



AI-driven sign language interpreting avatars: navigating challenges to address communication gaps

Estella Oncins¹ · Iris Serrat-Roozen² · Pilar Orero¹

Received: 22 January 2026 / Accepted: 27 August 2026
© The Author(s) 2026

Abstract

Media accessibility facilitates human interaction with digital products and services. Media accessibility is one of the many solutions to secure all humans can access information today. The Information Society offers many opportunities in all sectors of society, but also presents many challenges, and digital inclusion is perhaps the most persistent. The European Union has addressed this challenge by passing the European Accessibility Act (2019), which echoes the United Nations' request in the Convention on the Rights of Persons with Disabilities (2006). The European Union has also put in place the first worldwide Artificial Intelligence Act (2024), which coexists with the EU General Data Protection Regulation (2016). While most media accessibility services are labelled as “low-risk” according to the Artificial Intelligence Act, there is a caveat: Sign Language Interpreting. This paper looks at the artificial intelligence risks involved in the design and development of Sign Language Interpreting technologies. It concludes that AI-driven avatar Sign Language Interpretation could be the solution that fulfils all three EU laws.

Keywords Accessible communication · AI-driven sign language · Sign Language avatar · European Accessibility Act

1 Introduction

In the age of artificial intelligence (AI), accessibility services are undergoing a profound technological transformation. Recent advances in AI, particularly in machine learning and computer vision, including multimodal large language models (MLLM) that integrate visual and linguistic data, are enabling the real-time delivery of accessibility services. These technological developments promise to increase access to public information, education, healthcare, and digital services. Yet, this technological shift also introduces significant ethical and legal challenges. AI systems often struggle with transparency, privacy, accuracy, and diversity representation, creating risks of depersonalisation, misrepresentation, and over-reliance on automated solutions, especially in the case of Sign Language Interpreting (SLI) [7, 21].

The European Union regulatory frameworks, discussed in Sect. 2, play a crucial role in shaping how AI-generated Sign Language (AI-SL) can be safely integrated into society, especially through the recent EU AI Act. Although current AI Sign Language technologies can be labelled as “low risk” as they apply to domains such as public transportation [6, 20] and hospitality [12], developers are also pursuing “high-risk” areas like healthcare [9] and emergency services [10]. When used in essential public domains such as education, healthcare, and administration, AI-SL is considered a high-risk technology requiring rigorous transparency, human oversight, ethical data practices, and respect for linguistic rights [21]. This shift, if not carefully managed, may exacerbate existing inequalities and undermine trust in these AI systems.

This paper explores the potential of AI-driven Sign Language Interpreting avatars while critically situating them within the European regulatory landscape. Section 2 presents the European legal framework. Section 3 provides a risk analysis of the EU AI Act. Section 4 examines the technological pipeline and current solutions. Finally, Sect. 5 discusses the implications, challenges, and future directions of AI-generated avatars.

✉ Estella Oncins
estella.oncins@uab.cat

¹ Universitat Autònoma de Barcelona, Barcelona, Catalonia, Spain

² Universitat de València, Valencia, Spain

2 Legal framework for digital accessibility in Europe: AI Act, EAA, GDPR

The United Nations Convention on the Rights of Persons with Disabilities (CRPD)¹ came into force in 2006, when communication technology was shifting from analogue to digital. At the European level, the Strategy for the Rights of Persons with Disabilities 2021–2030,² advances the CRPD's principles of accessibility, non-discrimination, full participation, and equality by outlining a comprehensive policy vision for a barrier-free Europe. Within this framework, the European Accessibility Act (EAA, 2019)³ functions as a key legislative instrument. This directive came into force in 2025 and seeks to make digital products such as information content and services in the EU more accessible for all, and especially for vulnerable groups such as people with disabilities. The directive also imposes obligations to both public and private sector organisations, who are required to monitor the accessibility of their respective websites, mobile applications, and media content. In addition, organisations are required to provide an accessibility statement to a central authority in their respective countries.

2.1 Navigating the Bermuda triangle: EU AI Act, EAA, and GDPR

In 2026, the mature data-driven digital environment is increasingly shaped by AI. Customisation and recommendation are two features of AI that differ significantly from the analogue communication period where one size was meant to fit all. AI is driven by data that is broken down into smaller, more specific subgroups based on user features such as age, gender, ethnicity, or disability, instead of being presented as a single, broad average. This method of data segmentation is essential for identifying disparities, understanding the unique needs of different groups, and creating targeted, effective communication and policies.



