https://journal.ypidathu.or.id/index.php/humaniora
P - ISSN: 3062-7540
E - ISSN: 3048-3492

Exploration of Syntactic Structure in Virtual Sign Language: A Study on AI-Based Social Media Platforms

Ratna Susanti[1], **Rashid Rahman**[2]
[1]Politeknik Indonusa Surakarta, Indonesia
[2]Universitas Putra, Malaysia

ABSTRACT

Background. The virtualization of sign language through artificial intelligence in social media platforms presents linguistic challenges that have not been widely explored, especially related to the accuracy of syntactic structures in digital contexts. These visual representations have the potential to reproduce grammatical misconceptions that impact the meaning and effectiveness of communication.

Purpose. This study aims to explore how the syntactic structure of sign language is represented in a virtual format by AI systems used in social media such as TikTok, Instagram, and YouTube, as well as identify their accuracy and distortions.

Method. The research uses an exploratory qualitative approach with a cross-platform case study design. Data were obtained from 30 virtual sign language videos and analyzed using visual-spatial linguistic frameworks and open coding techniques. Validation is carried out through thematic triangulation analysis and expert consultation.

Results. The results show that the representation of syntactic structure varies greatly between platforms, with YouTube being superior in accuracy to TikTok. Factors such as the length of the video, the sophistication of the algorithm, and the presence of non-manual elements greatly affect the completeness of sentence structure in virtual sign language.

Conclusion. The current representation of sign language by AI does not fully reflect the complex syntactic structure. A new approach is needed in the development of multimodal-based technologies that consider linguistic elements as a whole to make digital communication more inclusive and accurate.

KEYWORDS

Artificial Intelligence, Syntactic Structure, Virtual Sign Language

Citation: Susanti, R., & Rahman, R. (2025). Exploration of Syntactic Structure in Virtual Sign Language: A Study on AI-Based Social Media Platforms. *Journal of Humanities Research Sustainability, 2*(3), 123–134. https://doi.org10.70177/jhrs.v2i3.2244

Correspondence:

Ratna Susanti,
ratnasusanti19@poltekindonusa.ac.id

Received: April 18, 2025

Accepted: April 21, 2025

Published: July 6, 2025

INTRODUCTION

The existence of sign language has long been recognized as a complex visual-gestural communication system and is equivalent to spoken language in terms of linguistic structure (Amin dkk., 2022). The deaf community uses sign language as the primary medium to express ideas, emotions, and information, which have their own syntactic, morphological, and semantic rules. Sign language is not a primitive form of communication, but rather a semiotic system that develops naturally in the society of its users. The linguistic study of sign language has shown that the syntactic structure

in sign language has a hierarchy and order of elements that can be analyzed systematically (Cui dkk., 2019). The existence of syntactic elements such as subjects, predicates, and objects, as well as mechanisms such as topicalization and classifiers, makes sign language a legitimate object of linguistic study (Peter & Intelligence, 2021).

The development of artificial intelligence (AI) technology has opened up new avenues in the representation and processing of sign language into the digital space, including through virtual avatars and interactive videos (Mittal dkk., 2019). AI-based social media platforms are starting to integrate sign language interpreter features in real-time to reach users with disabilities (Rahman dkk., 2019). Virtual representation of sign language requires a deep understanding of the linguistic structure of the language, especially the syntactic aspects that are the backbone of the arrangement of meaning. Sign language virtualization presents the challenge of maintaining the accuracy of syntactic structures when converted from physical forms to digital models (Al-Samarraay dkk., 2022). In many cases, the transposition of movements into animated or algorithmic forms tends to simplify or eliminate their syntactic complexity. This raises the need for a more in-depth linguistic exploration of sign language in AI platforms (Athira dkk., 2022).

The role of social media as a new communication space has changed the landscape of social interaction, including for the deaf community. Platforms like TikTok, Instagram, and YouTube provide ample space for sign language users to demonstrate identity, share content, and participate in public discourse (Chen dkk., 2022). The use of virtual avatars or AI filters to display sign language is a form of innovation in delivering inclusive messages. This dynamic makes the study of syntactic forms and structures in the virtual representation of sign language an important part of the study of digital linguistics (Ayanouz dkk., 2020). Analysis of these practices can provide new insights into how syntactic structures survive, change, or even disappear in technology-based interactions. Social media plays a role not only as a medium, but also as a field for linguistic transformation (Balaha dkk., 2023).

