Signing for the Deaf using Virtual Humans

Ian Marshall
Mike Lincoln
J.A. Bangham S.J. Cox
(UEA)
M. Tutt M. Wells
(TeleVirtual, Norwich)
SignAnim

School of Information Systems, UEA
Televirtual, Norwich

Subtitles to Signing Conversion

Funded by
Independent Television Commission (UK)
Tessa

School of Information Systems, UEA
Televirtual, Norwich

Speech to Signing of Counter Clerk Turns in PO Transactions

funded by Post Office
ViSiCAST

School of Information Systems, UEA
Televirtual, Norwich
Independent Television Commission (UK)
Post Office (UK)    RNID (UK)
IvD (Holland)       University of Hamburg (Germany)
IST (Germany)       INT (France)

EU funded 5th Framework Project
Background – Deaf Community

Deaf \( v \) Hard of Hearing

Signing \( v. \) Subtitles

60,000 \( v. \) 1 in 8 of population

300 Level 3 signers
### Background – Sign Language

<table>
<thead>
<tr>
<th>Signed English (SE)</th>
<th>Sign Supported English (SSE)</th>
<th>British Sign Language (BSL)</th>
</tr>
</thead>
</table>

- educated deaf community preferred first language
SignAnim – Aims and Aspirations

Exploration of (semi-)automatic conversion of subtitles to sign language ...

... to increase access for the Deaf ...

... with a potential of providing access to up to 50/80% of TV broadcasts.
SignAnim – Natural Language Processing

Subtitle stream up to 180 words min\(^{-1}\)
Sign rates typically 50\% of speech rate (100 signs min\(^{-1}\))

SE – too verbose to be signed in full
SSE – elision of low information words
BSL – translation to multi-modal signs
SignAnim Components – Simon the Avatar

Data Capture → Sign Dictionary → Avatar

Sign Stream
Motion Capture

Cybergloves
Magnetic Sensors
Video face tracker
Schematic of SignAnim system

TV Capture Card

Teletext Stream

Audio/Video Stream

Eliser

P1 P2 ... Pn

D1 D2

Avatar

Software Mixer
SignAnim Components – Eliser

Requirements
Resolution of Lexical Ambiguity

Elision

If @ receiver Timeliness of signing
  v
If @ transmitter prioritising of parts of sign sequence
Eliser - Summary

Subtitle Frames

CMU Parser → Prioritiser → Elision Level

Sign Stream

Sign Dictionary
‘Last night we brought you the tale of the duck that could not swim and had to learn while a guest of the RAF in Norfolk.’

26 words
in 2 subtitle frames
time to speak / time subtitles on screen 7 secs
time to sign in full 18 / 14 / 9 secs
finger spelling significant overhead
SignAnim – Natural Language Processing

‘Last night we brought you the tale of the duck that could not swim and had to learn while a guest of the RAF in Norfolk.’

Resolution of some lexical ambiguity by p.o.s. tagging

- duck noun/ verb
- had auxiliary/ verb
- swim noun/ verb
- in participle/ preposition

to facilitate correct sign selection
SignAnim – Natural Language Processing

‘Last night we brought you the tale of the duck that could not swim and had to learn while a guest of the RAF in Norfolk.’

Potential elision
determiners
auxiliary verbs
modifying phrases
adjectives and adverbs

in extreme cases jettison entire sentences
SignAnim – Natural Language Processing

‘Last night we brought you the tale of the duck that could not swim and had to learn while a guest of the RAF in Norfolk.’

Additional problems

structural ambiguity

appropriate sign
  no sign for guest, default finger spell
SignAnim – CMU link grammar

Positive features

Lexically driven sentence parser
Robust
Prioritizes multiple analyses
On failure returns partially parsed word sequence
Modifiability
Perhaps the hen was actually reared by a broody duck!
CMU link grammar parser - a shell

<noun> : ( {A-} & {D-} & Wd- & S+ ) or ( {A-} & {D-} & O- ) or ( {A-} & {D-} & PN- );

<adj> : A+ ;
<det> : D+ ;
<verb> : S- & O+ & {@PP+};
<prep> : PP- & PN+;

book.n books.n report.n reports.n room person : <noun> ;
yellow green : <adj> ;
the a : <det> ;
book.v books.v report.v reports.v brings : <verb> ;
on in : <prep> ;

CAPITALIZED-WORDS : <noun> or <adj> or <det> ;

"." : FS- ;
LEFT-WALL : (Wd+ & FS+);
CMU link Grammar Parser - link construction

books .n : ( {A-} & {D-} & Wd- & S+ ) or
( {A-} & {D-} & O- ) or
( {A-} & {D-} & PN- ) or
.v : (S- & O+ & {@PP+});
linkparser> A person reports the book.

Found 1 linkage (1 had no P.P. violations)
Unique linkage, cost vector = (UNUSED=0 DIS=0 AND=0 LEN=7)

+----------------FS---------------+
|-----Wd-----+       +------O-----+   |
|  |   +--D-+---S---+      +--D--+   |  |   |    |       |      |     |   |///// a person reports.v the book.n .
|  | |  |   |                   |   |   |   |   |   |   |   |   |عدل
|  |   |                     |   |   |   |   |   |   |   |   |   |عدل
|  |   |                     |   |   |   |   |   |   |   |   |   |عدل

///// a person reports.v the book.n .

/////      FS  <---FS----->  FS  
(m)   /////     Wd  <---Wd------>  Wd   person
(m)   a        D  <---D------->  D   person
(m)   person  S  <---S------->  S   reports.v
(m)   reports.v  O  <---O------->  O   book.n
(m)   the      D  <---D------->  D   book.n
Eliser - elision strategy

Augment CMU dictionary with further p.o.s. information
  e.g.  has.aux     v.     has.v

Rules for word and path priorities

<table>
<thead>
<tr>
<th>#Link</th>
<th>Weight</th>
<th>Left Path</th>
<th>Left Word</th>
<th>Right Path</th>
<th>Right Word</th>
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<td>X</td>
<td>-</td>
<td>-</td>
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Eliser - Prioritorising

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Eliser - Elision

Perhaps the hen was actually reared by a broody duck!
TESSA - Overview

Aim: To give access to Post Office services for those whose first language is not English.
TESSA Input: Speech Recognition

- Restricted Number of sentences (115)
- Variable quantities (monetary amounts, days of the week)
- Grammar defined as FSN
- MLLR acoustic adaptation
- Entropic recognition engine
TESSA Output: BSL and Foreign Language

- BSL sign sequences
- Signs for variable quantities blended into standard phrases
- Customer may ask for phrases to be repeated
- Text translations into 4 languages for non-English speakers
- English text for the hard of hearing
Conclusions

SignAnim and Tessa demonstrated
+ replay of motion captured sequences readable
+ usefulness of existing NLP and speech recognition technologies
+ desirability of BSL (rather than SSE)