

Technological Trends of Photography Projection Based on Patent Analysis

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Abstract: With the rapid development of the global film industry, film projection technology plays an increasingly prominent role in order to enhance the performance of film images and sound and enhance the interactive feeling of the audience. In order to accurately grasp the film shows the development of technology, puts forward a research method based on patent analysis study of film screening technology, the method from the trend of the global patent application, patent application for geographical, the main technology such as three angles were studied on the development of film technology, analyzes the development trend of related patent applications and the distribution of the technology, the technology has been clear about the movie is the main development direction. Through the analysis of global patent data, we can accurately grasp the development trend and characteristics of the field of film projection technology in the future, which has reference value and function for the development of film projection technology in the future.

1. Introduction

Film is a technology that USES photography, sound recording and other means to capture the image and sound of external things on film, and creates moving images and sound on the screen by projection, so as to represent certain content [1]. Ever since the Lumiere brothers in France invented film in 1895, mankind has been using film to reflect the real world through images, colors and sounds, and to show artists' thinking and creation [2]. Can be seen from the development history of movie hundred year, from the beginning of the birth, the film will benefit from the development of science and technology, the film is related to the development of science and technology as the foundation, in the interaction between technology and art in the development and mature gradually, its every change and progress, the corresponding relationship between science and technology have significantly can say without technology, there is no film, no movie art [3]. Films have widely absorbed and applied scientific and technological achievements in related fields in their historical development. To some extent, the development of films lies in the development of technology, and the progress of technology also represents the progress of films [4]. According to statistics, the total number of movie screens worldwide in 2018 was nearly 190,000, an increase of 7% compared with 2017. Total global box office reached \$41.1 billion, up 1% from 2017; By contrast, The total number of Chinese screens has exceeded 60,000, ranking first in the world, and the country's total box office in 2018 exceeded 60 billion yuan, up 9.1 percent year on year. Driven by market demand and high and new technologies, film technological innovation ability and technological application level have been continuously enhanced, and film production level, technological content and audio-visual quality have been significantly improved [5]. The research and development, promotion and application of high-tech films have been further strengthened, and the quantity and quality of high-tech films in giant screen, 3D, 4K and other formats have been steadily improved, promoting the development of theaters towards immersive comprehensive experience. Virtualized production platform and cloud production platform have been preliminarily established to promote the development of film production and projection technology [6].

In the process of film transmission, film projection has a direct impact on film transmission

effect. Projection technology plays a vital role in improving the quality and level of film projection and improving the audience's audition experience [7]. With the development of science and technology, film projection technology has gradually changed from 2D projection mode to 3D development and transformation. Digital stereo projection technology, represented by red retractable tone, digital back ring, high brightness gain, processor automatic control and other technologies, plays an important role in improving audiovisual experience and artistic restoration.

In order to more fully understand the film of the development of technology, the technology as the research object, based on the movie is based on the related patents in the field of film screening technology were analyzed, and the research development trend in the field of film technology, help to clear understanding of the dynamic development of film technology, master film screening technology development in the field of focus and direction, which movie screening technology development to provide the reference for the future.

2. Analysis of Technology Development Trend

In order to analyze the application trend in the field of film projection technology, this paper has counted the number of patent applications in the direction of film projection technology since 1970, and the changing trend is shown in Figure 1. As can be seen from Figure 1, before 2000, the number of film projection technology technology-related patent applications was relatively small, with an average annual application of less than 20. After 2000, the number of patent applications showed a trend of rapid development. Therefore, the analysis of film projection technology patent application trend can be divided into two stages, namely the embryonic stage (before 2000) and the developmental stage (from 2000 to now).

