

PERAN AVATAR BAHASA ISYARAT DALAM MENINGKATKAN AKSES PENDIDIKAN DAN LAYANAN PUBLIK BAGI KOMUNITAS TULI

THE ROLE OF SIGN LANGUAGE AVATARS IN ENHANCING EDUCATIONAL ACCESS AND PUBLIC SERVICES FOR THE DEAF COMMUNITY

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Diajukan: 16 November 2024/ Disetujui: 21 Maret 2025

ABSTRAK

Pada tahun 2021, terdapat sekitar 22,5 juta penduduk Indonesia dengan disabilitas, terutama gangguan pendengaran, akses pendidikan dan informasi bagi penyandang tunarungu masih rendah, terutama di daerah pedesaan. Kondisi ini membuat banyak penyandang tunarungu bergantung pada metode komunikasi visual seperti bahasa isyarat, yang sering kali sulit dipahami oleh masyarakat umum tanpa pelatihan khusus. Untuk berkomunikasi dengan orang yang tidak menguasai bahasa isyarat, masyarakat tunarungu memiliki beberapa opsi terbatas, seperti membaca gerak bibir, menggunakan penerjemah bahasa isyarat, atau memanfaatkan teknologi bantu. Avatar bahasa isyarat merupakan salah satu inovasi teknologi yang hadir untuk menjembatani kesenjangan akses informasi pada komunitas tunarungu. Penelitian ini bertujuan untuk meninjau perkembangan avatar bahasa isyarat, mengevaluasi efektivitasnya dalam meningkatkan akses pendidikan dan layanan publik bagi tunarungu, serta mengidentifikasi pentingnya keterlibatan komunitas tunarungu dalam pengembangan teknologi ini. Metode yang digunakan adalah tinjauan literatur dengan pendekatan PRISMA 2020, yang diambil dari tambang data melalui Publish or Perish. Hasil penelitian menunjukkan bahwa Teknologi mutakhir, seperti kecerdasan buatan, pemodelan 3D, dan augmented reality, telah meningkatkan cara penyampaian bahasa isyarat, memungkinkan interaksi yang lebih inklusif. Avatar yang dirancang dengan fitur visual seperti ekspresi wajah dan gerakan tubuh yang halus menunjukkan peningkatan pemahaman komunikasi bagi pengguna, berkat kemampuan mereka untuk menyampaikan emosi dan konteks percakapan. Avatar bahasa isyarat dapat meningkatkan motivasi belajar dan mendukung komunikasi yang lebih baik antara penyandang tunarungu dan masyarakat umum, terutama dalam konteks pendidikan inklusif dan pelayanan publik. Teknologi ini memiliki potensi besar untuk menjembatani kesenjangan akses informasi dan meningkatkan kualitas hidup tunarungu di Indonesia, terutama bila dikembangkan dengan melibatkan komunitas pengguna secara aktif.

Kata Kunci: Animasi 3D, Avatar bahasa isyarat, Efektivitas teknologi, Teknologi komunikasi dan Tuna rungu

ABSTRACT

In 2021, approximately 22.5 million people in Indonesia had disabilities, with hearing impairments being among the most prevalent. Access to education and information for the deaf community remains limited, particularly in rural areas. As a result, many deaf individuals rely on visual communication methods, such as sign language, which can be challenging for the general public to understand without specialized training. In situations where communication with non-sign language speakers is necessary, the deaf community often resorts to alternatives such as lip-reading, sign language interpreters, or assistive technology. Sign language avatars have emerged as a technological innovation aimed at bridging the information access gap for the deaf community. This study seeks to review the development of sign language avatars, assess their effectiveness in improving educational access and public services for the deaf, and highlight the importance of involving the deaf community in the

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development of such technologies. A literature review was conducted following the PRISMA 2020 approach, with data sourced from the Publish or Perish database. The findings suggest that advanced technologies such as artificial intelligence, 3D modeling, and augmented reality have significantly enhanced the delivery of sign language, facilitating more inclusive interactions. Avatars incorporating visual features such as facial expressions and smooth body movements improve communication comprehension by conveying emotions and contextual meaning. Sign language avatars not only boost learning motivation but also promote more effective communication between the deaf and the general public, particularly in inclusive education and public service contexts. This technology has substantial potential to bridge information access gaps and improve the quality of life for the deaf community in Indonesia, especially when developed with active involvement from the user community.

