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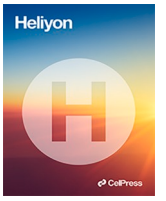

Research article

Optimization of Chinese film and television communication technology in Portuguese-speaking areas under the application of digital Internet of Things

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ABSTRACT

With the continuous change and progress of the world system, cultural communication has become a vital topic in today's society. This study aims to optimize the communication effect of Chinese film in Portuguese-speaking countries and promote the development of cultural communication in China through deep learning (DL) technology. First, this study utilizes DL technology to design film feature recognition and classification models to provide technical support for Chinese film communication. Second, by exploring the principle, development, and function of the digital Internet of Things, the study analyzes the evolution and spread of Chinese film in Portuguese-speaking countries and uses the Bayes algorithm to optimize the model. The results show that the calculation time of the designed model is shorter and the accuracy is higher, which offers an important reference for the effective communication of Chinese films in Portuguese-speaking countries. Hence, this study not only provides technical support for the improvement of the international communication effect of Chinese film but also contributes to the development of cultural communication in China.

1. Introduction

In the context of global cultural integration and development, the survival, growth, and exchange of culture have become significant focal points for various social groups, greatly accelerating the rapid development of information technology [1]. As an important field of cultural communication, China's Belt and Road (B&R) initiative has injected new vitality into cultural prosperity and development through film and television (TV) dissemination. However, with the increasing maturity of digital Internet of Things (IoT) technology, traditional film and TV communication methods face substantial transformations. It is foreseeable that, with the empowerment of digital IoT, Chinese films can more accurately reach audiences in Portuguese-speaking areas, overcoming geographical and linguistic barriers to achieve seamless cultural integration. With the assistance of digital IoT, films can be rapidly disseminated through online platforms and, leveraging IoT's intelligence and interactivity, provide audiences with richer and more colorful viewing experiences. Conversely, under the background of digital IoT, Chinese film and TV communication struggles to meet

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the demands for efficient and precise cultural communication. The selection of Portuguese-speaking areas as the focus of this study is not only due to their strategic importance in the B&R initiative but also because of their deep cultural ties with China. However, due to differences in language and culture, the communication of Chinese film and TV in these regions has not been very effective. To optimize film and TV communication technologies and improve their effectiveness in Portuguese-speaking areas, it is necessary to explore intelligent methods [2]. The maturity of digital IoT technology presents unprecedented opportunities for the international dissemination of Chinese films. Leveraging the intelligence and interactivity of digital IoT, Chinese films can more precisely target their audiences, develop personalized dissemination strategies, and achieve rapid and extensive dissemination through online platforms. This helps increase the visibility and influence of Chinese films in Portuguese-speaking areas, fostering deeper cultural exchange between China and Portuguese-speaking countries. Based on an in-depth study and analysis of relevant theories and previous research, it is evident that there are still many gaps in this field. For instance, how to better integrate digital IoT technology with film communication and how to effectively position and disseminate Chinese films in Portuguese-speaking areas are issues that require further exploration and research.

Vlassis (2021) pointed out that China's film communication had gone through the regional, domestic, and integrated communication stage centered on Shanghai cinema from 1905 to 1949, urban and rural screening from 1949 to 1979, and cinema screening/audio-visual products/film channels/online video/various film exhibitions from 1979 to 2004; Chinese films in the three historical stages had specific characteristics and carried different historical missions in terms of communication system, media, mode, and effect. From the synchronic analysis, Chinese film transmission in the past 100 years has been deeply impacted by Chinese traditional culture, especially politics, society, and economy, since the 20th century, and to some extent influenced Chinese economy, politics, and social psychology [3]. From the viewpoint of mass aesthetic culture change and mainstream value construction in the perspective of micro-communication, Huang (2022) put forward the following suggestions: focusing on the combination of professional groups and mass groups, the effective integration of business and art, exploring the profit-making ways of microfilms, promoting the dissemination of microfilms from the aspects of "fine", "new", "wide" and "complete", hoping to improve the dissemination effect of microfilms and play its role in the construction of mainstream value. Furthermore, he pointed out that new media had ushered in the best leapfrog development period, the mobile Internet boom had broken out, and IoT construction was running forward. In addition, integrating the three networks has made substantial progress, and "Internet politics inquiry" has become a new path for the government and officials to cope with media reform [4]. Wang et al. (2021) proposed that new media transmission promoted the transformation from screen to platform, from program to content, and from the audience to the user, indicating the changes in the new market pattern. In the face of the ongoing and upcoming technological progress and market evolution, media organizations should take the initiative to respond to, welcome, and attack, which is the most realistic and sensible approach in the new media era [5]. Fan et al. (2021) believed that China's film industry developed swiftly, with phenomenal-grade films emerging endlessly, and all kinds of optimistic and pessimistic attitudes in the film field are interwoven. In fact, this is because both the film industry and the overall economy are currently in a transitional stage of the new paradigm shift [6]. He et al. (2021) raised that "Internet +" was the external manifestation of the transformation of the traditional network paradigm, and the more profound revolution of industrial thinking mode, competitiveness, and operation method. It can be said that technological change and paradigm shifts opened the door to new opportunities for each industry, enterprise, and even everyone, and the film industry is no exception. It changed the operation mechanism of the film industry based on the traditional industrial assembly line and also provided an essential supporting role for film propagation [7].

To enhance the influence of Chinese films in Portuguese-speaking countries and promote the development of China's cultural communication, this study first comprehensively and thoroughly examines the development trends and characteristics of the digital IoT. It then analyzes the current state of Chinese film communication in these regions. Finally, utilizing deep learning (DL) technology, an intelligent film feature recognition and classification model is constructed, providing robust technical support for developing Chinese film communication technology. This study is highly innovative, integrating cutting-edge digital IoT technology into the film communication field and successfully creating a novel film feature recognition and classification model. This model not only markedly improves the accuracy and efficiency of film classification but also offers highly precise target positioning and scientifically sound strategy planning for film communication activities. Furthermore, the study conducts an in-depth and detailed investigation of the actual dissemination of Chinese films in Portuguese-speaking countries, proposing highly targeted and feasible suggestions and strategies for promoting Chinese films in the international market. This study holds significant importance in several aspects. Firstly, it provides novel technological means and solid theoretical foundations for the dissemination of Chinese films in Portuguese-speaking countries, effectively boosting the international influence of Chinese films. Secondly, the study greatly promotes the extensive application and in-depth development of digital IoT technology in the film communication domain, opening up new ideas and effective methods for future film communication efforts. Finally, it serves as a good example for the international dissemination of other cultural industries, offering valuable experiences and insights. Therefore, it can help advance the broader and deeper exchange and dissemination of Chinese culture globally, fostering mutual understanding and appreciation among different cultures.

