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DIGITAL HUMAN TECHNOLOGY IN THE APPLICATION OF LIVE STREAMING IN SOCIAL MEDIA

The subject of this article is the use of Digital Human Technology (DHT) in live broadcasts on social media platforms and its impact on audience engagement and content appeal. This study examines how elements of DHT, such as virtual avatars and AI-driven hosts, are increasingly being used in live broadcasts to improve viewer engagement and retention. The main objective is to evaluate whether the integration of DHT increases viewer engagement, interactivity, and retention, especially compared to traditional streaming methods. This study consists of several key tasks: reviewing the current live DHT landscape, developing a research framework for analyzing engagement metrics, collecting empirical data through surveys and interviews and conducting statistical analysis to identify correlations between DHT use and viewer engagement. The methods used in this study include quantitative approaches such as structured questionnaires to measure viewership indicators and qualitative approaches such as in-depth interviews with streamers and viewers. Statistical methods, such as factor and correlation analysis, are used to assess the impact of DGT on key engagement metrics, such as viewing time, frequency of interaction, and viewer satisfaction. Through systematic observation, this study also captured real-time interactions, providing a comprehensive understanding of DHT effects. The findings emphasize that DHT significantly increases engagement in live broadcasts, providing content creators with innovative ways to retain audiences. However, the high cost of such technology and technical requirements limit its availability to independent streamers. This study provides practical recommendations for streamers and marketers that suggest DHT is a valuable tool for optimizing content appeal and audience engagement. Future research should explore scalable DHT solutions to improve accessibility for a wider range of content creators.

Keywords: *artificial intelligence; meta-universe; virtual avatar; virtual host; broadcast; VTuber.*

1. Introduction

1.1. Motivation

Due to the rapid development of modern technologies, marketing and media specialists closely monitor new tools and methods of interaction with audiences. Of particular interest are tools that can increase audience engagement, improve the effectiveness of advertising campaigns, and promote active interaction with content on the part of consumers. In this context, the attention of marketers and media specialists is attracted to direct broadcasting, which is a trend. The development of this type of content is determined by the specifics of its functioning, which is based on the principles of direct interaction and real time. Due to the ability to instantly respond to user actions, live streaming has attracted the attention of both consumers and content creators. This phenomenon allows viewers to influence the broadcast process and improves their connection with performers, ultimately leading to increased engagement and maintaining long-term relationships with the audience.

Continuing to develop in this area, specialists are actively exploring not only new approaches to conducting live broadcasts, but also innovative technologies that can be used in combination with this format. One example of this is Digital Human Technology (DHT), which can further attract an audience. It is widely used in various industries to create digital characters as medical assistants or key entertainment characters and conduct marketing and sales campaigns. The proposed technology includes the application of various techniques, such as visual modelling, motion capture, and speech synthesis. The most common example of application in streaming in the field of social networks is digital avatars. They can repeat the movements, facial expressions, and intonations of a real person's speech, which allows creating almost perfect digital copies using technology that records a person's movements and transmits them to a digital avatar. Thus, in real time, the movement of the model is displayed on a screen, completely repeating the movements of the user.

1.2. State of the art

DHT combined with artificial intelligence creates more accurate avatar models, ensuring autonomy and interactivity, which makes interactions with them natural. The use of such models in live broadcasts contributes to their interactivity and audience engagement. For example, Azure AI Speech can create interactive bots that work in real time and are trained on examples of human images [1].

Research by Fu et al. proposed a solution to the problem of continuous 24-hour live streaming in the field of streaming services using the Miebo virtual avatar [2]. The avatar was designed and optimized through a series of experiments that helped determine the parameters corresponding to the emotions of "sadness", "joy", "surprise" and "anger". To simplify the use of virtual avatars, the authors developed a special Virtual full platform that allows ordinary users to create virtual avatars. Reflecting on current media trends, Ongkrutraksa focuses on analyzing the features of product presentations on YouTube in Thailand and Japan [3]. The researcher used in-depth interviews and online surveys as data collection tools. As a result, we found that Japanese YouTube users are more active in accepting products, content, and innovations presented by virtual influencers. Although virtual YouTubers (VTubers) have not yet received full recognition, their growing influence in a certain market segment is highlighted.

Siwasaranond and Singlumpong pointed out the significance of trust in virtual influencers in the decision-making process of buying fashionable clothes among Generation Z in Bangkok [4]. Through the survey, the researchers found a positive relationship between trust in influencers and the decision to buy clothing. Important factors in this context are the expertise, attractiveness, and relevance of influencers.

Tang et al. presented a new animation approach for virtual video bloggers called VTubers [5]. The AlterEcho method automatically generates expressive avatar animations without the involvement of streamers. This approach allows an avatar to be a separate unit from the streamer, and it has received high praise from viewers and VTubers. In addition, the study demonstrates the possibility of personalizing avatars for specific viewers.

The analysis of the impact of virtual influencers on consumer decisions was the main subject of research by Chaihanchanchai et al. [6]. The researchers focused on the role of brand trust and source reliability (expertise, reliability, and attractiveness) in purchase decisions. Through an online survey, it was found that the key mediator in this process was the attractiveness of the virtual influencer. The obtained data contribute to a deeper understanding of the role of influencers in the context of advertising and branding.