Fig. 1 The GDPR, EAA and AIA Bermuda triangle

The interaction between the EU Artificial Intelligence Act (AIA) (Regulation (EU) 2024/1689),⁴ the European Accessibility Act (EAA, 2019) (Directive (EU) 2019/882),⁵ and the European General Data Protection Regulation (GDPR, 2016) (Regulation (EU) 2016/679)⁶ establishes a three-part regulatory framework essential for safeguarding the rights of all citizens in terms of accessibility in a secure and ethical way. Yet, this legislative framework is not always clear for all agents involved in the design, development, and procurement of an AI solution (see Fig. 1).

On the top of the triangle there is the GDPR compliance framework, which is a complex but at the same time well-established and well-known legislative framework at a European level. The GDPR imposes strict obligations related to purpose limitation, data minimisation, and the protection of personal data. On the left, we have the EAA, which establishes the accessibility requirements for ICT products and services to ensure that persons with disabilities can access digital services, information systems, and communication tools on an equal basis with others. The EU member states are responsible for transposing this directive into their national laws. For instance, in Spain, the EAA was transposed via Law 11/2023 (enacted 8 May 2023), and a monitoring mechanism at an EU level has been set in place. Finally, on the right there is the EU AIA, which aims at ensuring that AI systems used in Europe are safe, transparent, and respectful to fundamental rights through a risk-based framework that imposes strict obligations on high-risk systems, including requirements for data quality, human oversight, and bias mitigation. However, the EU AIA remains challenging for most stakeholders, as it has not yet been fully tested, and implementation guidelines and monitoring mechanisms are not under development at either a national or European level. Complementary initiatives, such as the *Progress in Implementing the European Union Coordinated Plan on Artificial Intelligence (Volume 2)* [15],⁷ seek to support its practical implementation through coordinated policy and sectoral uptake.

To ensure that accessibility is provided to all, it is crucial to understand how compliance requirements under the EAA, AIA, and GDPR interact. This is essential especially if we are to move from principles and standards into practice [14] to enhance trustworthy, safe, and ethical AI systems.

¹ <https://www.un.org/disabilities/documents/convention/convopt-prot-e.pdf>

² https://commission.europa.eu/strategy-and-policy/policies/justice-and-fundamental-rights/disability/union-equality-strategy-rights-persons-disabilities-2021-2030_en

³ <https://eur-lex.europa.eu/eli/dir/2019/882/oj/eng>

⁴ <https://eur-lex.europa.eu/eli/reg/2024/1689/oj/eng>

⁵ <https://eur-lex.europa.eu/eli/dir/2019/882/oj/eng>

⁶ <https://eur-lex.europa.eu/eli/reg/2016/679/oj>

⁷ https://www.oecd.org/content/dam/oecd/en/publications/reports/2025/11/progress-in-implementing-the-european-union-coordinated-plan-on-artificial-intelligence-volume-2_92ec8756/3ac96d41-en.pdf

2.2 The Bermuda triangle in relation to sign language interpreting

The EAA, the AIA, and the GDPR form an interdependent regulatory triad that shapes the development and deployment of Sign Language Interpreting services. The EAA establishes the foundational obligation to ensure accessible communication, explicitly recognising Sign Language Interpreting as an essential service, while the rapid automation of these services through AI subjects them to the EU AI Act high-risk classification, triggering requirements for transparency, human oversight, and stringent bias mitigation. At the same time, GDPR compliance becomes critical, as Sign Language datasets inherently contain sensitive biometric information embedded in facial expressions, handshapes, and body movements, demanding robust safeguards such as informed consent, purpose limitation, and secure processing. Together, these three legal instruments reinforce that the pursuit of technological accessibility cannot compromise privacy, data protection, or linguistic rights, and that AI-based Sign Language solutions must augment, not replace, the protections ensured through human interpreting.

3 EU AI Act risk analysis of sign language interpreting

The European Union regulatory framework, especially the EU AI Act, plays a crucial role in shaping how AI-generated Sign Language (AI-SL) can be safely integrated into society. AI-SL is suitable for low-risk, strictly non-relevant structured public information, such as TV announcements [18]. When used in essential public domains such as education, healthcare, and administration, AI-SL is considered a high-risk technology requiring rigorous transparency, human oversight, ethical data practices, and respect for linguistic rights [21].

Given the fact that AI is led by data, and data is not equally representative of all humans, it becomes crucial to propose a framework in which to analyse data for bias. This can allow for the introduction of corrections to remedy the unrepresentativeness of some groups, and at the same time push for diversity. The final objective is to push for thorough bias testing of high-risk AI systems to prevent discrimination against vulnerable groups and especially persons with disabilities. This involves ensuring that the data

used to train, validate, and test these AI systems is diverse, reliable, safe, and free from biases [13, 18].