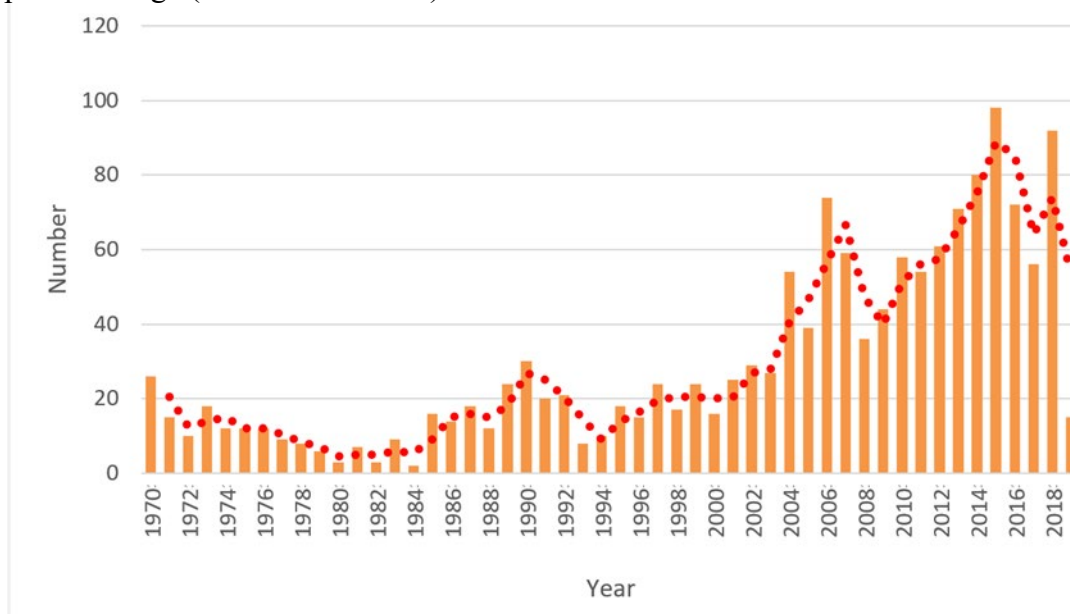


Figure 1 Trends in film projection technology patent applications

2.1. Stage in Germination

In seedling stage (before 2000), the film's screening model is given priority to with the traditional film screenings, still in the film projection model, the projector can be a drag along the rail continuous film equipment, so that each frame of film can brief stay in front of the light source, the effect of light source is to provide the strong light, the image on the film through the lens projected on the screen.

In this stage, the development of film projection technology in this stage, mainly in the following aspects.

1) Improvement of key lighting components. The main component of the film projector is the light source. Carbon arc lamp was widely used in the early 20th century, but due to its short service

life, it was gradually replaced by xenon lamp in the 1990s. At the embryonic stage, the development of xenon lamp lighting technology is mainly reflected in several aspects, such as improving brightness, enhancing anti-interference ability and extending service life. For example, CN2094173U proposes an ultra-high voltage star short-arc xenon lamp rectifier, using the new thyristor phase-controlled rectifier to replace the diode, so that the lighting system has a higher power factor and steady flow accuracy, to achieve the purpose of extending the life of xenon lamp; CN2047794U proposes a xenon lamp reflector system for film projectors, which improves the illuminance uniformity by adopting the crime of light superimposed cone-axis reflector.

2) Improved screen reflectivity and projection sharpness. For example, CN2070919U's method of arranging convex and concave rectangular reflectors on the screen improves the performance of focusing light on the screen and increases the reflectivity; CN86210530U proposes a microbead grating type gold-plated screen, which is composed of flat cloth, polyvinyl chloride resin coating and metal coating, and has the advantages of brightness light, large horizontal light distribution Angle, etc.

3) Improve screening efficiency and labor intensity of exhibitors. For example, CN1234575A proposes a method and device for automatic returning of film projection, which can automatically detect, automatically and control the automatic switch of the projector through the microprocessor, thus achieving the purpose of improving the working intensity and efficiency of the projector. CN2089185U proposed a film projection controller, which can realize the automatic changing of the projector and the projection process in the film projection process, so as to improve the projection efficiency.

In the early stage, limited by the technology development at that time, the improvement of film technology was still mainly based on the traditional film projection technology, and the number of patents in this stage was relatively small.

2.2. Stage of Development

During the development period (2000-present), thanks to the rapid development of digital technology, the number of patent applications in the field of film projection technology showed a fluctuating growth trend, with an average annual application of over 40. At this stage, thanks to the development of computer technology, material technology and network technology, the most prominent feature of film projection field is the rapid development of digital projection technology. Compared with the audience's experience under the traditional film projection technology, the digital film projection technology can make the visual and auditory effects of the audience more vivid and real, giving the audience a kind of immersive effect. Moreover, the synchronicity of the picture and sound also achieves a very good effect. At the same time, special screen, interactive experience related projection technology has also been rapidly improved.

