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AN APPLIED RESEARCH ON THE USE OF ARTIFICIAL INTELLIGENCE TECHNOLOGIES IN MOVING IMAGE PRODUCTION

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Abstract

Since the mid-20th century, artificial intelligence technologies, which have their roots in neuroscience and the discovery of neural networks, have created a rapidly growing competitive field on a global scale. Systems based on artificial intelligence technology are used today in important areas affecting individuals and society such as health, finance, trade, education, media, industrial production, energy, cyber security. Artificial intelligence companies receive significant funding from the world's leading corporations and governments. At the same time, machine learning based on big data is gaining increasing importance. The ethical issues associated with the negative uses of artificial intelligence, alongside its benefits, remain a topic of debate. However, the transformative potential of these technologies calls for a collective consensus rather than distancing from the field. The research aims to discuss the potential of artificial intelligence in moving image production by considering this reality. In humanity's artificial intelligence adventure, which started with the question 'Can machines think?', this research focuses on the question 'Can artificial intelligence produce professional, hyper-realistic scenes?' and analyses the outputs of three platforms operating in the field. Within the scope of the research, Runway, Luma Dream Machine, Imagine Art platforms were asked to produce moving images including two realistic and futuristic scenarios. The moving images produced were subjected to content analysis and analysed under the categories and subcategories determined. Despite certain errors, it has been observed that artificial intelligence technologies are poised to reshape the expertise-driven process of moving image production in a short time. Key areas of expertise in the industry are likely to be replaced by AI-based technologies. It is concluded that in the near future, artificial intelligence technologies can be used as an alternative to conventional production mechanisms such as script writing, scene design, visual effects, which require great cost, and will play an important role in moving image production.

Keywords: *Communication studies, artificial intelligence, machine learning, moving image*

HAREKETLİ GÖRÜNTÜ ÜRETİMİNDE YAPAY ZEKÂ TEKNOLOJİLERİNİN KULLANIMI ÜZERİNE UYGULAMALI BİR ARAŞTIRMA

Öz

20. yüzyılın ortalarından itibaren temelleri atılmaya başlayan, kökenleri nörobilime ve sinir ağlarının keşfine dayanan yapay zekâ teknolojileri küresel ölçekte hızla büyüyen bir rekabet alanı oluşturmuştur. Yapay zeka teknolojisine dayanan sistemler bugün sağlık, finans, ticaret, eğitim, medya, endüstriyel üretim, enerji, siber güvenlik

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** Yazar, makalede araştırma ve yayın etiğine uyulduğuna ve kullanılan fikir ve sanat eserleri için telif hakları düzenlemelerine riayet edildiğine yönelik beyanda bulunmuştur.

gibi birey ve toplumu etkileyen önemli alanlarda kullanılmaktadır. Dünyanın önde gelen şirketleri ve hükümetler tarafından yapay zekâ şirketleri fonlanmakta, büyük veriye dayalı makine öğrenimi giderek önem kazanmaktadır. Olumlu kullanımlarından doğan faydaların yanında olumsuz kullanımlarından doğan etik sorunların varlığı tartışma konusu olsa da yapay zekâ teknolojilerinin geleceği şekillendireceği gerçeği, alandan uzaklaşmak yerine uzlaşıyı gerektirmektedir. Araştırma söz konusu gerçekliği gözeterek yapay zekânın hareketli görüntü üretimindeki potansiyelini tartışmaya açmayı amaçlamıştır. "Makineler düşünebilir mi?" sorusuyla başlayan insanlığın yapay zekâ serüveninde bu araştırma, "Yapay zekâ profesyonel, hiper gerçekçi sahneler üretebilir mi?" sorusuna odaklanarak alanda faaliyet gösteren üç platformun çıktılarını incelemiştir. Bu kapsamda Runway, Luma Dream Machine, Imagine Art platformlarından gerçekçi ve fütüristik iki senaryoyu içeren hareketli görüntü üretmeleri istenmiştir. Üretilen hareketli görüntüler içerik analizine tabi tutulmuş, belirlenen kategoriler ve alt kategoriler altında incelenmiştir. Çeşitli hatalar olsa da yapay zekâ teknolojilerinin kısa süre içinde uzmanlık gerektiren hareketli görüntü üretim sürecini yeniden şekillendireceği, sektördeki önemli uzmanlık alanlarının yerini yapay zekâya dayalı teknolojilerin alacağı görülmüştür. Yakın gelecekte senaryo yazımı, sahne tasarımı, görsel efekt gibi büyük maliyet gerektiren konvansiyonel üretim mekanizmalarına alternatif olarak yapay zekâ teknolojilerinin kullanılabileceği, hareketli görüntü üretiminde önemli bir rol üstleneceği sonucuna varılmıştır.

Anahtar Kelimeler: *İletişim çalışmaları, yapay zekâ, makine öğrenimi, hareketli görüntü*

Introduction

Developments in the field of artificial intelligence have led to revolutionary innovations in many fields, forcing the transformation of many business models carried out with conventional methods. The rapid advancement in artificial intelligence technologies has led to the growing importance of machine learning and big data-based research. In addition to the benefits arising from the positive uses of artificial intelligence technologies, the negative uses of artificial intelligence technologies have also brought ethical debates to the agenda. Although there are negative aspects, the technology in question will undoubtedly play an important role in the future of humanity and mediate various sociological transformations. For this reason, determining the boundaries of the field has required the field of social sciences to carry out studies on artificial intelligence technologies.

Well-established fields of social sciences have focused on the subject with the increasing popularity of artificial intelligence technologies and have tended to conduct research on their positive and negative uses. In particular, researches such as the effects of artificial intelligence-supported technologies on society and the individual, and the determination of the effects arising from negative uses have come to the fore. Research on the relationship between mass media and artificial intelligence technologies has also reported important results by focusing on various contrasts. While these researches provide important clues for scientists to make inferences about the current situation and future of social transformation processes mediated by artificial intelligence technologies, they also expand the boundaries of social sciences (Miller, 2019; Deranthy & Corbin, 2024, p. 675; Hernández, 2024).