In the context of AI systems that process Sign Language data, GDPR data protection intersects the EAA and the EU AI Act. Because Sign Language recordings inherently contain biometric features (facial expressions, movement patterns, handshapes), these AI systems often trigger GDPR obligations for the protection of sensitive personal data. Facial features, hand movements, and body postures, when captured by AI systems, often fall under the definition of biometric data. Under Article 4 of the EU GDPR, such data is classified as “special category” data when processed for the purpose of uniquely identifying a person, triggering strict requirements for consent, purpose limitation, data minimisation, and data protection. AI systems processing SL input (via camera, computer vision, or sensors) are likely processing biometric data, even if the intent is accessibility-related. The use of biometric and visual data for training AI models implies the use of informed consent, data ownership, representation, and the commodification of bodily expression [21]. Consequently, Sign Language AI systems must treat visual-gestural data as sensitive biometric information, requiring rigorous protections throughout data collection, annotation, training, deployment, and evaluation.

4 Sign language technologies

As all natural languages, Sign Languages are also going through a digital evolution [7]. Sign Language technologies are inherently interdependent [16], as illustrated in Fig. 2.

Sign Language Capturing (SLC), Sign Language Recognition (SLR), Sign Language Translation (SLT), and Sign Language Production (SLP) represent distinct but interrelated components of the Sign Language technology pipeline. SLC involves recording Sign Language data using cameras and/or sensing technologies (e.g., RGB video, depth sensors, or motion capture) to collect datasets, which are often annotated for supervised learning, although recent approaches may rely on weak or no annotation. These datasets support the development of SLR systems, which can be categorised into isolated (single signs) or continuous (sentence-level) recognition, enabling the identification of signs or intermediate representations (e.g. glosses or learned features) from visual input.

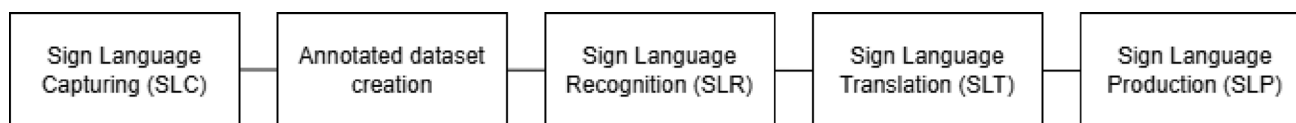


Fig. 2 Sign language technologies interdependency

While SLR, SLT, and SLP all rely on machine learning techniques, particularly deep learning and multimodal representations, they differ in their objectives. SLR focuses on patterns identification. SLT converts signed content into spoken or written language, either by building on SLR outputs or through end-to-end models that operate directly on visual input. It draws on Natural Language Processing (NLP) and Neural Machine Translation (NMT) techniques to model linguistic structure and translation. SLP focuses on generating Sign Language output using approaches such as generative modeling, motion synthesis, and avatar-based rendering [4]. Finally, output technologies include Sign Language avatars and systems that produce Sign Language from textual or spoken input, such systems typically involve both translation (SLT) and production (SLP), rather than SLP alone [19].

Recent advances in deep learning and generative AI have improved aspects of naturalness, expressiveness, and intelligibility across the pipeline, although important challenges remain in achieving fully natural, linguistically accurate, and widely accepted Sign Language outputs.

4.1 AI-based sign language technologies

AI, as a revolutionary technology, has shown great potential in Sign Language. Recent research on automatic Sign Language Production (SLP) has focused on the creation of signing avatars, aiming to generate natural and linguistically accurate visual representations of Sign Language [3]. There are two main approaches for recognising Sign Language gestures. The first is a hardware-based approach, involving gloves or other hardware to track hand position and determine gestures. However, such systems may not capture non-manual features such as facial expressions unless additional sensing technologies are employed. In practice, dedicated hardware for facial tracking (e.g. motion capture systems or facial sensors) can be integrated to address this limitation.