Keywords: 3D Animation, Communication Technology, Hearing Impaired or Deaf, Sign Language Avatar and Technology Effectiveness

INTRODUCTION

Based on a report by the Badan Pusat Statistik (BPS) in 2021, there are around 22.5 million Indonesians with disabilities, and most of them are hearing-impaired or deaf individuals. Inequality in access to education and information for deaf individuals is still high (Dewi et al., 2020). This leaves many deaf people dependent on visual communication methods such as sign language, which is often difficult for the general public to understand without specialized training.

Sign language is the primary means of visual communication for deaf people or those with hearing impairments. Success in communicating sign language relies heavily on the visual accuracy of each hand gesture, facial expression, and other body language. To communicate with people who do not know sign language, the deaf community has limited options, such as lip reading, using sign language interpreters, or utilizing assistive technology (Gugenheimer et al., 2017). Various computer technologies have now been developed to support this communication, including the conversion of text and voice into Gesture Mark-up Language (Brouer & Benabbou, 2019; Eryiğit et al., 2016; Kayahan, 2019; Raghavan et al., 2013) and the use of 3D avatars to translate text into sign language (De Martino et al., 2017; Ebling & Glauert, 2016; Gibet et al., 2016; Karaca, 2018;). These technologies, including gesture detection and digital sign language dictionaries, enable smoother human-computer interaction through gesture-based avatar animation. Over the past few decades, technological developments have brought about changes in the translation of sign language into three-dimensional (3D) animations that can make sign language communication more inclusive and accessible.

For deaf and hard-of-hearing people, whose native language is sign language, it is important to provide information not only with translated text but also with sign language. One way to provide information in sign language is by using animated avatars. The development of sign language-based avatar technology is important in bridging this communication need. This technology is able to provide more inclusive and comprehensive access, allowing the delivery of information and communication that is more easily understood by the deaf community. With avatars that are able to customize sign language gestures and expressions in various contexts, it is hoped that this technology can improve the effectiveness of communication in sectors such as education, public services, and health.

In this context, 3D sign language avatars have become an important tool in education. These avatars serve as educational agents in a digital environment, facilitating communication between the user and the system. When designing educational agents, factors such as the target group and the avatar's visual display features need to be considered, as these can affect the effectiveness of communication and learning (Z. Chen & Chen, 2014). This research aims to evaluate the visual display features of sign language avatars and their application within the

framework of educational agents, focusing on how visual elements can be improved to support students' learning experience (Bronack, 2011).

The urgency of this research is to contribute to the enrichment of literature and the development of more effective avatar technology in sign language animation, as an innovation to overcome communication limitations, gaps in access to information and services for deaf people. In addition, the findings of this study can provide guidance in designing more visually responsive avatars, maximizing their benefits in education and public communication, and supporting social integration for the deaf community, which can be applied in Indonesia.

METHOD

This research utilizes the literature review method following the PRISMA 2020 guidelines. This approach allowed them to capture a comprehensive view to identify trends, key findings, and challenges in sign language avatar development. The stages of the research include Initial database analysis, Database selection, Identification of relevant articles, Removal of duplicate articles, Article filtering, Article analysis, Article comparison and Conclusion (Erienda et al., 2023). Data was retrieved from publish or perish on September 21, 2024 with search keywords in the form of “animation” or “animations” and “sign language” or “sign languages” and “deaf” or “hearing loss”, so that 200 data were collected which were selected again based on file type, title, abstract, and full paper, so that 19 articles relevant to the research were filtered. The articles taken were published between 2014 and 2024. These articles were also reviewed to include recent research and the literature was selected based on its relevance to the four main research questions: (1) the extent to which technological and cultural developments affect sign language avatars, (2) the types of content that can be developed to enhance sign language learning, (3) what features of avatars are most influential in users' understanding of the sign being conveyed, and (4) the effectiveness of sign language avatars in conveying information and communication to deaf people.