In the processes of social transformation mediated by Internet technology, the structure of the act of watching, one of the most important sources of entertainment, has also changed. In today's world, where the basic practices regarding the use of traditional mass media for entertainment and information purposes have taken on a new structure, the development of artificial intelligence technologies has also gained great momentum. These issues have made it necessary to discuss attempts to use artificial intelligence-based technologies in the film-series sector. Various studies focusing on the subject have stated that artificial intelligence technologies can make positive contributions to areas such as script writing, cinematography, editing, music design, visual effects (Chow, 2020, p. 193; Aslanyürek & Aycan, 2024; 75). As in the revolution of video streaming services that changed the viewing experience and habits (Başer & Söğütlüler,

2023) the use of artificial intelligence technologies in the film-series sector undoubtedly has the potential to significantly change the dynamics of the field. It is necessary to conduct scientific research on the role of artificial intelligence technologies, which are stated to be suitable for use in various aspects in pre-production, production and post-production stages, in moving image production. Issues regarding how artificial intelligence-based technologies will affect various areas of the mass communication industry have led researchers, especially communication scientists, to new inquiries. One of these questions is 'Can artificial intelligence produce professional, hyper-realistic scenes?' and this discussion has become important for all sectors under the title of moving image.

The research focuses on analysing the moving images produced by three artificial intelligence platforms that are currently capable of producing moving images from text. It analyses the results of the moving images produced by entering commands containing two realistic and futuristic scenarios prepared by ChatGPT into the Runway, Luma Dream Machine and Imagine Art platforms by content analysis method. This research is important in terms of exploring the future potentials of artificial intelligence applications in the moving image production sector. It is foreseen that future researches exploring these production mechanisms with other prominent platforms, examining character production processes and rendering times will contribute to the field. Artificial intelligence technologies offer significant potential in the pre-production, production, post-production and distribution stages of film-series production. This research was conducted to examine the potential sectoral contributions of artificial intelligence by focusing on this issue. This study shows that in the future, artificial intelligence will be able to produce hyper-realistic scenes and thus image production processes, one of the important issues in the field of communication sciences, will take on a new structure.

1. Review of the Literature on Artificial Intelligence and Its Use in Art Production

The concept of artificial intelligence, one of the prominent research areas of the recent scientific field, has been one of the technologies that have left its mark on the 21st century. According to the Oxford Dictionary (2023), it is defined as 'The capacity of computers or other machines to exhibit or simulate intelligent behaviour', while according to Mondal (2020, p. 389) it means the effort to build machines with human-like senses (perception), analysis or understanding and reaction. This human-like capability includes cognitive functions such as learning, problem solving, reasoning, decision-making, etc., which in the recent past were exclusively human. Artificial intelligence technology has a wide range and concepts such as machine learning, deep learning, natural language processing, computer vision, etc. constitute the concept sets that artificial intelligence is related to. In the development process of the concept, especially after the mid-1900s, interest in the subject began to increase (Turing, 1950; Goodfellow et al., 2016; Letheren et al., 2020). The origins of technology are based on human inspiration from nature, as in many technological discoveries, and neuroscience plays a pioneering role in this development process.

In 1943, McCulloch and Pitts tried to understand how the brain could produce extremely complex patterns using interconnected cells called neurons, and the foundations of the relationship between science and humans and the development processes of artificial neural networks were laid (McCulloch & Pitts, 1943, p. 115; Voulodimos et al., 2018). This whole adventure, which started with the question 'Can a machine think?' just after the Second World War, was tried to be answered with the development of the 'Turing Test' to answer the question. The studies that resulted in the evaluation of the machine's ability to imitate humans as 'thinking' in the process of

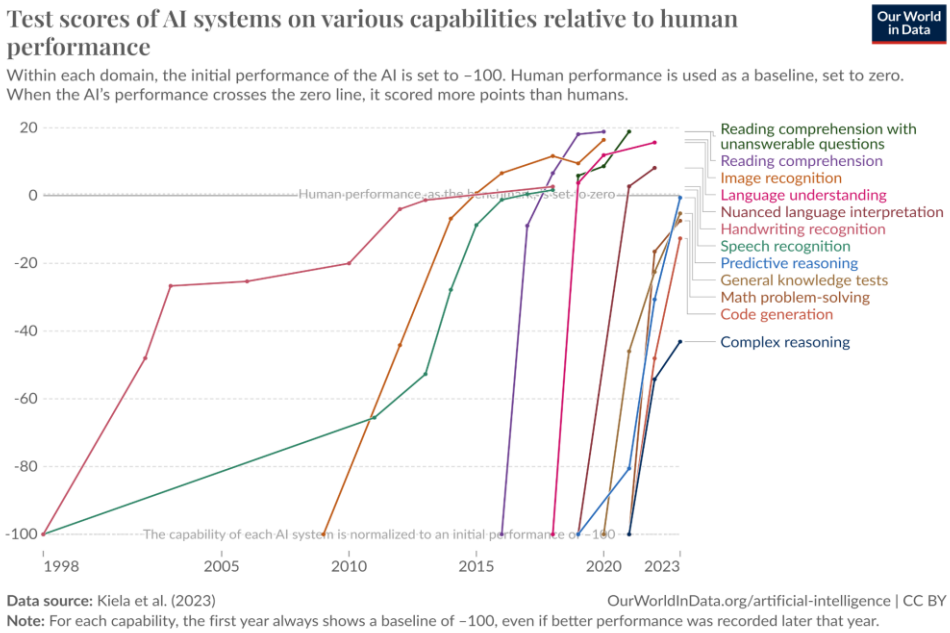
human-machine interaction led to the foundations of artificial intelligence (McCarthy et al., 1956; Minsky & Papert, 1969; Russel & Norvig, 2016; Turing, 1950).

The question 'Can machines think?' and the endeavour to establish a relationship between man and machine have helped to gather interest in the field. The emergence of the definition of artificial intelligence as a concept was in 1956 and the term was mentioned for the first time at a conference. Following this process, the pioneering studies on the concept primarily included issues such as the ability of machines to think, the development process of the term, artificial neural networks, the limits of artificial intelligence and trying to explain its technical structure. Although the ability of machines to learn is one of the popular topics of recent scientific studies, the first inquiries on the subject actually started just after the Second World War (McCarthy et al., 1956; McCarthy et al., 2006, p. 12). Along with these inquiries and studies on the field, especially the development of internet technology has been an innovation that has expanded the boundaries of the field of machine learning.

With the development and increasing use of Internet technology, the term artificial intelligence has started to be associated with concepts such as data science and the Internet of Things (IoT), and issues such as how data are collected over the Internet and how they are processed using artificial intelligence technologies have become important (Mayer-Schönberger & Cukier, 2013; Le & Mikolov, 2014). Artificial intelligence technologies have become closely related to the concept of 'big data' as they can learn certain processes by analysing data sets and make decisions about these processes. Big data, which is one of the most important concepts in the current dominance of artificial intelligence, is also related to the concept of deep learning, which is a sub-branch of machine learning. While these concepts are among the basic concepts of artificial intelligence, they play a role in analysing large data sets and providing machines with the ability to make decisions (Schönberger & Cukier, 2013; Goodfellow et al., 2016).

