





Application Research and Implementation of VR in the Integration of Culture and Tourism Under the Background of Smart City Internet of Things

Cong Ye^{1*} and Caiyuan Kuang²

¹Art College, Jingling Institute of Technology, Nanjing, Jiangsu, 211169, China
Yc05043@163.com, CaiyuanK2222@aliyun.com
 Corresponding author: Cong Ye, Yc05043@163.com

Abstract: In order to improve the effect of cultural and tourism fusion, this paper proposes a multi-sensor information fusion model of the intelligent cultural and tourism fusion positioning system, and establishes a cultural and tourism fusion pose system and system models of various sensors. Moreover, this paper conducts a simple research and analysis on the KF and EKF algorithms, and realizes the fusion of intelligent cultural and tourism fusion information in the scenic spot through the EKF filter, thereby making up for the shortcomings of the cumulative error of a single sensor in the positioning and navigation of cultural and tourism fusion. In addition, this paper proves the effect of EKF fusion filtering through simulation experiments, which can improve the accuracy of intelligent cultural tourism fusion in the positioning of scenic spots. The test evaluation shows that the application effect of VR in the integration of culture and tourism under the background of the smart city Internet of Things is very obvious, which can effectively promote the development of the integration of culture and tourism.

Keywords: application research and implementation of VR in the integration of culture and tourism under the background of smart city Internet of Things.

DOI: <https://doi.org/10.14733/cadaps.2023.S14.16-32>

1 INTRODUCTION

In the era of low-carbon economy, the two major industries of culture and tourism have gradually become the priority industries of major countries in the world. The integration of the two major industries of culture and tourism, as a new model of the tertiary industry that my country vigorously supports and develops, has brought a new round of opportunities to the development of the cultural and tourism industries, and is of great importance to promoting the development, upgrading and structural transformation of the entire national economy. significance. In the report of the 19th National Congress of the Communist Party of China, Comrade Xi Jinping emphasized: "Culture is the soul of a country and a nation. Culture rejuvenates the country, and culture strengthens the nation. Without a high degree of cultural self-confidence and without cultural prosperity, there will be no great rejuvenation of the Chinese nation.

If the culture is raised to a deeper level, the city will certainly occupy an absolute advantage in development, so the culture of a city is particularly important, and tourism can be perfectly combined with culture, making the integration of culture and tourism an important means of urban renewal and development. The integration of culture and tourism can well solve the problems of regional culture and image symbols, and can further solve the industrial vitality, so that regional culture shows new charm [4]. The integrated development of the cultural industry and tourism industry makes the cultural industry more dynamic and the tourism industry more attractive, both achieving mutual benefit and win-win results. In the case of the gradual saturation of the traditional sightseeing tourism market, the development of cultural tourism integration mode is undoubtedly a blue ocean. The excavation of regional culture can bring better benefits to the tourism industry. The development of tourism industry will also inject new blood into the inheritance of regional culture. Culture improves the quality of tourism and tourism promotes the wide spread of culture [13]. To develop tourism with the concept of culture, we should pay more attention to the role of tourism in promoting cultural development besides the economic benefits of tourism on the basis of existing industrial functions. Use tourism to spread culture, let more cultural resources and cultural derivatives play a role, and promote the transformation of tourism industry from "ticket economy" to "industrial economy", so as to improve the influence of regional culture [16].

The regional cultural and creative brands of tourist destinations are increasingly inseparable from the excavation of regional culture, and have become an important means to retain tourism consumers. The process of tourism is a process of experience, so rich regional cultural experience has become the most important support for the development of regional cultural and creative brands outside the natural scenery. Regional culture is the soul of regional cultural and creative brands, and regional cultural and creative brands become the carrier of regional culture [2]. The development of regional cultural and creative brands has been continuously promoted. On the basis of local regional cultural characteristics, cities have been constantly developing and mining cultural tourism industry projects with local characteristics, which has promoted the development of various industries in the city, but also brought good economic benefits. It has also achieved the return of urban regional culture, and has taken a successful step in the development of cultural tourism industry [8]. However, today's cultural tourism industry still has a variety of problems. Cultural tourism brand derivatives have a single form, and they do not deeply explore their own cultural connotation and blindly copy and imitate. Many tourism derivatives on the market have no branding and scattered sales, which can not convey the unique regional culture to consumers. At the same time, the prosperity and prosperity of cultural tourism industry is a rare and challenging opportunity for both cultural industry and tourism industry. Therefore, based on this background, the development of cultural and tourism integration must pay attention to the spread of regional cultural and creative brands [15].