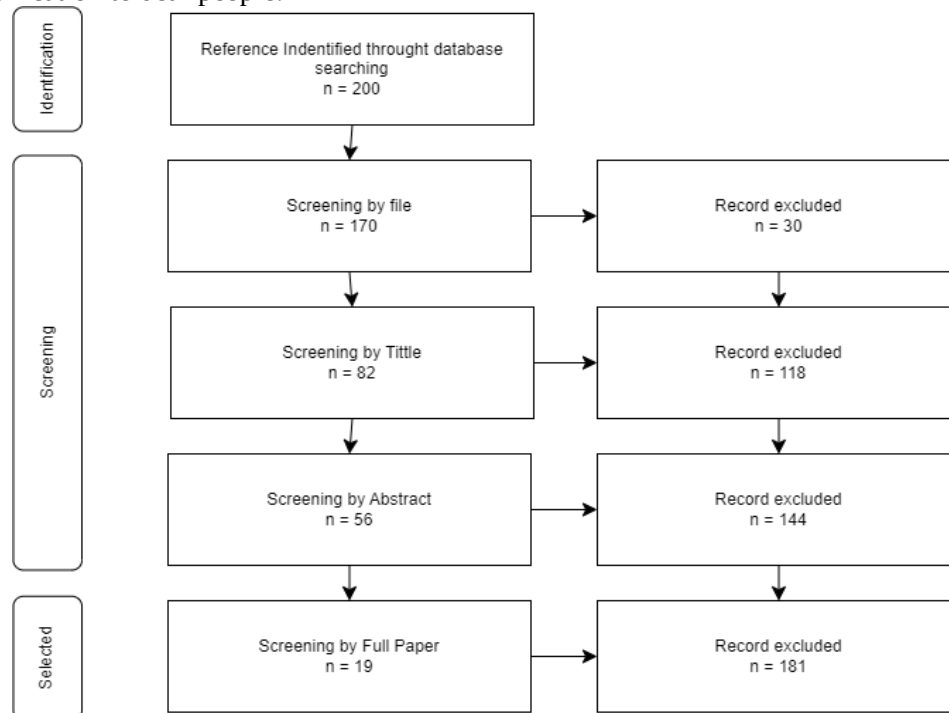


Figure 1. PRISMA method used for research
(Source: Results and Discussion)

Sign language avatar technology enables deaf people to interact with general users through animated representations that can perform gestures clearly and according to their communication needs. This research aims to review some of the literature related to the development of sign language avatar technology, including the influence of technological factors, culture, significant avatar features, and the effectiveness of its use in various communication and learning contexts.

The Development of Sign Language Animation Influenced by Technology and Culture

The development of sign language animation has been significantly influenced by technological and cultural advancements. Cutting-edge technologies such as artificial intelligence (AI), 3D modeling, and augmented reality (AR) have revolutionized the way sign language is presented and accessed. With the help of AI, the creation of avatars capable of conveying signs more dynamically and responsively has become more efficient. This speeds up the animation development process, making it possible to produce content that is more accurate and relevant to the needs of users, especially deaf people. In addition, 3D modeling gives new life to sign language animation by allowing avatars to express more realistic movements and emotions. These avatars can customize facial expressions and hand gestures based on the context of the conversation, which is particularly beneficial in educational environments for deaf students. This implementation shows how technology can enhance the learning experience and social interaction for them.

Cultural aspects also play an important role in the acceptance and effectiveness of sign language animations. The age, education, and background of the users are determining factors in how well they accept this technology. The younger generation, who are more familiar with technology, tend to adapt more easily to sign language animations. The emotional factor cannot be ignored either, when users feel emotionally connected to the avatar, their understanding of the signs increases. Thus, the development of sign language animation continues to be customized to meet the needs of people with hearing loss, so that they can better connect with the world around them.