1.3. Objectives and approaches

The purpose of this study is to test the hypothesis regarding the impact of Digital Human Technology (DHT) on engagement levels and content attractiveness across various social media platforms. Specifically, this study identifies how DHT integration affects audience interaction dynamics and engagement metrics. The final objective is to provide actionable insights into the effectiveness of DHT as a tool for content creators and marketers, assisting them in optimizing live streaming strategies to maximize audience reach and retention.

The main objectives and stages of this research are as follows:

– Stage 1. Review of the current landscape of Digital Human Technology (DHT) in live streaming, establishing research objectives and methodology based on existing solutions in audience engagement (Section 1);

– Stage 2. Developing a comprehensive research framework to assess DHT's impact, including the design of survey instruments and interview protocols to gather data on audience engagement metrics, stream content attractiveness and user responses (Section 2);

– Stage 3. Empirical data collection using structured questionnaires, surveys, and interviews. This includes gathering quantitative data on viewership metrics and qualitative insights from streamers and audiences across multiple social media platforms (Section 3);

– Stage 4. Analysis of results using statistical and content analysis techniques, such as factor and correlation analysis, to evaluate the impact of DHT on engagement metrics. This stage presents insights into specific DHT elements, such as virtual avatars and AI-powered hosts, that contribute to viewer interaction and satisfaction (Section 4);

– Stage 5. Summarizing findings and developing recommendations based on the data analysis. This stage includes a discussion of the practical implications for content creators and marketers aiming to utilize DHT effectively and identifies future research avenues to advance the field (Section 5).

The study's main contribution lies in establishing a clear correlation between DHT and heightened audience engagement, offering new evidence for the technology's potential to transform social media interaction. This study provides scientifically valuable insights by quantifying the engagement uplift attributed to virtual avatars and AI-driven hosts, underscoring the novelty of DHT in live streaming. These findings present practical applications for content creators that aim to harness DHT to enhance viewer interaction and experience.

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2. Materials and methods

The design of the study was intended to ensure its reliability and validity through the fusion of qualitative and quantitative methods aimed at a deep understanding of the topic. In the quantitative aspect, structured questionnaires were used to collect empirical data and then process them statistically. The qualitative segment included in-depth interviews that helped understand the detailed perspectives of respondents on the issues under study.

Questionnaires and interviews were used. The survey collected structured information from three groups: streamers using DHT, conventional streamers, and viewers. Interviews with DHT streamers provided a deeper understanding of their experiences using the technology.

The study utilized various analysis methods to evaluate the impact of DHT on streaming. Statistical analysis processed quantitative data from structured questionnaires, allowing for calculations like mean, median, standard deviation, and correlation, which helped identify trends between DHT usage and audience engagement. Content analysis was applied to open-ended questionnaire responses and interviews to identify common themes regarding DHT perceptions. The comparative analysis assessed engagement and interaction metrics between streamers using DHT and traditional streamers, examining DHT's effect on audience dynamics. Systematic observation analyzed real-time interactions, including comments, likes, and chat activity, to evaluate DHT's influence on streaming.

The results of the study were processed using factor and correlation analyses to uncover underlying relationships and patterns related to the use of Digital Human Technology (DHT) in streaming. Factor analysis identified key dimensions that influence audience engagement, revealing that factors such as the quality of virtual avatars, interactivity levels, and content uniqueness significantly contribute to viewer attraction and retention. This analysis highlights how these elements collectively enhance the streaming experience and affect audience satisfaction. Correlation analysis was employed to examine the relationships between DHT usage and various metrics of audience engagement, including the number of views, viewing duration, and viewer interaction rates. The findings indicated a strong positive correlation between the implementation of DHT and increased audience engagement, demonstrating that streams utilizing DHT attracted more viewers and fostered greater interaction through comments and reactions.

The study was designed to ensure its reliability and validity by integrating qualitative and quantitative methods, to provide a comprehensive understanding of the impact of DHT on streaming. The research involved three distinct groups: streamers using DHT, conventional streamers, and viewers, enabling multifaceted analysis of the subject. Structured questionnaires were distributed to gather empirical data from 100 streamers in each group, while in-depth interviews with DHT streamers provided nuanced insights into their experiences with the technology. The study also examined real-time interactions between streamers and their audiences, comparing engagement levels in streams using DHT with those in streams that do not. A significant sample of 1,000 viewers was included to assess their preferences and perceptions of technology's influence on content and engagement. The audience sample was drawn from active viewers of selected streamers, identified based on their engagement in chats and consistent viewing habits. Invitations to participate in the study were communicated through live stream chats and social media platforms. Confirmed participants were included in the analysis to ensure a robust representation of the perspectives of the viewers.