The methods of cultural creativity include thinking creativity, discovery creativity, analysis creativity, collaboration creativity and classified practice creativity. Among them, the method of thinking and creativity is one of the most important contents, which can stimulate the wisdom and imagination of designers. The creative method of discovery is the way to obtain creative methods through continuous discovery. The analysis creativity method is to apply the regional culture to the brand visual image design. The collaborative creativity method requires the creative person's active thinking. Through the cooperative investigation, the creative person can fully understand the regional culture, thus generating the spark of creativity. The classified practice method refers to adopting different cultural creative methods according to different brands and audiences [5]. The method of cultural creativity also includes the thinking training of cultural creativity theme. The thinking of creative theme is like the drug introduction in medicine. With it, the disease can be cured, but without it, success is imminent. The method of cultural creativity can be flexibly changed, depending on the choice of cultural creativity theme. Cultural creativity is an important choice that depends on the visual image of regional cultural and creative brands. A good cultural creativity should consider not only "novelty" and "trend", but also the acceptance of cultural tourism industry and the spiritual

needs of tourism consumers [11]. At the same time, cultural creativity leads the development of the industry. Using cultural creativity to design brand visual images, develop their own markets, and use unique cultural resources can not only create huge economic benefits, but also drive the development of related industries, and truly realize the optimization, upgrading and transformation of the industrial structure [12]

The brand conveys "value information" to the social environment and the market public. From brand construction to brand communication, the brand visual image is first contacted by consumers. Brand image is a comprehensive and systematic system, which shows its brand personality and brand culture by means of visual communication. Brand visual image is a part of the brand image in the brand system and an important part of the brand [14]. The brand visual image mainly consists of two parts: basic element design and application element design. The basic elements include logo, standard characters, standard colors, symbolic auxiliary graphics and other designs. The application elements include poster, packaging, brand derivatives and other designs. The unique spirit, concept and connotation contained in the brand can be expressed by visual communication through the brand visual image, so that the audience can accurately grasp the core spirit connotation in the brand image in the shortest time, so as to achieve the effectiveness of information transmission and promotion [10]. The same is true of the visual image of regional cultural and creative brands in the context of cultural and tourism integration. It can directly and quickly express the unique history, regional culture, natural resources, brand image positioning and other information contained in regional brands to distinguish them from other regional brands [18].

As we all know, vision is the most responsive organ of all senses. People get most of the information about the surrounding environment from vision. Consumers interpret the brand value through the brand visual image. At the same time of brand visual image communication and experience, the "language function" of brand visual image plays the role of visual imagination and forms "visual consumption" [9]. Excellent visual image can help to improve brand image and brand value, while a failed brand visual image will certainly bring negative impacts on brand image and value. The regional cultural and creative brands want to grasp the psychological needs of consumers, and spread the unique regional culture through the brand with the help of external visual expression, so as to attract more attention of tourism consumers. In the context of cultural and tourism integration, through the visual image design of regional cultural and creative brands, the unique cultural connotation, historical tradition, folk customs, architectural features, food, natural landscape and other elements of a city can be refined by design methods to form a unique visual symbol. Through the visual image display of cultural and creative brands, the regional cultural attraction can be improved, the local economic income can be increased, and the integration of industries can be promoted, Give cultural creativity to the cultural industry and tourism industry, and promote the inheritance and innovative development of regional culture [3].

The integration of cultural creativity and brand visual image design is like the integration of the external image and internal spirit of a brand. Brand visual image is an extremely important key element for a brand. Integrated brand visual image plays a vital role in the success of a brand [6]. For the brand visual image design, the added value of cultural creativity plays a guiding role in the brand visual image design, provides sufficient creativity for the brand visual image to blend deep feelings, and promotes the brand visual image design to be more meaningful. As the most intuitive visual experience of the brand, the brand visual image must be creatively designed based on the regional culture in its formation and design process, so as to achieve the integration and unity of material form and spiritual form [1]. In addition, the visual image of cultural and creative brands with regional culture is conducive to the material and psychological satisfaction of consumers. Those brand visual images with unique regional culture and creativity can make the brand better touch consumers' consumption demand and consumption psychology, and promote consumers to have cultural identity and emotional attachment to the brand [7]

This paper analyzes the application research and implementation of VR in the integration of culture and tourism under the background of the Internet of Things in smart cities, so as to improve the effect of cultural and tourism integration.

2 MULTI-SENSOR INFORMATION FUSION OF INTELLIGENT CULTURAL AND TOURISM FUSION

2.1 Positioning System Based On Hybrid Information Fusion

Most of the traditional intelligent cultural and tourism integrated positioning systems use a single sensor information as the basis to calculate their own position on the map. However, this positioning method using a single sensor is prone to problems such as observation error and accumulated error. Moreover, once these problems occur, the continuous positioning of cultural and tourism integration will fail. Therefore, this system will fuse the data information of the internal sensors used to monitor its own state information and the external sensors used to monitor the environment in the scenic spot through intelligent cultural and tourism fusion. The positioning of the system is realized through this hybrid data fusion method, and the structure diagram is shown in Figure 1.

