New Features in Synthesis of Sign Language Addressing Non-manual Component

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1 Introduction

The sign language synthesis system:
- fully animated 3D human figure
- parameterized movements of arms and body
- enables the movements of head, and facial gestures
- aim: for sign language as communication means

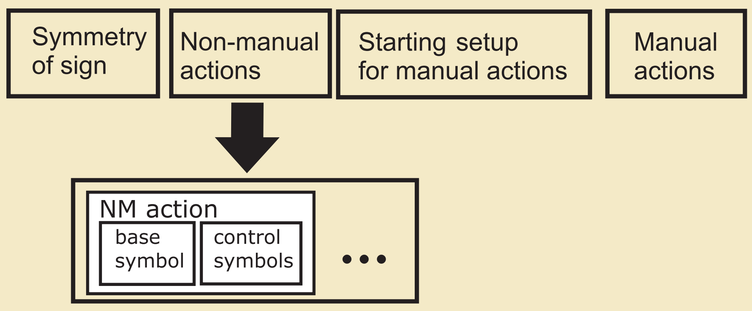
Non-manual signals (NMS):
- important for intelligibility
- several roles of NMS
- Sign language includes signs distinguishable only by the NMS
- more realistic result

Czech sign speech synthesis system:
- for manual component we use the Hamburg Notation System (HamNoSys)
- we need notation method (or rules) in order to transform NMS to 3D animation

HamNoSys does not define symbols for complex gestures
- gestures can be notated by a couple of symbols

We consider NMS to be expressed by one or more non-manual actions
- non-manual action describes the rotation of joints, or the movement in the face

A general notation form has following order:



- base and control symbols can optionally be supplemented by additional auxiliary symbols (modifiers)

2 Transformation of Joints

- transformation of joints is used for skeleton of figure
- actions of stomach, chest, shoulders, head and eyeview
- base symbols: ▽ ▽ ▽) (○
- side modifiers ▪ only for shoulders
- control symbol determines type of transformation: *rotation* or *movement*

upper view (1):

side view:

frontal view:

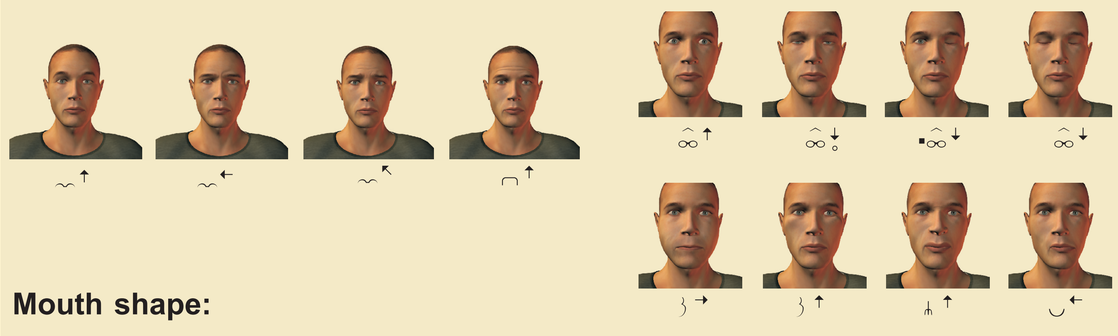
Notation of movements:
- from the base pose
- or in the noted joint rotation
- for example head moving from side to side:

(1) all ilustrations of 3D figure are created in the program Poser 8

3 Movements in Face

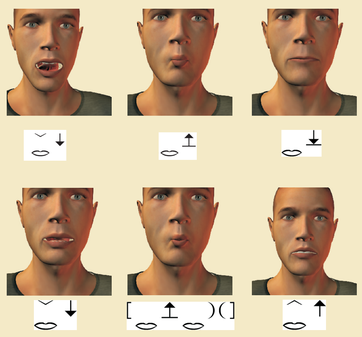
We use following actions to notate shapes of forehead, eyebrows, the area around the eyes, eyelids, nose, cheeks, chin, and mouth.

Base symbols: ∩ ~ ∞ ⅄ ∪ ⬭ ⬭ ⬭
Modifiers of base symbols: ▪ ^ ˇ (left, right, upper and lower part)
Control symbols: 18 elementary movements for straight movements controlling the shift in 3D space
Modifiers of control symbols: small, large, quick, slow, etc.