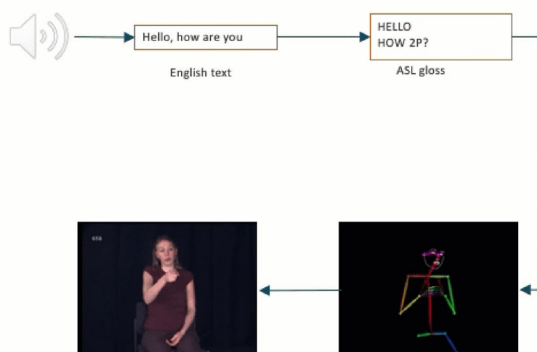


Fig. 3 Amazon GenASL solution (speech or text is converted to an ASL gloss, which is then used to produce an ASL video)

The second is a software-based approach, where a video is taken of the hands, and gestures are classified using computer vision techniques [8]. Furthermore, hybrid approaches combining hardware- and software-based methods are increasingly used to capture a more complete representation of SLP. SLR handles the problem of identifying words or signs from complex visual input signals [4]. Hence, computer vision plays a pivotal role in addressing these challenges by extracting meaningful information from visual data. However, the effectiveness of recognition systems is strongly dependent on the availability and quality of Sign Language datasets [24].

While Sign Language Recognition (SLR) focuses on identifying signs from visual input (e.g., video capturing hand, body, and facial movements), all three tasks (SLR, SLT, and SLP) rely on machine learning techniques, including multimodal modeling. SLT is concerned with converting signed content into spoken or written language.

Given that AI systems are fundamentally data-driven, Sign Language datasets are essential for the development of Sign Language avatar generation processes [3]. SLP aims to convert any of the many possible language inputs (text, audio, or Signed Language) into understandable Sign Language output (see Fig. 3).

This process also includes translation from Sign Language A to Sign Language B by an avatar [11]. A longstanding challenge in this area is the lack of standardised textual representation for Sign Language [17]. As a result, research has traditionally relied on the use of linguistic representations to describe signs textually or glosses [2, 5], although the field is increasingly shifting towards gloss-free and end-to-end AI-driven representations [7].

4.2 Sign language technologies and the EU AI Act risk categories

From an EU AI Act perspective, AI-based Sign Language technologies predominantly fall within the high-risk category, as they process sensitive and potentially biometric data. While Sign Language solutions may be considered limited-risk in low-stakes contexts, capturing, annotation, recognition, translation, and representation pipeline phases require strict compliance with transparency, data governance, human oversight, and accuracy obligations (see Table 1). The risk level of each component ultimately depends on both the technical function and the context of deployment, reinforcing the need for careful system design and ethical governance throughout the Sign Language technology pipeline.

In addition, end-to-end real-time bidirectional SL Systems processing speech, text and/or video can be labelled as High Risk, mainly because integrated systems can amplify

Table 1 EU AI Act risk categories across the Sign Language technology pipeline

Pipeline phase	EU AI Act risk category	Rationale
Sign language capturing (SLC)	High risk (context-dependent)	Visual and facial data may constitute biometric data and is high risk due to sensitivity of personal data. If repurposed for biometric identification, it could fall under stricter regulatory categories
Annotated dataset creation	High risk	Involves large-scale processing of potentially biometric and sensitive personal data, raising concerns around consent, data minimisation, representativeness, and bias
Sign language Recognition (SLR)	High risk	Recognition systems directly affect accessibility and inclusion, and may operate in regulated domains (education, public services), requiring robustness, accuracy, and human oversight
Sign language translation (SLT)	High risk	Translation errors may significantly impact users' rights and access to information, especially in legal, medical, or public service contexts
Sign language production (SLP)	Limited to high risk (context-dependent)	Generally limited risk, but escalates to high risk when deployed in critical domains or when misrepresentation or exclusion may cause harm

risks across all stages and are often used in high-stakes settings such as education or healthcare, requiring appropriate transparency, accountability, and fallback mechanisms. However, despite promising technological progress, it is not yet feasible to automatically deliver all types of accessibility services in real time within the Sign Language domain; existing systems are still limited in scalability, generalisation, and reliability, especially in high-stakes environments such as education and healthcare.

4.3 AI-based sign language solutions

Currently available AI-based technologies illustrate a rapidly expanding ecosystem aimed at improving access, communication, and inclusion for Deaf communities across different contexts. While avatar rendering is fundamentally based on computer graphics, recent advances in AI have improved upstream processes such as motion generation, animation, and realism in Sign Language avatar systems.

In this regard, current SL applications present two main types of avatars, namely cartoon-based avatars and synthetic human-like avatars. Further important aspects are the input and output modalities, languages supported, and context of use. In recent years, a new generation of Sign Language multimodal technologies are being developed with AI to improve communication in Sign Language in different domains as required by the EAA (see Table 2).