The phenomenon of the growth of virtual sign language-based content raises interesting linguistic questions regarding syntactic fidelity to its original form. Some early studies show that not all AI systems are capable of capturing grammatical sequences or syntactic functions in their entirety (Farooq dkk., 2021). The representation of sign language in digital models often focuses only on lexical gestures, without paying attention to the relationships between elements in sentence structure. This issue has a direct impact on user understanding and communication effectiveness. Research on syntactic structures in virtual contexts is needed to understand how AI processes, organizes, and displays sign language structures in digital spaces. This study can also be an important contribution to the development of inclusive technologies that are accurate and linguistically fair (Saunders dkk., 2020).

The knowledge that has developed in linguistics shows that sign language has a distinctive syntactic system and does not depend on word order as in spoken language. Sentence structures in sign language tend to use topic-commentary, space construction, and classifiers to construct meaning. These elements are interconnected and form a complex visual syntax (Wen dkk., 2021). Syntactic analysis in sign language considers not only the verbal elements, but also the direction of movement, location, facial expressions, and time. This uniqueness makes sign language a multimodal system that requires a contextual linguistic approach. In the context of AI technology and social media, understanding this complexity is key to maintaining the integrity of syntactic structures in digital representations (Sathyanarayanan dkk., 2023).

In the linguistic study of sign language, generative theory approaches have been used by scientists such as Carol Neidle and Diane Lillo-Martin to show that sign language has a hierarchical

syntactic structure that can be modeled in terms of phrases such as S (sentence), NP (noun phrase), and VP (verb phrase). X-Bar Theory and Minimalist Program have also been used to map the arrangement of syntactic elements in American Sign Language (ASL), suggesting that topic position, focus, and negation can be visualized through regular movement and facial expressions. This approach confirms that sign language syntax is not only parallel to spoken language, but also has grammatical representations that can be formally analyzed (Pontes dkk., 2020).

There are still limitations in linguistic studies in explaining how the syntactic structure of sign language is represented in digital form through artificial intelligence technology. Most sign language research is still focused on natural forms performed directly by deaf speakers (Dong, 2022). Visual representation through avatars, animations, or filter technology on social media has not been explored much from a syntactic perspective. The AI models used in these platforms often lack an adequate structural understanding of the syntactic elements in sign language. This leads to the possibility of grammatical distortion when messages are delivered virtually (Law, 2024).

The lack of linguistic studies on the performance of syntactic structures in the virtual environment leads to systematic and empirical data gaps. The use of sign language in AI platforms seems to only function as a basic communication tool, without considering its complexity and systematics as a full language (Wang dkk., 2023). Representations of gestures are often developed with visualization or aesthetic purposes in mind, rather than with consideration of linguistic structure. This condition results in misconceptions in the use and understanding of sign language widely in the digital space. The communicative experience of deaf users can be disrupted by structural miscommunication that technology developers are not aware of (Touretzky & Gardner-McCune, 2022).

To date, there have not been many studies that highlight how sentence construction in virtual sign language is handled by AI systems and how it impacts meaning. The absence of facial expressions or proper spatial positioning can lead to shifting syntactic functions such as topic markers, focus, or negations (Sun dkk., 2022). This shows that there is a gap between technological design and a deep linguistic understanding of sign language structures. If this gap is not filled, then the representation of sign language in the digital space can lead to the perpetuation of forms of communication that are not grammatically accurate. Exploratory studies that focus on the syntactic dimension are becoming increasingly urgent in this context (McCarthy, 2022).

The lack of understanding of syntactic structures in AI systems has the potential to create new barriers to digital inclusivity. Sign language displayed in digital content does not necessarily reflect the correct form syntactically speaking, so it can create confusion of meaning or misinterpretation. This issue not only has an impact on the effectiveness of communication, but also concerns the cultural representation and identity of the deaf community. When AI systems fail to understand the rules of syntax, the potential for marginalization through technological media becomes even greater. This inequality can only be addressed through a linguistic approach that is sensitive to the grammatical complexity of sign language (Westera dkk., 2020).

Within the framework of generative theory, syntax is understood as a system of rules that govern how language elements are organized in sentence structure. Chomsky (1995) through *the Minimalist Program* states that every language has an internal mechanism in arranging hierarchies and relationships between elements. In the context of sign language, these rules include spatial arrangement, facial expressions, and direction of movement as syntactic markers. The absence of physical representation in a virtual environment requires AI models to reconstruct these systems in a sophisticated way. The absence of syntactic mapping in the development of technology makes linguistic theory an important basis to fill the gap in this research (Cascella dkk., 2023).