The data collection methodology encompassed the systematic observation and analysis of virtual characters and influencers in common digital spaces. Data were gathered using structured questionnaires, which facilitated statistical processing of responses to identify trends and patterns. In-depth interviews allowed for a deeper exploration of individual experiences, focusing on the application of DHT and its implications for audience engagement. The primary aim of the survey was to examine the extent of DHT usage among streamers and to explore the relationship between audience engagement and the implementation of DHT compared to conventional streaming methods. Careful attention was paid to the clarity, accuracy, and objectivity of the questions, tailored to the unique characteristics of each participant group. This approach collected critical information on the understanding and application of DHT, its effects on audience satisfaction, and the preferences of viewers. Key performance indicators, such as the number of views, viewing duration, audience activity, and overall interaction, were analyzed to assess the impact of DHT over the past year.

The table 1 presents an analysis of the participants in the experiment, which includes three groups of streamers: those who used DHT technology, traditional streamers without DHT, and streamers who tried DHT but then gave up. The table demonstrates the differences in audience engagement, viewing duration, and interaction level for each group.

To investigate the use of DHT in streaming, a group of 100 streamers was created according to the following criteria: use of the technology for 6-12 months, at least 3 streams per week, and the presence of a permanent audience. Participants were selected from various platforms, such as Twitch and YouTube, and were invited to participate in the study via social networks, email, or contact forms. Similarly, a control group of conventional

streamers that do not use DHT was formed. Both groups were formed to compare the impact of technology on audience engagement.

Table 1

Distribution of streaming participants by activity and streams

Streamer type	**Audience engagement (views)**	**Duration of viewing**	**Viewer interaction (comments)**
Streamers using DHT	Increased significantly	Increased	Increased significantly
Conventional streamers	Stable	Unchanged	Stable
Streamers who abandoned DHT	Decreased slightly	Decreased	Decreased

Table 2 shows excerpts from the questionnaire used to collect the empirical data. The questions cover various aspects of DHT use by streamers, including information about platforms, audience engagement, interaction with viewers and technical difficulties.

Table 2

Questionnaire fragments for empirical data collection

Section	Question
General information	What is your streaming platform (TikTok, YouTube, Twitch, etc.):
Use of dht	Do you use DHT technologies in your streams? (Yes/No)
Audience engagement	How do you assess the level of audience engagement during the use of DHT? (High/Medium/Low)
Viewer interaction	How do you assess the activity of your audience in comments during a DHT stream? (High/Medium/Low)
Technical aspects	What difficulties have you encountered while using DHT? (technical issues, learning difficulties, lack of equipment)

The audience sample was obtained from active viewers of the selected streamers. The selection was based on the participants' activity in chats, regular viewing of streams, and expressed interest in content. Viewers were sent offers to participate in the study via live stream chats or social networks. Viewers who confirmed their participation were included in the study.

Data was collected through systematic observation and analysis of virtual characters and influencers in common digital spaces. The main source of information for studying virtual people, which was obtained directly from industry professionals, was the Virtual Human service. Virtual influencers such as KFC's Newest Colonel in China, Noah, and Luo Tianyi were studied to gain insight into the role and influence of virtual influencers in China. Additionally, examples like CodeMiko, which combines comedy and interactivity in streaming, highlight how virtual characters enhance audience engagement. These virtual personas illustrate the evolving interaction between brands and consumers across various digital platforms.

The purpose of the survey was to collect empirical data on which platforms streamers use (and to what extent) and whether there was a direct link between increased audience engagement and the use of DHT compared to conventional streamers. When creating questions, the focus was on clarity, accuracy, and objectivity, considering the specifics of different groups of participants to collect key information about streaming. The questions were designed to analyze the understanding and application of DHT by streamers, its impact on audience engagement and satisfaction and to identify audience preferences using both quantitative and qualitative research methods. Streamers noted how many key indicators of their streams had changed, such as the number of views, viewing duration, audience activity, and overall interaction during the year.

Interviews with streamers who use DHT focus on their experience applying the technology and its impact on their work. The reasons for using the technology, its advantages and disadvantages, and how the technology helps attract an audience were discussed. This helped to assess the impact of DHT on streaming.

3. Results

This study focused on the role of DHT in multiplatform streaming. The study collected data from three groups of respondents: streamers who actively used DHT, conventional streamers, and viewers of these streams. The consideration of these groups of respondents is fundamentally important for understanding the type and scope of the influence of technology on streaming. Contacting streamers who use DHT allowed the authors to analyse the process of using the technology: what goals they set, what advantages they see, and what they consider difficulties or disadvantages. This is important for understanding the extent to which reality corresponds to theoretical ideas on the benefits of DHT. For comparison, it is necessary to include conventional streamers that do not use DHT in the sample. An analysis of the

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work of this group will identify differences in attracting audience attention depending on the use or absence of DHT. Viewers, in turn, will help understand the perception of this technology from the perspective of real users, who consume content. The audience's opinion helps to assess the actual perception of DHT and its impact on the level of satisfaction and engagement of the audience. Thus, the analysis of data from the three groups of respondents provides a comprehensive understanding of the role and impact of DHT in the field of streaming, considering opinions and assessing the impact of this technology on various aspects of streaming.