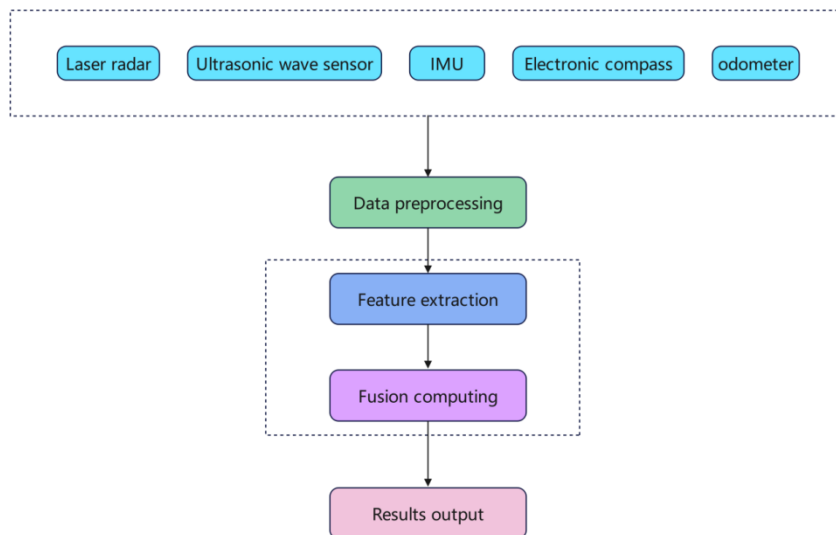


Figure 1: Block diagram of the information fusion structure of the positioning system.

A number of relatively independent sensors are installed on the intelligent cultural and tourism fusion experimental platform. The information acquisition board preprocesses the data acquisition information of the electronic compass, inertial measurement unit, odometer and the observation information of laser and ultrasonic sensors and sends it to the main controller. The main controller fuses these data to obtain the consistent observation of the positioning information of the cultural and tourism fusion system. Through data fusion processing of the observation information of the laser sensor and the ultrasonic sensor, the obstacle information and local environment map information required by the cultural and tourism fusion in the path planning process can be obtained.

2.2 Kalman Filtering

Kalman filtering is the basis of extended Kalman filtering, so before introducing EKF, we must first conduct a simple analysis of the KF filtering algorithm. The system equation of the intelligent cultural and tourism fusion robot can be expressed as:

$$\begin{cases} X(k+1) = \Phi X(k) + \Gamma U(k) \\ Z(k) = HX(k) + V(k) \end{cases} \quad (1)$$

Therefore, the one-step state estimation equation in KF is:

$$\hat{X}(k+1/k) = \Phi(k)\hat{X}(k/k) + \Gamma(k)U(k) \quad (2)$$

The error equation for one-step state estimation is:

$$\tilde{X}(k+1/k) = \Phi(k)\tilde{X}(k/k) + G(k)W(k) \quad (3)$$

The one-step covariance of the state estimate is:

$$P(k+1/k) = \Phi(k)P(k/k)\Phi^T(k) + G(k)Q(k)G^T(k) \quad (4)$$

Therefore, the predicted measurement vector of the system is:

$$\hat{Z}(k+1/k) = H(k+1)\hat{X}(k+1/k) \quad (5)$$

The prediction error of the measurement vector is:

$$\Delta = Z(k+1) - H(k+1)\hat{X}(k+1/k) \quad (6)$$

Therefore, the measured prediction error covariance is:

$$S(k+1) = H(k+1)P(k+1/k)H^T(k+1) + R(k+1) \quad (7)$$

The filter gain of KF is:

$$K(k+1) = \frac{P(k+1/k)H^T(k+1)}{H(k+1)P(k+1/k)H^T(k+1) + R(k+1)} \quad (8)$$

Then the state update equation of the KF algorithm is:

$$\begin{aligned} \hat{X}(k+1/k+1) &= [\hat{X}(k+1/k) + K(k+1)]Z(k+1) - H(k+1)\hat{X}(k+1/k) \\ &= \hat{X}(k+1/k) + K(k+1)\Delta \end{aligned} \quad (9)$$

Then the error covariance of the KF filter is:

$$P(k+1/k+1) = [I - K(k+1)H(k+1)]P(k+1/k) \quad (10)$$

2.3 Extended Kalman Filtering

Compared with the Kalman filter algorithm, the extended Kalman filter algorithm is more practical in the practical engineering field with nonlinearity. The reason is that KF is only suitable for linear Gaussian systems, and if it is applied to nonlinear systems, it will produce larger errors. The EKF is obtained by the first-order Taylor expansion of the nonlinear function, which realizes the filtering target tracking.

$$\begin{cases} X(k+1) = f[k, X(k)] + G(k)W(k) \\ Z(k) = h[k, X(k)] + V(k) \end{cases} \quad (11)$$

$P(0/0)$ is the covariance matrix, $\hat{X}(0/0)$ is the initial state estimation of the system, and the state transition matrix $\Phi(k+1/k)$ and measurement matrix $H(k+1)$ are replaced by Jacobian matrices of f and h , respectively.