2. The development of Chinese film and TV under the application of digital IoT

This study focuses on the application of digital IoT technology in the field of film communication and its impact on the spread of Chinese films in Portuguese-speaking areas. In the context of digital IoT, various physical devices and objects are interconnected via the Internet, enabling data collection and exchange to create a network of interconnected devices. Specifically, digital IoT refers to the application of IoT technology in digital or virtual environments, connecting and integrating digital devices, systems, and platforms through IoT principles. Digital IoT extends the concept of physical IoT to include virtual objects, such as digital entities, virtual reality systems, and cloud-based services, enabling higher levels of communication, data exchange, and interoperability among virtual

entities. This study leverages digital IoT technology to optimize film communication techniques through intelligent means, particularly in the process of spreading Chinese films to Portuguese-speaking areas. Compared to dissemination in other regions, spreading Chinese films in Portuguese-speaking areas faces dual challenges of language and cultural differences. Therefore, this study specifically concentrates on overcoming these challenges in the context of digital IoT to achieve precise dissemination of Chinese films in Portuguese-speaking areas. By constructing a film feature recognition and classification model based on DL technology, this study aims to provide technical support for the accurate dissemination of Chinese films in Portuguese-speaking areas. This model can more accurately analyze audience preferences and develop targeted dissemination strategies, thereby enhancing the international influence and dissemination effect of Chinese films. Additionally, this study offers new perspectives and methods for the international promotion of Chinese films and provides valuable references for the application and development of digital IoT technology in the film communication field. Through in-depth research and analysis, this study furnishes more targeted and effective strategic recommendations for disseminating Chinese films in Portuguese-speaking areas [8].

The key features of IoT are comprehensive perception, dependable transmission, and intelligent processing. Various sensor information devices are interconnected to form a comprehensive information network, which has become the mainstream development trend of the control industry today. The IoT structure can be roughly divided into three layers: network, perception, and application [9]. Fig. 1 displays the IoT system's fundamental framework.

With the rapid development of digital IoT technology, this study focuses on the dissemination effects of Chinese films in Portuguese-speaking areas and their optimization strategies. Digital IoT technology, with its robust connectivity, data processing capabilities, and security mechanisms, provides new opportunities and possibilities for the promotion of Chinese films in Lusophone countries. Firstly, digital IoT technology, through its sensing layer, can capture and analyze real-time information on the viewing preferences and market trends of audiences in Portuguese-speaking areas. This information is crucial for formulating targeted dissemination strategies [10]. By deploying various sensors and actuators, this study can gather behavioral data and feedback from viewers of Chinese films, thereby more accurately understanding market demand and providing strong support for film promotion [11]. Secondly, the data layer of digital IoT technology plays a significant role. It can store and manage massive data collected from the sensing layer and, through advanced data analysis techniques, deeply mine and process this data [12]. Such analysis can uncover audience preferences, changes in taste, and potential market opportunities, offering valuable insights for film production and distribution. The service layer and application layer transform the data processing results into specific services and applications. By building intelligent recommendation systems and customized content delivery applications, this study can offer personalized viewing experiences based on individual audience preferences and needs. This greatly enhances audience engagement and satisfaction with Chinese films, further improving dissemination effectiveness [13–15]. Meanwhile, the network layer and security layer of digital IoT technology ensure smooth data transmission and the safe, stable operation of the system. The stability and security of the network layer are critical when handling large volumes of data. By adopting advanced network technologies and security strategies, this study can ensure the accuracy and timeliness of data transmission, ensuring the smooth progress of film communication [16–18]. The core question of this study is: How can develop efficient and precise dissemination strategies that enhance the spread of Chinese films in Portuguese-speaking countries, leveraging digital IoT technology while considering the characteristics of Chinese films and the cultural background of these areas? To address this issue, this study delves into the application of digital IoT technology in the field of film communication, combining advanced technologies such as DL and big data analysis to construct film feature recognition and classification models. These models help to more accurately understand the characteristics of the films and the preferences of the audience, furnishing scientific evidence for film promotion. Furthermore, the study concentrates on the integration of digital IoT and digital technologies, exploring their potential and application prospects in the development of intelligent technologies. Through continuous research and practice, this study aims to provide stronger technical support for the international promotion of Chinese films, thereby

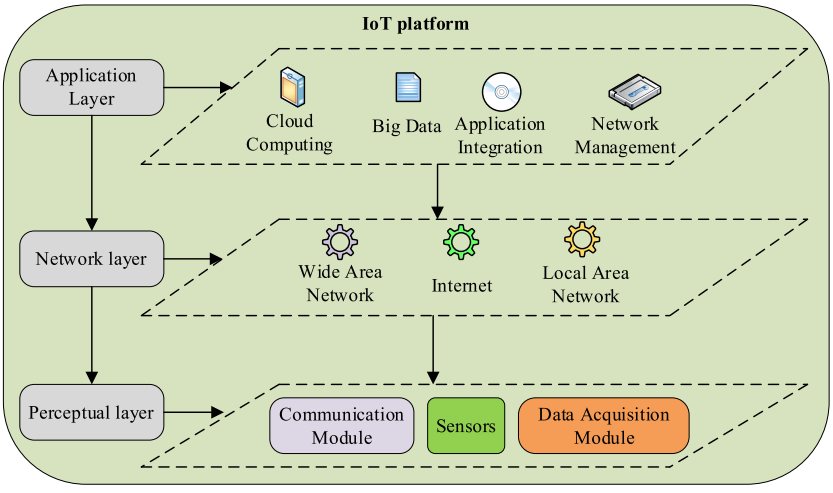

Fig. 1. The basic architecture of the IoT system.

enhancing their influence in Portuguese-speaking countries and on a global scale.

3. The spread of Chinese films in Portuguese-speaking areas under the background of B&R

(1) B&R industry

China put forward the B&R initiative in 2013, and its main significance lies in its economic connotation. It covers the two important initiatives of jointly building the Silk Road Economic Belt and the 21st Century Maritime Silk Road. China aims to connect economically developed countries in East Asia and Europe through these two Silk Roads, creating the broadest and largest platform for Eurasian economic cooperation. When this concept is formally put forward, China's B&R initiative will play a decisive role in shaping a new order of economic growth, connecting markets, and improving the global economic situation. The orderly implementation of this initiative will help expand the supply and sales market of raw materials for industrial products in China. Against the backdrop of the global economic downturn, China has raised the level of socio-economic development, expanded economic and trade exchanges with Eurasian and African countries, strengthened political, cultural, and spiritual exchanges between continents, and made important contributions to international trade, political and cultural integration, and the development of international stability.