DHT is widely used on broadcast platforms and social networks such as TikTok, YouTube Live, and Twitch [7]. This technology attracts the attention of a new audience and expands the boundaries of interaction with viewers. Because of the analysis, it was found that streams that use DHT technologies are much more attractive to viewers. The level of interaction increased due to the development of DHT. Viewers commented more actively and participated in stream chats when streamers used virtual avatars or characters. Most DHT streams were observed on platforms such as Twitch and YouTube, where most of the technological innovations in streaming are introduced. Viewers embraced DHT favourably and actively interacted with DHT elements in the streams. They left comments, participated in voting, and actively interacted using emoticons and reactions. Virtual avatars were the most popular among all DHT elements. They offer a new and innovative way to interact with viewers and present themselves in a virtual space. Streamers now have the opportunity to build a complex system of personalised virtual characteristics in order to interest and attract the audience. In most cases, streamers customise their virtual avatars to reflect their style, character, and personality. This can attract an audience that likes a particular streamer because of its unique style or content.

Despite the active use of individual DHT elements, the introduction of truly full-fledged virtual people or synthetic characters in streaming has now faced a number of limitations, which explains their rare presence on the social media scene. Creating a realistic synthetic human with good animation and facial detail still requires a lot of time and effort from qualified professionals, which entails high costs, especially for small or independent content creators [8]. This may include the cost of professional services such as 3D modelling and rendering, animation, motion detection, and processing software. The technology requires complex and expensive equipment. Typically, a stream using DHT requires professional equipment in the form of a motion capture system, special software, and powerful computing resources capable of processing high-quality graphic images in real time. In addition, mastering DHT requires an understanding of complex systems and applications, which can make it difficult for some streamers to implement this technology.

However, there are several examples of using fully fledged virtual people and virtual influencers in streams. For example, virtual stars such as CodeMiko have become popular due to their quality and realism [9]. CodeMiko, which uses advanced motion capture and virtual reality technologies, combines elements of comedy and interactivity, attracting a large audience. More and more brands are looking to collaborate with virtual influencers in advertising, live broadcasts, and other marketing campaigns in the hope that this will help increase brand awareness and attract younger consumers [10]. Digital representatives of the brand can appear at several events at once and work 24/7, providing their subscribers with an opportunity for individual communication. The study demonstrates the important role of virtual influencers in Chinese culture. An example of this is the virtual character "Newest Colonel Sanders" from KFC in China [11]. He broadcasts live, shares cooking tips, and interactively communicates with fans of the brand. This creates a virtual interaction that ultimately serves to increase KFC product sales. In May 2022, the largest Chinese online retailer Alibaba introduced the virtual influencer Noah, who was created based on the consumers' preferences [12, 13]. The initiative, with Tommy Hilfiger, attracted more than 400,000 fans, and Noah became the first virtual influencer to organize a live broadcast with real people. This new implementation of interaction with the audience at a new level attracted additional attention from the brand, thus increasing its sales. A special place in Chinese pop culture is Luo Tianyi, one of the first virtual personalities that users customise. With over 5 million subscribers on Weibo and active livestreams on Taobao, Luo Tianyi has become the face of many advertising campaigns.

The survey of ordinary streamers who do not use DHT plays an important role in this study. The most important criterion for interviewing regular streamers is to understand how the non-use of DHT affects audience engagement and engagement. This includes investigating indicators such as changes in the number of viewers, the level of interaction between viewers (comments, likes, reposts), and the duration of viewing the stream. Comparing these parameters between groups of streamers using and not using DHT can provide valuable insights into the role and potential of DHT in increasing audience engagement. This will also help determine whether a lack of DHT can have a significant impact on audience engagement and stream success.

Most of the surveyed DHT streamers were from YouTube and Twitch. Rare cases of DHT use on other platforms have also been reported. This suggests that the use of DHT has become widespread in streaming communities, especially among VTubers. To integrate

DHT on their platforms, the streamers highlighted the following elements: virtual avatars, real-time animation, movements, and speech matching with the streamer. Most streamers use virtual avatars for visual purposes. However, 2 % of streamers indicated using virtual people as hosts or co-hosts with the ability to interact with the audience using artificial intelligence. The streamer can act as a "shadow" director, controlling the actions of a virtual person. Streamers using DHT report an increase in the number of views, viewing duration, audience activity in comments, degree of participation in interactive elements of the stream, and overall interaction.

Streamers using DHT have noticed that viewers are more likely to comment on their broadcasts. This can be attributed to the visual appeal of DHT, which encourages viewers to take a more active part in the broadcast discussions. This indicates the attractiveness of DHT, which is directly related to increased audience engagement. In addition, 2 % of streamers using virtual characters controlled by artificial intelligence as presenters or co-hosts noticed an even more significant increase in audience engagement (Figure 1). This can be explained by the higher level of interactivity of communication with virtual artificial intelligence characters, which can respond to the input of viewers and communicate in real time. The results of this study reveal a significant impact of DHT on broadcasting performance, particularly when comparing the use of virtual avatars and virtual hosts. Streams that utilized virtual avatars showed a substantial increase in audience engagement, with a 30 % increase in the number of views, a 25 % increase in viewing duration, and a 37 % growth in overall engagement. In contrast, streams featuring virtual hosts, especially those controlled by artificial intelligence, exhibited even stronger results. These broadcasts experienced a 45 % increase in the number of views, a 35 % increase in viewing duration, and an impressive 53 % increase in overall engagement. The higher level of interactivity and responsiveness of virtual hosts played a pivotal role in fostering audience participation, as viewers responded positively to the ability of AI-powered characters to engage in real-time conversations.