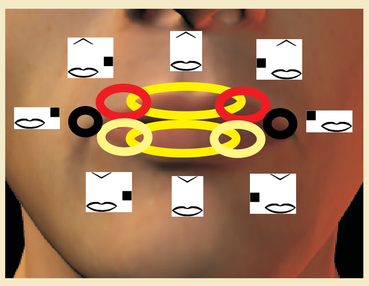
Mouth shape:
- only 3 base symbols (lips, teeth and tongue)
- for straight movements arrows notate direction of movement (contraction of facial muscles, shift of teeth or tongue)
- for lip shape movement should have meaning of complex articulatory movement
- extra control symbols) (X ◊ for relationshift of base symbols with each other
- default notation for the right half of the mouth (the dominant hand)

Articulatory shapes:
- 3 main articulatory action are: *lip opening, lip protrusion, lip raising*

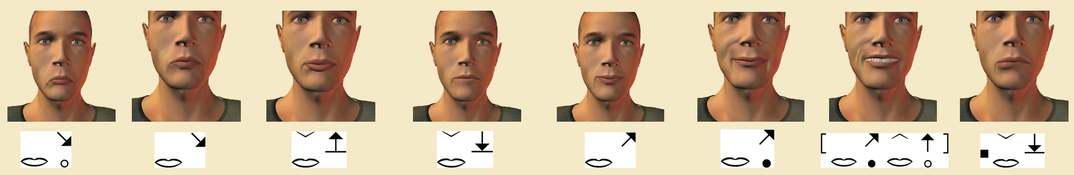


Examples of contact visemes:

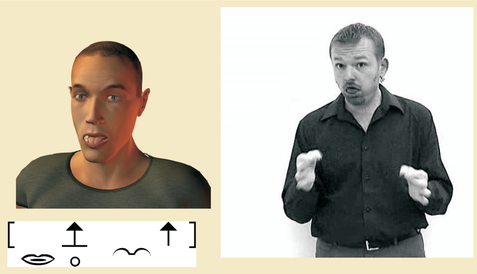
Other lip shapes:
- only 1 base symbol: ⬭ (lips)
- 3 modifiers and (8+2) control symbols
- totally 8 locations x 10 directions
- = **80 non-manual actions for lips**



Examples:



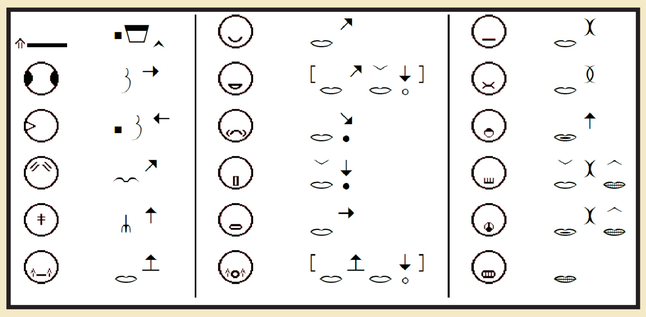
4 Application of Non-manual Actions



Composition of several non-manual actions allows to notate more complex NMS
Two or more non-manual actions can be enclosed in parentheses

Two types of the composition:
- consecutive actions in time (...)
- simultaneously in time [...]

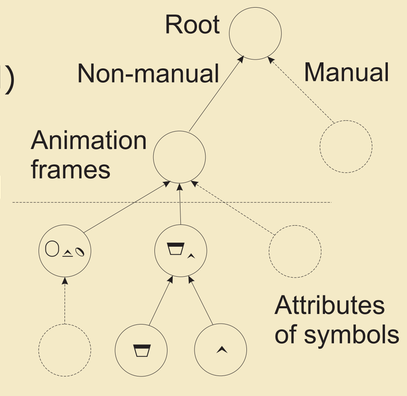
SignWriting and HamNoSys of main NMS incorporated in CSL:



5 Parsing and Rule Actions

Conversion technique:
- syntactic analysis
- parse tree for the structurally correct entry
- terminal nodes (hold attributes of the symbol)

Rule actions convert attributes to key frames
- rules split the parse tree into the manual and non-manual sub-tree (see Figure)



Animation technique:
- face animation by morph targets
- avatar pose - skeleton and skin deformers

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