Capturing Methodology for Generating Synthetic and 3D Training Data in Catalan Sign Language (LSC): The Case of Verbal Agreement

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signarIA

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1. Introduction and goal: Overcoming data scarcity

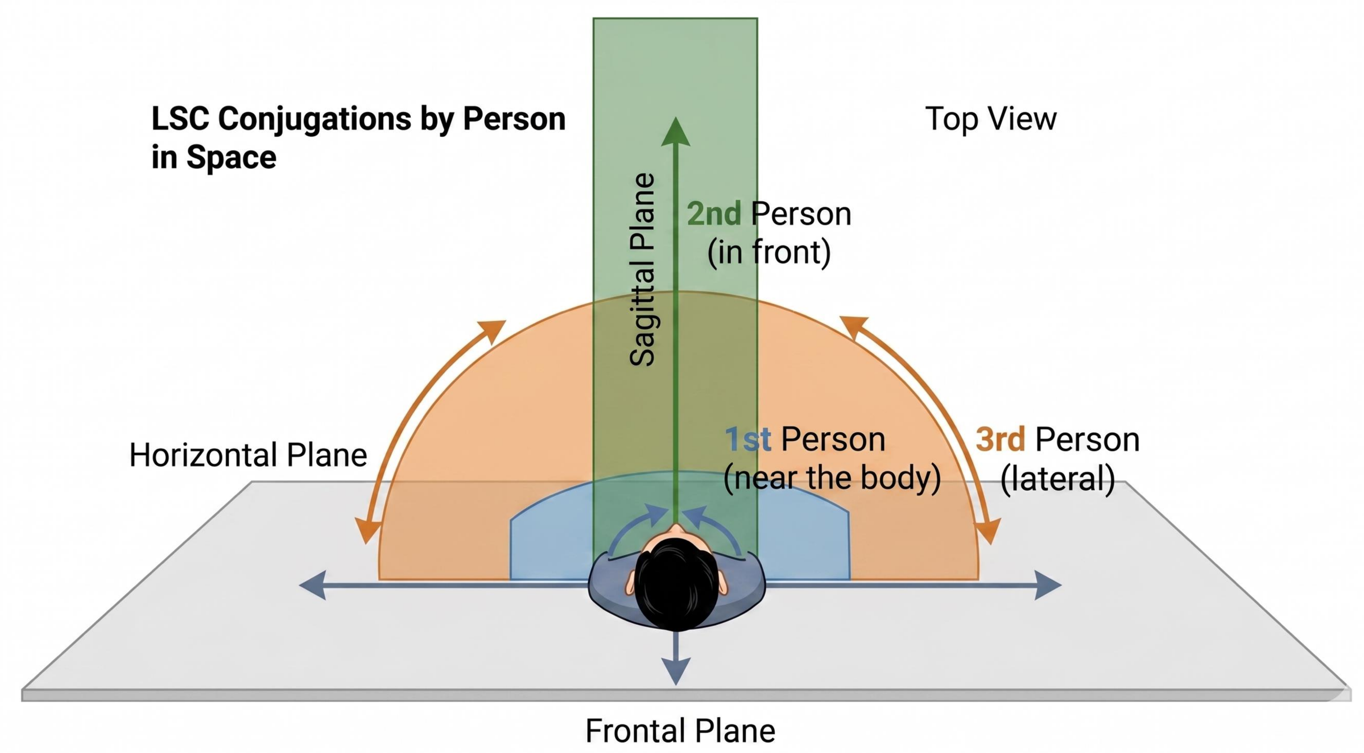
The problem: Sign Language Recognition systems require massive amounts of data, which is unfeasible to record manually for low-resource languages like Catalan Sign Language (LSC) [1].

Goal: To demonstrate that it is possible to synthetically expand a dataset by focusing on verb agreement, a domain known for its morphological and articulatory complexity.

2. Theoretical framework: Verb agreement and signing space

Agreeing verbs: Marking reference to arguments by linking the start and end points of a movement to spatial referential locations.

Spatial planes: Agreement is expressed across three structured spatial planes.



Gloss-level annotated dataset: Augment a gloss-level annotated dataset by leveraging the linguistic rules that govern sign–gloss transcriptions.

3. Corpus design: Calibration dataset

Complex repertoire of gramatical constructions including different features.

Person-marked forms of TELL:

Gloss	Translation
TELL	(infinitive)
1TELL2	'I tell you.'
2TELL1	'You tell me.'
1TELL3_a	'I tell him.'
3_aTELL1	'He tells me.'
1TELL3_b	'I tell her.'
3_bTELL1	'She tells me.'
2TELL3_a	'You tell him.'
3_aTELL2	'He tells you.'
2TELL3_b	'You tell her.'
3_bTELL2	'She tells you.'
3_aTELL3_b	'He tells her.'
3_bTELL3_a	'She tells him.'