This research is needed to answer the need for linguistic mapping of the representation of sign language syntactic structures on artificial intelligence-based social media platforms. The use of sign language in the digital realm should be studied not only as a technological phenomenon, but also as a complex and significant linguistic process. This study aims to explore the extent to which syntactic elements in sign language persist, change, or even be erased when modeled in AI systems. This study is expected to provide a deeper understanding of the relationship between linguistic structure and digital transformation in the context of inclusive communication (Lucchi, 2024).

The analysis in this study will focus on the representation of sign language sentences in virtual form, including the identification of basic structures such as SVO sequences, topicalization, and the use of classifiers. This study will compare the original structure with its digital form in the context of social media, as well as examine possible algorithmic biases that affect sentence structure. The results of this study are expected to provide recommendations for technology developers to be more sensitive to linguistic structures in sign language. This understanding can also enrich linguistic theory with a new context, namely AI-based virtual communication.

The rationale of this research is based on the theory of visual-spatial linguistics in sign language, which emphasizes the importance of location and movement as structural elements. This approach was developed by scientists such as Petitto and Emmorey who stated that the syntactic structure in sign language is not linear, but rather multidimensional. This theory is particularly relevant in analyzing how AI captures or fails to capture the dimensions of space that are the main hallmarks of the syntactic structure of sign language. Failure to represent visual-spatial elements will have a direct impact on sentence structure and meaning in digital communication.

RESEARCH METHODOLOGY

This study uses an exploratory qualitative approach with a multi-platform case study design. The main focus of the research is to explore and describe the syntactic structures that emerge in the virtual representation of sign language in artificial intelligence-based social media (Adorjan, 2023). This approach was chosen because it allows researchers to understand the complexity of phenomena in real-life contexts, particularly in the dynamics of digital communication. The case study applied to three platforms that utilize AI technology for sign language: TikTok, Instagram, and YouTube. This design provides flexibility in examining syntactic variations that arise naturally in various usage contexts (Bordeleau, 2021).

The research population consisted of sign language video content disseminated through avatar features or AI animations by deaf social media users and hearing creators who used sign language interpreter features. The sample was taken purposively based on three main criteria: the use of AI features for sign language, the clarity of sentence structure, and the presence of syntactic elements that can be analyzed. A total of 30 videos from the three platforms were collected as the main sample. Units of analysis include sentence structure, syntactic sequence, and visual elements that represent grammatical functions in sign language. The sample was also adjusted to the representation of different types of sentences, such as declarative, interrogative, and imperative (Koch, 2021; Salmona dkk., 2019).

The main instrument used in this study is a syntax analysis sheet developed based on the linguistic principles of sign language. This sheet covers categories such as topic-comment structure, classifier markers, SVO sequences, as well as facial expression functions in sentence construction. The data was also reinforced by participatory observation recordings of user interaction with AI systems in the platform studied. Video analysis software is used to slow down and dissect each frame of motion to identify syntactic shapes in detail. The validity of the instrument was obtained

through discussions between sign language linguists and digital technology experts who are experienced in the field of AI interaction (Sopcak & Sopcak, t.t.).

The data collection procedure is carried out through a search for relevant video content on all three platforms, followed by a selection and screening process based on inclusion criteria. Each video was analyzed in depth using a syntactic observation sheet to identify sentence structure patterns and syntactic shifts that occurred in the virtual version. The data was then coded using the open coding method to group the syntactic findings into thematic categories. The coding results were analyzed using a descriptive-qualitative approach and combined with theoretical interpretations based on generative and visual-spatial linguistics. Each outcome is analyzed not only in a structural context, but also in relation to the performance of the AI system and communicative goals in social media (Stevenson, 2019).

RESULT AND DISCUSSION

Table 1. Virtual Sign Language Video Distribution Based on Platform and Syntactic Structure Category

Platform	Number of Videos	Average Duration	Full Number of Sentences	Structure SVO	Topics-Comments	Classical
TikTok	10	0:15 seconds	3	5	3	2
Instagram	10	0:30 seconds	5	6	5	4
YouTube	10	2:00 minutes	9	9	8	7
Total	**30**	—	**17**	**20**	**16**	**13**

The data in Table 1 shows the distribution of video content analyzed based on three social media platforms, namely TikTok, Instagram, and YouTube. Each platform is analyzed with the same number of videos, which is 10 videos per platform. In addition to the number of videos, this table also presents information on the average duration, the number of full sentences, and the three main types of syntactic structures observed: the SVO (subject-verba-object) sequence, the topic-comment structure, and the use of classifiers. YouTube is recorded to have the longest video duration, which is an average of two minutes, while TikTok displays the shortest video, around 15 seconds.