The development of sign language animation is not only influenced by technical factors but also by social and cultural aspects. The combination of cutting-edge technology and an understanding of user needs and characteristics can create more adaptive and useful sign language animations, so that the deaf community can better connect and interact with the environment around them.

Developable Content of Sign Language Animation

Content development in sign language avatars is increasingly diverse, especially in the field of education and learning. Sign language avatars are starting to be used in formal and non-formal educational settings, especially for materials that require strong visual delivery. The development of an automatic translation system from Arabic to Arabic sign language by utilizing 3D avatar technology has brought significant innovation in communication between sign language users and speakers. The system is able to translate speech into sign language gestures in real-time, creating a more fluid and intuitive interaction. One of the featured applications, the virtual teacher application, has successfully improved students' understanding of sign language through engaging and interactive animations. In addition, these animations can also be integrated in augmented reality (AR), which makes the visualization of information more interactive, fun, and inclusive for deaf people. The application of haptic feedback in video games shows an increase in hearing-impaired users' responses to events in the game. This allows them to experience key moments that are usually expressed through audio elements, adding a dimension to the gaming experience. Gamification in sign language learning apps has also proven effective

in increasing user motivation and interest. Research shows that elements such as points, levels and challenges in the game can create a more enjoyable learning atmosphere, resulting in users feeling more confident in using sign language after interacting with the app. Furthermore, content development for sign language avatars is increasingly diverse, especially in the field of education. These avatars are now being used in a variety of formal and non-formal environments, especially for materials that require strong visual delivery. For example, research conducted by Ahmad et al. (2021) showed that sign language avatars can help deaf students understand abstract concepts such as computer programming. In addition, there are game-based educational applications such as "i-Sign," which applies gamification to make sign language learning more engaging and interactive.

With so many opportunities and innovations open, the development of sign language avatars continues to grow in various aspects of learning. From introducing basic skills to complex academic concepts, these avatars promise a more inclusive future for deaf people, while expanding the reach and effectiveness of accessible education to a wider community.

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Features Most Influential to User Understanding of Sign Language

To create an optimized sign language animation, the involvement of the sign language user community, especially deaf people, in the development process is crucial. They serve as a live model that sets the standard for ensuring the accuracy and fluidity of sign language message delivery through avatars. Data on hand and body movements collected from this community became the foundation for sign language animations that were not only realistic but also responsive to users' visual communication needs. Research shows that sign language comprehension through avatars is greatly influenced by various visual elements in the avatar itself. Features such as facial expressions, body movements, as well as the avatar's resemblance to the user's physical characteristics, have been shown to play an important role in improving user comprehension.

For example, dynamic and responsive facial expressions on avatars help convey the nuances of emotions more clearly, making the messages conveyed easier to receive emotionally. Micro-movements such as eye and mouth movements in particular can enhance readability and non-verbal communication, giving users a more real and personalized experience of interacting with the avatar.

In addition to facial expressions, the subtlety and fluidity of body movements such as hands and torso also contribute significantly to the user experience. Animations that take into consideration the fine details of hand movements and the right tempo in conveying signs make sign language in animated form easier to understand. Appropriate torso movements can add a layer of emotion to communication, helping avatars convey certain emotional nuances, such as emphasis or affirmation in conversation.



Figure 2. Example of mouthing and torso movement variations in the SiMAX sign language avatar system
(Source : simax.media)

Avatar design should also consider physical characteristics that are similar or familiar to the user. Research has found that avatars that are similar to the user can increase emotional connectedness and trust, which in turn deepens sign language comprehension. Users tend to feel more comfortable and connected when the physical characteristics of the avatar resemble them, as it creates a stronger sense of empathy and visual connection. Features like these are important because they improve the quality of communication in sign language animation and open up wider opportunities for inclusive and adaptive communication.

