Experimental Machine Translation of the Swiss German Sign Language via 3D augmentation of body keypoints

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Introduction

Challenges for MT of signed languages:
(a) **multimodal and multilateral** nature
-> different ML architectures than classical text-to-text MT
(b) **lack of data**
-> hard for end-to-end deep learning
- experiments in few SLs and domains
- open questions for generalization

WMT SLT 2022:
- new language pair (DSGS-German), data sources: former Deaf TV channel, SRF
- dataset based on originally signed content (not interpretation-based)

Motivation

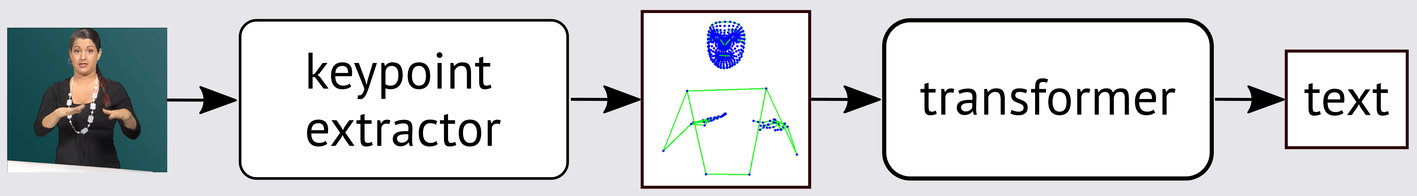
Keypoint extraction:
- lack of data: employ external knowledge from computer vision models
- possibility of utilizing additional data thanks to anonymize of speakers

Geometric transformation:
- models should be robust to speakers seen from different angles
- more valid training instances
- avoid spurious feature correlation during training

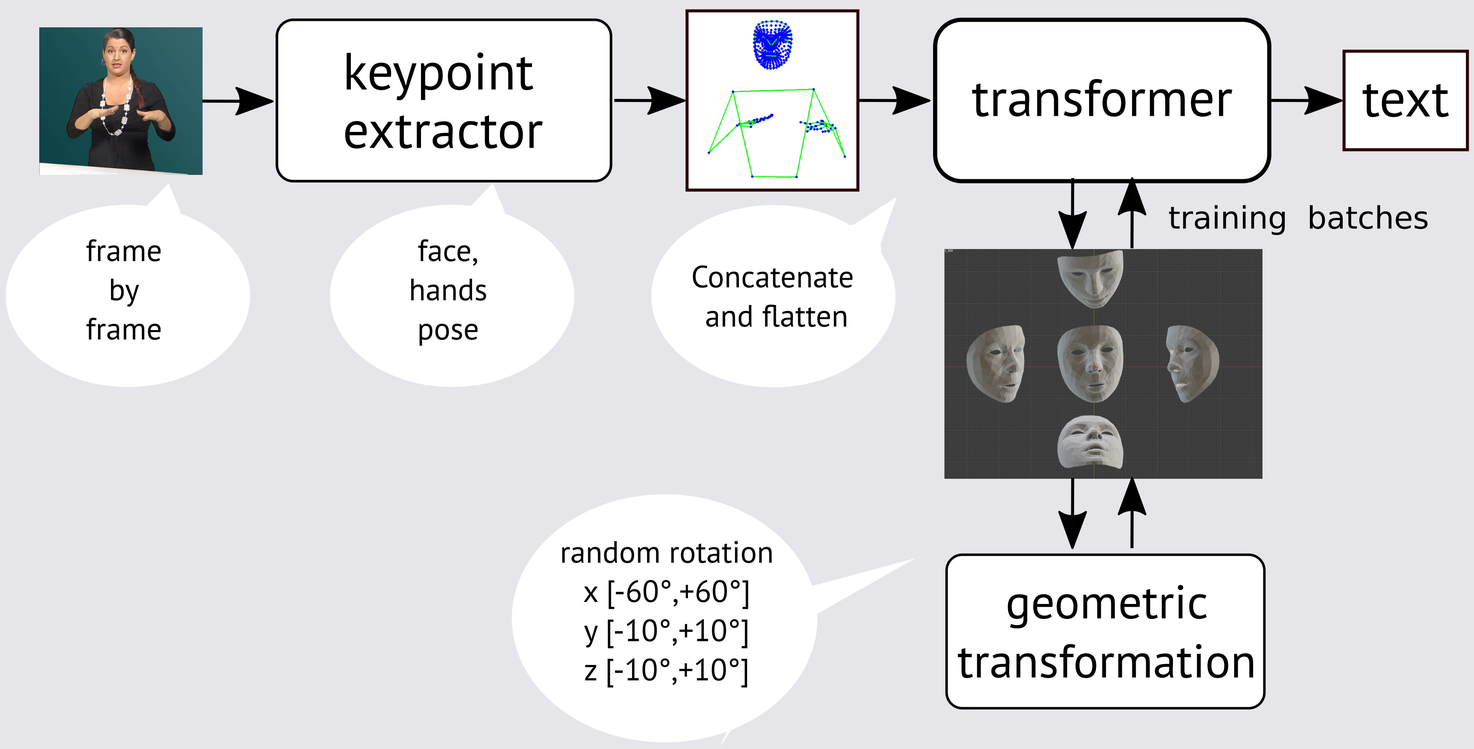
Method: Body Keypoints + 3D augmentation

Classical text-to-text translation

SL translation via keypoints extraction



SL translation via keypoints extraction and 3D transformation



Experiment setup

training dataset: FocusNews (10,000 sent.)
pre-extracted keypoints: Mediapipe holistic
features: face, hands, pose (708)
3D transformations: NumPy arrays
MT framework: JoeyNMT
validation metrics: BLEU/chrF (SacreBLEU)

parameter	value
feature size	708
max sentence len.	400
dropout	0,1
FF size	2048
heads	8
embeddings dim.	512
hidden size	512
optimizer	adam
batch size	32
random seed	42
weight decay	0,001
learning rate	0,001
validation freq.	100
beam size	1
beam alpha	-1
translation max len.	30

Results

max rotation +/- (°) x	y	z	LR scheduler patience	metric	layers	scores BLEU-3	BLEU-4	ChrF	runtime (h)
10	10	10	25	BLEU	4	0,28	0,00	15,36	00:21
10	10	10	50	BLEU	4	0,28	0,00	15,36	00:31
60	10	10	50	BLEU	4	0,00	0,00	17,58	00:24
60	10	10	500	ChrF	3	0,310	0,00	16,08	07:44
▶ 60	10	10	500	ChrF	4	0,314	0,00	16,43	04:14

- **very low scores:** repetitive sentences and irrelevant translations, hard to draw conclusions
- **limited time and resources:** not possible to experiment with all possible combinations
- **validation metrics:** zero BLEU-4 could not be used, switched to chrF

Conclusions and Further work

- **dataset difficulty**: bad performance by all systems, better results using external SL data
- **imprecision of keypoints**: lack of details needed for SL, error propagation

Possible next steps:
- **ablation study** in other datasets - comparison with state of the art experiments
- **better keypoint extraction** taking the frame sequences into consideration
- **better combination** of keypoints with frame embeddings and training process
- **more data**: dataset collection, data augmentation techniques,

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