

Machine Translation with Corpus Linguistics and HPSG?

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Structure

- Aims and work in DictaSign project (funded under the European Union's 7th Framework Programme)
- Building on previous project ViSiCAST - overview
- HPSG – advantages and disadvantages
- HPSG or other grammar for recognition?
- Signing space planning
- Translation quality



1. DictaSign - Electronic corpus and Grammar Development

- promoting the development of natural human computer interfaces (HCI) for Deaf Users
- researches and develops recognition and synthesis systems for sign languages (SLs) at a level of detail necessary for recognising and generating authentic signing
- research outcomes are aimed to be integrated in three laboratory prototypes (a Search-by-Example tool, a SL-to-SL translator and a sign-Wiki) leading to a practical project demonstrator.



1. DictaSign - Electronic corpus and Grammar Development

- more precise definitions and formulations of grammar phenomena are required in order to build computational models for a fully functional avatar
- little is known about timing, pauses, eye-gaze, stress and rhythm in sign languages to be added to the avatar's signing
- investigated in DictaSign in a more refined way using the collected parallel electronic corpus
- list of thousand concepts has been collected for parallel corpora, which initially serve the purpose of guiding the annotation of the collected corpus. It has to be refined to be used in SL grammars enhanced with the linguistic knowledge gained from the corpus analysis



2. Further Challenges

2.1. Building on the previous research

- Lexicalist approach for sign synthesis grammar
- Preceding ViSiCAST project (2000-2002) therefore investigated MT techniques with Head-driven Phrase Structure Grammar (HPSG)
- The MT system (Marshall & Safar, 2005) used the CMU Link parser, Kennedy & Boguraev (1996) pronoun resolution algorithm, Discourse Representation Structures (DRS) (Kamp & Reyle 1993), lambda calculus (Blackburn & Bos 1999), Attribute Logic Engine (ALE), HamNoSys (Hamburg Notation System), SIGML



The Previous VisiCAST Structure

(a quick overview, 1st part)

- Input written English sentence: I take my mug.
- CMU parser output: $[[m,2,A,3],[m,0,Wd,3],\dots]$
- Linkages are processed in DCG (Definite Clause Grammar) in Prolog associated with Linkages lexicon $np1(\text{Sent},\text{Det}@\text{Noun}) \rightarrow \text{Det}(\text{Sent},\text{Det}), n2(\text{Sent},\text{Noun})$.
- $\lambda N.\lambda V.drs([X],[\text{exist}(X)] \text{ } \textcircled{c} \text{ } N@\text{X} \text{ } \textcircled{c} \text{ } V@\text{X})$ – reduction and merge
- The labelled propositions of the resulting DRS is used as input for generation flattened for ALE.



2.1 HPSG

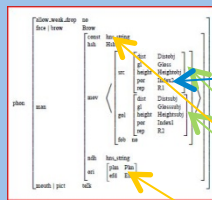
- fruitful approach for building structures with classifiers and for signing space planning
- feature structures can incorporate modality-specific aspects (non-manual features) of signs appropriately
- computationally viable grammatical theory, also poses problems regarding the reusability of HPSG grammars



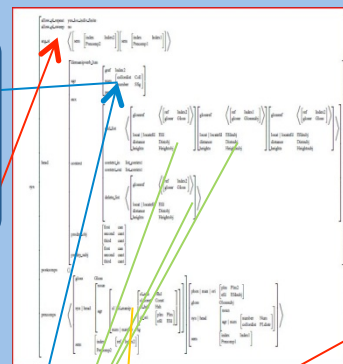
The Previous VisiCAST Structure (a quick overview, 2nd part)

```
sem:(index:Ind1,mode:decl,
  restr:[(sit:Ind3,reln:take,act:Ind2,thm:Ind4,
    args:[(index:Ind2, restr:[(sit:Ind3,reln:i)]),
      (index:Ind5, restr:[(sit:Ind3,reln:my,
        args:[(index:Ind4, count:number:sg,
          restr:[(sit:Ind3,reln:mug)]))])])])]) + signing space positions
```

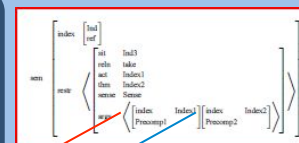
Feature Structure



The phonetic component describes how signs are formed by handshape, orientation, finger direction, movement, eyebrow and mouth picture



The syntactic component contains syntactic features which determine sentence mode, the argument structure, classifiers, pluralisation, (pronoun drop, and placement (anaphoric reference) in signing space.



The SEM structure includes semantic roles with WordNet definitions for sense to avoid eventual ambiguity in the English gloss.

Rules and Principles

Examples for Parameterization to Instantiate HamNoSys:

- Signing space planning :positions of hands
- Classifier information: handshape, palm orientation and extended fingerdirection
- Pluralization: repetition in movement
- Argument structure

Output:

Flattened HamNoSys (after conversion to SiGML it drives the avatar):

```
[ [ take ],
  [ non_raised ],
  [ hamceeall, hamextfingeror, hambetween,
    hamextfingerr, hampalml, hamshoulders, hamrat,
    hamarmextended, hamreplace, hamextfingeror,
    hambetween, hamextfingerr, hampalml, hamchest,
    hamclose ] ]
```

Future Work

- the VisiCAST grammar was specifically constructed for sign synthesis, so ways to make this process reversible still have to be developed
- we have to avoid any specification in the entries, which would restrict recognition, but be specific enough to guide the production

2.2. *DictaSign and HPSG*

- SL-to-SL translator is seeking to implement only shallow translation
- in DictaSign we experiment with extending the HPSG lexicon structure of the previous project and using a dependency grammar to support recognition of SLs



Combining feature structures with other grammars

- taking their relatively free sign order into account and relaxing the strict unification requirements by sufficient constraints on SL features
- This approach could benefit from the achievement of the feature structure of the previous research but avoid the rigid sign order problem of the ALE-based generation algorithm
- sign recognition will contain unknown, erroneous input for the parser
- How to handle asynchronous features?



2.3. *Signing Space planning*

- The difficulty lies in the assignment of the location to a referent.
- depends on the type of referent and on how it is introduced (by eyegaze, pointing or mentioning)
- assignment may be to an arbitrary position not conflicting with other referents or in relation to locations for other referents
- how long a certain position stays available



2.4. Translation quality

- good automatic translation quality in open domains and in such a new modality overly ambitious
- In ViSiCAST a semi-automatic, human-aided system had been designed
- continuous dictation with an error rate comparable to today's spoken language dictation is not achievable
- Instead, in DictaSign the users have to learn a dictation-style of signing, and will have to select between alternatives