(2) Portuguese-speaking areas

Portuguese-speaking countries include Brazil (population 150 million), Mozambique (15.3 million), Portugal (9.9 million), Guinea-Bissau (one million), Cape Verde (346,000), Sao Tome and Principe (126,000), Angola (103,000), East Timor, with a total population of 264 million [19]. Portuguese-speaking countries' per capita economic and social development capacities are still very different, which is mainly reflected in the large gap between the rich and the poor, and most of them rely on agricultural planting and export as the main economic source [20]. Among them, Portugal, one of the developed countries in Europe, has been seriously affected by the Asian sovereign debt financial crisis for many years, and the international situation is not optimistic [21]. These countries face significant opportunities and severe challenges in coping with the economic crisis, transforming their industries, and seeking economic development. It can be seen that these countries have large populations and exert a great influence on the world. Thereupon, to promote the development of Chinese films' outward communication, this study designs and uses intelligent ways to optimize the propagation technology of Chinese films, thus enabling the development of the Chinese cultural communication industry [22].

(3) The communication status of Chinese films

The study of the international transmission of Chinese films is a data research project with its own core and foreign audiences as the object [23]. Now, the international popularity rankings of Chinese films are as follows: "Shadow", "White Snake", "Big Fish & Begonia", "Vanguard, "Ip Man 4", "The Finale", "Ip Man 3", "Legend Of The Demon Cat", "Better Days", "Kung Fu Panda 3", "Nezha: Birth of the Demon Child", "The Great Wall", "The Foreigner", "The Monkey King 2", Wolf Warriors 2″, "Operation Red Sea", "The Mermaid", "Railroad Tigers", "The Eight Hundred", "The Captain", and "Operation Mekong" [24]. Among them, action films are the most widely accepted film genre by international Internet audiences. The co-production of the mainland and Hong Kong and the co-production of Chinese and foreign films have become the mode of Chinese film creation that international network audiences pay more attention to Ref. [25].

The geographical distribution of international audiences of Chinese films is very wide, covering 64 countries such as the United States, Britain, France, Japan, Spain, Canada, Greece, Sweden, Singapore, South Korea, etc. Among them, the number of effective comments and likes reached up to five figures in the English-speaking regions of Europe, America, Asia, Japan, and South Korea. Some audiences in the Russian and French regions also showed a strong interest in Chinese films, with a high rate of mentions on Twitter. However, the present rate and reach rate of Chinese films on the six overseas online viewing platforms are far from enough, which still needs to be promoted [26]. And the spread of Chinese films in the Portuguese-speaking areas is not very good, or even no progress. As such, to encourage the development of Chinese films in the international market and improve their recognition in Portuguese-speaking areas, an analysis of the current situation of film communication is designed, and a model for the optimization of Chinese films' communication effect in these areas is implemented, thus offering support for the future growth of Chinese films in the international market.

4. Digital IoT-based film communication technology

This study focuses on how to optimize the dissemination of Chinese film in Portuguese-speaking areas through the combination of IoT technology and artificial intelligence (AI) technology. In the current field of information and communication, IoT technology, as a mainstream technology, has shown remarkable advantages [27]. To improve the international communication effect of Chinese film, especially in Portuguese-speaking areas, this study adopts IoT technology combined with AI technology to analyze and disseminate Chinese film. First, DL technology is employed to identify and classify film styles, subdivide Chinese films into multiple categories, and clarify their transmission process [28]. With the DL algorithm, this study can more accurately understand the content and characteristics of the film, to develop more targeted strategies for its dissemination in Portuguese-speaking areas. On this basis, this study further uses convolutional neural network (CNN) technology to design a technical model for film style recognition and classification. CNN technology has powerful image recognition ability and can effectively capture key elements and features in the film, thereby

achieving accurate classification of film style. The specific design of this technical model is presented in Fig. 2.

Fig. 2 signifies the film feature recognition design of the CNN model. Using CNN technology, the model can classify and label films accurately, with Portuguese as the main classification index, thus providing users with a better viewing experience. To achieve this goal, a relatively comprehensive analysis of film content is needed in this study. The designed model must be able to accurately and reasonably explain the film's content to make the results of classification and labeling more accurate and reliable. The design of the CNN model involves the working principle of convolutional and pooling layers. The convolutional layer is the CNN model's key component, it can extract the key features in the film by convolution operation. The convolution operation provides a local perception of the film image and captures features at different scales through a continuous sliding window. The pooling layer is used to reduce the size of the feature map and the number of parameters while preserving key feature information. Through reasonable design and optimization of the CNN model, the recognition and extraction of film features can be effectively realized, to improve the accuracy of film classification and labeling, and provide users with a higher-quality film-watching experience [29]. The convolution and pooling operation design is suggested in Fig. 3.

Fig. 3 (a), (b), and (c) show the operation mechanism of CNN technology, which mainly covers pooling and convolution operations. Forward propagation and backpropagation together constitute the core calculation process, which can accurately analyze images and provide relevant error information, thus offering powerful data references for model optimization and greatly improving its calculation effect [30]. Here, the convolutional layer of the CNN model plays a critical role, which can effectively extract the key content of the film and significantly improve the interpretation efficiency of the film content. In addition, in the subsequent design, the two methods of average and maximum pooling are comprehensively used to achieve accurate extraction and feature recognition of film content, further enhance the reasonable classification of films, and greatly improve the interpretation effect of film content.

The typical structure of CNN comprises the input, convolution, pooling, output, and fully connected layers. For the input image, CNN can perform feature extraction and dimension reduction. Feature extraction of images can be written as Eq. (1):

$$\mathbf{H}_i = \boldsymbol{f}(\mathbf{W}_{i\otimes}\mathbf{H}_{i-1} + \mathbf{b}_i) \tag{1}$$

$\boldsymbol{i}$ refers to the network convolution level; $\mathbf{b}$ expresses the offset vector in the calculation process, $\mathbf{W}$ means the calculation weight, and the excitation function obtains the feature graph $\mathbf{H}\boldsymbol{i}$. The pooling process of CNN is calculated, as illustrated in Eq. (2):

$$\mathbf{H}_i = \boldsymbol{subsampling}(\mathbf{H}_{i-1}) \tag{2}$$

After multiple pooling, the changed features are represented and classified through the Fully Connected Network (FCN). The final mapping result is shown in Eq. (3):

$$\mathbf{Y}(\boldsymbol{m}) = \boldsymbol{P}(\mathbf{L} = \boldsymbol{l}_m | \mathbf{H}_0; (\mathbf{W}, \mathbf{b})) \tag{3}$$