Most solutions presented in Table 2 rely on cartoon-based or synthetic human-like signing avatars to display output in public spaces, websites, videos, or educational settings. Most solutions allow for multimodal input and output by converting text, audio, or video/webcam input into SL or vice versa. The tools differ in language coverage, but most of them cover spoken English, ASL, or BSL; others also include International Sign, Libras, Kenyan Sign Language, or a large set of spoken languages paired with different SL outputs. Their use cases range from public announcements, transport hubs, hospitals, and government services to classrooms, family learning, enterprise accessibility, and research environments. Yet, none of the solutions provide bidirectional real-time communication through an avatar.

This fact might be due to current statements made by both Deaf communities and experts warning that governments may use avatars as a cost-cutting measure, undermining Sign-Language rights, interpreter professions, and the cultural and sociolinguistic integrity of Deaf signing [21]. In terms of Deaf community involvement, one solution, namely Sign-Speak, claims to be a Deaf-owned solution. Other solutions such as Signapse, Silence Speaks, Signvrse, and Kara.tech, report the involvement of Deaf persons in the development of such technologies. Furthermore, solutions such as Kara.tech have a statement available on their webpage⁸ on the use of signing avatars, acknowledging that the evolution of technology is causing the wider signing community to reconsider how technology is applied in their daily lives.

5 AI-generated avatars

The use of SL avatars has been historically questioned. In 2018, the World Federation of the Deaf (WFD) and the World Association of Sign Language Interpreters (WASLI) published a joint statement about the use of SL avatars: “WFD and WASLI jointly express particular concern where avatars are used when the information being delivered is live, complex or of significant importance to the lives of deaf citizens such as news broadcasts, public emergency

⁸ <https://www.kara.tech/post/kara-technologies-position-statement-on-the-use-of-signing-avatars>

Table 2 Classification of AI-Driven Sign Language solutions by avatar type, input and output modality, and context of use

Name	Avatar	Input → Output	Languages	Context of use
SignAvatar ^a	Cartoon-based	Text/Audio → Text + SL avatar	30+ spoken languages → IS & ASL	Public announcements, transport hubs, signage
Signapse ^b	Synthetic	Text/Audio/ Video → SL Video	English → ASL & BSL	Web/video accessibility in organisations
Hand Talk ^c	Cartoon-based	Text/Audio → SL avatar	Portuguese → Libras BSL → ASL	Mobile app for translation & learning, families, classrooms
Silence Speaks ^d	Synthetic	Text/ Audio/ Video → SL avatar + captions	BSL; plans for ASL	Public spaces (stations/ transport), education, corporate accessibility
Sign-Speak ^e	Synthetic	SL video → Captions/Text; Text/ Audio → SL avatar	ASL ↔ Spoken English	Deaf-owned solution Live event accessibility, enterprise platforms, video content
Signs (NVIDIA Platform) ^f	Cartoon-based + webcam	SL video → SL avatar	ASL	Sign Language education, family members of Deaf children, early childhood
SignForDeaf ^g	Cartoon-based	Text → SL avatar	English → ASL	General accessibility/ translation service for Deaf/hard-of-hearing; limited public detail
Signvrse ^h	Synthetic	Text/Audio → SL avatar	English → KSL	Webapp beta, education settings, health/hospitals, public services in Kenya
Kara.tech ⁱ	Synthetic	Text → SL (AI translation and human revision)	ASL	For educational materials, campaign and explainer videos
OmniBridge ^j	No Avatar	SL → Text Audio → Text	English → ASL ASL → English	Business
ChatGPT SL/SignGPT (Assistant GPT) ^k	No Avatar	Prompt text → SL output SL → Text output (experimental)	English ↔ ASL, BSL	Research/assistant context; Sign-Language translation experiments
Google SignGemma ^l	No Avatar	SL → Text/Audio	ASL	Research model for SL recognition
Amazon GenASL ^m	Synthetic	Text/Audio/Video → SL	English → ASL	For accessibility and content creation
Connect Hear ⁿ	Cartoon-based and synthetic	Text/Audio → SL Video/Text/Audio (AI translation and human revision)	Pakistan; English → PSL	CODA-owned solution. Avatars for training, capacity building, teaching, and emergency services

Note. Libras, Língua Brasileira de Sinais (Brazilian Sign Language); SL, Sign Language; ASL, American Sign Language; BSL, British Sign Language; IS, International Sign; KSL, Kenyan Sign Language; PSL, Pakistan Sign Language

