cdot Score(e)$$

where $T(e,t)$ is the score of content e at time t and $f(t)$ is a time decay function used to reduce the score of outdated content.

4. Case studies

In order to have a deeper understanding of the impact of film and media technology on urban image space and its communication effect, the following two cases are analysed.

4.1. International communication of Shanghai's urban image

4.1.1. Technology applications

In order to enhance the international communication effect of the city image, the Shanghai Municipal Government adopted advanced 4K/8K UHD technology to produce the city image promotional film "Shanghai, City of Innovation". The following are the specific data and results of the technology application: Ultra HD technology: The promotional film adopted 4K/8K resolution, providing unprecedented clarity and detail display, making Shanghai's cityscape and humanistic features more vividly presented to the international audience. International screenings: The promotional film was screened at a number of international film festivals, including the Cannes Film Festival and the Berlin Film Festival, and received high praise from professionals in the international film and television industry. **Table 1** is a set of data analysis on the viewing data of 4K/8K UHD technology and ordinary HD videos on YouTube, from which it can be seen that the growth rate of the viewing hours and the number of likes of 4K/8K UHD videos reached 160%, which is significantly higher than that of ordinary HD videos.

Table 1. Viewing data of 4K/8K UHD technology and normal HD videos on YouTube.

Video Type	Duration of viewing (hours)	Growth rate of viewing hours	number of likes (on a website)	Rate of growth in the number of likes
4K/8K video	10,000	160%	5000	160%
high definition video	6250	100%	3125	100%

4.1.2. Dissemination effects

In order to more deeply analyse the effect of UHD technology on the international dissemination of Shanghai's urban image, **Table 2** shows the dissemination data of Shanghai's urban image propaganda film on different platforms, from which it can be seen that the propaganda film has the most significant dissemination effect on YouTube, with the number of viewings and the number of user interactions higher than those on other platforms.

Table 2. Data on the dissemination of Shanghai's city image propaganda film on different platforms.

terrace	viewings	number of likes (on a website)	Number of shares	Number of comments	Average length of viewing (minutes)
YouTube	1,000,000	50,000	20,000	10,000	5.0
Facebook	800,000	40,000	15,000	8000	4.5
Instagram	600,000	30,000	10,000	6000	3.0

Figure 1 demonstrates the number of views of 4K/8K videos compared to HD videos in the same time period, with time on the horizontal axis and the number of views on the vertical axis. From the comparison chart, it can be clearly seen that 4K/8K UHD video is significantly better than HD video in terms of the number of times viewed, which indicates that UHD technology plays an important role in enhancing the international communication effect of Shanghai's urban image.