Therefore, the state estimation equation in EKF is:

$$X(k+1) = f(\hat{X}(k/k)) \quad (12)$$

The EKF covariance is estimated as:

$$\begin{aligned} P(k+1/k) &= \Phi(k+1/k)P(k/k)\Phi^T \\ &\times (k+1/k) + Q(k+1) \end{aligned} \quad (13)$$

The EKF gain is:

$$\begin{aligned} P(k+1) &= P(k+1/k)H^T(k+1) \\ &\times [H(k+1)P(k+1/k)H^T(k+1) + R(k+1)]^{-1} \end{aligned} \quad (14)$$

The EKF state update equation can be expressed as:

$$\begin{aligned} \hat{X}(k+1/k+1) &= \hat{X}(k+1/k) + K(k+1) \\ &\times [Z(k+1) - h(\hat{X}(k+1/k))] \end{aligned} \quad (15)$$

The EKF covariance matrix update variance can be expressed as:

$$p(k+1) = [I - K(k+1)H(k+1)]P(k+1|k) \quad (16)$$

2.4 Indoor Positioning Model Based on EKF

The driving mode of the navigation vehicle for intelligent cultural and tourism integration designed in this paper is dual rear wheel differential drive, so the motion process model of cultural and tourism integration can be simplified as shown in Figure 2

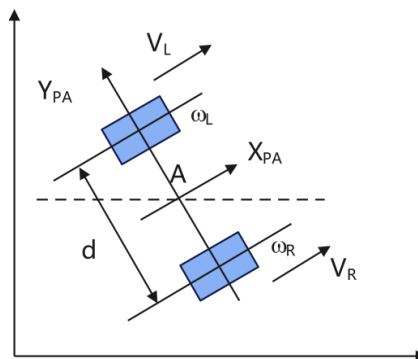


Figure 2: Simplified model of intelligent cultural and tourism integration.

As shown in the figure, the center of mass in the intelligent cultural and tourism fusion is point A. At this time, the position information and attitude information of the cultural and tourism fusion can be expressed as $[x_A, y_A, \theta]^T$, and θ is the heading angle of the cultural and tourism fusion. The radius of the left and right wheels of the cultural and tourism fusion is r , and the rotational angular velocities are ω_L and ω_R respectively, then the kinematics equation of the cultural and tourism fusion can be obtained as:

$$\begin{cases} x_A = r/2(\omega_L + \omega_R)\cos\theta \\ y_A = r/2(\omega_L + \omega_R)\sin\theta \\ \theta = r/d(\omega_R - \omega_L) \end{cases} \quad (17)$$

The kinematics model of the integration of culture and tourism can be described as:

$$\begin{bmatrix} x_A \\ y_A \\ \theta \end{bmatrix} = \begin{bmatrix} r/2\cos\theta & r/2\cos\theta \\ r/2\sin\theta & r/2\sin\theta \\ -r/d & r/d \end{bmatrix} \begin{bmatrix} \omega_L \\ \omega_R \end{bmatrix} \quad (18)$$

From the above formula (18), the calculated positioning formula based on the kinematic model of the cultural tourism fusion can be obtained as:

$$\begin{cases} x_{i+1} = x_i + r/2\cos\theta_i \int_{t_i}^{t_{i+1}} (\omega_L(t) + \omega_R(t)) dt \\ y_{i+1} = y_i + r/2\sin\theta_i \int_{t_i}^{t_{i+1}} (\omega_L(t) + \omega_R(t)) dt \\ \theta_{i+1} = \theta_i + r/d \int_{t_i}^{t_{i+1}} (\omega_R(t) - \omega_L(t)) dt \end{cases} \quad (19)$$

By discretizing the above formula (19), the state equation of cultural tourism fusion can be obtained as:

$$X(k+1) = \begin{bmatrix} x(k) + Tr\cos\theta(\omega_{Ri} + \omega_{Li})/2 \\ y(k) + Tr\sin\theta(\omega_{Ri} + \omega_{Li})/2 \\ \theta(k) + Tr(\omega_{Ri} - \omega_{Li})/d \end{bmatrix} + w(k) \quad (20)$$

In the formula, $X(k) = [x(k) \quad y(k) \quad \theta(k)]^T$; $w(k)$ is the state error.

When the fusion of culture and tourism moves in a straight line from time k to time $k+1$, the motion model of the fusion of culture and tourism is shown in Figure 3.