Avatars equipped with dynamic facial expressions and subtle body movements can improve user comprehension, as these visual elements help convey nuances of emotion and meaning in communication. Research shows that the involvement of the user community in avatar development is crucial to ensure accuracy and smoothness of message delivery. Avatar features such as physical resemblance to the user also contribute to increased emotional connectedness, which in turn deepens understanding of sign language.

Effectiveness of Sign Language Animation in Information Delivery to the Deaf

The effectiveness of sign language animation as a visual communication tool for deaf people is significant, especially in conveying complex information. Sign language avatars have been shown to convey information more quickly and accurately than text, as described in a study by Zhang et al. (2021). Other research shows that the use of Augmented Reality (AR) in sign language animation increases user engagement, making it easier to understand the information conveyed. With this technology, users can access information across multiple platforms, including mobile apps and public information boards, which makes information easier to understand in the context of health, public services, and education. Dynamic and realistic animations improve communication comprehension between sign language users and audiences unfamiliar with the language. Survey results show that animations with clear hand gestures are easier to understand than static images, allowing users to better recognize letters in sign language. In addition, well-designed avatars that include realistic facial expressions and body movements can improve students' understanding of sign language and subject matter. Further evaluation shows that the use of avatars in an educational context makes students feel more engaged and motivated to learn, better compared to traditional teaching methods that tend to be static. Avatars animated with appropriate gestures in mind create more realistic and expressive interactions, making hearing-impaired users feel more confident and engaged. With better accessibility, this animation-based application provides opportunities for more students to learn sign language independently, improving the quality of their communication and understanding.

The effectiveness of sign language animation as a visual communication tool for deaf people is made even more apparent with the help of technologies such as AI, 3D modeling, and augmented reality (AR). These technologies allow sign language avatars to convey information more quickly, accurately and engagingly than text. This, as found by Zhang et al. (2021), suggests that avatars can be a more effective communication solution, especially in conveying complex information. Especially in the context of health, public services, and education, sign language avatars make information more accessible and comprehensible to deaf users through a variety of developed content.

CONCLUSION

Sign language avatars designed with cutting-edge technology not only provide benefits in terms of ease of communication and accessibility, but also open up opportunities for deaf people to be more involved in various aspects of social, educational and professional life. This avatar technology can be an effective communication bridge between deaf people and the general public who are not familiar with sign language. In the education sector, sign language avatars enable the delivery of teaching materials that are easier to understand, especially in the learning of complex concepts. The use of gamification and AR-based applications in sign language learning is also proven to increase the motivation and interest of deaf students, making learning more interesting and fun.

Sign language avatar technology contributes to improving communication and access to information for deaf people. The development of sign language animations involving artificial intelligence (AI), 3D modeling, and augmented reality (AR) has shown great potential in creating more inclusive and effective interactions, not only in the education sector but also in public services and healthcare. Dynamic sign language avatars, with realistic facial expressions and subtle body movements, are proven to amplify message comprehension, accelerate the learning process, and increase user engagement.

However, the development of this avatar technology required the direct involvement of the user community, namely deaf people. This ensured that the avatars created met the needs of accurate and intuitive visual communication. Features such as the avatar's resemblance to the user, responsive facial expressions, and appropriate body movements can create a stronger emotional connection between the user and the avatar, thus increasing understanding and acceptance of sign language.

The use of sign language avatars has the potential to significantly impact the development of inclusive communication in various sectors. In education, avatars can expand accessibility for deaf students by providing more interactive and easy-to-understand learning media. This can create greater opportunities for them to succeed in school.

As for suggestions for further use, the use of avatars in education and training can be expanded by creating more diverse content, including materials for more complex technical and academic topics, which can make it easier for deaf people to access education. Sign language avatars can also be applied to the public service sector, such as health services and administration. These sectors are important for ensuring deaf people can access information effectively and independently. With this innovation, it is expected to reduce the information gap for deaf people, provide more inclusive solutions, and improve their overall quality of life.

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