^a<https://www.signavatar.org/>

^b<https://www.signapse.ai/>

^c<https://www.handtalk.me/en/>

^d<https://silencespeaks.io/>

^e<https://sign-speak.com/>

^f<https://signs-ai.com/>

^g<https://www.signfordeaf.com/>

^h<https://signvrse.com/>

ⁱ<https://www.kara.tech/>

^j<https://omnibrige.ai/>

^k<https://chatgpt.com/g/g-4JLkhC8KJ-sign-language-assistant-gpt>

^l<https://deepmind.google/models/gemma/>

^m<https://aws.amazon.com/blogs/machine-learning/genasl-generative-ai-powered-american-sign-language-avatars/>

ⁿ<https://www.connecthear.org/>

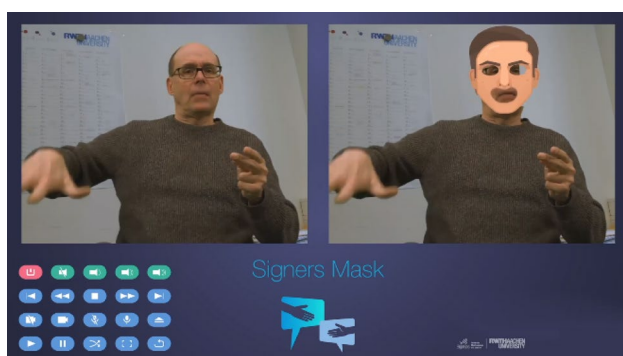


Fig. 4 Signers mask from SignGes

announcements, or political announcements”.⁹ According to their views, avatars might be useful for pre-recorded static customer information, as a one-way communication channel only from spoken to Sign Language and not vice versa. For example, in hotels or train stations where instructions might be given, and no interaction or “live” signing is foreseen. As they argue, avatars can complement, but never replace, qualified human interpreters, and their development must involve Deaf professionals to avoid harmful, unethical, and ineffective accessibility solutions. Current concerns on the use of SL avatars, more specifically AI-generated avatars, are that 1) they often fail to meaningfully involve Deaf communities or reflect the linguistic and cultural integrity of Sign Languages, and 2) protection of personal and cultural identity such as signers’ names, images, voices, facial expressions, and signing styles in the development of the systems remain unclear [21].

Conversely, the use of AI-driven avatars for automated Sign Language Interpreting (SLI) is promising, especially in the case of synthetic human-like avatars. This is because SL avatars have improved significantly in the last decades, especially with personalisation features [23]. However, avatars must be understandable, by default adopting a born-accessible perspective and the participation of the end user community from the design phase [21, 22]. A major advantage of SL avatars is their flexibility in appearance, as they can be designed to resemble a real person or take on a stylised, cartoon-like form [1]. This adaptability also enables anonymisation, as the avatar can convey signing without revealing the identity of the original signer [23]. Anonymisation has been identified as a key feature in research involving Deaf users. For example, the completed Signers Mask project developed by the Visual Computing Institute and the Center for Sign Language and Gesture (SignGes)¹⁰

at RWTH Aachen introduced software that anonymises signers by replacing their appearance in the video with a real-time avatar (see Fig. 4). A neural network is trained to convert video input into pose information for the face and hands, enabling an anonymised avatar to sign the content, ensuring the provision of the service as well as GDPR compliance and mitigation of the risk assessment of the EU AI Act. While this approach enhances privacy by masking personal identity, it also presents limitations, as simplified or less expressive avatars may fail to capture critical non-manual features, such as facial expressions, which are essential for conveying meaning in Sign Languages. Moreover, full anonymisation cannot always be guaranteed, as individual signing styles may still allow recognition of a signer, although this may be less critical from a regulatory perspective under frameworks such as the GDPR, the EAA, and the EU AIA. For this reason, the use of Sign Language data requires robust ethical and legal safeguards, including informed consent procedures, ensuring that participants are fully aware of how their data will be collected, processed, anonymised, and potentially reused [13].

Future AI-based solutions should prioritise facial animation, better interaction design, and participatory development with Deaf communities. Avatars should be developed and researched in interdisciplinary teams, including also Deaf participants as necessary humans in the loop, and in line with the UN’s “Nothing about us without us” slogan. The use of appropriate protocols in the development phase of any SL avatar [23] could also prove to be essential to ensure that linguistic, ethical, situational, social, and aesthetic aspects are considered from an end-user perspective.

