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A Structure and Framework for Sign Language Interaction

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Objective: The goal of this thesis is to design the interaction structure and framework of system to recognize sign language.

Background: The sign language of meaningful individual gestures is combined to construct a sentence, so it is difficult to interpret and recognize the meaning of hand gesture for system, because of the sequence of continuous gestures. This being so, in order to interpret the meaning of individual gesture correctly, the interaction structure and framework are needed so that they can segment the indication of individual gesture.

Method: We analyze 700 sign language words to structuralize the sign language gesture interaction. First of all, we analyze the transformational patterns of the hand gesture. Second, we analyze the movement of the transformational patterns of the hand gesture. Third, we analyze the type of other gestures except hands. Based on this, we design a framework for sign language interaction.

Results: We elicited 8 patterns of hand gesture on the basis of the fact on whether the gesture has a change from starting point to ending point. And then, we analyzed the hand movement based on 3 elements: patterns of movement, direction, and whether hand movement is repeating or not. Moreover, we defined 11 movements of other gestures except hands and classified 8 types of interaction. The framework for sign language interaction, which was designed based on this mentioned above, applies to more than 700 individual gestures of the sign language, and can be classified as an individual gesture in spite of situation which has continuous gestures.

Conclusion: This study has structuralized in 3 aspects defined to analyze the transformational patterns of the starting point and the ending point of hand shape, hand movement, and other gestures except hands for sign language interaction. Based on this, we designed the framework that can recognize the individual gestures and interpret the meaning more accurately, when meaningful individual gesture is input sequence of continuous gestures.

Application: When we develop the system of sign language recognition, we can apply interaction framework to it. Structuralized gesture can be used for using database of sign language, inventing an automatic recognition system, and studying on the action gestures in other areas.

Keywords: Sign language interaction, Sign language pattern, Interaction framework, Barrier free design

1. Introduction

Due to the development of information technology (IT), many studies on more comfortable gesture interface are carried out in the various fields of HCI (Human

Computer Interaction). Sign language, which is hand gesture, is a means for the deaf to communicate with hand movement. Sign language is well defined to deliver various and complex intentions and ideas used in daily life. Sign language delivers verbal information for symbolic communication with systematized gestures, and a variety of expressions can be made, due to interactions corresponding to natural language (Quek, 1994). Therefore, sign language can be used for natural interface development with computers (Lee et al., 1998), and the development of a system recognizing sign language and then interpreting it into text or voice is carried out so as to help smooth communication among people with normal hearing.

Korean sign language basically uses Korean manual alphabet and Korean sign words simultaneously. Kim (2004) categorized Korean sign word structure within the sign language scope. This study re-constructed the Korean sign language as shown in Figure 1 by adding the Korean manual alphabet structure to know entire sign language structure scope.