In the period of development, the technology patents related to the projection method, projection device and projection system of digital film are the most concentrated and prominent. For example, WO2014005553A1 proposed to improve the projection resolution of the projector and the viewing effect by using the method of composing sub-images based on digital movie packages. WO2015051612A1 proposed a digital film projection system including an image acquisition and analysis system. The image processing module was built into the projector system to ensure the security and stability of the image information during the film projection process. In the aspect of special screen, CN1687844A adopts the film projection screen made of traffic safety reflective material, which not only has the characteristics of high reflectance and high definition, but also has the advantages of small transportation volume and light weight. CN108441037A proposes a screen optical coating formula, which can produce digital screen with different brightness coefficients according to the demand, making the film screen exquisite and clear, colorful, bringing unprecedented visual impact to the audience; In terms of interactive experience, CN110048989A proposes a method and device for interactive film projection, which emancipates the audience from the unilinear narrative mode of traditional films, so that the audience is no longer just passively watching the film, but can participate in the development of the plot and interact with the film in

real time. CN201917850U proposes a digital interactive film projection system, which integrates interactive elements of the game with the film, shoots and produces different plot development when the plot needs, and lets the experient choose the interactive form of the game. In addition, in the field of traditional film projection technology, attention has also been continuously enhanced. In the field of projector light source cooling, CN104710966B proposed a film projector cooling liquid and its preparation method, so that the projector light source has a wide operating temperature range, better heat transfer performance, less corrosive, better light stability. CN206638936U proposes a water-cooled film projection lamp, which can quickly dissipate the heat of the reflection lamp, avoid the situation that the projection lamp temperature is too high, ensure the reflection effect, and extend the service life of the lamp. In the field of fault monitoring, CN109274963A puts forward a fault prediction method of cinema projection server, which can timely find problems during the film projection, avoid the occurrence of projection accidents, and improve the economic benefits of cinema.

3. Analysis of Geographical Distribution

Figure 2 statistics the output of patented technology of each country or region in the world to understand the investment and technological innovation strength of each country or region in the field of film projection. According to the analysis results, patent applications in the field of film projection technology mainly come from China, the United States and Japan.

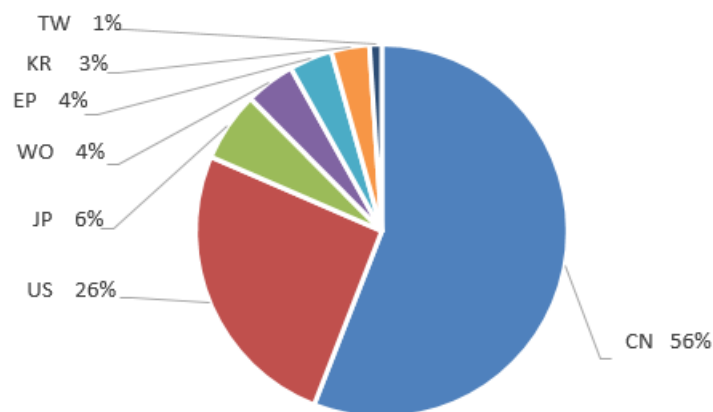


Figure 2 Analysis of global regional patent distribution

3.1. China

China ranked first in the number of patent applications, accounting for 56 percent of the total, reaching 943. In recent years, the number of patent applications in the field of film projection technology in China has shown a rapid growth trend, which mainly depends on the following aspects:

1) The rapidly growing market demand. Since the 21st century, China's film industry has developed rapidly, with rapid growth and breakthroughs in box office revenue, number of movie goers, number of films released and number of movie screens. In 2018, the box office revenue of Chinese films exceeded 60 billion yuan, with a year-on-year growth of 7.9%. The number of cinema visitors in the whole year reached 1.717 billion, with a year-on-year growth of 5.9%. The number of screens reached 61,071, with a year-on-year growth of 15.5%, and the three-year average growth rate was 18.6%. The box office revenue, the number of screens and the number of movie goers are all showing a rapid growth of market demand;

2) Policy and legal support. The Film Industry Promotion Law of the People's Republic of China issued in 2016 includes the development of the film industry in the national economic and social development plan. From the policy perspective, the film industry is regarded as an important industry to boost domestic demand, promote employment and promote national economic growth.

3) The rapid development of Science and technology in China. In recent years, the state has

taken scientific and technological innovation as a strategic support for the improvement of social productivity and comprehensive national strength. Through a series of strategic guidance and promotion, China's scientific and technological undertakings have realized the path of development from laying the foundation, to reform and opening up, and then to independent innovation. In recent years, China has made great progress in materials science, data science, artificial intelligence and other fields. The progress in these fields has promoted China to achieve rapid development in digital movies, high dynamic range light source technology, high reflectance and high definition screen technology.