6 Conclusions

AI-based solutions are increasingly being integrated in the development of ICT services and products of public services, education systems, and digital platforms to address the needs of a diverse society, and the Deaf community is no exception. While the recently adopted EU AI Act sets clear obligations, its provisions remain limited when it comes to safeguarding questions related to the GDPR in terms of data privacy, transparency and accuracy in relation to bias. While the EU AI Act classifies AI-based Sign Language technologies as high-risk in essential domains such as education, healthcare, and public administration, its current limitations, particularly the lack of clear implementation guidance, standardisation, and coordinated oversight, pose challenges for ensuring effective and trustworthy deployment [15]. Consequently, AI-based Sign Language systems must treat visual gestural data as sensitive biometric information, requiring

⁹ <https://wasli.org/wp-content/uploads/2023/07/WFD-and-WASLI-Statement-on-Avatar-FINAL-14032018-Updated-14042018-1.pdf>

¹⁰ <https://www.rwth-aachen.de/cms/root/forschung/Angebote-fuer-Forschende/Forschungsfoerderung/ERS-Angebote/ERS-Praxisbeispiele/~vjuwi/SignersMask/lidx/1/>

rigorous protections throughout data collection, annotation, training, deployment, and evaluation.

Artificial intelligence has emerged as a transformative technology in the field of Sign Language, demonstrating significant potential for advancing automatic SL recognition and production, particularly in the development of signing avatars [3]. AI-generated Sign Language avatars offer potential benefits such as affordable low-cost, always-available signing for routine public information, increased visibility of signed languages, and supplementary support in education or situations where no interpreter is available. The use of avatars could further allow Deaf individuals to remain anonymous, for example by signing their own text but replacing their face and body with an avatar. By masking personal features, avatars replicate an important characteristic of written language: the ability to communicate content without exposing the speaker's or signer's identity, offering privacy that live SLI does not inherently provide. Avatars are useful supplementary tools that can enhance accessibility, particularly for rendering written or spoken information into Sign Language when immediate human interpretation is not available.

Acknowledgements This article has been funded by the European Union project ALFIE Enhancing Accessible, Ethical and Unbiased AI Grant no. 101177912. Views and opinions expressed are however those of the authors only and do not necessarily reflect those of the European Union. The authors are part of the Universitat Autònoma de Barcelona's research group TransMedia Catalonia, funded by the Catalan government under the SGR call (2021SGR00077).

Author contributions Estella Oncins is the corresponding author, Estella Oncins and Iris Serrat-Rozen wrote the main manuscript text and Estella Oncins prepared figures 1–4 and Tables 1 and 2. All authors reviewed the manuscript.

Funding Open Access funding provided thanks to the CRUE-CSIC agreement with Springer Nature.

Data availability No datasets were generated or analysed during the current study.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

1. Adamo-Villani, N., Anasingaraju, S.: Toward the ideal signing avatar. *EAI Endorsed Transac. Learn.* **3**(11), e1 (2016). <https://doi.org/10.4108/eai.15-6-2016.151446>
2. Arvanitis, N., Constantinopoulos, C., Kosmopoulos, D.: Translation of Sign Language glosses to text using sequence-to-sequence attention models. In: *Proceedings of the 15th International Conference on Signal Image Technology and Internet Based Systems, SISITS*, pp. 296–302. Sorrento, Italy (2019)
3. Aziz, M., Othman, A.: Evolution and trends in sign language avatar systems: unveiling a 40-year journey via systematic review. *Multimodal Technol. Interact.* **7**(10), 97 (2023). <https://doi.org/10.3390/mti7100097>
4. Bragg, D., Koller, O., Caselli, N., Thies, W.: Exploring collection of sign language datasets: privacy, participation, and model performance. *ASSETS '20: Proceedings of the 22nd International ACM SIGACCESS Conference on Computers and Accessibility*, pp 1–14. (2020). <https://doi.org/10.1145/3373625.3417024>
5. Chen, Y., Wei, F., Sun, X., Wu, Z., Lin, S.: A simple multi-modality transfer learning baseline for Sign Language translation. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*, pp 5120–5130. (2020)
6. David, B., Bouillon, P.: Prototype of automatic translation to the sign language of French-speaking Belgium evaluation by the deaf community. *Model. Measure. Control C* **79**(4), 162–167 (2018)
7. De Meulder, M.: Deaf in AI: AI Language Technologies and the Erosion of Linguistic Rights. HU University of Applied Sciences, Utrecht (2025)
8. Dignan, C., Perez, E., Ahmad, I., Huber, M., Clark, A.: An AI-based approach for improved sign language recognition using multiple videos. *Multimed. Tools Appl.* (2022). <https://doi.org/10.1007/s11042-021-11830-y>
9. Esselink, L., Roelofsen, F., Dotlacil, J., Mende-Gillings, S., De Meulder, M., Sijm, N., Smeijers, A.: Exploring automatic text-to-sign translation in a healthcare setting. *Univ. Access Inf. Soc.* (2023). <https://doi.org/10.1007/s10209-023-01042-6>
10. Guo, Y., Zhao, J., Ding, B., Tan, C., Ling, W., Tan, Z., Miyaki, J., Du, H., Lu, S.: Signto-911: emergency call service for sign language users with assistive AR glasses. In: *Proceedings of the 29th Annual International Conference on Mobile Computing and Networking* (p. 1). New York, NY, USA: ACM. (2023) <https://doi.org/10.1145/3570361.3613260>
11. Heloir, A., Gibet, S., Multon, F., Courty, N.: Captured motion data processing for real time synthesis of sign language. In *Proceedings of the Gesture in Human-Computer Interaction and Simulation: 6th International Gesture Workshop, Berder Island, France, 18–20 May 2005*; Springer: Berlin/Heidelberg, Germany, pp. 168–171 (2005)
12. Leeson, L., Morrissey, S., Shterionov, D., Stein, D., van den Heuvel, H., Way, A.: How it started and how it's going: sign language machine translation and engagement with Deaf communities over the past 25 years. In: Way, A., Leeson, L., Shterionov, D. (eds.) *Sign Language Machine Translation*, p. pp 27–72. Springer (2024)
13. Noori, K.: A disability-inclusive Artificial Intelligence Act. A guide to monitor implementation in your country. *European Disability Forum* <https://www.edf-feph.org/publications/a-disability-inclusive-artificial-intelligence-act-updated-guide-to-monitor-implementation-in-your-country/> (2025)
14. Oncins, E., Orero, P.: Pongamos en práctica la estandarización: servicios de accesibilidad e interacción. *Hikma* **20**(1), 71–90 (2021)
15. OECD: Progress in Implementing the European Union Coordinated Plan on Artificial Intelligence. OECD Publishing (2026)