Innovations such as analysing big data sets and machines starting to take an active role in decision-making processes have had a global impact, shaping the production practices of large companies, and conventional production forms and business models have begun to be abandoned. Many important companies have focused on the development of artificial intelligence technologies, and developments in this field, especially in engineering fields such as design, production and data analysis, have become the new research areas of these companies. Major technology companies such as Apple, Google and Amazon have started to include artificial intelligence in their product launches and focused on making it available in their products. Educational institutions have aimed not to lag behind technology with innovative models and curriculum arrangements, and many states have funded researchers operating in this field. Industrial processes based on artificial intelligence continue to improve the mutual relationship between the individual and technology, and in this process, artificial intelligence adds new ones to its capabilities (Agrawal et al., 2017; Benriyene & Bakkali 2023, p. 215). The capabilities of artificial intelligence have started to be analysed under three basic categories: Narrow AI, General AI and Super AI. Narrow AI is used to describe artificial intelligence technologies that are designed to fulfil a single or limited task, General AI is used to describe artificial intelligence technologies that are expressed to have cognitive abilities similar to human intelligence and have a wide scope, and Super AI is used to describe a superhuman artificial intelligence category that refers to the cognitive abilities of humans (Bostrom, 2016; Banafa, 2024). The situation summarised below by Kiela et al. (2023) compares human and artificial intelligence capabilities and shows that modern AI technologies tend to cross the zero line rapidly.

Figure 1. Comparison of the capabilities of human and artificial intelligence technologies



Source: Kiela et al., (2023)

Due to the rapidly developing capabilities of artificial intelligence technologies, there are important concerns as well as increasing interest in the subject. One of these concerns is the potential for some professions to be performed by artificial intelligence tools, just as in the industrial revolution, due to the convergence of artificial intelligence and human capabilities. The table summarised above, which includes human-artificial intelligence capabilities, is important in terms of providing a prediction on the subject, and studies focusing on the subject have been carried out in the academic field. For example, Frey and Osborne (2017), in their study titled '*The Future of Employment: How Susceptible Are Jobs to Computerization*?', investigated the expected effects of future computerization on US labour market outcomes, the number of jobs at risk and gains. The researchers stated that labour force dynamics will change in the near future and concluded that many occupations are under threat.

The only concern about the negative aspects of artificial intelligence technologies is not only the fact that some professional groups are under threat. Although artificial intelligence technologies have many positive uses in areas such as health, production, education and security, there are also various problems arising from their negative use. Problems such as privacy issues, ethical issues, manipulative content constitute the negative aspect of artificial intelligence technologies, and academic studies are rapidly being carried out on this issue. Issues such as the use of clinical data to train artificial intelligence, security issues and possible vulnerabilities in systems using artificial intelligence, deepfake fraud are also examined from the perspective of privacy, ethical grounds and security concerns (Larson et al., 2020, p. 675; Iftikhar et al., 2020; Dash et al., 2022, p. 13). For example, the study titled '*Ethics of Artificial Intelligence and Robotics*' by Müller (2020) deals with the prejudices and ethical issues arising from artificial intelligence technologies. The researcher states that artificial intelligence technologies and robotic processes will have significant effects on the development of humanity in the near future, and focuses on what risks they involve and how we can control them. At the same time, the misrepresentation of artificial intelligence technologies by the mass media has triggered

technophobia, which has sometimes led to a negative perception of artificial intelligence technologies as a whole. Undoubtedly, the fact that the capacity to think and produce, which humanity has positioned itself at the centre of the universe, can be realised by another being has been one of the factors that have given rise to these concerns (Littman et al., 2021). As seen in the examples, many of these studies both evaluate artificial intelligence technologies as an innovation that can offer potential opportunities and point out the negativities that may arise from its use. Attempts to overcome this dilemma have also existed in the academic field, and Calo's (2017) study titled '*The Legal and Ethical Implications of Artificial Intelligence*' discussed the ethical and moral ground. Some studies, such as Cath (2018), have expressed ideas for the design and management of artificial intelligence in an accountable, fair and transparent manner, and have attempted to explain by asking the question of how and through which circles this can be achieved. The potential negativities and opportunities arising from the use of artificial intelligence technologies in various fields have been frequently discussed in the academic field, as seen in the examples. One of these discussions has been the use of artificial intelligence technologies in artistic works. The use of artificial intelligence in various fields that require human creativity has led to significant changes and caused discussions about the nature and originality of art. Some academics have begun to see screens as a canvas, an instrument or an art instructor, while others have stated that human creativity is paramount in the production of artistic works, although they acknowledge its role in developing creative endeavours (Aris et al., 2023, p. 219).

Some researchers have interpreted the integration of this technology, especially in the field of visual arts, as the beginning of an era that affects various aspects of the art world and stated that artists can produce new ideas and compositions in collaboration with artificial intelligence (Mazzone & Elgammal, 2019; Monser & Fadel, 2023). Some studies have stated that human consciousness is far superior to any form of artificial intelligence, and that producing artistic works through artificial intelligence technologies will pose various problems such as not being able to predict the outcome of the work and not knowing the ownership of the work (Güney & Yavuz, 2020, p. 434-435; Yetkiner & Özdemir, 2022, p. 284).

This dialectic between artificial intelligence and art is not only related to creative processes, but also expresses a future full of unlimited possibilities and new challenges in the production of artistic works. One of these challenges is that human beings are affected by social realities and are in constant interaction with their immediate environment. For this reason, many academics have opposed the prioritisation of artificial intelligence over human beings in art production by stating that art is unique to humans (Ashour & Rasdan, 2024, p. 19). These discussions are also valid for applications that have the potential to produce moving images or images from text using artificial intelligence technology, which is the subject of this research. This issue is addressed in academic research in Turkey and around the world, and whether image production from text has artistic qualities and the opportunities it offers are discussed (Aslan & Aydın, 2023, p. 1049; Jiang et al., 2023, p. 363; Avinç, 2024, p. 641). This research aims to question whether the applications that promise to produce moving images from text can realise productions in accordance with the prompts given, the potential of these outputs to serve the moving image industry, and to provide a framework on the subject.

2. The Role of Artificial Intelligence Technology in Moving Image Production

Although humans can directly perceive the three-dimensional structure of the world, the texture of objects and colours, the perception process of machines is quite different from that of humans, and screens present a two-dimensional simulation of the real world (Szelisk, 2022). Through the screens surrounding modern everyday life, the real world is attempted to be redescribed in a two-dimensional space. This process is a fundamental interaction process between man and machine, and this mutual relationship has become increasingly interactive. Human-machine interaction and computer science have a great influence on all these developments.