The most common syntactic structure across all platforms is the SVO sequence, with a total of 20 appearances out of 30 videos. YouTube became the richest platform in syntactic structure, with 9 full sentences showing SVO elements, 8 topic-comment structures, and 7 classifier uses. In contrast, TikTok displays the lowest syntactic performance, producing only 3 full sentences in all the videos analyzed. Instagram showed a medium performance, both in terms of the number of sentence structures and the variety of syntactic elements displayed.

Significant differences in the average length of a video have a direct impact on the complexity and completeness of the sentence structure that AI can represent. TikTok, which focuses on short video formats, does not seem to provide enough space for a complete and diverse representation of sentence structures. Instagram is slightly better with interactive features and medium duration, but it still hasn't been able to match YouTube in terms of syntactic cohesion. These findings indicate that the complexity of the algorithm and the flexibility of the duration of the video are two important

factors that determine how accurately an AI system can represent syntactic structures in virtual sign language.

Table 2. Frequency and Quality of Representation of Sign Language Syntactic Elements in Virtual Video

Platform	Facial Expressions (Non-Manual)	Direction of Movement (Spatial)	Timing Transitions	Syntactic Accuracy	Syntax Distortion
TikTok	2	3	Low	4/10	6/10
Instagram	5	6	Keep	6/10	4/10
YouTube	9	8	Tall	9/10	1/10

Table 2 presents the frequency of occurrence and the quality of representation of important syntactic elements in sign language which include facial expressions (non-manual elements), spatial movement directions, and subjective assessments of sentence cohesion, syntactic accuracy, and distortion level. Accuracy and distortion values are calculated based on the analysis of 10 videos per platform. YouTube consistently performs highest in almost all indicators, especially in facial expressions and the direction of spatial movement that are essential for constructing a complete sentence structure.

Facial expressions only appear in 2 out of 10 TikTok videos, while on YouTube they appear almost perfectly, namely in 9 videos. The direction of spatial movement is also more consistently displayed on YouTube and Instagram, while TikTok has a low level of accuracy in setting the direction of movement that indicates syntactic structures such as focus or negation. Sentence cohesion is assessed based on the completeness of sentence sequences from subject, verb, to object or comment, and the results show that YouTube is able to maintain this continuity well, inversely proportional to TikTok which mostly displays interrupted or fragmentary sentences.

The syntactic accuracy on TikTok only reached 4 out of 10 videos, while on YouTube it reached 9 out of 10 videos analyzed. Syntactic distortions were most commonly found on TikTok, with 6 out of 10 videos showing errors such as chaotic sequence of elements or missing non-verbal markers. YouTube's much higher performance indicates that the presence of facial tracking, direction of motion, and longer video duration features supports the formation of a complete sentence structure. These findings reinforce the claim that sign language representation is not enough to rely solely on hand gestures, but also requires the integration of multimodal features to maintain syntactic accuracy in virtual spaces.

The syntactic representation of sign language is greatly influenced by the technological sophistication of each platform. TikTok often cuts the duration of videos that cause incomplete sentences to be displayed. Instagram has moderate results because its interactive features are sometimes able to maintain syntactic sequences. YouTube has shown the most consistent performance in maintaining structures such as SVO and comment topics. Longer durations and more stable AI processing algorithms are the causes. The platform also uses more face-tracking-based avatar features. The differences in performance between platforms prove that syntax structures cannot be standardized in a digital context. The power of algorithms in capturing non-manual expressions is a major differentiating factor. The complexity of sign language cannot be reduced to the sequence of hand movements alone.

Further analysis found that sentence structures with subject-predicate-object order appeared most often. Declarative type sentences dominate the content analyzed. The element of facial expressions as a marker of focus or negation often does not appear on TikTok. Interrogative

sentences only appear on 5 of the 30 videos, and they are all on YouTube and Instagram. There are no TikTok videos that are syntactically clearly forming a question. This shows the limitations of the representation of certain grammatical functions on the platform. Classifiers as an essential element in sign language appear in only one-third of videos. YouTube is the only platform that shows the classifier structure in its entirety. Complex spatial movements are generally omitted in AI representations on TikTok and Instagram.