$\boldsymbol{m}$ signifies the index of the label category; $\boldsymbol{P}$ indicates the mapping operation; $\boldsymbol{L}$ stands for the loss function; The calculation process is expressed in Eqs. (4) and (5):

$$\mathbf{NLL}\ (\mathbf{W}, \mathbf{b}) = -\sum_{\boldsymbol{m}=1}^{|\mathbf{Y}|} \log \mathbf{Y}(\boldsymbol{m}) \tag{4}$$

$$\mathbf{MSE}\ (\mathbf{W}, \mathbf{b}) = \frac{1}{|\mathbf{Y}|}\sum_{\boldsymbol{m}=1}^{|\mathbf{Y}|} (\mathbf{Y}(\boldsymbol{m}) - \widehat{\mathbf{Y}}(\boldsymbol{m}))^2 \tag{5}$$

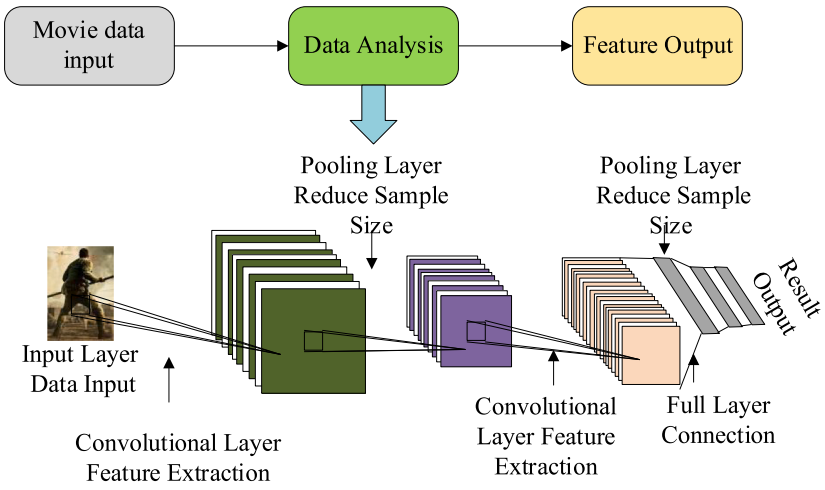

Fig. 2. Recognition design of film features by the CNN model.

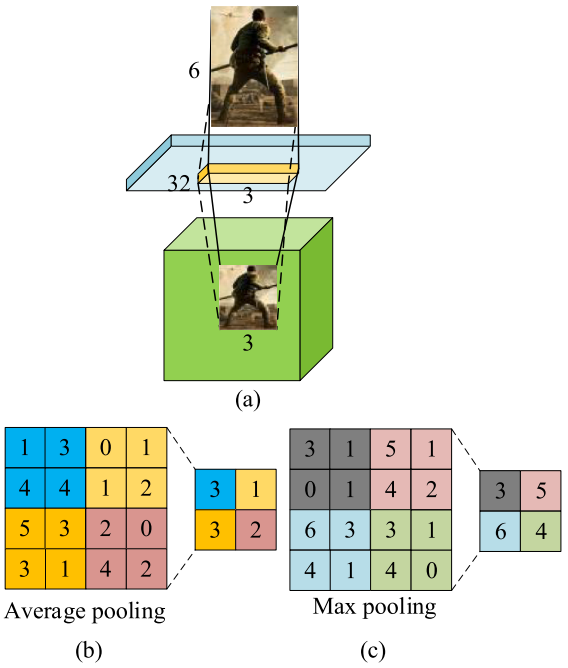

Fig. 3. The working principle of the CNN model (a: The convolutional layer; b: The average pooling; c: The maximum pooling).

To reduce the overfitting of network parameters, a binary norm term is typically added to the final loss function. The calculation process is as follows:

$$\boldsymbol{E}(\mathbf{W},\mathbf{b}) = \mathbf{L}(\mathbf{W},\mathbf{b}) + \frac{\lambda}{2}\mathbf{W}^{\mathrm{T}}\mathbf{W} \tag{6}$$

$$\mathbf{W}_i = \mathbf{W}_i - \boldsymbol{\eta}\frac{\partial \boldsymbol{E}(\mathbf{W},\mathbf{b})}{\partial \mathbf{W}_i} \tag{7}$$

$$\mathbf{b}_i = \mathbf{b}_i - \boldsymbol{\eta}\frac{\partial \boldsymbol{E}(\mathbf{W},\mathbf{b})}{\partial \mathbf{b}_i} \tag{8}$$

$\boldsymbol{\eta}$ refers to the learning rate. The above is the designed film content's specific recognition and classification process. Then, the Bayes algorithm is used to optimize the designed model. The Bayes network (BN), also known as the reliability network, is an extension of the Bayes method and one of the most effective theoretical models in reasoning and uncertain knowledge representation [31]. A BN is a directed acyclic graph consisting of nodes expressing variables and directed edges connecting these nodes. Nodes are random variables, and the directed edges between nodes signify their mutual relationship (from a parent node to a child node). Conditional probability is adopted to denote the strength of the relationship, and prior probability is applied to demonstrate information if there is no parent node. The nodes in the directed acyclic graph of a BN represent the random variable $\{\boldsymbol{X}_1, \boldsymbol{X}_2, \ldots, \boldsymbol{X}_n\}$. Based on this, the probability calculation method of the Bayes algorithm is signified in Eq. (9):

$$\boldsymbol{p}(\boldsymbol{x}) = \prod_{i \in \boldsymbol{I}} \boldsymbol{p}\left(\boldsymbol{x}_i | \boldsymbol{x}_{\mathrm{pa}(i)}\right) \tag{9}$$

Eq. (10) can be obtained by expanding Eq. (9):

$$\boldsymbol{p}(\boldsymbol{x}_1, \ldots, \boldsymbol{x}_K) = \boldsymbol{p}(\boldsymbol{x}_K | \boldsymbol{x}_1, \ldots, \boldsymbol{x}_{K-1}) \ldots \boldsymbol{p}(\boldsymbol{x}_2 | \boldsymbol{x}_1)\boldsymbol{p}(\boldsymbol{x}_1) \tag{10}$$

On this basis, the core calculation method of Bayes algorithm is shown in Eq. (11).

$$\boldsymbol{P}(\boldsymbol{B}|\boldsymbol{A}) = \frac{\boldsymbol{P}(\boldsymbol{A}|\boldsymbol{B})\boldsymbol{P}(\boldsymbol{B})}{\boldsymbol{P}(\boldsymbol{A})} \tag{11}$$

$\boldsymbol{A}$ and $\boldsymbol{B}$ represent the different characteristics of the film. Films are classified accurately through probability calculation among different features, and Eq. (12) can be gained by simplifying the above equation:

$$P(B) = \sum_{i=1}^{n} P(A_i)P(B|A_i) \tag{12}$$

This study realizes a better film classification model based on the above calculation process. The process of the designed Bayes classification calculation is plotted in Fig. 4.