16. Papastratis, I., Chatzikonstantinou, C., Konstantinidis, D., Dimitropoulos, K., Daras, P.: Artificial intelligence technologies for sign language. *Sensors* **21**(17), 5843 (2021). <https://doi.org/10.3390/s21175843>
17. Porta, J., López-Colino, F., Tejedor, J., Colás, J.: A rule-based translation from written Spanish to Spanish sign language glosses. *Comput. Speech Lang.* **28**(3), 788–811 (2014)
18. Serrat-Roozen, I., Orero, P., Oncins, E.: People at the centre of research: tools for democratic and participatory research in ethics and communication. En A. Barrientos-Báez (Ed.), *CILCS 2025: congreso CILCS 10, 11 y 12 de Diciembre del 2025 Madrid* (2025)
19. Stoll, S., Camgöz, N.C., Hadfield, S., Bowden, R.: Sign language production using neural machine translation and generative adversarial networks. In: *Proceedings of the 29th British Machine Vision Conference (BMVC 2018)*, Newcastle, UK. British Machine Vision Association (2018)
20. Van Gemert, B., Cokart, R., Esselink, L., De Meulder, M., Sijm, N., Roelofsen, F.: First steps towards a signing avatar for railway travel announcements in the Netherlands. In: *7th International Workshop on Sign Language Translation and Avatar Technology (SLTAT): The Junction of the Visual and the Textual: Challenges and Perspectives*, pp. 109–116. Marseille, France (2022)
21. Venade de Sousa, F.: Sign Language in the Era of Artificial Intelligence. European Union of the Deaf, (2025)
22. Wasserroth, F., Avramidis, E., Czehmann, V., Kojic, T., Nunnari, F., Möller, S.: Evaluation of a sign language avatar on comprehensibility, user experience and acceptability. In: *Adjunct Proceedings of the 25th ACM International Conference on Intelligent Virtual Agents (IVA Adjunct '25)*. Association for Computing Machinery, Article 26, pp. 1–10. (2025) <https://doi.org/10.1145/3742886.3756719>
23. Wolfe, R., McDonald, J.C., Hanke, T., Ebling, S., Van Landuyt, D., Picron, F., Krausneker, V., Efthimiou, E., Fotinea, E., Braffort, A.: Sign language avatars: a question of representation. *Information* **13**(4), 206 (2022). <https://doi.org/10.3390/info13040206>
24. Yin, K., Moryossef, A., Hochgesang, J., Goldberg, Y., Alikhani, M.: Including signed languages in natural language processing. In: *Proceedings of the 59th Annual Meeting of the Association for Computational Linguistics and the 11th International Joint Conference on Natural Language Processing (Volume 1: Long Papers)*. Online. Association for Computational Linguistics, pp 7347–7360. (2021)

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.