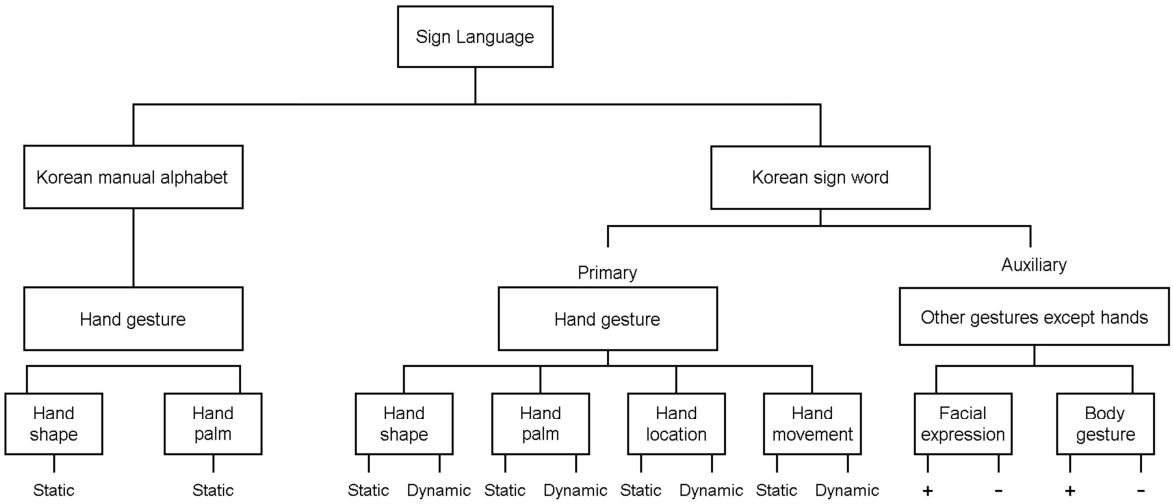

Figure 1. Structure of sign language

The Korean manual alphabet has the structure of hand shape and hand palm direction by imitating the Korean alphabet's consonant and vowel shapes, and is a static gesture type with instrumental characteristics. Meanwhile, concerning the Korean sign words, a gesture is mainly made by hand, and meaning is made by using the gestures of face and boy as auxiliary means as well. In this regard, the gesture interaction of sign language is defined as the hand gesture and other gestures except hands. A hand gesture consists of hand shape (arrangement of finger joints), hand location (classified as head, facial part, shoulder, chest, belly and hand), hand movement (deciding the movements of shoulder, arm, wrist and finger joint), hand palm or finger direction (hand or hand palm direction or open finger tip direction). Other gestures except hands are composed of facial expression and body gesture (eyebrow movement, the direction of eye, mouth shape and tong movement, shoulder movement and foot movement). Namely, sign language is not just imitating shape or movement, but is completing meaningful words by the change and combination of gesture components of hand gestures and other gestures except hands. Table 1 below shows the classification of characteristics according to the components of hand gestures and other gestures except hands.

Lee (2008) analyzed the simple structure type that Korean sign language has, and demonstrated eight morphemes of one hand sign language, and seven morphemes of the same form, and five morphemes of different forms among two hands sign language morphemes. Yoon and Kim (2004) defined non-hand gestures, which are other gestures except hands, as the signals revealed with

Table 1. Classification of sign language gestures

Sign language gesture	Hand gesture				Other gestures except hands
	Hand shape	Hand location	Hand movement	Hand palm	Face, body
Characteristics	It appears related to status	Location of acting hands when sign language is shown	Expression of sequence of flow	Composition of words and important elements for distinguisher	Case of showing grammatical relationship of flow

facial expressions used together with hand gestures, or exclusively used head movement, eye, mouth shape and body movement. They divided meaningful gestures into morpheme 1, morpheme 2, morpheme 3 and morpheme 4, according to the combination of expression and movement. From all these, hand gestures can be more systematically structuralized, focusing on various hand gestures, and other gesture except hands can also be analyzed as auxiliary meanings.

When communication is made through sign language, a sentence is constructed by combining individual gestures in meaning unit. In doing so, a difficulty arises in system's identifying and recognizing meanings, because gestures are made continuously. Since a gesture has no clear segment, therefore, the system has a difficulty in distinguishing continuous gestures. The reason is that there is difficulties for the system to recognize in the interpretation of hand gesture's meaning, due to hand gesture's various change factors (Lee et al., 1998).

Lee et al. (1998) presented a rule to classify sign language's continuous movement interaction with speed together with the hand gesture movement rule presented by Quek (1994), and they researched the system actualization that can be recognized in real time. However, their research is the one based on contact type recognition, and gestures that can be recognized were limited, and their research explains that a study on the difference of many people's gestures and precise recognition rate should be carried out furthermore (Lee et al., 1998). Therefore, difficulties still exist in the recognition of various change factors and various meanings interpretation on the individual gestures of sign language words.

Therefore, individual gestures need to be clearly segmented for the system to precisely recognize the meaning of sign language, and structuralization and framework, in which the classification of individual gestures in meaning unit can be made in continuous movement situation, are needed. To this end, this study defines, segments and structuralizes hand gestures and other gestures except hands from the interaction perspective. This study proposes the utilization measures by designing framework that can raise recognition rate of the individual gestures in each meaning unit of sign language.

2. Structure of Sign Language Interaction

To make a system that can recognize sing language, the interaction of sign language gestures needs to be structuralized. That is, various individual word gestures need to be structuralized with clear segments by segmenting hand gestures and other gestures except hands. In this context, the systematic segmentation and classification of gestures, and recognition of them can be made in a parallel way, and these can be the method to distinguish the delicate differences between people, and differences that can tell similar gestures faster and more easily. Consequently, precise recognition and interpretation can be made, and vast sign language can be interpreted systematically. To do so, this study analyzed 700 sign language words with simp0le structure type, and conducted the following: First, drawing the change pattern of hand gestures. Second, analyzing the hand movement of change pattern gestures. Third, analyzing the other gesture pattern except hands.