The presentation of images captured by a camera to the screen is one field, digital reproduction is another. Recording the moving image through a camera and presenting it on the screen presents a reflection of reality. According to Forsyth and Ponce (2002), the production of new moving images with given commands, which includes artificial intelligence and machine learning processes, is "computer vision". A topic that has been talked about since the 1960s, "computer vision" has become a term used to describe the universe that the computer sees, which needs to be considered more and more comprehensively. People want to organise their photo collections, make 3D models of the world around them, manage and edit their video collections. The development of our understanding of the basic geometry and physics underlying the act of seeing has necessitated the acceptance that computers have their own way of seeing and that it has developed in direct proportion to the human. While all these processes are related to the physical nature of vision and image production, another form of vision is related to artistic creation.

While a large part of moving image production is related to the physical aspect of our conceptions of the visual world, another large part is related to the meaning of the images produced. The study by McCormack et al., (2019) attempts various classifications to understand the nature of artistic creation in relation to artificial intelligence. Undoubtedly, the artistic dimension in moving image works becomes more complex when concepts such as artificial intelligence and machine learning are involved. Researchers have questioned the structure of artificial intelligence in production processes through four categories that they categorise as autonomy, originality, authorship and purpose.

The creation of moving images based on artificial intelligence in the field of digital content production, television and cinema is a recent development. The reason why this subject is relatively new compared to other artificial intelligence fields is that hardware competences are also important for the video production process through computers. The series and cinema industry, which is one of the most advanced methods of telling a story with moving images, is also undergoing transformations under the leadership of artificial intelligence technologies.

The relationship between digital content or television and cinema content with artificial intelligence is much more than the act of producing a scene by writing a promt. Today, the scriptwriting of artificial intelligence tools shows that even the foundations of the whole process can be built on artificial intelligence technologies. Initiatives on the use of artificial intelligence in pre-shooting, shooting and post-shooting stages continue rapidly. Academic studies are being carried out in the world and in Turkey on this situation, and scientists present opinions on the current situation and future of artificial intelligence (Muratoğlu & Türkgeldi, 2020, p. 2638; Cevher & Aydın, 2020, p. 614; Anadolu, 2020, p.682; Kaya, 2021, p. 897; Zengin, 2021, p. 700; Zengin, 2022; Aydemir & Fettah, 2023, p. 255; Cake, 2023, p. 89; Türten, 2024, p. 399).

By giving the source video of a person, certain areas can be changed with the target person, scenarios can be written, realistic scenes, visual effects can be produced, these can be systematically edited and made ready, videos can be restored, interactive content and much more can be produced, subtitles and dubbing can provide convenience to editors, content can be presented according to people's tastes, and audience behaviour can be analysed. Due to these advantages, investments are shifting in this direction by large companies leading the sector, and some global companies such as Netflix are very open to innovations (Steck et al., 2021; Koren, 2009; Dong et al., 2015, p. 295; Söğütlüler & Başer, 2023). These possibilities of artificial intelligence show that many dynamics in the field of moving image will be reshaped. With the technological progress of companies operating in the field of moving image production based on artificial intelligence and the development of hardware features in image production, goals such as creating hyper-realistic scenes, making lip synchronisation more successful, and accurately reflecting the cinematographic atmosphere can be achieved.

According to Bastian (2024), Sony Pictures CEO Tony Vinciquerra stated that the company is "focused on artificial intelligence" and wants to use this technology to make film-TV content more efficient. Alphabet, Meta and OpenAI companies have also directed their investments to develop their own artificial intelligence video production systems. Sony Pictures plans to make use of artificial intelligence technologies to reduce the huge costs in the film production process and aims to directly involve artificial intelligence in the film production process. According to Bloomberg (2024), technology giants such as Alphabet, Meta and OpenAI are also preparing to collaborate with Hollywood. Companies that approach this issue more cautiously than others and do not want to lose their position as the determinant of the act of watching are also developing their own strategies. Video streaming services have a positive approach to the use of artificial intelligence technologies to improve the user experience. For example, Netflix established a Machine Learning Platform focusing on this issue and started to carry out its activities related to artificial intelligence under this platform (Netflix Research, 2024).

Film festivals are undoubtedly of great importance for the cinema industry, which has rapidly become an industry with the birth of the moving image. Today, films created with artificial intelligence technology have started to take place in film festivals. The fact that films produced only with artificial intelligence tools or films that make use of artificial intelligence technology to produce various elements take place in film festivals, which can be called the heart of the cinema industry, has shown the importance of conducting research in the field (Netflix Privacy, 2024; The Walt Disney Company, 2024)

Image 1. Artificial intelligence film festival organised by Runway

Source: www.runwayml.com

Tribeca Enterprises (2024) announced a programme where films made using OpenAI's text-to-video AI model Sora will be showcased for the first time at a festival. By giving filmmakers

access to Sora's capabilities, this initiative has begun to explore the emerging field of generative AI as a creative tool. Jane Rosenthal, co-founder and CEO of Tribeca Enterprises, said: "Sometimes these stories come to us as a feature film, an immersive experience, a piece of art, or even an AI-generated short film. I can't wait to see what this group of fiercely creative Tribeca alumni come up with." This initiative is in a very important position in the field. Filmmakers have been granted early access to Sora by OpenAI. Thanks to this opportunity, films were produced and this initiative was seen as an important opportunity for series-film production (OODA Analyst, 2024).

The relationship between artificial intelligence and moving image production has the potential to contribute to various stages of professional image production. Artificial intelligence technologies promise significant potential in script writing and visualisation processes in the pre-production, production and post-production stages of film-series production. Artificial intelligence technologies can provide new narrative contributions by analysing scripts, and can make significant contributions to the shooting process and post-production stage for editing and visual effects specialists. The research is important in terms of providing a projection for the role of artificial intelligence in moving image production processes. For this reason, the research aimed to address the subject in an applied manner and analysed the observations in a systematic way.

