RULES OF ORGANIZING MOTOR COMMANDS FOR CONCATENATION: TAKING EXAMPLE OF SIGNING GESTURES

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ABSTRACT

Rules of organizing motor commands for concatenation is investigated taking example of signing gestures. In order to control the hand shapes and arm movements in sign gestures, timing and duration of the action of the elements involved in the symbols of their descriptive system are specified for a series of words in phrases, clauses or sentences. They are accompanied with a note concerning whether they are mandatory or obligatory. Those data are stored temporally in the form of matrix of word vs. symbol. Next, concatenation rules are applied to provide distinction between the priority symbols, reduction of the adjacent symbols, or diffusion of the symbols if the elements are not occupied by other symbols. By combining the specification of the elements and the concatenation rules, control commands for each of the elements are currently being computer programmed, and the sign gestures synthesized on a graphic display.

1. HAND SHAPES AND ARM MOVEMENTS

In the previous study by present authors, a new symbolic descriptive system for hand shapes and arm movements was developed, in order to apply to detailed analysis of sign gesture. The structure of the system was as follows.

Hand shapes: In order to model the finger actions, firstly, hand shapes were described combining both the combination of finger actions for changing the shapes, and the mutual relationships among the fingers. Hand shapes used in signing were described by combining the finger actions described above with symbols for the five fingers, marks denoting actions, and several marking conventions.

Arm movements: The position of the wrist was described by a combination of the rotation of the shoulder and the elbow joints. Movement of the hand were described by the transition from a state classified by the position and direction of the hand and the facing of the palmar or dorsal surface to another state [1, 2].

Then, the hand shapes which were difficult to manipulate, or difficult to be perceived, were classified on this system [3, 4].

2. ORGANIZING MOTOR COMMANDS

In this study, rules of organizing motor commands for concatenation is investigated taking example of signing gestures. In order to control the hand shapes and arm movements in sign gestures, timing and duration of the action of the elements in the symbols are specified for a series of words in phrases, clauses or sentences. They are accompanied with a note concerning whether they are primary (mandatory) or secondary (voluntary). The voluntary actions are realized only when the elements are not occupied by the mandatory ones. Those data are stored temporally in the form of matrix of word vs. symbol (Figure 1).

Next, concatenation rules are applied to provide Factor 1) distinction between the priority symbols, Factor 2) reduction of the adjacent symbols, or Factor 3) diffusion of the symbols if the elements are not occupied by other symbols (Figure 2).

These three factors were derived from the analysis of signing gestures of the native traditional Japanese signers [5, 6, 7, 8].

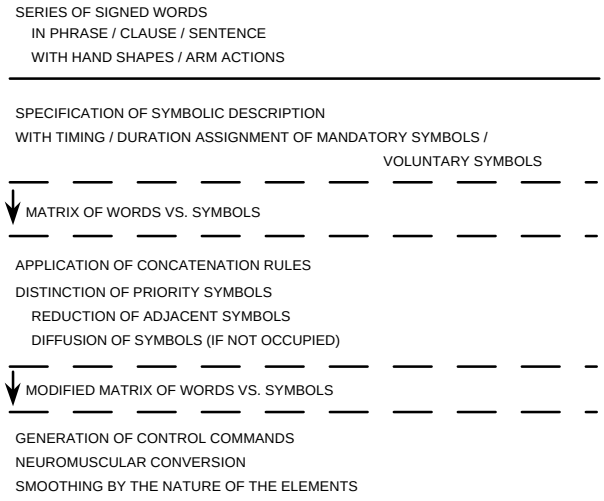

Figure 1. Process of generation of the control commands for signing gestures.