4) The increasing perfection of China's intellectual property system has also prompted film projection related technology R&D units to gradually increase their awareness of patent protection for technological innovation.

3.2. The United States

The United States ranked second with 431 patent filings, accounting for 26 percent of the total. The dominant position of the United States in this field is mainly due to the following reasons:

1) The world's leading technological level. After the war, the United States formed an organizational system and research environment that encouraged innovation, and brought into full play the enthusiasm and ability of talents in various fields, so as to promote the continuous development of science and technology. Technology is the main force leading the long-term transformation of the film industry, including film projection technology. America's leading position in the field of science and technology effectively combines technology with computer-aided design, digital editing and editing equipment, and promotes the rapid development of technology in the field of film reflection.

2) A continuously growing market environment. From the perspective of global pattern, although the North American film market gradually tends to saturation, its dominant position is still obvious. In 2017, the total box office in North America reached \$11 billion, accounting for 27.09% of the global total, up nearly 7% year on year. The number of movie goers reached 1.301 billion, a year-on-year increase of 5.3%, and the number of screens reached 43,495, a slight year-on-year increase.

3) Perfect film talent system and industrial system. Many famous Universities in the United States offer majors and courses related to the film and television industry, providing a steady supply of talents for the film industry. In addition, the American film and television industry has hundreds of thousands of talents. The personnel structure of this volume will inevitably lead to the development trend of competition and virtuous circle. At the same time, the United States has a complete film industry system, from cameras, sound, sound effects, visual effects, set props production, projection and so on, there is a complete industrial chain.

4) The United States has recognized the importance of patents since its founding. In order to promote the development of science and technology and protect the rights and interests of inventors, the United States has written the protection of patents into the Constitution. During its more than 200 years of development, the United States has been able to achieve remarkable achievements in many fields such as economy, science and technology, military and so on. One of the most important factors is its awareness of patent application and protection, as well as its sound intellectual property system.

3.3. Japan

Japan ranked third in patent filings, accounting for 6% of the total, with 102. Japan can take a leading position in this field mainly due to the following reasons:

1) Strong policy support. Relevant departments of the Japanese government provide intellectual, financial and material support to the domestic film and television industry, and set up a special "Art and Culture Revival Meeting" to provide financial support for film production, screening and operation. The differentiation strategy of the film industry has been formulated and the innovation has been carried out in many aspects of film projection. For example, in the construction of cinema projection facilities, the construction of multi-hall modern cinema plays a great role in attracting the audience to the cinema. Like Japan's traditional and smaller theaters, these new ones typically have

multiple screens that cater to different tastes at the same time. The delightful audio-visual system enables the audience to fully experience the sense of presence that can only be experienced in the cinema. Policy support for the film industry has become a strong foundation for the sustained recovery of the Film industry in Japan, which has created a prerequisite for the development of film projection technology.

2) A resurgent film market. Japan in the 1950 s, the film is to be the king of the entertainment industry, not only the screen number, work number peak, level and of the film, have repeatedly won the Oscar for best foreign language film, although in the past 30 years the years failed to state out of recession, but in recent years, the use of television in filmmaking, broaden financing channel, strengthening propaganda, under the action of multiple means such as Japan's in 2018 at the box office, 222.511 billion yen, equivalent of RMB 13.493 billion yuan, moviegoers times 169 million, 2018, in spite of all decreased, compared to the same But still third in the world.

3) under the action of patent protection consciousness gradually enhanced, Japan to realize the patent in scientific research and the role of market competition, to enhance its especially in the field of film and television transmission film screening in the field of competitiveness, create more economic value, we intensified the efforts on the patent application in the field, make the Japanese technology in the movie is in a leading position in the patent application.

4. Composition Analysis of Patented Technology

As shown in Table 1, patent applications in the field of film projection technology mainly involve film projection method, system and device, image processing technology, optical system, component or method, digital signal processing, information storage, etc., among which the technology reserves of film projection method, system and device are the largest.