3. Research Design

The research began with the discovery of text-to-video tools with artificial intelligence to create relevant content. The platforms selected for moving image generation in the study offer the features that are sufficient for the research design to the users through trial versions. For this reason, moving images were produced using trial versions. In addition to the Runway, Luma Dream Machine, Imagine Art platforms in the sample, pilot studies were carried out using Pika, Synthesia, InVideo and Deepbrain AI applications. The promt to be used to include the text writing ability of artificial intelligence in the process was produced by ChatGPT. In the scientific field, Chat GPT has been found successful in terms of using the Transformer architecture and offering advanced language consistency and language modelling (Vaswani et al., 2017; Radford et al., 2019; Brown et al., 2020). Within the framework of these views, it was decided that prompts used in the research would be generated by Chat GPT, one of the widely used and leading artificial intelligence platforms in the field. Before deciding on the platforms in the sample, the same prompts were entered into Pika Labs, Vidgenie, Runway, Luma Dream Machine, Imagine Art platforms (Pika, 2024; Vidgenie, 2024; Runway, 2024; Luma Dream Machine, 2024; Imagine Art, 2024). All videos produced were archived by the researcher. The moving images produced by the three platforms that gave the most consistent responses to the prompts were included in the sampling. The Runway platform was chosen for its emphasis on scene coherence and motion flow, the Luma Dream Machine platform for its promise to produce realistic, cinematographic frames and advanced camera movements, and the Imagine Art platform for its emphasis on artistic creation and character coherence. Runway, Luma Dream Machine and Imagine Art artificial intelligence moving image generation tool were given the same prompt and asked to produce two different moving images, one realistic and one futuristic. It was observed that the two prompts produced were long, and some of them were removed from the research in order not to obtain complex visuals. The prompts used for the production of moving images are presented below.

Table 1. Prompts used in the production of moving images and their extracted parts

Prompt Used for ChatGPT	*"Create a text prompt to generate a realistic film scene."*	*"Create a text prompt to generate a realistic film scene."*
Prompt Used for Motion Image Generation	*"Set in a bustling city park during a sunny afternoon, the scene opens with children playing on the swings while families picnic on the grass. In the background, a street musician plays a lively tune on a guitar. A young couple sits on a bench, engaged in a heartfelt conversation."*	*"Set in a sprawling metropolis in the year 2150, the scene opens with sleek, towering skyscrapers that pierce the sky, their surfaces covered in holographic advertisements. Autonomous flying vehicles zip through the air, navigating complex traffic patterns above the bustling streets. People walk along elevated walkways, their outfits incorporating advanced technology with integrated displays and adaptive materials."*
Extracted section from Moving Image Production	*"Nearby, an elderly man feeds pigeons, his face showing a mix of contentment and nostalgia. The sounds of laughter, music, and distant traffic blend to create a vibrant, lively atmosphere. The camera captures the diverse expressions and interactions, highlighting the warmth and dynamism of the park."*	*"A market area below showcases vendors selling exotic, genetically-engineered foods and high-tech gadgets. In the distance, a monorail glides silently on an electromagnetic track. The scene captures the blend of cutting-edge technology and daily life, with a focus on the interactions between people and their advanced surroundings, highlighting the innovation and energy of this futuristic world."*

Source: www.chatgpt.com

The three platforms whose productions were analysed in the sample are among the prominent platforms in the field of moving image production. Basic information about Runway, Luma Dream Machine and Imagine Art platforms used in moving image production stages in the research is presented below.

Founded in 2018, Runway has made it accessible for both professionals with technical knowledge and amateur users to produce new models and designs with artificial intelligence tools. According to Bloomberg (2023), Runway, with its structure based on artificial intelligence technology, has started to receive funding from major companies such as Nvidia, one of the leading companies in technology, and has established cooperation with Google, proving that it will be in an important position in the field of artificial intelligence in the future.

According to AI Businness (2023), Runway, which has advanced image, video and audio processors, was developed in collaboration with Stable Diffusion, a text-to-image company, and raised $141 million in its latest financing, with investors including Google, Nvidia and Salesforce. Runway, an artificial intelligence research lab, has launched Gen-1, an artificial intelligence model that can create new moving images from existing images, as well as Gen-2, which converts text into moving images. To date, $ 237 million has been one of the pioneers of the industry. Nvidia CEO Jensen Huang said that Runway is "doing great work" to "push the boundaries of creativity and storytelling for millions of artists around the world". The company, which attracted the attention of financiers immediately after the launch of a mobile application that allows users to shoot video and create new 15-second versions through their mobile devices, is also a company that is working on research projects with Amazon Web Services (AWS).

According to Perrigo (2023), Cristóbal Valenzuela, CEO of Runway, a New York-based startup, emphasises the pioneering role of AI in storytelling: "So many of the stories we've told ourselves for the last 150 years are rooted in one idea of how film and videos and images work." It develops AI-powered "text-to-video" and video editing applications that can help anyone, including the team behind the Oscar-winning film Everything Everywhere All at Once, turn their original ideas into moving images.

Artificial intelligence has taken 2D art production to the next level, especially with applications such as Midjourney and Stable Diffusion that can generate images from text. The creation of 3D assets is a time-consuming process and also requires long rendering times, but currently, developments in artificial intelligence in this field have simplified the processes considerably. Luma Dream Machine, one of these applications, was one of the applications used in the research (Diamond and Lindberg, 2023). Founded by Amit Jain, Alex Yu and Alberto Taiuti, LumaLabs has developed an application that allows people to produce moving images without the need for various hardware. The company was founded by Yu, an artificial intelligence researcher at UC Berkeley, and Jain, an Apple employee working on the multimedia experiences of Apple Vision Pro. In 2021, LumaLabs, which started to popularise rapidly, continues to be developed by Yu and Jain. Luma Dream Machine is an application designed to produce high quality realistic moving images from text or given images. Known for producing quality results with its system structure focusing on moving images, Luma can produce fluid moving images with realistic structure. Luma Dream Machine is accessible to the whole world and paid subscription packages are also available to produce more comprehensive progress (Luma, 2024).

According to Luma AI (2024), people enjoy producing and creating new products. Luma Dream Machine is another artificial intelligence application that will help remove the barriers that prevent people from creating creative products that were previously impossible for them to access. Luma Dream Machine is a platform created by researchers, designers and engineers at Luma. According to Yu, Luma is an initiative to "see and understand, show and explain, and eventually interact with the world." Light detection and ranging (LiDAR) sensors enable precise detection of an object in 3D (Li et al., 2022). Recently, LumaLabs has also been working in advanced areas of modelling such as generating 3D images from text and LiDAR technology. LumaLabs, which focuses on technologies that make the details very clear by adding neural networks to the object scanning process, today reaches a competitive position with the leading companies in the field.

In 2019, Imagineart.ai, a platform of Vyro.ai, a company founded by Abdullah Rafique, Ahmed Aubakır, Zain-ul-Abedin, which started operating in the field of artificial intelligence and machine learning, has shown a development process that prioritises artistic creation. In recent years, artificial intelligence-supported text-moving image or image-moving image converters have revolutionised and brought a new dimension to artistic creation. Imagine.Art uses text or image inputs to analyse the data and create the desired content. With its user-friendly interface, the site allows users to reach their requests effortlessly (Medium, 2023). Imagine AI is an artificial intelligence art platform accessible on the web, Android and iOS platforms, allowing users to create unique physical paintings, etc. by utilising the power of artificial intelligence. Imagine AI is a platform capable of producing a wide range of images from abstract compositions to realistic themes.