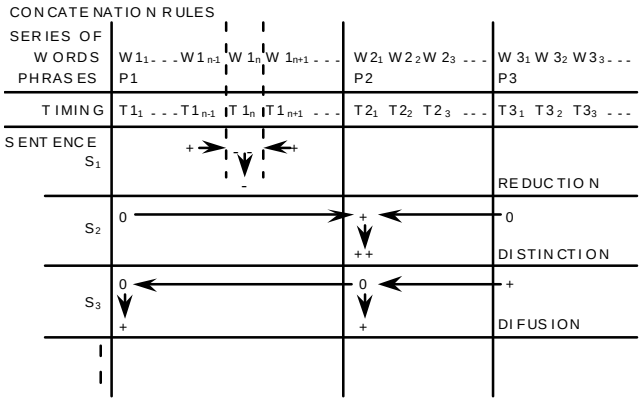

Figure 2. Factors involved in the concatenation rules of organizing motor commands.

3. RANGE OF JOINT ROTATION IN SIGNING

organizing motor commands, especially of the elements in the voluntary symbols, are based on the economy of mechanical

In order to estimate the mechanical work necessary for moving the upper extremities, the upper arm, forearm and hand were

inertia of the whole upper extremity for the movement within the ranges of rotation of the shoulder, elbow and wrist joints

with the inertia about an axis through their center and perpendicular to the length of the cylinders (Figure 3).

rotation of the upper extremity joints, the range with lesser dynamic work required is used in actual sign gestures.

The principle which underlays the design of control rules are applicable to the control of the speech production, as it explains

common to any communication channel.

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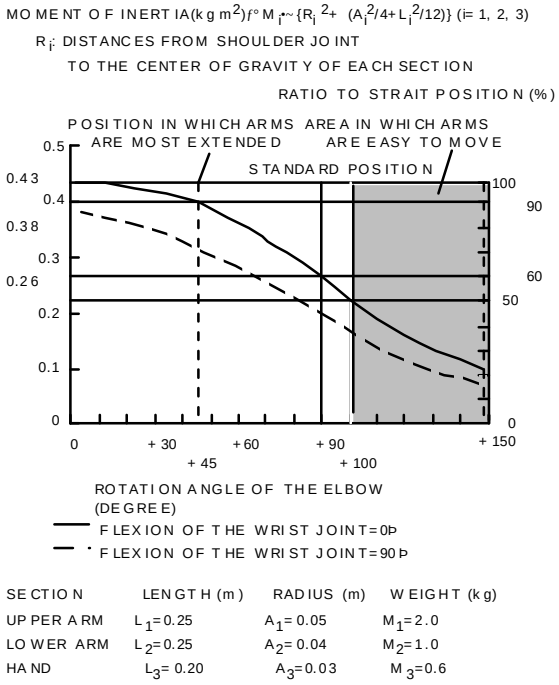

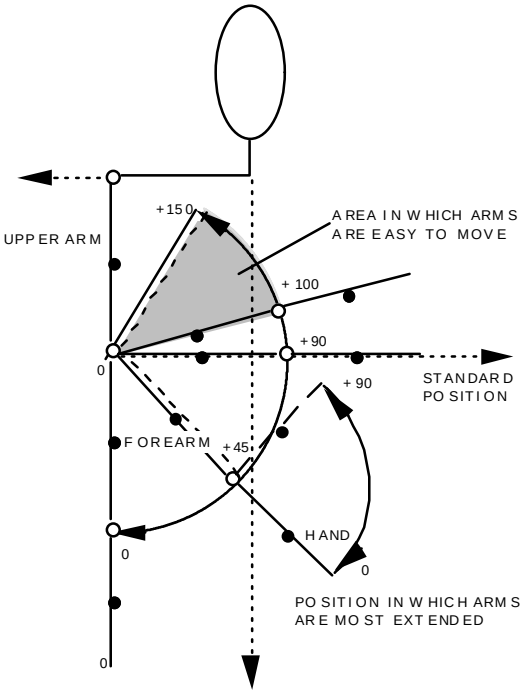

Figure 3. Moment of inertia of upper extremities (Left) and range of joint rotation (Right).