In Fig. 4, this study employs the Bayes algorithm to classify films rationally, providing clear definitions and labels. This facilitates a straightforward selection process for users by offering a comprehensible list. The classification operation is fundamentally based on optimization theory, aiming to significantly enhance the viewing experience and effectively boost the dissemination of Chinese films. Accordingly, a Bayes-Convolutional Neural Network (B-CNN) model has been meticulously constructed. This study utilizes advanced research methods and DL techniques to optimize Chinese film communication in Portuguese-speaking countries. Firstly, a carefully designed film feature recognition and classification model is developed using DL technology. By training on a large-scale film dataset, the model can automatically and accurately identify and extract key features such as plot, style, and cast. The successful extraction of these features, grounded in optimization theory, helps in comprehending the film's essence and value more precisely, offering a solid scientific basis for subsequent dissemination strategy formulation. The planning of dissemination strategies follows communication theory, ensuring that films are effectively delivered to the target audience.

Secondly, an in-depth and comprehensive exploration of the principles, development process, and functional characteristics of the digital IoT is conducted. Guided by communication theory, this study aids in a thorough understanding of the dissemination environment and audience characteristics of Chinese films in Portuguese-speaking countries. The practical application of digital IoT, supported by optimization theory, enables real-time monitoring and in-depth analysis of the dissemination effects of films, providing immediate and effective feedback for optimizing dissemination strategies. During the data analysis phase, the Bayes algorithm is meticulously optimized. Based on optimization theory, this algorithm dynamically updates the prior probabilities according to new evidence, thereby predicting the dissemination effects of films more accurately. Continuous iteration and optimization greatly enhance the model's computational speed and accuracy, fully meeting the requirements of communication theory. Finally, a comprehensive dissemination strategy for Chinese films in Portuguese-speaking countries is formulated, integrating the aforementioned diverse methods and approaches. This strategy emphasizes the application of technology based on optimization theory and considers multiple

```
def classify NB(vec2Classify, p0Vec, p1Vec, pClass1):

    Desc:

      Input the 0-1 sequence vec2Classify of a document, output the category to which the article belongs (insulting document 1, non-insulting document 0)

    Args:

      vec2Classify: the 0-1 sequence of a document

        p0Vec: probability (in logarithmic form) of occurrence of each word in the de-duplicated vocabulary in category 0, i.e. non-insulting documents

        p1Vec: the probability of each word in the de-emphasized vocabulary (in logarithmic form) in the case of class 1, i.e., insulting documents

        pClass1: the probability that the document is an insulting document (a priori probability), note the conversion to logarithmic form

    Return:

      Class 1/0

    p1 = sum(vec2Classify * p1Vec) + np.log(pClass1)

    p0 = sum(vec2Classify * p0Vec) + np.log(1.0 - pClass1)

    if p1 > p0:

        return 1

    else:
      return 0
```

Fig. 4. Bayes algorithm for film classification.

factors, such as cultural, social, and economic aspects, according to this theory. This ensures that Chinese films gain effective and widespread recognition abroad.

When researching the dissemination strategies of Chinese films in Portuguese-speaking areas, it is essential to recognize the limitations of traditional film theme classification methods. Although film posters possess some symbolic significance, relying solely on posters for theme classification fails to capture the deeper essence of films and the diverse preferences of audiences. Therefore, this study innovatively proposes integrating the communication theory-based in-depth theoretical analysis with advanced digital IoT technology based on this theory to address this issue. Theoretical analysis, grounded in communication theory, lays the foundation for understanding the essence of film communication and the psychological needs of the audience. Meanwhile, digital IoT technology, based on optimization theory, enables precise capture of audience feedback and preferences through real-time data collection and analysis. This ingenious combination allows for a more comprehensive integration of film themes and audience preferences, thus planning more precise and effective dissemination strategies. Specifically, in studying the dissemination strategies of Chinese films in Portuguese-speaking areas, this study employs a uniquely innovative approach by deeply integrating theoretical analysis based on communication theory with digital IoT technology based on optimization theory. Theoretical analysis relies on communication theory, using influence theory and cultural studies to delve into the intrinsic nature of film communication and the psychological demands of audiences, revealing the profound meanings and themes behind the films. Simultaneously, digital IoT technology, based on optimization theory, captures audience feedback and preferences accurately through real-time data collection and big data analysis. Instead of solely relying on traditional film posters, this method integrates multidimensional information including plot summaries, cast, and director styles, making theme recognition more comprehensive and accurate. This method remarkably enhances the precision of dissemination strategies and provides robust theoretical support and technical assurance for promoting and disseminating Chinese films in Portuguese-speaking areas. By organically integrating optimization theory with communication theory, this approach closely links fundamental theory and optimization theory with practical application, effectively advancing the dissemination of Chinese films in these regions.

5. The design of experimental data

The study uses datasets to train models, improving their computational efficiency and enhancing image feature recognition capabilities. The dataset comes from the Internet Movie Database (IMDB), a widely used film information database. This dataset contains 28 attributes, covering 5043 films and 4906 film posters. These films span over a century of history, involving 66 countries and including 2399 directors and thousands of actors. The attributes are extensive, encompassing movie titles, ratings, release dates, directors, reviews, countries of release, leading actors, IMDB scores, languages, and more. By collecting this comprehensive data, the study can thoroughly analyze the films' multi-dimensional features, furnishing a solid foundation for subsequent model training and feature extraction.

In terms of data collection techniques, this study utilizes the publicly available Application Programming Interface (API) provided by IMDB and web scraping technologies to ensure the accuracy and completeness of the data. Additionally, data preprocessing and cleaning are performed to eliminate redundant and erroneous information, thereby improving the data quality. This study falls under the category of data-driven DL applications, specifically employing deep CNN technology to explore the features of film posters. By comparing the training results of the designed model with other models, the study can deeply analyze the designed model's performance characteristics and advantages. Regarding the data nature of the determination method and analysis reference, the dataset used in this study is diverse, comprehensive, and rich. It covers different types of film posters and includes comprehensive information from film production to audience feedback. This diversity and richness help the model learn broader and deeper features, enhancing its accuracy and generalization ability in film classification and recognition tasks. For the experimental environment, the study is