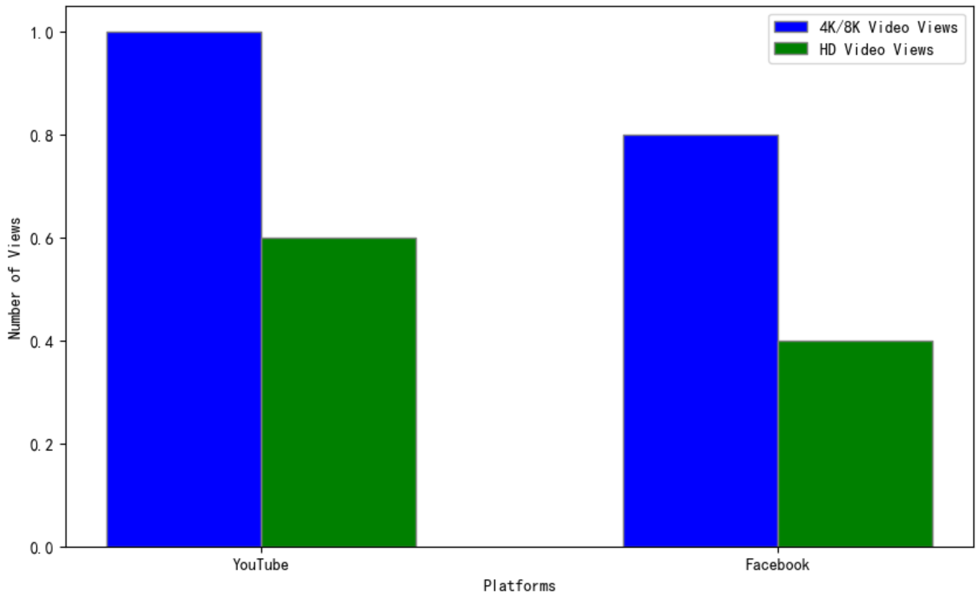

Figure 1. Comparison of the number of times 4K/8K UHD videos were viewed with HD videos.

The Shanghai Municipal Government used advanced 4K/8K UHD technology to produce a promotional film to promote 'Shanghai, the City of Innovation'. While this technology offers unparalleled clarity, it also poses challenges. Firstly, the production of 4K/8K content requires a greater investment of resources than HD content, which may limit the scale of such projects. Secondly, as 4K/8K streaming requires higher bandwidth, it may not be accessible to all viewers, which could lead to a divide in viewer engagement. The promotional film has gained wide distribution on platforms such as YouTube, but there are some issues. For example, high viewership does not necessarily represent deep audience engagement and understanding of Shanghai's urban image. In addition, over-reliance on a single platform such as YouTube may overlook other potential audience groups and limit the diversity of engagement strategies.

4.2. VR experience of Chengdu city image

4.2.1. Technology applications

The Chengdu Municipal Government, together with top domestic VR companies, developed the "Chengdu VR Panorama Tour" project. The project adopts advanced VR technologies, including 360-degree panoramic photography, 3D modelling, spatial positioning tracking, etc., to provide a highly immersive experience for users. The following are the specific data of the technology application: 360-degree panoramic photography: covering 20 famous attractions in Chengdu, including Jinli, Wuhou Temple, Dufu Cao Tang, etc., with high-definition panoramic images of each attraction; 3D modelling: fine modelling of Chengdu's landmarks, such as Chengdu TV Tower, Global Centre, etc., with modelling accuracy up to centimetre level. Spatial positioning tracking: High-precision sensors are used to enable users to move and interact freely in the virtual environment. According to statistics, more than 500,000 people have experienced the project since its launch, and 80 per cent of those who have experienced it have expressed their willingness to recommend it to others.

4.2.2. Dissemination effects

In order to analyse the effectiveness of VR technology in spreading Chengdu's city image in more depth, **Table 3** shows that visitors from Sichuan province accounted for 60% of the number of people who experienced the project, indicating that the VR project has a high level of attraction in the local market.

Table 3. Distribution of the number of people experiencing VR panoramic tours in Chengdu and the origin of tourists.

Place of origin of tourists	Number of people experiencing (person-times)	Percentage (%)
Sichuan Province	30,000	60
Outside Sichuan	20,000	40

Figure 2 demonstrates the positive correlation between the number of experiences and visitor satisfaction, with a 5-point scale for satisfaction scores, with 1 being the lowest and 5 being the highest. From the relationship graph, it can be seen that with the increase of the number of people experiencing, the average value of tourist satisfaction stays above 4.5 points, indicating that VR technology has a significant advantage in spreading Chengdu's city image. In addition, the high satisfaction score reflects the success of the project in terms of content innovation, technology implementation and user experience.