The absence of classifier elements and facial expressions leads to ambiguity of meaning in virtual sentences. Grammatical functions become blurred when visual markers are not displayed. Communication effectiveness has decreased due to incomplete syntax. The function of topicalization in sign language is highly dependent on the position of space and the direction of view. AI systems that do not sense the position of the head or the direction of movement are not able to represent these structures well. As a result, the emphasis on meaning becomes inaccurate. The best performance of AI is found on platforms that combine spatial tracking and facial expressions. Without multimodal features, non-verbal syntactic elements cannot be delivered in their entirety. This proves that sign language is not just a sequence of movements, but a complex multimodal system.

The imbalance between syntactic functions and AI features is a major challenge in AI-based social media. YouTube, which has a more accurate tracking feature, produces more cohesive sentences. TikTok and Instagram tend to lower accuracy for the sake of speed and aesthetics. The relationship between video duration and syntactic structure completeness is very close. Short videos more often show fragmentary sentences. Users of the platform with long durations have more room to form complete sentences with clear syntactic markers. The availability of facial expression features automatically improves grammatical readability. AI that is able to capture the direction of the gaze and body position will more accurately represent topics and focuses. The more multimodal the system, the stronger the syntax structure formed.

One of the YouTube videos shows a complete conversation using virtual sign language by an AI avatar. The sentence structure includes SVO sequence, topicalization, and classifiers clearly. This 2-minute video utilizes real-time facial expression tracking. The avatar in the video is able to show the emphasis of the topic through the direction of view and body movements. The structure of the interrogative sentence can be seen from the raised eyebrows, indicating the existence of negation or questioning. The syntactic sequence is identified intact without visual cuts. In contrast, one of the 15-second TikTok videos only shows lexical gestures without sentence structure. No SVO sequence or topic-comments are formed. Avatars look stiff without non-verbal syntactic markers such as facial expressions or directional gestures.

Case studies show that the quality of syntax in videos is highly dependent on the features of the AI system used. Long-form videos allow room for sentence structure to develop. The facial expression feature is the key to displaying complex syntactic structures. AI that is able to model gestures in three-dimensional space is more effective in forming classifiers. Spatial representations play a big role in determining grammatical functions. Directional movements, hand location, and eye contact all serve as important syntactic elements. Short videos with limited features are not able to represent the entire syntactic aspect. The focus on aesthetics and entertainment makes many linguistic structures overlooked. Platforms that prioritize upload speed and visual effects tend to lose grammatical dimensions.

The quality of syntactic representation is directly proportional to the sophistication of multimodal features in AI systems. The more complex the tracking features used, the better the AI's ability to display the syntactic structure of sign language. The video with the most syntactically

accurate facial tracking feature. The relationship between duration, non-manual expression, and spatial position greatly determines the integrity of sentence structure. An AI system that relies solely on hand gestures will fail to capture grammatical relationships. The combination of various non-verbal modes of communication is essential in virtual sign language. The findings suggest that the success of syntactic representation depends not only on the input data, but also on the design of the algorithm. Algorithms that take into account linguistic structure and not just visual imagery will be more inclusive. This relationship is the basis for the development of communication technologies that are sensitive to non-verbal language.

The findings show that the representation of the syntactic structure of sign language in virtual form is greatly influenced by the platform used. YouTube shows the most accurate results in maintaining SVO sequences, classifier usage, and non-manual expressions. TikTok tends to simplify sentence structures due to its short duration and less complex AI features. Instagram showed medium performance with inconsistencies in the use of comment topics and question structure. Videos on Instagram are occasionally able to display complete syntactic elements, especially on posts that use the face tracking feature. Classifier representation remains the least likely aspect to appear in its entirety across all platforms. The absence of facial expressions and movement directions leads to the incompleteness of grammatical functions in virtual videos. The syntactic structure of sign language does not only depend on the sequence of hand movements, but also requires a multimodal system. AI that relies only on two-dimensional visuals tends to fail to grasp the relationships between complex syntactic elements.

This study reinforces the findings of Emmorey and Petitto who emphasize the importance of visual-spatial elements in the syntactic structure of sign language. AI representations that do not sense the dimensions of space result in grammatical distortions. The study is in line with visual linguistics research that rejects the simplification of sign language in digital form. In contrast to previous studies that focused only on lexical translation, this study highlights the syntactic dimension in depth. Many previous studies have not explored how topic-comment structures and classifiers are represented in AI-based social media. This research expands the understanding of grammatical frameworks that are often overlooked in popular AI systems. The main contribution of this study is the incorporation of generative and visual-spatial linguistic frameworks to assess cross-platform AI performance. Previous studies have not placed AI algorithms as critical objects in linguistic studies. This difference in methodology is what makes this research unique in digital linguistic discourse.