Table 1 Global distribution of major technologies in film projection

ISN	USA	CHINA	EU	JAPAN	WIPO	Taiwan	Korea
G03B	309	303	34	30	16	8	4
H04N	31	163	8	25	15	3	8
G02B	9	55	2	1	3	2	3
G06F	7	28	4	1	2	1	2
E04H	2	38	0	1	1	0	0
G06Q	2	26	0	0	2	0	10
A63J	1	27	1	3	1	1	2
G11B	5	7	2	3	2	0	0
H04L	1	16	0	1	1	0	0
B32B	0	0	0	0	7	0	0

4.1. Film Projection Methods, Systems and Devices

In terms of film projection methods, systems and devices, a total of 704 related patent applications were filed, mainly relating to the structure of the film projection system, projection methods, projection devices and other technologies related to the projection system as a whole. In terms of film projection methods, systems and devices, the distribution of global patent applications is shown in Figure 3. It can be seen from Figure 3 that the patents of film projection methods, systems and devices around the world are mainly from the United States, China, the European Union and Japan. Among them, the United States filed the most patents in this technology field, reaching 309, accounting for about 44% of the global applications of this major technology direction. At the same time, it can be seen from the statistical data shown in Table 1 that the patents applied by the United States in this direction account for 84% of the patents applied in the direction of film projection technology, which is the key direction of the development of film projection technology in the United States.

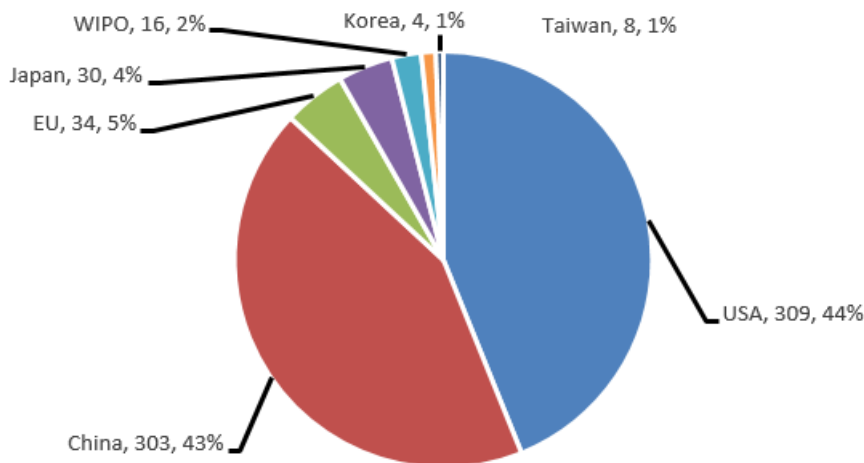


Figure 3 Global patent distribution of film projection system structure and projection method

4.2. Image Processing Techniques

In terms of image processing technology, there were 253 related patent applications. The technology in this field mainly involves the equipment and methods of image processing in the process of film projection. The purpose is to improve the viewing effect of film projection, enhance the clarity and dynamic effect of film images, and ensure the security and stability of images in the process of film projection. As for the direction of image processing technology, the distribution of global patent applications is shown in Figure 4. As can be seen from Figure 4, patents in this technology field are still mainly from China, the United States, the European Union and Japan. The number of patents filed by China in this technology direction was the highest, reaching 163, far surpassing the United States, which ranked second, and accounting for about 65 percent of the total number of patents filed globally in this technology direction.

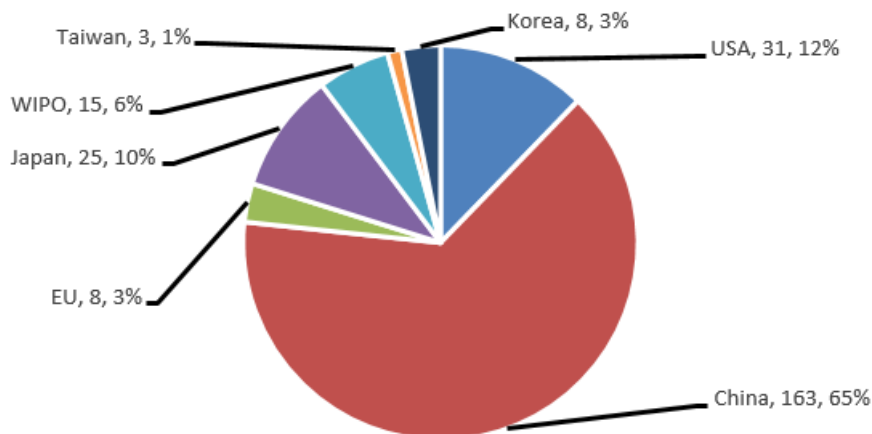


Figure 4 Global patent distribution in image processing direction

4.3. An Optical System, Element, or Method

In terms of optical systems, components or methods, there are a total of 75 related patent applications. The technology in this field mainly involves the use of optical means or methods to effectively show the film picture on the screen more perfect, which is to improve the quality of the projection picture or obtain a better stereo vision effect. In this technical direction, the global distribution of patent applications is shown in Figure 5. As can be seen from Figure 5, the number of patents applied by China in this technology direction is in the absolute leading position, accounting for 73% of the global number of applications in this field.