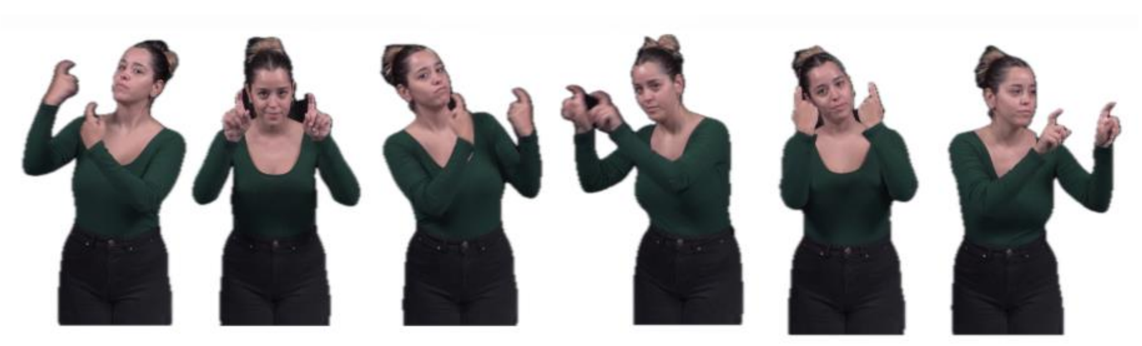
High/indefinite third-person subject forms of TELL [2]:

Gloss	Translation
3_{ahi}TELL1	'They/Someone tells me.'
3_{bhi}TELL1	'They/Someone tells me.'
3_{ahi}TELL2	'They/Someone tells you.'
3_{bhi}TELL2	'They/Someone tells you.'
3_{ahi}TELL3_b	'They/Someone tells her.'
3_{bhi}TELL3_a	'They/Someone tells him.'

Signer's profile and amount of data:

	Gender	Age group	Recordings
TG	M	51-80	949
BF	M	31-50	952
CW	F	18-30	952
TOTAL			**2853**

Various agreement forms of the verb ADVICE:



4. Multiplicative data augmentation

The methodology augments along three procedural axes:

- **Spatial conjugation**: Automatically synthesizing thousands of new conjugations from infinitives by mapping them to target spatial loci, with an inverse kinematics algorithm [3].
- **Prosodic variation**: Modifying temporal dynamics (tempo, holds, and easing) within linguistically attested ranges [4].
- **Body morphology**: Scaling body proportions (arm length, shoulder width) to simulate inter-signer diversity [5] and prevent model overfitting.

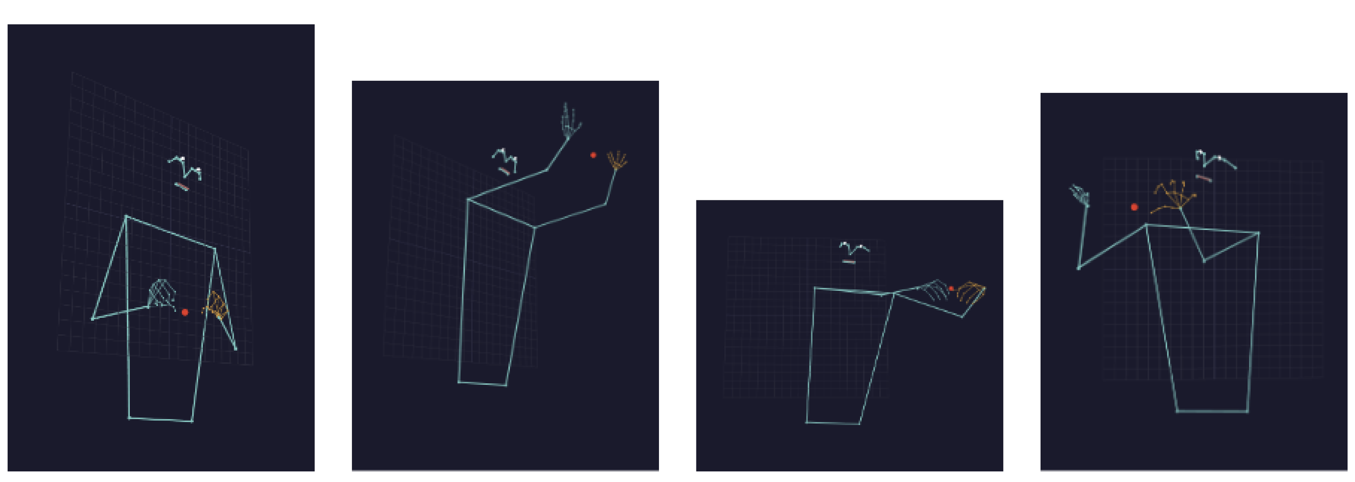
Augmented dataset size as a function of *V* (number of infinitive verbs) and *n* (number of prosodic x morphological variants:

V	Base ($\times$13)	n=5	n=10	n=25	n=50
1	13	65	130	325	650
10	130	650	1,300	3,250	6,500
25	325	1,625	3,250	8,125	16,250
48	624	3,120	6,240	15,600	31,200

5. Evaluation and conclusions

- **Three-layered validation**: The system is assessed based on anatomical feasibility (not exceeding physiological limits), kinematic fluency (smooth velocity curves), and linguistic legibility (user testing with deaf LSC signers).
- **Key finding**: Preliminary results suggest that procedural synthesis can effectively bridge the data gap for low-resource sign languages.
- **Future work**: Integration of these synthetic datasets into end-to-end SLR systems to measure actual improvements in translation performance.

Examples of procedurally generated skeletons using different spatial conjugations from the same infinitive verb TELL:



References

[1] Bragg, Danielle et al. 2019. Sign language recognition, generation, and translation: An interdisciplinary perspective. In *Proceedings of the 21st International ACM SIGACCESS Conference on Computers and Accessibility*.

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[5] Li, Dongxu et al. 2020. Transferring cross-domain knowledge for video sign language recognition. In 2020 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)

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