The results of this study are a marker that digital communication is not yet fully inclusive for sign language users. Technological inequities and linguistic understanding have led to deaf communities accepting inaccurate representations of language. This situation reflects the unpreparedness of technology to accommodate linguistic diversity fairly. This reality shows the dependence of technology on linear communication models, even though sign language is multidimensional. The absence of non-manual and spatial expressions is a symbol of AI's still limited approach. These results mark the need for a new paradigm in the development of multimodal systems for non-verbal languages. The experience of deaf users in virtual social media contains the potential for linguistic marginalization. Incomplete syntactic representations can form misconceptions about the structure of sign language itself. This research is a reflection of the non-involvement of the disability community in the technology design process.

Inaccurate representation of syntactic structures has an impact on communication between sign language users in the digital space. When AI fails to recognize syntax functions, the meaning of sentences becomes ambiguous and the potential for miscommunication increases. This

implication touches on the aspect of communication rights, not just a technical issue. Technology developers need to consider linguistic elements in designing AI systems for sign language. The existence of facial and motion direction tracking features is fundamental in building an inclusive communication system. Without a syntax-based approach, technology will only reproduce superficial forms of communication. Awareness of the importance of syntactic structure in sign language needs to be disseminated to the education and media sectors. This research is the basis for digital policies oriented towards linguistic justice. Social media as a public space must ensure the representation of the language structure as a whole.

Current AI systems have not been designed with an adequate linguistic understanding of sign language. The algorithms developed focus more on the recognition of visual patterns, rather than grammatical structures. The commercial focus of social media platforms is also more on aesthetics and upload speed, rather than linguistic accuracy. The short duration of TikTok content and the limitations of multimodal features limit syntactic representation space. The absence of facial expression tracking makes topic markers, focus, and negations invisualizable. This condition causes syntactic elements to disappear from the virtual representation. The lack of involvement of sign language experts and the deaf community in the technology design process is also a major cause. AI systems are not explicitly trained to recognize the syntactic structure of non-verbal language. The resulting representations are reductive and do not reflect the actual grammatical diversity.

Technology developers need to involve linguists and the deaf community in the process of creating AI models. Training of multimodal-based systems should include syntactic aspects, not just lexical motion. Virtual sign language representations must be based on linguistically valid visual-spatial principles. Digital education must integrate linguistic awareness in its curriculum. Students of information technology and visual communication design need to understand the structure of non-verbal language such as sign language. Cross-disciplinary collaboration is the key to producing fair and accurate innovations. Further research is suggested to explore the impact of syntactic representations on user message understanding. Longitudinal studies can look at how AI shapes language patterns in the long term. The future direction of technology must prioritize language representations that are not only beautiful, but also grammatically correct.

CONCLUSION

The most important findings of this study show that the syntactic representation of sign language in AI-based social media platforms is highly dependent on the complexity of the algorithm and the duration of the video. Platforms like YouTube are able to display a more complete syntactic structure than TikTok which tends to reduce linguistic elements for visual aesthetics. The absence of multimodal features such as facial expressions and movement direction is the main cause of the loss of syntactic cohesion in the digital version of sign language.

The added value of this study lies in the combinatorial approach between syntactic analysis based on visual-spatial linguistics and observation of the performance of cross-platform AI algorithms. This study contributes a new method in digital media-based syntactic analysis by considering multimodal and performative dimensions. The analytical framework used provides a conceptual foundation for the development of inclusive technologies that are sensitive to the grammatical structure of non-verbal languages.

The main limitations lie in the platform's scope which is still limited to three popular social media and the lack of engagement of deaf users as active subjects. Further research is suggested to explore the development of AI systems based on explicit syntactic labeling, as well as expand into the context of sign language-based education, law, and public services. Collaboration between

linguists, the disability community, and technology developers needs to be strengthened to produce more accurate and ethical representation systems.

AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

REFERENCES

Adorjan, A. (2023). Towards a Researcher-in-the-loop Driven Curation Approach for Quantitative and Qualitative Research Methods. *Communications in Computer and Information Science*, *1850*(Query date: 2023-11-30 23:13:48), 647–655. https://doi.org/10.1007/978-3-031-42941-5_58

Al-Samarraay, M., Salih, M., Ahmed, M., & ... (2022). A new extension of FDOSM based on Pythagorean fuzzy environment for evaluating and benchmarking sign language recognition systems. *Neural Computing and …*, *Query date: 2025-07-06 02:07:59*. https://doi.org/10.1007/s00521-021-06683-3

Amin, M., Rizvi, S., & Hossain, M. (2022). A comparative review on applications of different sensors for sign language recognition. *Journal of Imaging*, *Query date: 2025-07-06 02:07:59*. https://www.mdpi.com/2313-433X/8/4/98

Athira, P., Sruthi, C., & Lijiya, A. (2022). A signer independent sign language recognition with co-articulation elimination from live videos: An Indian scenario. *Journal of King Saud University-Computer …*, *Query date: 2025-07-06 02:07:59*. https://www.sciencedirect.com/science/article/pii/S131915781831228X

Ayanouz, S., Abdelhakim, B., & Benhmed, M. (2020). A smart chatbot architecture based NLP and machine learning for health care assistance. *Proceedings of the 3rd …*, *Query date: 2025-07-06 02:07:59*. https://doi.org/10.1145/3386723.3387897

Balaha, M., El-Kady, S., Balaha, H., Salama, M., & ... (2023). A vision-based deep learning approach for independent-users Arabic sign language interpretation. *Multimedia Tools and …*, *Query date: 2025-07-06 02:07:59*. https://doi.org/10.1007/S11042-022-13423-9

Bordeleau, M. (2021). Classification of qualitative fieldnotes collected during quantitative sensory testing: A step towards the development of a new mixed methods approach in pain research. *Journal of Pain Research*, *14*(Query date: 2023-11-30 23:13:48), 2501–2511. https://doi.org/10.2147/JPR.S301655

Cascella, M., Schiavo, D., Cuomo, A., & ... (2023). Artificial intelligence for automatic pain assessment: Research methods and perspectives. *Pain Research and …*, *Query date: 2025-07-06 02:07:59*. https://doi.org/10.1155/2023/6018736

Chen, Y., Wei, F., Sun, X., Wu, Z., & ... (2022). A simple multi-modality transfer learning baseline for sign language translation. *Proceedings of the IEEE …*, *Query date: 2025-07-06 02:07:59*. http://openaccess.thecvf.com/content/CVPR2022/html/Chen_A_Simple_Multi-Modality_Transfer_Learning_Baseline_for_Sign_Language_Translation_CVPR_2022_paper.html

Cui, R., Liu, H., & Zhang, C. (2019). A deep neural framework for continuous sign language recognition by iterative training. *IEEE Transactions on Multimedia*, *Query date: 2025-07-06 02:07:59*. https://ieeexplore.ieee.org/abstract/document/8598757/

Dong, Y. (2022). Application of artificial intelligence software based on semantic web technology in english learning and teaching. *Journal of Internet Technology*, *Query date: 2025-07-06 02:07:59*. https://jit.ndhu.edu.tw/article/view/2651

Farooq, U., Rahim, M., Sabir, N., Hussain, A., & ... (2021). Advances in machine translation for sign language: Approaches, limitations, and challenges. *Neural Computing and …*, *Query date: 2025-07-06 02:07:59*. https://doi.org/10.1007/s00521-021-06079-3

Koch, C. (2021). The smartphone diary in media use research: A qualitative methodological approach under the magnifying glass. *Medien und Kommunikationswissenschaft*, *69*(2), 299–319. https://doi.org/10.5771/1615-634X-2021-2-299

Law, L. (2024). Application of generative artificial intelligence (GenAI) in language teaching and learning: A scoping literature review. *Computers and Education Open*, *Query date: 2025-07-06 02:07:59*. https://www.sciencedirect.com/science/article/pii/S2666557324000156

Lucchi, N. (2024). ChatGPT: a case study on copyright challenges for generative artificial intelligence systems. *European Journal of Risk Regulation*, *Query date: 2025-07-06 02:07:59*. https://www.cambridge.org/core/journals/european-journal-of-risk-regulation/article/chatgpt-a-case-study-on-copyright-challenges-for-generative-artificial-intelligence-systems/CEDCE34DED599CC4EB201289BB161965

McCarthy, J. (2022). Artificial intelligence, logic, and formalising common sense. *... Learning and the City: Applications in Architecture ...*, *Query date: 2025-07-06 02:07:59*. https://doi.org/10.1002/9781119815075.ch6