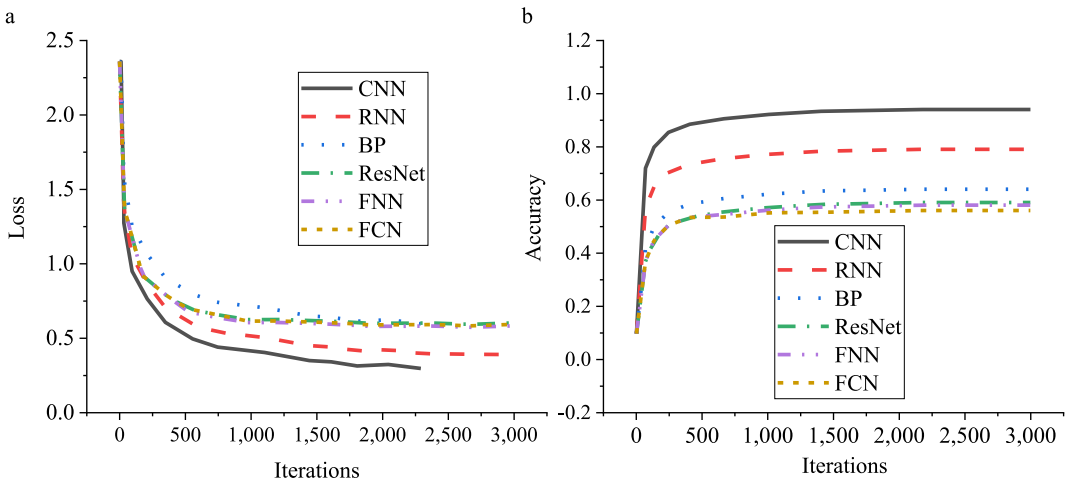

Fig. 5. Basic performance evaluation of CNN model (a: Evaluation of loss rate; b: Evaluation of accuracy).

conducted on a Win7 operating system, using an Intel® Xeon® CPU E5-4607v2 @ 2.60 GHz processor with a frequency of 2600Mhz, 6 cores, 12 logical threads, and 32 GB RAM. MATLAB R2012b is used as the programming and data analysis tool, ensuring high efficiency and accuracy in the experiments.

6. Evaluation of Chinese film communication model based on digital IoT application

6.1. Performance analysis of CNN-based film style recognition

With the development of science and technology, digital cultural communication has become the mainstream cultural communication technology in today's society. As one of the main ways of cultural communication, the film needs to be greatly optimized in the current environment to promote the development of cultural communication effectively. Consequently, to improve the communication effect of films, this study uses CNN technology to realize film style recognition, thus promoting the improvement of the film

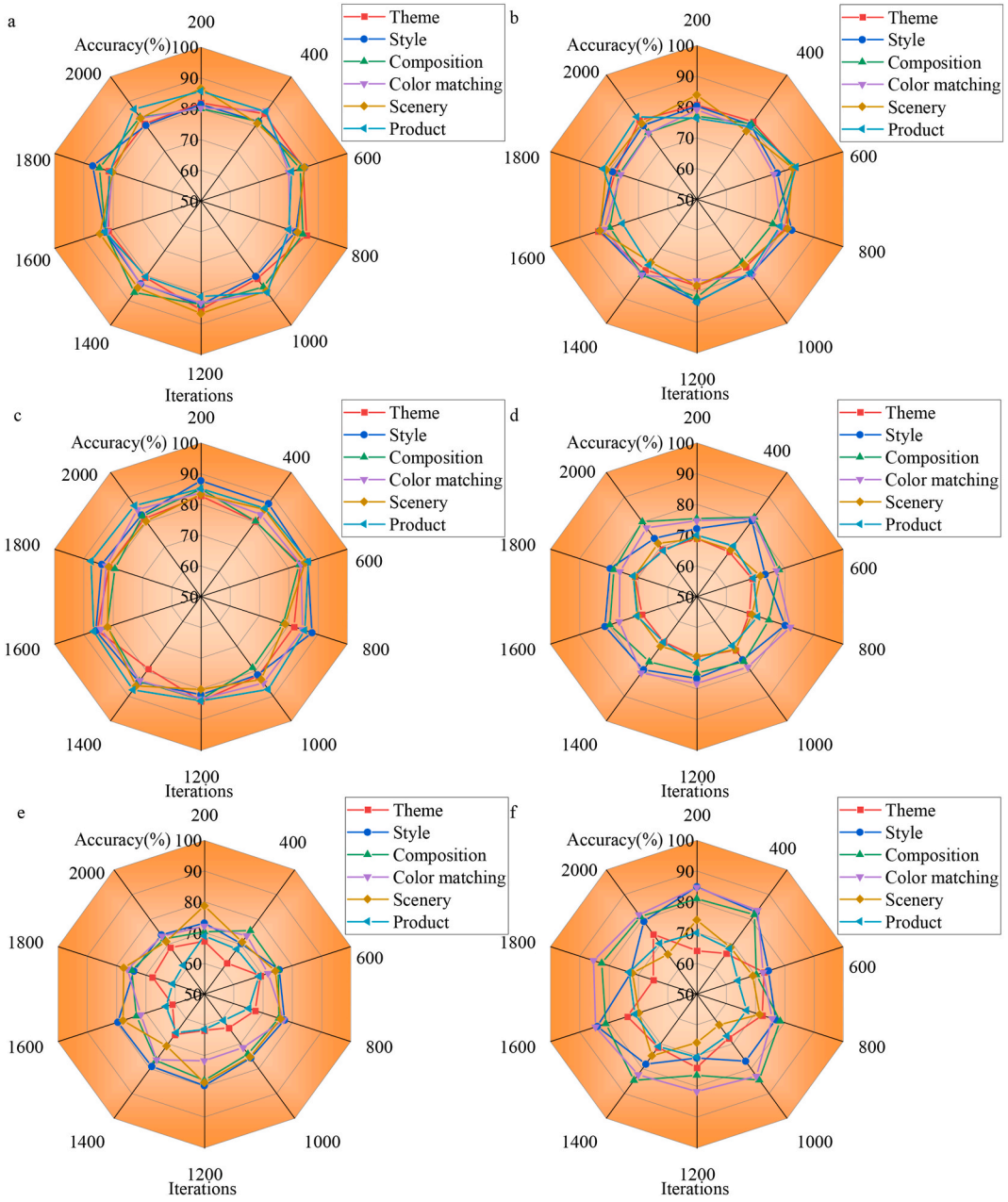

Fig. 6. Evaluation of the recognition and accuracy of film styles (a: thriller; b: romance; c: drama; d: documentary; e: action; f: comedy).

communication effect. On that basis, combining the CNN model with FCN, Recurrent Neural Network (RNN), Back Propagation neural network (BPNN), Residual Network (ResNet), and Feedforward Neural Network (FNN) are used as the main reference indicators to evaluate the proposed model. The above model is employed to carry out comparative research mainly has the following two advantages. On the one hand, the superiority of CNN in image processing and classification is suitable for film style recognition. On the other hand, ResNet, AlexNet, RCNN, and Faster RCNN are classic improvements based on CNN, and can better cope with tasks such as image recognition and target detection so that they can be applied to film style recognition. It can be seen that comparing the model proposed here with the above model can fully reflect the advantages of this model. Fig. 5 presents the performance of the proposed model compared to other models.