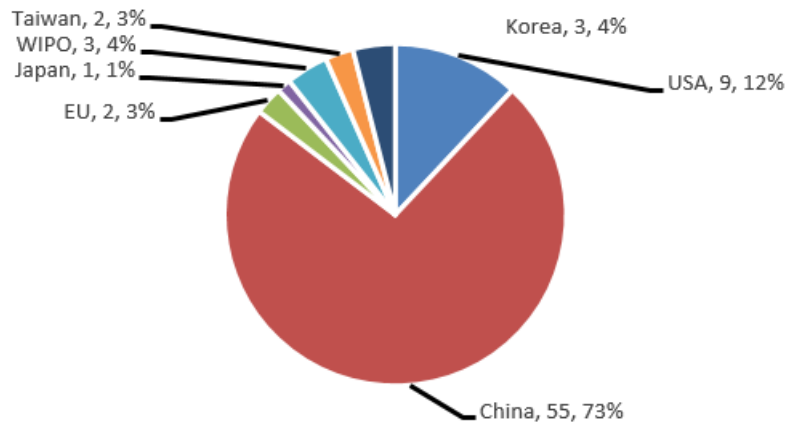


Figure 5 Global distribution of patents for optical systems, components or methods

4.4. Other

In other aspects of film projection technology, it mainly includes using digital processing methods to manage film projection so as to realize automatic methods such as projector equipment management and fault monitoring, so as to improve the reliability and efficiency of projection. The function of the film screening place is optimized to meet the needs of different audiences and create the theme effect. At the same time, there are also a certain number of patent applications in other technical fields such as information storage and digital information transmission. Similar to the main technical directions of film projection methods, systems and devices, image processing and optical processing, its patent applications are still mainly from China, the United States, the European Union, Japan and other countries, showing that these countries attach importance to and take the lead in the field of film projection technology.

5. Conclusion

Film projection technology is an important standard to measure the quality of film broadcast, which will have a direct impact on the economic benefits brought by films. Therefore, while people are putting forward higher and higher requirements on film quality, the film industry needs to pay attention to the improvement of its projection level and improve the market competitiveness of the film industry through the rational use of advanced science and technology. Film screening technology involves numerous content, made up of multiple complex system and task, in the future to realize from the traditional film screenings to digital film screening process, must be involved in film technology for scientific control system of each link, in the screening venues, screen, such as image and sound involves the audience receive information channels, developing and using new technology, enhance the audience's experience and interaction.

This paper analyzes the global patent data of film projection technology. The results show that with the development of film industry, science and technology and patent protection awareness, the number of patent applications in the field of film projection technology develops exponentially. With the development of film projection system towards digitalization and interaction, the United States, China, Japan and other major countries have increased their technical input in the main directions involving film projection technology, such as overall film projection technology, image processing, optical system, components or methods involved in film projection, etc. Through the analysis of global patent data, we can accurately grasp the technology development trend and characteristics in the field of film projection technology in the future, which has a high reference value and function for the development of relevant technology in China.

References

- [1] Jun Z, Cinema T C. Analysis on the application of digital movie projection technology. *Wireless Internet Technology*, 2018.

- [2] Wei G. On the Application and Future Development of the Film Projection Technology in China. *ence & Technology Information*, 2017.
- [3] Tachi, Susumu. Retroreflective Projection Technology (RPT). *Telexistence*, 2015, 10.1142/9248:112-123.
- [4] Yu L, Quan-Cai J, Ming-Ming L, et al. Design of the Virtual Keyboard Based on the 3D Holographic Projection Technology. *Management & Technology of SME*, 2019.
- [5] Wu G, Shen Z, Shang X, et al. 3D Printer Optical Detection System Based On DLP Projection Technology// 2019 Chinese Automation Congress (CAC). 2019.
- [6] Maosheng H, Jiqiang L, Chengbo F, et al. Research on precise assembly technology of railway vehicles based on laser scanning projection. *Optical Technique*, 2019.
- [7] Sinha R, Bhattacharya P, Iben I E T, et al. ESD Reliability Study of a-Si: H Thin-Film Transistor Technology: Physical Insights and Technological Implications. *IEEE Transactions on Electron Devices*, 2019, PP (99):1-7.