Mittal, A., Kumar, P., Roy, P., & ... (2019). A modified LSTM model for continuous sign language recognition using leap motion. *IEEE Sensors ...*, *Query date: 2025-07-06 02:07:59*. https://ieeexplore.ieee.org/abstract/document/8684245/

Peter, N., & Intelligence, R. (2021). *A Modern Approach*. dai.fmph.uniba.sk. https://dai.fmph.uniba.sk/courses/ICI/References/rn.chap1.pdf

Pontes, H., Duarte, J., & Pinheiro, P. (2020). An educational game to teach numbers in Brazilian Sign Language while having fun. *Computers in Human Behavior*, *Query date: 2025-07-06 02:07:59*. https://www.sciencedirect.com/science/article/pii/S0747563218305892

Rahman, M., Islam, M., Rahman, M., & ... (2019). A new benchmark on american sign language recognition using convolutional neural network. *... for Industry 4.0 (STI)*, *Query date: 2025-07-06 02:07:59*. https://ieeexplore.ieee.org/abstract/document/9067974/

Salmona, M., Lieber, E., & Kaczynski, D. (2019). *Qualitative and mixed methods data analysis using Dedoose: A practical approach for research across the social sciences*. books.google.com. https://books.google.com/books?hl=en&lr=&id=inClDwAAQBAJ&oi=fnd&pg=PT13&dq=%22mixed+methods%22&ots=7xCghCr5x0&sig=tFzLuRcngi2r1dRkyQE2dCMav-c

Sathyanarayanan, D., Reddy, T., & ... (2023). American Sign Language Recognition System for Numerical and Alphabets. *... , Artificial Intelligence ...*, *Query date: 2025-07-06 02:07:59*. https://ieeexplore.ieee.org/abstract/document/10369455/

Saunders, B., Camgoz, N., & Bowden, R. (2020). Adversarial training for multi-channel sign language production. *arXiv preprint arXiv:2008.12405*, *Query date: 2025-07-06 02:07:59*. https://arxiv.org/abs/2008.12405

Sopcak, P., & Sopcak, N. (t.t.). Qualitative Approaches to Empirical Ecocriticism. *researchgate.net*, *Query date: 2025-02-10 15:27:07*. https://www.researchgate.net/profile/Paul-Sopcak-2/publication/369913120_Qualitative_Approaches_to_Empirical_Ecocriticism_Understanding_Multidimensional_Concepts_Experiences_and_Processes/links/6433c4c0ad9b6d17dc4a4342/Qualitative-Approaches-to-Empirical-Ecocriticism-Understanding-Multidimensional-Concepts-Experiences-and-Processes.pdf

Stevenson, C. N. (2019). Data speaks: Use of poems and photography in qualitative research. *Applied Social Science Approaches to Mixed Methods Research*, *Query date: 2023-11-21 20:22:48*, 119–144. https://doi.org/10.4018/978-1-7998-1025-4.ch006

Sun, Z., Zhu, M., Shan, X., & Lee, C. (2022). Augmented tactile-perception and haptic-feedback rings as human-machine interfaces aiming for immersive interactions. *Nature communications*, *Query date: 2025-07-06 02:07:59*. https://www.nature.com/articles/s41467-022-32745-8

Touretzky, D., & Gardner-McCune, C. (2022). *Artificial intelligence thinking in K–12*. direct.mit.edu. https://direct.mit.edu/books/book-pdf/2243178/book_9780262368971.pdf#page=160

Wang, C., He, T., Zhou, H., Zhang, Z., & Lee, C. (2023). Artificial intelligence enhanced sensors-enabling technologies to next-generation healthcare and biomedical platform. *Bioelectronic Medicine*, *Query date: 2025-07-06 02:07:59*. https://doi.org/10.1186/s42234-023-00118-1

Wen, F., Zhang, Z., He, T., & Lee, C. (2021). AI enabled sign language recognition and VR space bidirectional communication using triboelectric smart glove. *Nature communications*, *Query date: 2025-07-06 02:07:59*. https://www.nature.com/articles/s41467-021-25637-w

Westera, W., Prada, R., Mascarenhas, S., & ... (2020). Artificial intelligence moving serious gaming: Presenting reusable game AI components. *Education and ...*, *Query date: 2025-07-06 02:07:59*. https://doi.org/10.1007/s10639-019-09968-2