ΔS_k is the distance moved by the integration of culture and tourism. According to the above figure, the motion model of the integration of culture and tourism can be obtained as:

$$\begin{cases} x_{k+1} = x_k + \Delta S_k \cos\theta_k \\ y_{k+1} = y_k + \Delta S_k \sin\theta_k \\ \theta_{k+1} \approx \theta_k \end{cases} \quad (21)$$

The curvilinear motion model of the integration of culture and tourism is shown in Figure 4.

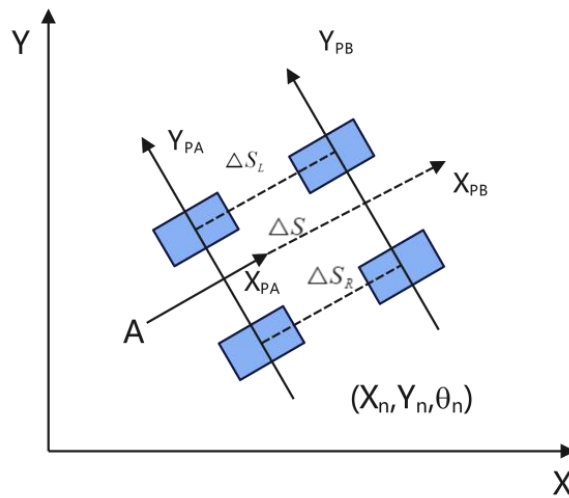


Figure 3: Linear motion model of intelligent cultural and tourism integration.

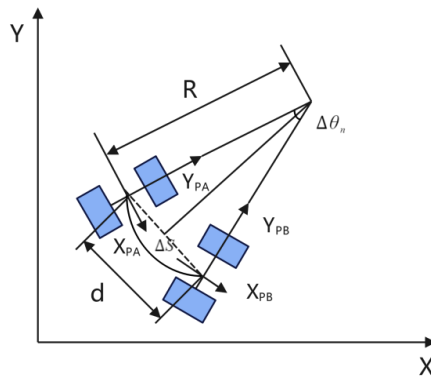


Figure 4: Curve motion model of intelligent cultural and tourism integration.

It can be concluded that the calculation formula of the motion model of the cultural and tourism fusion during the curve movement is:

$$\begin{cases} x_{k+1} = x_k + d \cos\left(\theta_n + \frac{\Delta\theta_n}{2}\right) \\ y_{k+1} = y_k + d \sin\left(\theta_n + \frac{\Delta\theta_n}{2}\right) \\ \theta_{k+1} = \theta_n + \Delta\theta_n \end{cases} \quad (22)$$

Figure 5 shows a schematic diagram of the intelligent cultural and tourism fusion using laser sensors to observe objects.

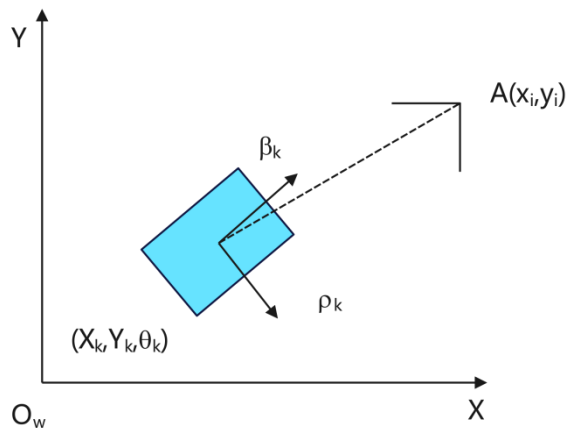


Figure 5: Observation diagram of intelligent cultural tourism integration.

The distance between the target object detected by the laser sensor and the fusion of culture and tourism is ρ , and the angle between the heading angle of the fusion of culture and tourism and the target object is β . The position coordinate of the target object i is $A(x_i, y_i)$. According to the information in the figure, it can be concluded that the observation value of the target object i at the pose X_k of the cultural tourism fusion at time k can be expressed as:

$$Z_{ki} = \begin{pmatrix} \rho_{ki} \\ \beta_{ki} \end{pmatrix} = \begin{pmatrix} \sqrt{(x_k - x_i)^2 + (y_k - y_i)^2} \\ \arctan \frac{y_i - y_k - \theta_k}{x_i - x_k} \end{pmatrix} \quad (23)$$

This system uses the EKF filter to fuse the observation information of the ultrasonic sensor with the odometer-based dead reckoning positioning method to achieve the purpose of improving the positioning accuracy of the intelligent cultural and tourism fusion system. The state vector of dead reckoning positioning is X_k , then:

$$X_k = [x_n \quad v_x \quad a_x \quad y_n \quad v_y \quad a_y]^T \quad (24)$$

The equation of state for the fusion of culture and tourism is modeled:

$$\begin{bmatrix} \dot{x} \\ \ddot{x} \\ \ddot{x} \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} x \\ \dot{x} \\ \ddot{x} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} w(t) \quad (25)$$