Further data analysis using statistical methods confirmed the significance of these trends. The average increase in audience engagement across both groups was substantial, and the standard deviation within each group suggested that the effects were consistent and not driven by outliers. Correlation analysis demonstrated a strong positive relationship between advanced DHT elements and audience interaction, particularly in broadcasts with virtual hosts. Additionally, hypothesis testing indicated that the differences in engagement metrics between the two experimental groups were statistically significant, supporting the conclusion that DHT has a measurable and positive impact on streaming outcomes.

In this study, conventional streamers that do not use DHT exhibited a different dynamic. Most conventional streamers noted the stability of the audience during the observation period. They did not experience a significant increase or decrease in views, which underscores the stability of their audience base. As with the number of viewers, conventional streamers also noted a steady level of engagement. This includes interactivity in the chat, the number of likes, shares, and comments. This indicator indicates that the audience's activity level remained unchanged during the period studied. Unlike streamers that use DHT, conventional streamers reported less dynamic growth and viewer retention. However, conventional streamers point out that reality streaming can offer more direct and natural interactions, which some viewers may find more appealing.

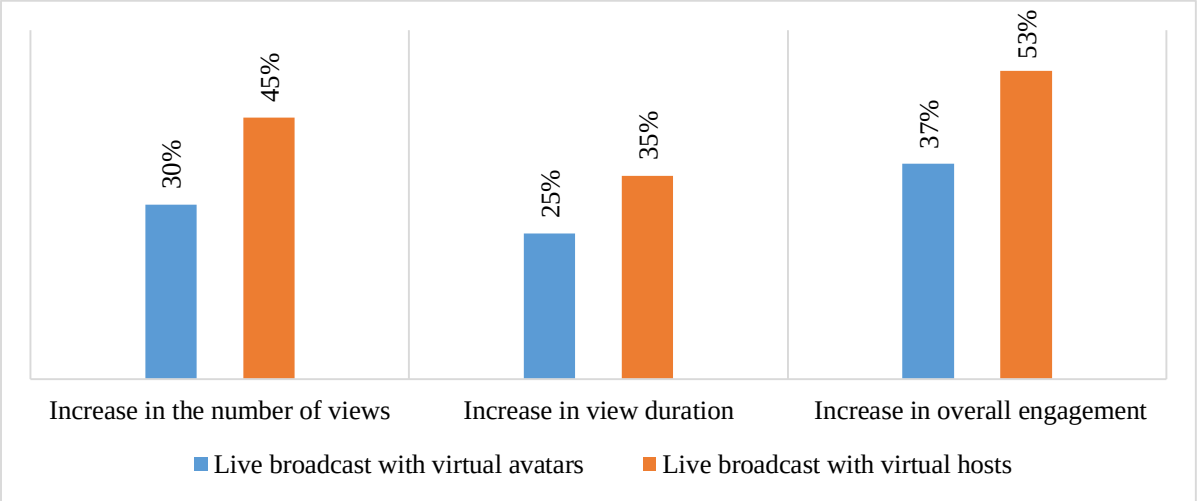

Fig. 1. Impact of DHT on broadcasting indicators

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The streamers who tried using DHT but then abandoned it during the specified study period had their own dynamics. Most streamers noticed a slight decrease in audience engagement after discontinuing their use of DHT. They noted a decrease in the number of views, viewing duration, and viewer activity in the comments. This can be explained by the fact that a part of their audience may have been attracted precisely by the uniqueness and novelty of DHT, and the loss of this element may have led to a decrease in interest. In addition, some streamers pointed out that switching back to conventional streaming caused a change in the format of their content, which could also affect the audience's impressions and engagement. However, some streamers noted that stopping using DHT allowed them to better focus on other key aspects of their streams, such as content quality and real-time interaction with viewers (Figure 2).

During the study, a survey was conducted among viewers to determine their attitude to DHT in streaming. The questionnaire included questions about how they perceived the use of technology, how much it affected their viewings, their level of engagement and overall interest in streams. 65 % of viewers said that DHT changes their perception of streams, adding an element of virtuality and innovation. The majority of viewers (74 %) expressed curiosity and interest in using DHT for streaming. This was due to the originality and uniqueness of the technology. Some viewers noted that DHT makes streams more interactive and engaging, which increases their viewing time. A total of 36 % of viewers still prefer conventional streams, citing a sense of naturalness and direct interaction. These results demonstrate that viewers are generally positive about the use of DHT in streaming. They find it interesting, exciting, and innovative. However, some viewers still prefer conventional streams because they appreciate the naturalness and direct interaction that they offer.

During the interviews, streamers shared their experiences using DHT virtual avatars. To integrate DHT into their platforms, streamers use 3D modelling, real-time motion capture and speech technology, and software to integrate these avatars into live broadcasts and interact with viewers on social media. Most streamers used specialized programmes such as Adobe Character Animator, FaceRig, or Custom Cast. Real-time animation makes the interaction of streamers with viewers' dynamic and lively, while matching movements and speech with the streamer makes the interaction natural and exciting [14]. Most streamers noted that the use of virtual avatars gives them an element of uniqueness and curiosity, increasing viewer engagement. They also noted that virtual avatars allow them to remain anonymous, which may be preferable for streamers.