Imagineart.ai (2021), an artificial intelligence platform founded with the idea that everyone can be a part of art production and create masterpieces, allows users to transform their photos or texts into artistic products. By imitating human visual mechanisms, it can perform both text-to-

moving image and image-to-moving image conversions. Focusing more on the artistic creation process, the platform also allows users to print their artworks on physical canvases.

3.1. Method

This research, in which an important platform in the field of artificial intelligence on a global scale was used to produce prompts and three platforms were used to produce moving images, used thematic content analysis method. Qualitative content analysis, which is widely used in social sciences research, is a method that includes the process of collecting, compiling, coding, categorising, analysing and reporting data (Weber, 1990; Krippendorff, 2018). In line with these views, the requirements of the method were adapted to the study. The moving images were systematically collected, compiled, categorised, analysed and the results were compiled. The main categories in the realisation of the research were thematic structure, physical qualities of the characters and technical elements. All moving image contents were produced and analysed following the same procedure. The thematic structure included the sub-categories of a crowded city park, children playing on swings, families having a picnic on the grass, a couple sitting on a bench, a plot that takes place in 2150, sleek, high skyscrapers piercing the sky, holographic advertisements, autonomous flying vehicles, people walking in high-tech clothes. The physical qualities of the characters included the subcategories of human faces, anatomical structure, suitability for the scene, and conformity with physical reality. The subcategories of technical elements were determined as shooting scales, colour arrangement, environment depiction, object-ground relationship.

Artificial intelligence technologies are used to produce plots and scenarios. In the research, thematic elements were analysed to discover how artificial intelligence contributes to thematic depth, how it uses storytelling norms, and how it constructs narrative structure. In these analyses, the appropriateness of the given prompts was discussed and subcategories consisted of bustling city park, children playing on the swings, families picnic on the grass, street musician, couple sitting on a bench.The physical characteristics of the characters were included in the analysis in order to discuss how artificial intelligence contributes to character design, how the characters produced find expression in terms of appearance, expressiveness and originality, how well they maintain consistency in their physical characteristics, whether they offer new visual styles or physical characteristics. The sub-categories in this analysis consisted of human faces, anatomical structure, suitability for the stage, conformity with physical reality. Technical elements were examined in order to question the adherence of artificial intelligence to the traditional narrative patterns of film-series production, to question whether it brings new technical possibilities or whether it relies on existing technologies. In these analyses, subcategories consisted of camera scales, colour grading, environmental description, figure-ground relationship. The analyses were carried out according to these subcategories, and the findings, comments and conclusion sections were formed by considering the related categorisation process.

4. Findings and Interpretations

Using four artificial intelligence platforms, this research analysed the moving image outputs of three platforms designed to produce moving images. It was discussed whether the thematic structure, physical qualities of the characters and technical elements corresponded with the prompts and to what extent the moving images were successful. In addition to the basic categories, sub-categories were also created; thematic structure, physical qualities of the characters and technical elements were analysed under the categories described in the method section. Two

prompts containing a realistic and futuristic narrative were created with ChatGPT and given to Runway, Luma Dream Machine and Imagine Art platforms to produce moving images. Under the heading of findings and interpretations, the data were compiled systematically.

4.1. Runway

During the research process with Runway, the platform was prompted to produce two moving images. The first video was asked to have a realistic theme, while the second video was asked to realise a futuristic narrative. The two moving images, produced in 1408*768 scale, 24 frames per second and 4 seconds, are in MP4 format and do not contain any auditory elements. The images below are taken from the moving images produced by the website.

Image 2: Screenshot taken from the moving images produced by Runway

Source: www.runwayml.com

Thematic Structure:

In the moving images produced by Runway, various elements related to the desired thematic structure were included, but some elements were not included in the narrative. The four items required to be included in the thematic structure in the moving image to be prepared realistically were not included in the narrative by artificial intelligence in a completely appropriate way. A similar situation is also observed in the themes that were asked to realise futuristic narration. Although the artificial intelligence included various thematic elements in its narration, it did not include some of them appropriately. The table below shows whether the elements in the prompts are appropriately included in the narrative.

Table 2. Concordance of thematic structure with prompt

Thematic Elements Related to Realistic Moving Image Content	Bustling city park	Suitable for the prompt
	Children playing on the swings	Not suitable for the prompt
	Families picnic on the grass, street musician	Suitable for the prompt
	Couple sitting on a bench	Suitable for the prompt
Thematic Elements Related to Futuristic Moving Image Content	Plot set in the year 2150	Suitable for the prompt
	Sleek, high skyscrapers piercing the sky, holographic adverts	Partially suitable for the prompt
	Autonomous flying vehicles	Suitable for the prompt

	People walking in their high-tech clothes	Not suitable for the prompt

Physical Characteristics of Characters:

Although some of the physical characteristics of the characters in the two videos produced by Runway were compatible with the desired structure, they were not suitable in various aspects. It was observed that the Runway platform had problems especially in issues such as original human faces. In the moving images, which were required to produce a futuristic scenario, no human was included.

Table 3. Concordance of physical characteristics of characters with prompt

Thematic Elements Related to Realistic Moving Image Content	Human Faces	Not suitable for the prompt
	Anatomical Structure	Suitable for the prompt
	Suitability for the stage	Suitable for the prompt
	Conformity with Physical Reality	Suitable for the prompt
Thematic Elements Related to Futuristic Moving Image Content	Human Faces	Not suitable for the prompt
	Anatomical Structure	Not suitable for the prompt
	Suitability for the stage	Not suitable for the prompt
	Conformity with Physical Reality	Not suitable for the prompt

Technical Elements:

The visual expression techniques of the elements in the produced videos were examined within the framework of universally accepted shooting scales, colour arrangement, environment depiction and object-ground relationship. As a result of these analyses, it was seen that the moving image contents did not fully meet the criteria and showed partial conformity. The following table presents the relationship between the themes and the elements in the narrative.

Table 4. Concordance of technical aspects with prompt

Thematic Elements Related to Realistic Moving Image Content	Camera Scales	Suitable for the prompt
	Color Grading	Suitable for the prompt
	Environmental Description	Suitable for the prompt
	Figure-Ground Relationship	Partially suitable for the prompt
Thematic Elements Related to Futuristic Moving Image Content	Camera Scales	Suitable for the prompt
	Color Grading	Suitable for the prompt
	Environmental Description	Not suitable for the prompt
	Figure-Ground Relationship	Suitable for the prompt

In the moving images produced by the artificial intelligence application named Runway, conformity with the prompt was partially achieved. Although it was observed that the anatomical structure of the characters in the scenes with intense movement in the images did not conform to reality, the object-ground relationship was disrupted from time to time, such as the feet of the benches not stepping on the ground or misstepping, and some elements in the command were not included in the narrative, the production process was evaluated positively in terms of user experience, and the outputs were generally successful.