The state equation of the system is:

$$\dot{X}_k = A_k X_k + W_k \quad (26)$$

Among them,

$$A_k = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \quad (27)$$

W_k is the system noise matrix with covariance Q .
The above formula (26) is discretized to get:

$$X_{k+1} = \Phi_{k+1/k} X_k + W_k \quad (28)$$

In the formula,

$$\begin{bmatrix} 1 & T & T^2/2 & 0 & 0 & 0 \\ 0 & 1 & T & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & T & T^2/2 \\ 0 & 0 & 0 & 0 & 1 & T \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \quad (29)$$

The formula (28) is the state equation of the dead reckoning system.

(1) The observation method of the odometer is:

$$l = T \sqrt{v_x^2 + v_y^2} + \lambda \quad (30)$$

In the formula, λ is the accumulated error of the odometer.

(2) The observation equation of the electronic compass can be expressed as:

$$\theta = \arctan \frac{v_x}{v_y} + \gamma \quad (31)$$

In the formula, γ is the measurement error of the electronic compass.

(3) The observation equation of the IMU is:

$$\omega_g = \frac{\theta}{T} = \frac{\arctan \frac{v_x}{v_y}}{T} + \eta \quad (32)$$

In the formula, η is the measurement error of the IMU.

(3) The observation equation of the ultrasonic sensor is:

$$l = vt / 2 + \zeta \quad (33)$$

$$v = v_0 \sqrt{1 + t / 273} \approx 3331.5 + 0.607t \quad (34)$$

Among them, v_0 is the speed of sound when the temperature is 0°C , and ζ is the measurement error of the ultrasonic sensor.

Therefore, the observation equation of the positioning system can be expressed as:

$$Z_k = \begin{bmatrix} l \\ \theta \\ \omega_g \\ L \end{bmatrix} = \begin{bmatrix} T\sqrt{v_x^2 + v_y^2} \\ \arctan \frac{v_x}{v_y} \\ \arctan \frac{v_x}{v_y} / T \\ vt / 2 \end{bmatrix} + \begin{bmatrix} \lambda \\ \gamma \\ \eta \\ \zeta \end{bmatrix} \quad (35)$$

The observation equation of the cultural and tourism fusion positioning system obtained after discretization processing is:

$$Z_k = H[X_k] + V_k \quad (36)$$

In the formula, $Z_k = [l_k \ \theta_k \ \omega_k \ L_k]^T$.

Because the observation equation of the system is nonlinear, we use the EKF filter for fusion, and expand the first-order Taylor series of $H[X_k]$ at the predicted value $\hat{X}_{k/k-1}$ to get:

$$Z_k = H[\hat{X}_{k/k-1}] + H_k[X_k - \hat{X}_{k/k-1}] + V_k \quad (37)$$

It can be simplified to:

$$Z_k = H[\hat{X}_{k/k-1}] + H_k X_k + V_k - H_k \hat{X}_{k/k-1} \quad (38)$$

Among them,

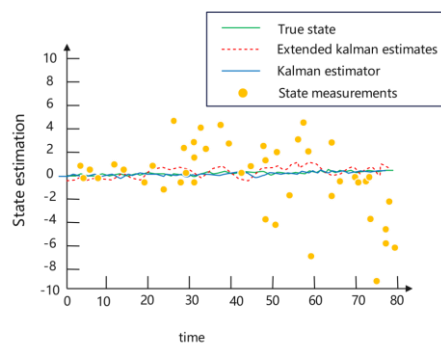
$$H_k = \frac{\partial H[X_k]}{\partial X_k} / (x_k = \hat{X}_{k/k-1}) = \begin{bmatrix} 0 & h_1 & 0 & 0 & h_2 & 0 \\ 0 & h_3 & 0 & 0 & h_4 & 0 \\ 0 & h_5 & 0 & 0 & h_6 & 0 \end{bmatrix} \quad (39)$$

Through the EKF filter equation, the recursive filter equation of the corresponding positioning system for cultural and tourism fusion can be obtained as:

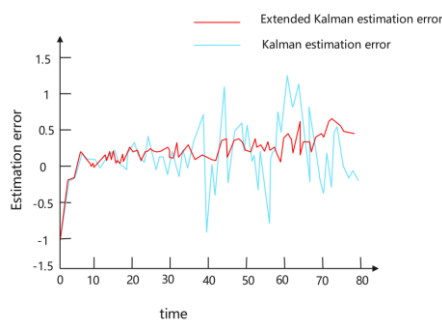
$$\left\{ \begin{array}{l} \hat{X}_{k+1/k} = \Phi_{k+1/k} \hat{X}_{k/k} \\ P_{k+1/k} = \Phi_{k+1/k} P_{k/k} \Phi_{k+1/k}^T + Q \\ K_k = P_{k+1/k} H_k^T (H_k P_{k+1/k} H_k^T + R)^{-1} \\ P_{k/k} = (I - K_k H_k) P_{k/k-1} \\ \hat{X}_{k+1/k} = \hat{X}_{k+1/k} + K_k (Z_k - H [\hat{X}_{k+1/k}]) \end{array} \right. \quad (40)$$

2.5 Simulation Experiment

(1) The filtering effects of KF and EKF are simulated and compared through the MATLAB simulation experiment platform. In the simulation process, some random numbers that will change with time are placed on the basis of the original constants, and they are regarded as the measured values of the sensor, so as to realize the observation of the change of the error covariance. The simulation results are shown in Figure 6.



(a)



(b)

Figure 6: Comparison of estimated effects.

According to the results of the simulation experiments, it can be observed that when the statistical characteristics of the measurement noise change, the general KF cannot adapt to the changes of its statistical characteristics, but the EKF can remove the influence of the measurement noise changes on the system estimation effect, and greatly improve the filtering effect.

(2) The experiment analyzes the state of the intelligent cultural and tourism fusion in the uniform linear motion, and the observation distance information obtained by the sensor uses the EKF filter to track the target. When the target object is moving in a straight line at a uniform speed, the state of the system is:

$$X(K+1) = [x(k), \dot{x}(k), y(k), \dot{y}(k)]^T \quad (41)$$

Then the state equation of the system is:

$$X(K+1) = \Phi X(k) + \Gamma U(k) \quad (42)$$

In the formula,

$$\Phi = \begin{bmatrix} 1 & T & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & T \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (43)$$

$$\Gamma = \begin{bmatrix} T^2/2 & 0 \\ T & 0 \\ 0 & T^2/2 \\ 0 & T \end{bmatrix} \quad (44)$$

The observation equation is:

$$Z(k) = \sqrt{(x(k) - x_0)^2 + (y(k) - y_0)^2} + V(k) \quad (45)$$

In the formula, $V(k)$ is the measurement error of the lidar itself. The Jacobian matrix is:

$$H = \frac{\partial Z(k)}{\partial X(k)} = \begin{bmatrix} \frac{\partial Z(k)}{\partial x(k)}, \frac{\partial Z(k)}{\partial \dot{x}(k)}, \frac{\partial Z(k)}{\partial y(k)}, \frac{\partial Z(k)}{\partial \dot{y}(k)} \end{bmatrix} \\ = \begin{bmatrix} \frac{x(k) - x_0}{\sqrt{(x(k) - x_0)^2 + (y(k) - y_0)^2}}, 0, \frac{y(k) - y_0}{\sqrt{(x(k) - x_0)^2 + (y(k) - y_0)^2}} \end{bmatrix} \quad (46)$$

The effect of the simulation experiment is shown in the figure below. In Figure 7, the blue line is the actual trajectory of the intelligent cultural and tourism fusion, and the red line is the estimated trajectory of the cultural and tourism fusion after EKF filtering and fusion. In Figure 8, after

observation, we can see that the cultural and tourism fusion location positioning accuracy is high and the error is small after EKF filtering and fusion.

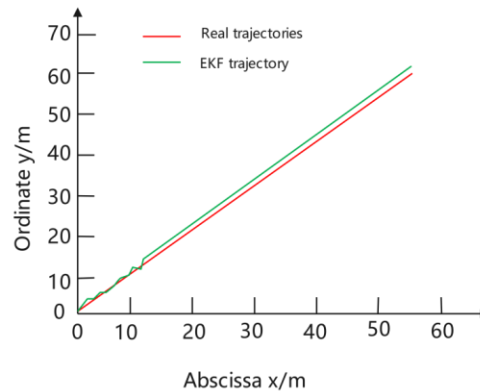


Figure 7: Motion trajectory diagram.

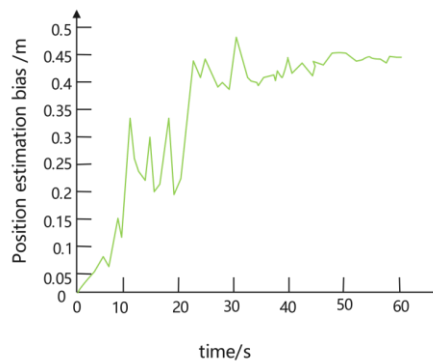


Figure 8: Position error diagram.