According to the results of the interviews, DHT is used in various fields. In digital media, DHT is used to create virtual avatars that provide stream interactivity. In the field of media technology and the arts, DHT is a tool for creating visual media projects. In New Media Arts,

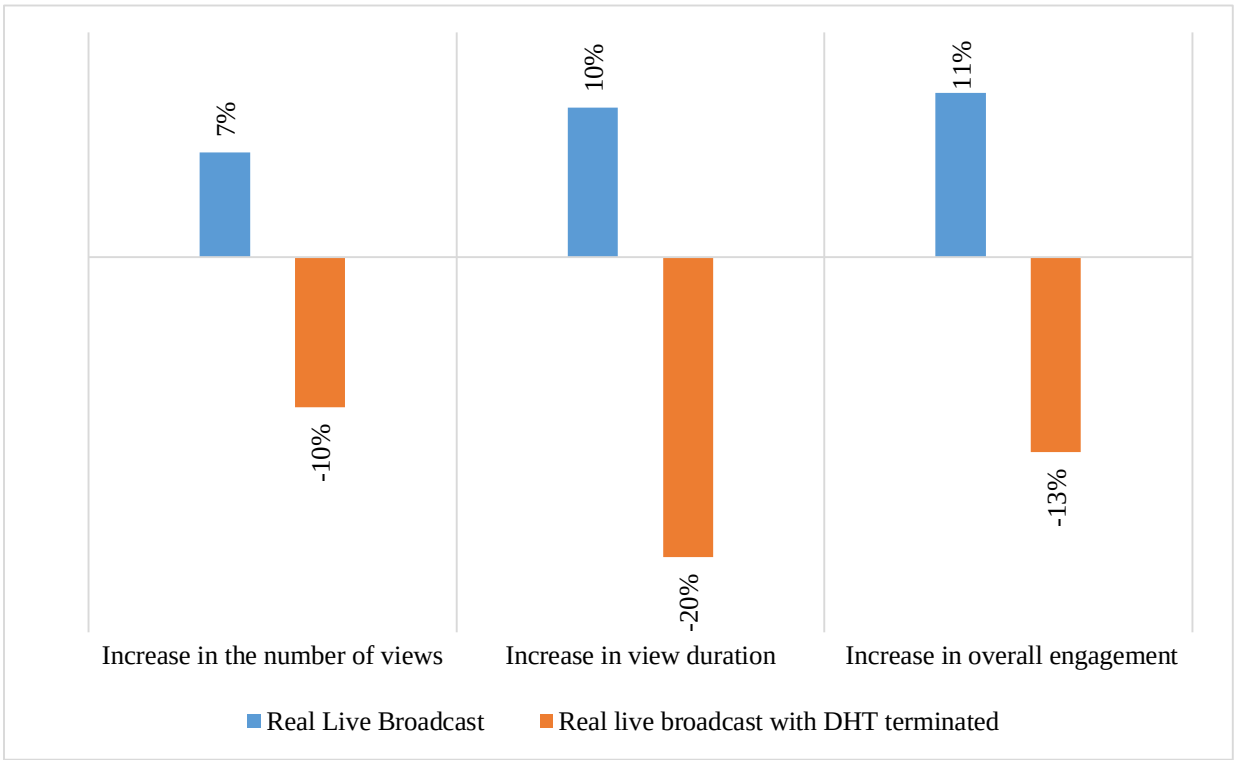

Fig. 2. Indicators of conventional streaming (real person live broadcast)

DHT allows exploration of virtual worlds in a new dimension, and in the context of the "human-machine" interface, it helps develop intuitive user interfaces.

Streamers also talked about their experiences using DHT. In particular, they noted that DHT gave them opportunities to innovate and create unique content, helping them stand out from other streamers and express themselves creatively. In addition, DHT increases the level of interactivity and audience engagement because virtual avatars offer new forms of interaction with viewers. Streamers who used virtual speakers also emphasized the benefits of reducing stress levels. Due to the use of a virtual avatar, they do not need to maintain such control over the broadcast process. For some streamers, an important feature was their ability to maintain anonymity and control their level of communication with viewers by using virtual avatars. In addition to the identified advantages, streamers also highlighted the disadvantages of using DHT. These include technical difficulties: setting up and working with software to create and animate virtual avatars can be difficult and require a lot of time to learn. Moreover, ensuring high-quality DHT operation often requires powerful equipment, which can be expensive or inaccessible to all streamers. In addition, streamers expressed concerns about the time required to be set up and maintain virtual avatars. A virtual host cannot completely replace a real streamer. In addition, despite progress in the fields of artificial intelligence and machine learning, virtual presenters still need control from a streamer to broadcast and interact with viewers.