4.2. Luma Dream Machine

For the use of moving images to be produced by the Luma Dream Machine, the procedure applied to other platforms was applied. The Enhance Prompt tab was clicked and Luma Dream Machine responded positively to both commands. The two moving images, produced in 1360*752 scale as 24 frames per second and 4 seconds, were in MP4 format and did not contain any auditory elements. The tables for the content analysis of the moving images show the correspondence between the commands and what was produced.

Image 3: Screenshot taken from the moving images produced by Luma Dream Machine

Source: www.lumalabs.ai

Thematic Structure:

In the moving images produced by Luma Dream Machine, it was observed that although various elements in the prompt were included, some elements were removed from the narrative. The platform did not include children playing on swings, holographic screens and autonomous vehicles in its narrative. The table below shows whether the elements expected to be included in the theme were included or not.

Table 5. Concordance of thematic structure with prompt

Thematic Elements Related to Realistic Moving Image Content	Bustling city park	Suitable for the prompt
	Children playing on the swings	Not suitable for the prompt
	Families picnic on the grass, street musician	Suitable for the prompt
	Couple sitting on a bench	Suitable for the prompt
	Plot set in the year 2150	Suitable for the prompt
	Sleek, high skyscrapers piercing the sky, holographic adverts	Partially suitable for the prompt

Thematic Elements Related to Futuristic Moving Image Content	Autonomous flying vehicles	Not suitable for the prompt
	People walking in their high-tech clothes	Suitable for the prompt

Physical Characteristics of Characters:

It was observed that human face and anatomical features were successfully created in moving images produced by Luma Dream Machine. It has been determined that the distortions in human faces, which are encountered in the moving images prepared with artificial intelligence, are not serious in the moving images produced by Luma Dream Machine. Although the left hand of the man playing guitar on the bench plays the guitar, his right hand is positioned outside the guitar. Such elements appear as qualities that weaken the power of narration. Although there are distortions in the anatomical structure and object-ground relationship in scenes with intense movements, it is thought that this problem will be overcome in a short time.

Table 6. Concordance of physical characteristics of characters with prompt

Thematic Elements Related to Realistic Moving Image Content	Human Faces	Suitable for the prompt
	Anatomical Structure	Partially suitable for the prompt
	Suitability for the stage	Suitable for the prompt
	Conformity with Physical Reality	Suitable for the prompt
Thematic Elements Related to Futuristic Moving Image Content	Human Faces	Suitable for the prompt
	Anatomical Structure	Suitable for the prompt
	Suitability for the stage	Suitable for the prompt
	Conformity with Physical Reality	Suitable for the prompt

Technical Elements:

When we look at the technical structure of the moving images produced by Luma Dream Machine, it is seen that it has produced successful results. It was observed that the shooting scales, colours and object-ground relationship were reflected correctly, but various problems occurred in the depiction of the environment. It was observed that some prompts in the Prompt were not included in the narrative by Luma Dream Machine.

Table 7. Concordance of technical aspects with prompt

Thematic Elements Related to Realistic Moving Image Content	Camera Scales	Suitable for the prompt
	Color Grading	Suitable for the prompt
	Environmental Description	Suitable for the prompt
	Figure-Ground Relationship	Partially suitable for the prompt
	Camera Scales	Suitable for the prompt

Thematic Elements Related to Futuristic Moving Image Content	Color Grading	Suitable for the prompt
	Environmental Description	Suitable for the prompt
	Figure-Ground Relationship	Suitable for the prompt

4.3. Imagine Art

As in other production procedures, the same procedure was applied in the moving image process to be produced by Imagine Art. The prompts above were entered and the system was requested to produce two moving images. The system responded positively to two commands and fulfilled the request. In 960*512 scale, 28 frames per second, 2 moving images of 2 seconds were obtained. The videos are in MP4 format and do not contain any auditory elements. Below, frames from the moving images that the system responded to the commands are presented.

Image 4. Screenshot taken from the moving images produced by Imagine Art

Source: www.imagineart.ai

Thematic Structure:

In the moving images produced by Imagine Art, as in the other artificial intelligence platforms in the sample, it was observed that some elements in the prompt were included and some were excluded. In two scene descriptions with realistic and futuristic narratives, it was observed that the Imagine Art platform was more successful in terms of describing the futuristic narrative. The table below shows the compatibility of the prompts and the narrative.

Table 8. Concordance of thematic structure with prompt

Thematic Elements Related to Realistic Moving Image Content	Bustling city park	Suitable for the prompt
	Children playing on the swings	Not suitable for the prompt
	Families picnic on the grass, street musician	Suitable for the prompt
	Couple sitting on a bench	Suitable for the prompt
Thematic Elements Related to Futuristic Moving Image Content	Plot set in the year 2150	Suitable for the prompt
	Sleek, high skyscrapers piercing the sky, holographic adverts	Suitable for the prompt
	Autonomous flying vehicles	Suitable for the prompt

	People walking in their high-tech clothes	Not suitable for the prompt

Physical Characteristics of Characters:

It was observed that the physical qualities of the characters in the two videos produced by Imagine Art were not compatible with reality. The platform made mistakes especially in human faces, and compared to other moving images, it was found to be in the background in terms of image quality. The table below shows the commands and results regarding the physical structure of the characters.

Table 9. Concordance of physical characteristics of characters with prompt

Thematic Elements Related to Realistic Moving Image Content	Human Faces	Not suitable for the prompt
	Anatomical Structure	Suitable for the prompt
	Suitability for the stage	Suitable for the prompt
	Conformity with Physical Reality	Suitable for the prompt
Thematic Elements Related to Futuristic Moving Image Content	Human Faces	Not suitable for the prompt
	Anatomical Structure	Not suitable for the prompt
	Suitability for the stage	Suitable for the prompt
	Conformity with Physical Reality	Suitable for the prompt

Technical Elements:

It was observed that the moving images produced by Imagine Art lagged behind other platforms in terms of resolution. Although the system, which outputs 28 frames per second, cares about the fluidity of the image, the low image quality made it difficult to notice various details. Partial conformity was observed in the moving images examined in terms of shooting scales, colour arrangement, environment depiction and object-ground relationship.