2.1 Gesture interaction sets of the change patterns from starting point to ending point

Sign language words are classified into static gestures, if hand movement does not exist in terms of each gesture type, and into dynamic gestures, if hand movement exists. A dynamic gesture is defined as the starting point when a gesture starts, and the ending point when a gesture ends. Namely, the starting point of a sign language word is made through the combination of three factors, hand shape, hand location and hand palm or finger direction, and the ending gesture is transformed through hand movement. Although, static gestures are distinguished as the gestures in static state, dynamic gestures are classified as individual gestures in a meaning unit in terms of the shape of which starting and ending points change. In this regard, precise individual gestures can be classified, if the transformation of individual gestures' starting and ending points is distinguished. To classify the patterns of sign language words having differences in the starting and ending points, this study set hand shape, hand location, hand palm or finger direction as factors, and analyzed simp0le structure sign language words. Therefore, this study classified the sign language patterns into eight patterns, and defined as the interaction of gestures as shown in Table 2 (Table 2). The gestures classified according to each defined pattern can classify the change patterns at the starting and ending points.

Table 2. Classification change patterns from starting point to ending point

(keeping same gesture from starting point to ending point) (changing gesture from starting point to ending point)

No	Gesture	Description	Gesture of change patterns	Gesture action-example
1	Static	Keeping same gestures from starting point to ending point.	Shape Palm Location	Korea-manual Alphabet "ㄱ"
2	Shape dynamic	Changing hand shape of gesture from starting point to ending point.	Shape Palm Location	"disperse"
3	Palm dynamic	Changing hand palm of gesture from starting point to ending point.	Shape Palm Location	"book"
4	Location dynamic	Changing hand location of gesture from starting point to ending point.	Shape Palm Location	"divide"
5	Shape & location - dynamic	Changing hand shape and location of gesture from starting point to ending point.	Shape Palm Location	"hard"

Table 2. Classification change patterns from starting point to ending point (Continued)

(◯ keeping same gesture from starting point to ending point) (● changing gesture from starting point to ending point)

No	Gesture	Description	Gesture of change patterns	Gesture action-example
6	Palm & location - dynamic	Changing hand palm and location of gesture from starting point to ending point.	Shape Palm Location	"dead leaves"
7	Shape & palm - dynamic	Changing hand shape and palm of gesture from starting point to ending point.	Shape Palm Location	"everybody"
8	All dynamic	Changing all gesture from starting point to ending point	Shape Palm Location	"snatch"

2.2 Gesture sets of the movement and pattern

The dynamic gestures of sign language words change at the starting point and ending point by movement. To recognize the individual gestures in the meaning unit, not only hand gesture shape, but hand movement existing between dynamic gestures should be examined. Consequently, this study analyzed 700 sign language words having change patterns by dividing hand movements with three factors, namely, movement pattern, direction and the status of repetition to analyze hand movement.

To analyze hand movement pattern existing between dynamic individual gestures, this study defined as follows:

The hand movement of sign language words can be classified into straight (line) movement, curve movement and compound movement. A straight line is defined as straight form movement without curve, a curve is defined as curve form movement, no straight line type, and a compound movement is defined as the mixed movement of various lines. According to the classified

Table 3. Gesture sets of hand movement pattern

Straight				Curve						Compound		
Straight form without curve				Curving form not straight						Mixed form with various lines		
Straight basic	Dotted line	Right angle	Z shape	Curve basic	Wave	Wand	Spin	Circle	Ribbon	Straight + curve	Straight + spin	Chinese character

definitions, this study elicited 13 gesture movement patterns by dividing the movement patterns in a second-phase classification in more detail (Table 3).

The straight (line) movement is classified into straight basic, dotted line and Z shape movements. The straight basic has the straight (line) movement pattern, and the dotted line is the pattern of movement for which two or more times of cutting-off of the straight (line) movement occur. The right angle pattern is the one, where straight lines meet and make an angle. The Z shape pattern is the one of movement drawing Z shape. The curve movement is classified into curve basic, wave, wand, spin, circle and ribbon patterns. The curve basic pattern is the one of curve movement, and the wave pattern is the one for which curve moves up and down. The wand pattern is that the front part is made by curve, or a curve is made by moving upward. The spin pattern is the one rotating in one axis, and the circle pattern is the one drawing a circle. The ribbon pattern is the one moving to a curve, drawing a circle, and then moving to the curve again. The compound pattern is the one of mixed straight basic and curve basic movements, and the one of mixed straight basic and spin movements. The compound pattern is also divided into a movement pattern imitating Chinese signs.

This study analyzed the gesture's moving direction by dividing sign language movement into a single direction and a compound direction. The hand gestures of sign language are the 3D (3 dimension) movements, not 2D (2 dimension) movements. Thus, sign language has X, Y and Z axes. This study applies relative values by making the starting point, where sign language starts. Sign language does not occur, centered on one axis all the time, but each sign language word has different reference points, there is a difficulty to set absolute values.