4. Discussion

The results of this study underscore the substantial role that DHT plays in transforming the dynamics of audience engagement in streaming. The notable increase in views, viewing duration, and interaction metrics for streams that employ virtual avatars and AI-powered virtual hosts indicates the significant advantages these technologies offer over traditional streaming methods. This aligns with existing literature on the increasing role of virtual influencers and avatars in enhancing audience interaction by offering a more dynamic, customisable, and immersive experience. The sharp contrast between the engagement levels of streams using DHT and those relying on traditional methods highlights viewers' growing preference for interactive and innovative content.

The 45 % increase in views and 53 % increase in overall engagement for streams featuring AI-powered virtual hosts, in particular, suggest that audiences are drawn to the novelty and interactivity that DHT provides. This supports the idea that streamers leveraging these tools are better positioned to attract and retain a larger audience because AI-driven characters create a more responsive and personalized interaction environment. The consistency of these results, as confirmed by statistical analysis, demonstrates the reliability of DHT in improving streaming performance. The low variability in the data indicates that the observed increases are not anomalies but rather consistent outcomes of DHT implementation. This highlights the potential for DHT to become a standard feature in the streaming industry, particularly as more content creators explore its capabilities.

Given the need for effective online education, S.W. Jun describes the development and use of a system with avatars to implement real interaction between the teacher and students in the context of live video broadcasting for online learning [15]. Despite the differences in scope, both studies highlight the importance of active interaction and attractiveness in the context of broadcasting. However, unlike the current study, the researcher did not address the problem of optimization and the availability of technology for streamers. Author's research on the development of a system utilizing avatars for real interaction between teachers and students in online education aligns well with the findings of the current study regarding the significance of active interaction and attractiveness in broadcasting. Both studies underscore the critical role that engaging visual elements play in enhancing audience involvement, whether in educational or entertainment contexts. While author emphasizes the implementation of such systems in educational settings, the current study expands upon this by specifically addressing the optimisation and accessibility of DHT for streamers. This aspect is vital, as it not only impacts the quality of interactions and determines the feasibility of adopting these technologies among various streamers, particularly those who may lack the resources to implement advanced systems.

According to previous studies on parasocial interactions and relationships, J.P. Stein et al. [16], C. McLaughlin and D.Y. Wohn [17] investigated these phenomena in the context of broadcasting. This paper compares the predictors of parasocial interactions and relationships while separating these two concepts, which, in the past, were used interchangeably. The results show that streamer characteristics are the most important predictors of both parasocial phenomena in the context of broadcasting, although viewer characteristics and relationships also have a significant impact. The research conducted by the authors on parasocial interactions and relationships in broadcasting complements the current study by emphasizing the pivotal role of streamer characteristics in shaping audience engagement. In the context of DHT, the characteristics of streamers whether they use virtual avatars or traditional methods, significantly influence how audiences perceive and interact with content.

Considering the pressing issue regarding the influence of a virtual character's voice on audience

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perception, T. Ferrell et al. [18], M. Park et al. [19] explored the effect of voice quality on the confidence and comprehension of participants in a training module. Their findings revealed that the voice quality of a virtual character did not significantly impact participants' understanding of the materials or their trust levels. There were no notable differences in perceptions of trust, learning capacity, agent plausibility, agent humanity, or external attractiveness among the groups. The insights into the effects of voice on perception and learning presented in their research can be relevant to the current study's examination of streaming and DHT use. Factors such as the selection of a virtual character's voice and its influence on audience engagement may hold significance for streamers [20]. The practical insights gained from streamers' use of DHT can provide valuable avenues for future research into the role of virtual characters in educational settings.

As part of the study of the impact of virtual technologies on the viewer experience, Lee et al. [21], H. Sakuma et al. [22] analyzed the concert of a virtual YouTuber. They investigated the audience and community surrounding this phenomenon by conducting surveys among concert-goers and interviewing volunteer content creators. The results show that the type of platform and perception of VTuber's role (such as an idol or regular streamer) affect audience presence and immersion. Compared to this study, the paper by the researchers focuses on a specific event and is closely related to fan culture and audience, and also analyses the impact of the type of platform on the viewer experience, which goes beyond the goals of the current study.

Focusing on the technical aspects that influence live streaming, Z. Zhu et al. [23] A. Wan and M. Jiang [24] investigated an energy-efficient streaming system for VTubers that enhances their operational capabilities. They addressed this challenge by creating a system that offloads video streaming and intensive computing tasks from mobile devices to nearby servers. This innovation significantly decreases the power consumption of mobile devices and enables the rendering of multiple avatars on a larger scale. This functionality was previously unattainable with VTuber's mobile systems. Their approach is particularly pertinent for developers and engineers working on the technical aspects of streaming systems. In contrast, the present study offers valuable insights for researchers and marketers interested in understanding the factors that can impact broadcast success and boost audience engagement.

In their detailed analysis of the impact of virtual influencers, Byun and Ahn [25] identified key elements that distinguish them from their human counterparts in the context of advertising activities. This study makes a systematic comparison between virtual and human influencers, highlighting their similarities and differences. The researchers analyzed 44 scientific papers to determine the potential and limitations of using virtual influencers in interactive advertising. The current study does not address the topic of interactive advertising and related consumer behaviour because it focuses on the perspective of streamers, not consumers. Combining data from both studies can provide a better understanding of various aspects of DHT use, bringing together the perspectives of both streamers and consumers.