Fig. 5 (a) denotes the unique advantages of film poster recognition based on CNN technology in the comparison of different algorithms. When the number of iterations reaches about 500, the model's accuracy and learning rate begin to stabilize, and the final loss value is around 0.5. This result strongly demonstrates the excellent effectiveness of CNN technology in film genre recognition and classification. To realize more accurate film genre recognition, this study classifies films into six major genres, including thriller, action, romance, comedy, documentary, and drama. By using CNN models for film poster recognition, it is possible to quickly and accurately determine the genre of a film. When evaluating the model's performance, this study carefully selects six indicators: product, composition, color matching, visual effects, theme, and style. Additionally, in Fig. 5 (b), when the number of iterations reaches about 500, the accuracy and learning rate of the model tend to stabilize. The accuracy can achieve approximately 0.9, and the model's accuracy for comedy and romance genres is relatively low. This may be due to the similar design styles of these two genres of posters, or the relatively small number of posters of these two genres in the dataset. This study constructs a film genre recognition and classification technology model based on CNN technology and achieves significant results in experiments. This technological achievement not only opens up new possibilities for the international dissemination of Chinese films but also points out the direction for research on film classification and recommendation systems. Most importantly, these research findings have had many profound impacts on society. From the perspective of cultural communication, more accurate classification and recognition of film genres can help Chinese films carry out more targeted promotion activities on the international stage. This makes it easier for audiences from different cultural backgrounds to find Chinese films that match their preferences, thereby promoting cultural exchange and integration, enhancing understanding and tolerance between various cultures. For the film industry, accurate genre classification can help producers better understand market demand, optimize creative directions, improve the adaptability and competitiveness of films in the market, and promote innovative development and quality improvement of the entire industry. From the viewpoint of the audience, it is possible to obtain film recommendations that cater to personal preferences more quickly and accurately, thereby remarkably enhancing the viewing experience, enriching people's cultural and spiritual lives, and meeting the growing cultural needs of the public.

Fig. 6 reveals the model's performance evaluation results under these indicators, and the model has achieved good performance in all indicators, especially in color matching and composition.

Fig. 6 (a), (b), (c), (d), (e) and (f) vividly demonstrate the stability of the designed model in feature recognition and classification of film posters. For the eight evaluated film posters, in Fig. 6 (a), the accuracy ranges from 60 % to 90 %. This result indicates that the model can accurately identify the style category of film posters in most cases. Specifically, the model performs the best in identifying drama and thriller genres, with accuracy ranging from 80 % to 90 %. This may be because these two genres of films have distinct features in poster design. Dramas often focus on facial expressions and narrative elements, while thrillers tend to employ darker tones and tense visual effects, and models can effectively capture and recognize these features. However, in Fig. 6 (b), the model performs relatively poorly in identifying romance, documentary, and action film genres, with accuracy ranging from 60 % to 80 %. This may be because the design styles of these genres of film posters are more diverse and difficult to distinguish based solely on a single feature. For example, romances may include romantic scenes and affectionate eye contact; Documentaries may cover a wide range of themes and filming techniques; Action films may emphasize intense action scenes and fast-paced editing. These complexities pose challenges to the

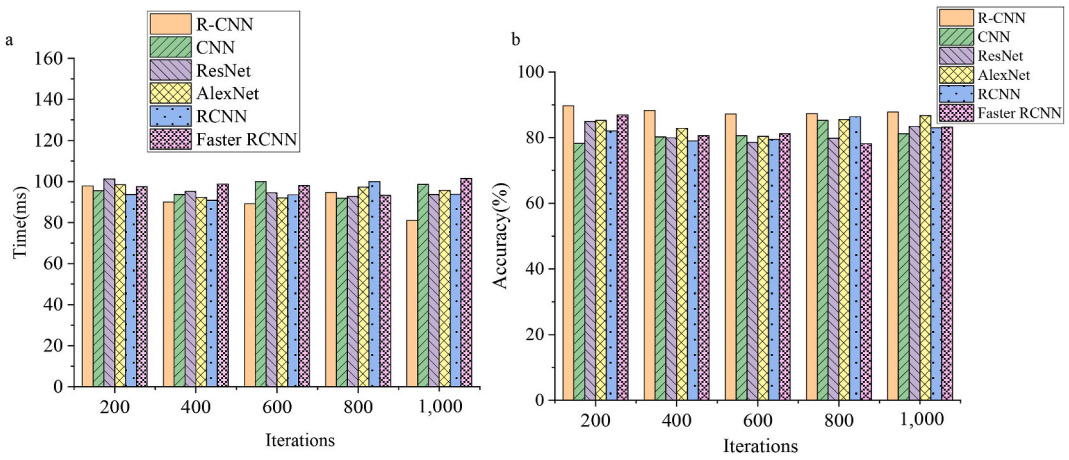

Fig. 7. Comparison results of model performance (a: Calculation time; b: Accuracy).

model's recognition ability. This study has multiple impacts on society. For filmmakers, Fig. 6 (c) provides a clearer understanding of the advantages and disadvantages of poster design for different genres of films, enabling them to make more precise adjustments in their promotional strategies to enhance the market appeal of their films. For the audience, Fig. 6(d) and (e) and (f) suggests that this study helps them more accurately judge the film style based on the poster, saving time in selecting films and improving viewing satisfaction. From the perspective of cultural dissemination, this study facilitates Chinese films to better understand the aesthetic preferences of international audiences, optimize poster design, and promote the dissemination and promotion of Chinese films in the international market. In addition, this study offers direction and basis for the further development of related technologies, promoting the application and innovation of image recognition technology in the film and television industry and other fields.

6.2. Comprehensive performance evaluation of the Chinese film communication model

To explore the actual working performance of the model designed in this study, the designed model is compared with other advanced models of the same type, including the CNN, ResNet, AlexNet, Region CNN (RCNN), and Faster RCNN models. The comparison results between the designed model and other different models are presented in Fig. 7.