In this regard, this study defined six single directions, based on X axis to the right as the reference of the starting point, -X axis to the left, Y axis upward, -Y axis downward, Z axis forward and -Z axis backward (Figure 2).

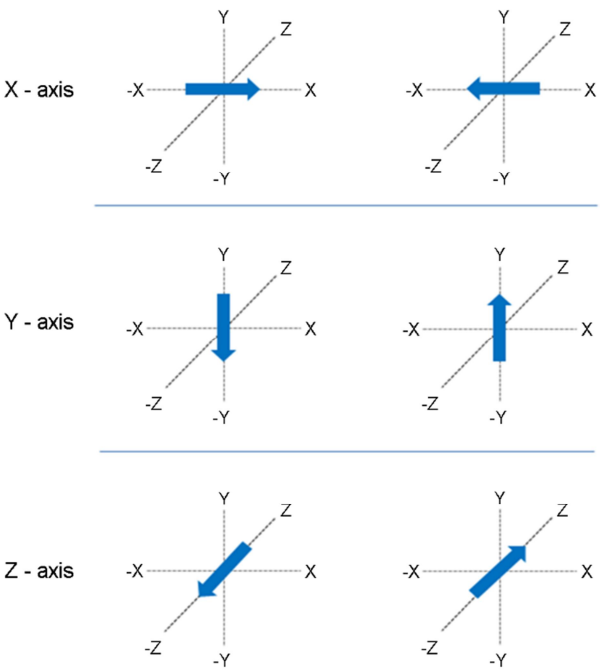

Figure 2. Gesture sets of single movement direction

The compound direction of sign language gestures is talking about the directions of relationship of two hands and relationship of fingers, as the movement players are two and more. This study classified five compound directions by adding basic axis directional and compound directional movements to pattern movement. "Same" is to move to the same direction from the same axis, "Open" is to move to the opposite direction from the same direction, and "Close" is to move to the meeting direction from the same axis. "Cross" is the pattern in which mutually different directions cross, and "Different" is the movement of non-crossing pattern into mutually different directions. This study defined all these as above (Figure 3).

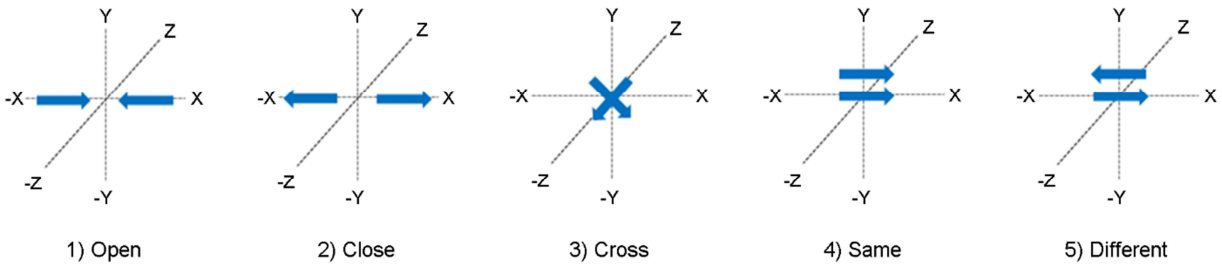

Figure 3. Gesture sets of compound movement direction

Lastly, the factors deciding movement pattern according the status of movement repetition. This is to distinguish the gestures having repeated interaction in the sign language gesture pattern. Repetition is defined as the case that meaning is established, if interaction like repetition continuously occurs.

2.3 Gesture sets of non-manual signals

Sign language makes the intentions such as question, emphasis, positivity and negativity clear in a manner to deliver intention using facial expressions and body gestures, in addition to basic meaning. Namely, a sign language user completes a sentence by expressing language's tone through the addition of facial expressions and body gestures to the basic meaning of sign language. Therefore, the meaning of a sentence may become different by non-manual signals, and thus, the system needs to distinguish gestures in addition to hand gestures. The meaning of other gestures except hands is decided according to facial expressions and body gesture movement: the meaning can be decided by exclusive movement, and a meaning can be made by combination of factors' movements. Yoon and Kim (2004) defined the types of such non-manual signals, and this study analyzed by simplifying the non-manual signals into useful scope, when those types were classified by the system.