Table 10. Concordance of technical aspects with prompt

Thematic Elements Related to Realistic Moving Image Content	Camera Scales	Suitable for the prompt
	Color Grading	Suitable for the prompt
	Environmental Description	Suitable for the prompt
	Figure-Ground Relationship	Suitable for the prompt
Thematic Elements Related to Futuristic Moving Image Content	Camera Scales	Suitable for the prompt
	Color Grading	Suitable for the prompt
	Environmental Description	Suitable for the prompt
	Figure-Ground Relationship	Suitable for the prompt

Conclusion

The research, which focuses on a current issue by addressing the transformation processes in artificial intelligence technologies, questioned whether artificial intelligence provides production in accordance with the commands given in text-to-motion image production processes and the success of the images produced. Four artificial intelligence platforms were used in the realisation of the research. These platforms were ChatGPT, Runway, Luma Dream Machine and Imagine Art respectively. The participants were asked to create a scenario through ChatGPT developed by OpenAI. This command was carried out in order to get an idea of how artificial intelligence can contribute to the scenario writing phase of professional image production processes. Two scenarios, a realistic and a futuristic one, were requested by ChatGPT, and the prompt provided by artificial intelligence was integrated into the three platforms that claimed to promise qualified results in the field of moving image. As a result, the three platforms produced two different short moving images. Qualitative content analysis method, one of the well-established research methods of social sciences, was used in the research, and the image compatibility with the given prompts was discussed. As a result of these discussions, it has become possible to make inferences about artificial intelligence platforms and the future of the field.

Runway was the first platform asked to produce images. The platform in question is one of the world's leading platforms in artificial intelligence and image generation processes. Although there were various errors in the images produced after the prompt given to the Runway platform, it was observed that the platform was able to apply commands with high accuracy and produce results. The Runway platform achieved a high rate of success in the implementation of thematic elements related to realistic video content.

The second platform that was asked to produce images was Luma Dream Machine. After the promt given to the Luma Dream Machine platform, two moving images, realistic and futuristic, were obtained. High accuracy was also achieved in the images produced by this platform, but problems were experienced in various issues. Although there were various problems especially in moving scenes and scenes with a clear action, it gave successful results in general.

The third platform that was asked to produce images for the prompts given was Imagine Art. Compared to the other two platforms, it was concluded that it had problems in image quality and therefore needed to improve in rendering processes. The platform was found to be more powerful than the other two platforms in terms of implementing the prompts given. Although it was not as successful as other platforms in producing hyper realistic images, it was successful in reflecting the prompts to the image.

When all findings are evaluated from a relational perspective, it is concluded that artificial intelligence technologies can contribute to professional moving image production in the future. It has been determined that some of the artificial intelligence platforms that produce moving images from the text in the sample stand out with their narrative integrity and some with their technical elements.

Considering all these developments, it is predicted that the need for human resources in the pre-shooting, shooting and shooting stages in the fields of cinema and television will begin to decrease with the developments in the field of artificial intelligence. It has become possible to infer that artificial intelligence can play an active role in various stages of sectors with high cost items such as film and TV series. It is predicted that artificial intelligence platforms that produce moving images from text may start to operate in the film-series industry and may become a part of the

professional moving image industry in the future. It is important for future studies to investigate how artificial intelligence contributes to professional productions.

Genişletilmiş Özet

Yapay zekâ teknolojilerindeki dönüşümler küresel ölçekte çeşitli yeniliklere yol açmış, dünya ekonomisinin önde gelen şirketleri ve hükümetler, alanda faaliyet gösteren şirketleri fonlamaya başlamıştır. Bu durum tıpkı dijitalleşme süreçlerinde olduğu gibi yeni bir dönüşümün başlayacağını göstermiştir. Söz konusu dönüşüm süreçleri kuşkusuz birey ve toplum yaşantısını etkileyecek güce sahiptir ve bu nedenle sosyal bilimlerin araştırma alanları konuya yönelik hızla çalışmalar üretmeye başlamıştır. İletişim bilimleri çatısı altında ele alınan hareketli görüntü üretim süreçlerinin yapay zekâ teknolojileri tarafından nasıl etkileneceği akademik alandaki güncel tartışma konularından biri olmuştur.

Yapay zekâ teknolojilerindeki hızlı ilerleme hareketli görüntü üretimi üzerinde önemli etkiye sahip olmuş, yapay zekâ şirketleri kullanıcılar tarafından verilen imajlara veya komutlara uygun hareketli görüntüler üretebileceğini vadetmiştir. Küresel ölçekli teknoloji şirketleri de yapay zeka teknolojileri hareketli görüntü üretimi arasındaki ilişkiyi destekleyen adılar atmakta, bu alana yönelik yatırımlar gerçekleştirmektedir. Araştırma belirtilen durumları göz önüne alarak ChatGPT tarafından üretilen senaryoların Runway, Luma Dream Machine ve Imagine Art platformları aracılığıyla hareketli görüntüye dönüşüm sürecini ve çıktılarını içerik analizi yöntemiyle incelemeye odaklanmıştır. Yapay zekâ platformlarına hareketli görüntüleri üretmesi istenen komut gerçekçi ve fütüristik iki senaryoyu içermiştir. Her üç platform da başarılı biçimde hareketli görüntü içeriğini üretmiş olsa da özellikle insan yüzlerinin gerçeğe uygun olmadığı, komutlarda yer alan tüm ögelerin anlatıda yer etmediği, nesne-zemin ilişkisi konusunda sorunlar yaşadıkları tespit edilmiştir.

Söz konusu platformların hızla kendini geliştirme ve alandaki yeniliklere ayak uydurabilme potansiyelleri düşünüldüğünde karşılaşılan sorunların ortadan kalkacağı, yakın gelecekte yapay zekânın profesyonel hareketli görüntü üretiminin uzmanlık gerektiren alanlarında söz sahibi olacağı sonucuna varılmıştır. Yapay zekâ ile üretilmiş filmlere yönelik film festivallerinin hayata geçirilmesi, hareketli görüntülerde çeşitli görsel unsurların yapay zekâ araçlarıyla üretilmesi gibi gelişmeler, film-dizi sektöründeki insan kaynağına olan ihtiyacın azalacağı konusundaki ilk sinyaller olarak değerlendirilmiştir.

Yapay zekâ teknolojileri film-dizi üretiminin yapım öncesi, yapım ve yapım sonrası aşamalarında önemli bir potansiyel vaat etmektedir. Yapay zekânın hareketli görüntü üretim süreçlerindeki rolüne dair bir projeksiyon sunmayı amaçlaması bakımından önemli olan bu ampirik araştırma, konuyu uygulamalı bir şekilde ele alarak gözlemleri sistematik bir biçimde analiz etmiştir.

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