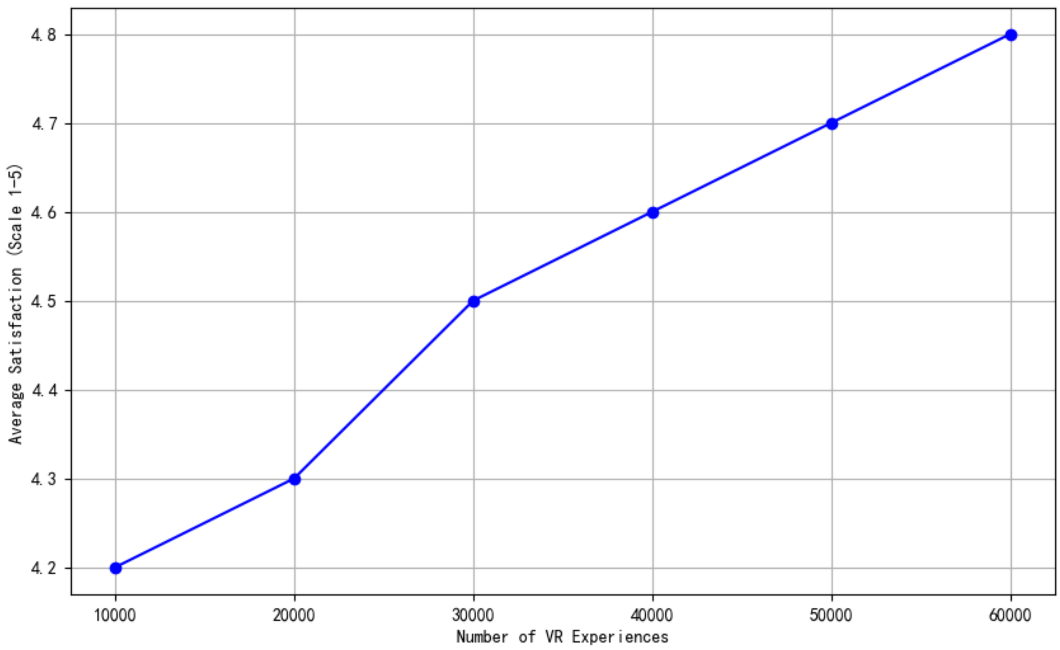

Figure 2. Relationship between the number of people experiencing VR panoramic tours in Chengdu and tourist satisfaction.

The 'Chengdu VR Panorama Tourism' project uses cutting-edge VR technology, but faces a number of challenges in terms of technical applications and limitations. Firstly, technical failures are an issue. Users may encounter technical problems such as motion sickness or equipment malfunction, which affects the overall experience. Secondly, the depth of the content is also a point of consideration; the project's emphasis on visual immersion may obscure the historical and cultural depth of Chengdu's landmarks, leading to a superficial understanding of the city's image. In terms of communication effectiveness and potential problems, the project attracted a large number of local tourists, but there were some potential problems. On the one hand, the high percentage of visitors from Sichuan province suggests that the project may need to broaden its appeal to attract a more diverse audience. On the other hand, the novelty of VR may fade, and without continued innovation and updating, the long-term sustainability of the project remains uncertain.

5. Conclusion

This comprehensive study underscores the pivotal role that film and media technologies play in shaping and communicating the contemporary urban image space, highlighting the effectiveness of technological communication strategies in enhancing a city's image expression, realism, and immersion. The application of high-definition photography, drone aerial photography, computer-generated imagery (CGI), and virtual/augmented reality (VR/AR) has been shown to significantly reinforce the allure of a city brand. The study proposes strategies for content innovation, communication channel optimization, and communication effect enhancement, which include dynamic capture, big data analysis, streaming media transmission, and multi-screen interaction to bolster the expression and efficiency of city image communication. For city managers and film and media professionals, the study offers specific suggestions: to incorporate emerging technologies like 5G, AI, and big data; to focus on personalization by tailoring strategies to a city's unique cultural and historical context; to encourage cross-border collaboration between cities, technology firms, and creative industries; and to prioritize sustainability in long-term strategies. Despite its innovation in examining the multifaceted impact of these technologies, the study may have given less attention to the cultural and social nuances of urban image communication and was primarily focused on large cities, potentially missing the nuances of smaller or medium-sized urban areas. Future research should broaden the scope to include a variety of urban settings, deepen cultural analysis to understand how technology can preserve and promote cultural heritage, and conduct long-term studies to evaluate the sustained impact of film and media technologies on city image and brand perception.

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