Unlike other studies that focus on the technical aspects of streaming, hardware settings, or analysis of the impact of virtual influencers in e-commerce, this study can contribute to understanding the psychology of viewers and methods of attracting their attention using DHT technologies. The results can provide a deeper understanding of how different environments use DHT to improve streaming content and attract viewers, which can be useful for strategic planning and development of streaming technologies.

5. Conclusions

This study confirmed the significant impact of DHT on the streaming industry. The diverse perspectives from streamers in various fields have allowed the authors to form a broader and more complete picture of the impact of technology on both streamers themselves and their audience. By analysing the results, it was possible to identify not only the advantages of this technology but also its disadvantages.

Streamers using DHT have seen an increase in viewer engagement and commentary activity, which is believed to be due to the visualization and interaction features that DHT provides. In addition, using virtual avatars allows streamers to feel more confident because they can fully control the visual experience they create. Virtual avatars help remain anonymous, which is useful in various streaming scenarios. For example, streamers can use virtual avatars to avoid unwanted publicity or risk of harassment by third parties. According to streamers, DHT provides more opportunities for creativity. Virtual influencers can have no design and style, allowing streamers to experiment and create unique visual images. Virtual presenters created using DHT can work continuously for a long time without interruption, which helps to retain viewers' attention and increase the number of views. All the benefits identified during the study confirm the link between increased audience engagement and the use of DHT.

However, it is necessary to approach the use of DHT considering the specifics of the audience and the topic of the stream and to maintain the quality of content and interaction with viewers to make the use of DHT as effective as possible. Despite the advantages of DHT for

streaming, some obstacles to its use have also been identified. In particular, the complexity of use and the need for technical equipment may limit streamers' access to such technology. It is also important to consider the different attitudes of the audience towards virtual presenters: while some viewers welcome such innovations, others may prefer to communicate with real people. Based on these findings, it is recommended to develop training programmes for streamers to simplify the use of DHT. In addition, it is important to focus efforts on making technology more accessible, including in terms of the appropriate equipment. Further research may help determine how best to attract the part of the audience that prefers conventional streams and how to balance the use of virtual presenters with the preservation of the "human" element in the broadcast.

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Conflict of interest

The authors declare that they have no conflict of interest concerning this research, whether financial, personal, authorship, or otherwise, that could affect the research and its results presented in this paper.

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Use of artificial intelligence

The authors confirm that they did not use artificial intelligence methods in their work.

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ЦИФРОВІ ТЕХНОЛОГІЇ ЛЮДИНИ В ЗАСТОСУВАННІ ПРЯМИХ ТРАНСЛЯЦІЙ У СОЦІАЛЬНИХ МЕРЕЖАХ

Сі Чен, Сіва Шанкар Рамасамі, Бібі Ше

Предметом цієї статті є застосування цифрових людських технологій (Digital Human Technology, DHT) у прямих трансляціях на платформах соціальних мереж та їхній вплив на залучення аудиторії і привабливість контенту. У дослідженні розглядається, як елементи DHT, такі як віртуальні аватари та ведучі, керовані штучним інтелектом, все частіше використовуються в прямих трансляціях для покращення взаємодії з глядачами та утримання аудиторії. Основна мета - оцінити, чи підвищує інтеграція DHT рівень залученості, інтерактивності та утримання глядачів, особливо порівняно з традиційними методами потокового мовлення, рівень залученості, інтерактивності та утримання глядачів. Це дослідження складається з кількох ключових завдань:

огляд поточного ландшафту DHT у прямому ефірі, розробка дослідницької бази для аналізу метрик залучення, збір емпіричних даних за допомогою опитувань та інтерв'ю, а також проведення статистичного аналізу для виявлення кореляцій між використанням DHT та залученням глядачів. Методи, використані в цьому дослідженні, включають кількісні підходи, такі як структуровані анкети для вимірювання показників глядацької аудиторії, та якісні підходи, зокрема глибинні інтерв'ю зі стримерами та глядачами. Статистичні методи, такі як факторний і кореляційний аналіз, застосовуються для оцінки впливу ЦГТ на ключові показники залученості, такі як тривалість перегляду, частота взаємодії та задоволеність глядачів. Завдяки систематичному спостереженню це дослідження також фіксує взаємодію в реальному часі, що дає змогу отримати комплексне розуміння ефектів DHT. Зроблені висновки підкреслюють, що DHT значно підвищує залученість у прямі трансляції, надаючи творцям контенту інноваційні способи утримувати аудиторію. Однак висока вартість технології та технічні вимоги обмежують її доступність для незалежних стрімерів. Це дослідження містить практичні рекомендації для стрімерів і маркетологів, які пропонують DHT як цінний інструмент для оптимізації привабливості контенту та залучення аудиторії. Майбутні дослідження заохочуються до вивчення масштабованих рішень DHT для покращення доступності для ширшого кола творців контенту.

Ключові слова: штучний інтелект; мета-всесвіт; віртуальний аватар; віртуальний ведучий; трансляція; VTuber.

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