3 THE APPLICATION OF VR IN THE INTEGRATION OF CULTURE AND TOURISM UNDER THE BACKGROUND OF SMART CITY INTERNET OF THINGS

From the perspective of cultural and tourism integration, it is guided by the needs of tourists and local residents, in order to achieve the purpose of promoting the development of rural tourism industry in northern Shaanxi. Based on the above logic, it is an important content of this paper to establish the path of building the brand image of rural tourism in northern Shaanxi from the perspective of cultural and tourism integration (Figure 9).

This paper combines the algorithm of the second part to process the cultural and tourism fusion data, constructs a smart city cultural and tourism fusion system, and conducts research through the path shown in Figure 9. The application effect of VR in the integration of culture and tourism in the context of the Internet of Things in smart city proposed in this paper is verified, and the reliability of the method is calculated[17]. The computer simulation method is used for experimental research, and the cultural and tourism integration effect is verified through multiple sets of data, and the results shown in Table 1 are finally obtained.

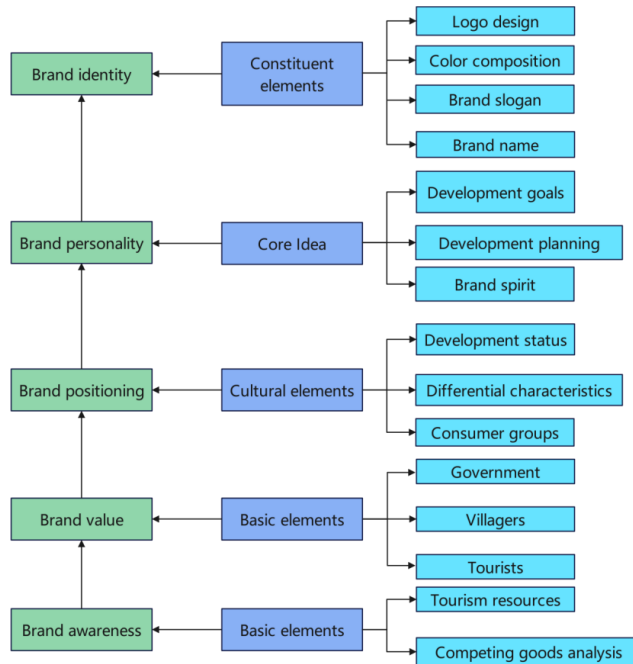


Figure 9: Construction path of cultural and tourism integration.

Number	Fusion effect	Number	Fusion effect	Number	Fusion effect
1	86.611	25	87.764	49	91.103
2	86.221	26	87.275	50	87.113
3	88.227	27	92.582	51	86.600
4	88.037	28	90.903	52	92.659
5	91.262	29	86.886	53	92.605
6	91.700	30	91.379	54	90.417
7	86.233	31	87.644	55	91.059
8	86.650	32	91.636	56	90.252
9	88.218	33	89.167	57	91.351
10	91.717	34	88.758	58	92.131
11	90.878	35	90.351	59	87.520
12	87.091	36	88.584	60	91.456
13	92.669	37	87.412	61	89.174
14	90.737	38	89.821	62	90.609
15	91.014	39	92.398	63	90.022
16	92.320	40	92.209	64	86.152
17	86.617	41	91.489	65	92.494
18	89.867	42	88.541	66	86.308
19	88.034	43	92.103	67	89.334

20	89.419	44	89.841	68	90.228
21	86.098	45	91.828	69	86.312
22	88.481	46	87.495	70	88.338
23	88.423	47	92.608	71	90.849
24	89.928	48	90.587	72	86.169

Table 1 :Verification of the effect of cultural and tourism integration.

4 CONCLUSION

Academia has not yet formed a theoretical system for the research on the influence of red education bases, and it is mostly a description of the promotion of the influence of red culture. Based on the research results of other authors on cultural influence, brand influence, communication influence, and media influence, this paper tentatively proposes the elements of the influence of red education bases. It provides a theoretical basis for enhancing the influence of red education bases. Moreover, this paper proposes countermeasures and suggestions for enhancing the influence of red education bases, which can not only enrich the research results of red education bases, but also have supplementary significance to the research on cultural tourism. In addition, this paper analyzes the application research and implementation of VR in the integration of culture and tourism in the context of the Internet of Things in smart cities. The test evaluation shows that the application effect of VR in the integration of culture and tourism under the background of the smart city Internet of Things is very obvious, which can effectively promote the development of the integration of culture and tourism.

Cong Ye, <https://orcid.org/0009-0006-1785-969X>

Caiyuan Kuang, <https://orcid.org/0009-0007-7094-8920>

ACKNOWLEDGEMENTS

This paper is sponsored by Nanjing Cultural Talents Training Funding Project(22BM7005) and Jiangsu Province Key Construction Discipline of Design (Jinling Institute of Technology) during the 14th Five-Year Plan.

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