In Fig. 7(a) and (b), comparing the results of the two models, it can be found that the proposed model's average calculation time is around 98 ms, while the other models average about 102 ms. Regarding accuracy, other models and the proposed model reach 87 % and 90 %, respectively. This comparison highlights the slight advantage of the proposed model in computational efficiency and demonstrates a significant improvement in accuracy. This technological breakthrough shows that the proposed model employs more efficient algorithms and data processing techniques in its design and optimization. The proposed model is only a few milliseconds faster than other models. However, this small difference can accumulate into significant performance improvements in practical applications, especially where large-scale data processing or real-time response is required. In addition, a 90 % accuracy indicates the reliability and stability of the proposed model in recognition and classification tasks. This high accuracy illustrates that the model can accurately recognize film posters, styles, or other features, providing more accurate data support for film classification, recommendation systems, or related applications. Despite significant improvements in accuracy and computational efficiency, there is still room for further optimization. Future improvements could include introducing more advanced algorithms, increasing the diversity and scale of the dataset, or optimizing the model's hyperparameters. Moreover, in Fig. 7 (a), combining the proposed model with other technologies such as natural language processing or computer vision can achieve a more comprehensive understanding and analysis of film content. This study has significant social implications. In the film industry, Fig. 7 (b) suggests that this study can offer more accurate and efficient technical support for film production, promotion, and marketing. For instance, more accurate recognition and classification of film posters can help producers better understand market feedback and develop more effective promotion strategies, thus improving the film's box office performance and influence. For audiences, a more accurate recommendation system can help them quickly find films that match their preferences and enhance their viewing experience. From the perspective of cultural communication, efficient and accurate models can help promote and distribute Chinese films globally, facilitating communication and understanding between different cultures. In the technology field, this study provides valuable insights and ideas for developing and innovating related technologies, promoting the continuous progress of image recognition and data processing technology. In addition, it offers reference examples for applying similar technologies to solve practical problems in other industries. Compared with the studies of Chen et al. (2023) [32] and Maddikunta et al. (2022) [33], the CNN model is more advanced than the similarity-constrained style transfer mapping and the model with geodesic flow core. Its calculation effect is more refined. The model is compared with more advanced models, and the results reveal that the designed model performs well. This provides a reference for the development of digital IoT technology and contributes to the development of the "B&R" industry.

7. Discussion

With the swift growth of digital media, films as important cultural products are experiencing explosive growth in both quantity and quality. However, effectively classifying, recommending, and retrieving films has become a pressing issue. Traditional film classification methods primarily rely on manual annotation and expert reviews, which are time-consuming, labor-intensive, and highly subjective. Therefore, using computer technology to automate film classification and recognition has become a hot research topic. This study aims to develop an efficient and accurate film classification and recognition model to automatically identify and classify film posters, styles, and other features. By leveraging this model, the study hopes to provide more accurate data support for film recommendation systems, search engines, and other applications, thereby enhancing user experience and overall system performance. To achieve the research objectives, this study employs a CNN-based model design. As a powerful DL model, CNN has achieved remarkable success in image recognition. This study preprocesses and extracts features from film posters, constructing a CNN model with multiple convolutional layers, pooling layers, and fully connected layers. The model can automatically learn features from film posters and accurately classify film styles. In terms of experimental results, this study first evaluates the model's computational efficiency and accuracy. The proposed model's average computation time is about 98 ms, slightly less than other models (approximately 102 ms). Additionally, the proposed model achieves a recognition accuracy of 90 %, significantly higher than the other models (around 87 %). This result demonstrates the proposed model's advantages in both computational efficiency and accuracy. Furthermore, this study tests the model's recognition performance across different film styles. The results denote that the model performs best in recognizing drama and thriller films, with accuracies between 80 % and 90 %. This is likely because these two genres have distinct features in their poster designs: dramas often emphasize facial expressions and plot elements, while thrillers typically utilize darker tones and intense visual effects. These characteristics are well captured and recognized by the model. Despite the remarkable technological

breakthroughs in computational efficiency and accuracy, there is still room for further optimization. Firstly, this study can improve the model's performance by incorporating more advanced algorithms and techniques. For example, exploring more complex network architectures, increasing the depth or width of the model, and adopting more efficient optimization algorithms could be beneficial. Secondly, increasing the dataset's diversity and scale can enhance the model's generalization ability and robustness. Additionally, it is also possible to consider integrating the model with other technologies such as computer vision or NLP to gain a more comprehensive understanding and analysis of film content. The main contribution of this study is the development of an efficient and accurate film classification and recognition model. This model not only accurately identifies film posters and styles in a short time but also exhibits high generalization ability and robustness. This achievement provides new possibilities for research and applications in film classification and recommendation systems, as well as offering new ideas and methods for similar image recognition tasks. Furthermore, the study's experimental results validate the model's advantages in computational efficiency and accuracy, furnishing strong support for future research and applications.

8. Conclusion

With the emergence and development of digital IoT technology, intelligent technology has occupied a vital position in many industries and fields in today's society, having a huge impact on social progress and playing a huge role in promoting the growth of cultural exchanges. In the industries covered by the B&R initiative, the film is a main means of cultural retransmission. Optimizing film transmission technology through intelligent means is an extremely important reform. Thus, in this study, firstly, the development of digital IoT technology is described; Secondly, it discusses the spread of Chinese films in Portuguese-speaking countries and areas, which provides the relevant theoretical basis for the study. Finally, based on DL technology, an intelligent film style recognition and classification model is designed, offering technical support for optimizing Chinese film communication technology. The results show that the CNN technology has the best learning curve after the design. When the number of iterations is about 500, the learning and accuracy rates are basically stable, and the final loss value and accuracy reach 0.5 and 0.9, respectively. Then, in classifying and recognizing film features, the designed model has a relatively stable recognition effect while processing eight film posters. Its accuracy is usually between 60 % and 90 %. The model has the best recognition results for thriller and drama films, with an accuracy of between 80 % and 90 %. For romantic films, action films, and documentaries, the recognition is less effective, with the relevant accuracy between 60 % and 80 %. Ultimately, the average calculation time of other models and the designed model is 102 ms and 98 ms. The maximum accuracy of the designed and other models is about 90 % and 87 %, respectively. It can be concluded that the designed technical model has achieved a major breakthrough. Although this study designed a relatively excellent technology model for film recognition and classification, it did not conduct a more in-depth analysis of this model's practical application effects and growth opportunities in the film transmission process. Therefore, these issues will be explored and analyzed in future studies to promote the spread and development of Chinese films in Portuguese-speaking countries and areas, and ultimately have a positive impact on the progress of social science and technology as well as the development of cultural industries.

Data availability statement

The data supporting the findings of this study are available upon request. Contact the corresponding author for details.

CRediT authorship contribution statement

Dong Han: Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jie Xu:** Writing – review & editing, Writing – original draft, Resources, Project administration, Formal analysis, Data curation, Conceptualization. **Ping Zhou:** Writing – review & editing, Writing – original draft, Visualization, Validation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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