First, this study analyzed by setting eyebrows, eyes, mouth, face and upper body as the basic factors of other gestures except hands in order to segment movement patterns. If movement is extended on the basis of the basic pattern of set factors, the movement is set as open; if reduced, as close; if goes up, as up; if goes down as down. If movement is made to the left and right, it is defined as shake, and if up and down, as up and down. This study ultimately segmented 11 movement patterns (Table 4).

To find out what meanings are revealed, when 11 movement patterns are used exclusively or in a combined way, this study defined the meanings as interaction through gesture analysis. To this end, this study defined many used non-manual signals' gestures (interrogatives of what and yes or no, positive sentence, strong negative sentence, requesting sentence, imperative sentence and surprising exclamatory sentence) as eight interactions, and they are as follows (Table 5).

Table 4. Gesture sets of other gestures except hands

Eyebrows		Eyes		Mouth		Face				Upper body
Raise one's eyebrows	Reduce one's eyebrows	Open one's eyes wide	Close one's eyes	Open one's mouth	Close one's mouth	Put one's face forward	Lower one's head	Nod one's face up and down	Shake one's head	Raise one's upper body
UP	Down	Open	Close	Open	Close	Up	Down	Up & Down	Shake	UP

Table 5. Gesture interaction sets of non-manual signals

No	Gesture	Description	Gesture -action
1	What	Opening your eyes wide and putting your face forward with your mouth open.	open + open + up
2	Yes or no	Raising your eyebrows, opening your mouth, with your face leaning forward.	up + open + up
3	Positive	Nodding your face up and down.	up & down
4	Negative	Shaking your head.	shake
5	Strong-Negative	Reducing your eyebrows with your mouth close.	down + close
6	Request	Lower your head	down
7	Imperative	Raising your eyebrows with your mouth open.	up + open

Table 5. Gesture interaction sets of non-manual signals (Continued)

No	Gesture	Description	Gesture -action
8	Surprise	Raising your eyebrows, opening your mouth wide and raising your upper body with your face leaning forward.	up + open + up + up

3. Sign language Interaction Framework

Continuous movements occur through making a sentence by individual gestures are combined in the unit of meaning in terms of sign language. Because, gestures continuously made, there is a difficulty for the system to identify and recognize meanings. Therefore, this study designed the following framework to distinguish individual gestures from the continuous movements (Figure 4).

Typical hand gesture consists of three action stages - preparation, stroke and retraction (Quek, 1994). Structuralization was made so that individual gestures can be recognized in the stroke stage, where the most important movement gesture takes place. When sign language words' individual gestures are inputted in the system continuously, this study structuralized the preparation and retraction stages, which are the action stages of hand gesture in each meaning unit. The preparation stage is to locate hands for stroke stage, and the retraction stage is to locate hands for the next stroke gesture, or is the stage for action to rest. Actually, the separation of meaningless gestures and meaningful gestures is possible. This study set the initial stage of preparation, preparation stage, point of contact stage of preparation and stroke stages, point of contact stage of stroke and retraction stages and closing stage of retraction, and applied the speed and speed change rules presented by Lee et al. (1998) as follows:

1. Initial stage of preparation: Preparatory state to perform sign language, or low speed movement to move, or unintended small movement state.
2. Point of contact of preparation and stroke stages: Initial stage's strong movement performed, when intended gestures start.
3. Point of contact of stroke and retraction stages: After judging as intended gestures, this ends as suspension state at the moved location for the next action.
4. Closing stage of retraction: At the end of meaningful sign language, speed is clearly reduced, which can be distinguished from the sign language performed next.

For precise recognition of individual gesture's meaning, this study classified three stages as starting point, movement and ending point, based on the sequence of movements, when sign language words are dynamic gestures. Starting point is starting point gesture stage, where individual gesture in the meaning unit starts for the first time, and ending point is the gesture stage that ends action, and they were structuralized for the gesture analysis of shape, palm and location. Movement is the stage through which hand movement taking place between the starting and ending points can be analyzed. Therefore, this study structuralized the pattern, direction and repetition in the movement stage to classify "what pattern, moving to which direction and whether the movement continuously occurs lastly" (Figure 4).

Lastly, this study designed the framework as shown in Figure 5 to distinguish individual gestures for which non-manual signals were added to basic meanings of sing language. In the case that other gestures except hands exclusively or together with hand gestures cause meaningful movement, it is indicated as (+), if not as (-). In this regard, when movements other than hands occur, this framework applies. Therefore, this study applied the gesture factors (eyebrows, eyes, mouth, face, upper body) except hands

set above to the framework, and this study classified and structuralized eight patterns of gestures for the interpretation of meaningful movement.

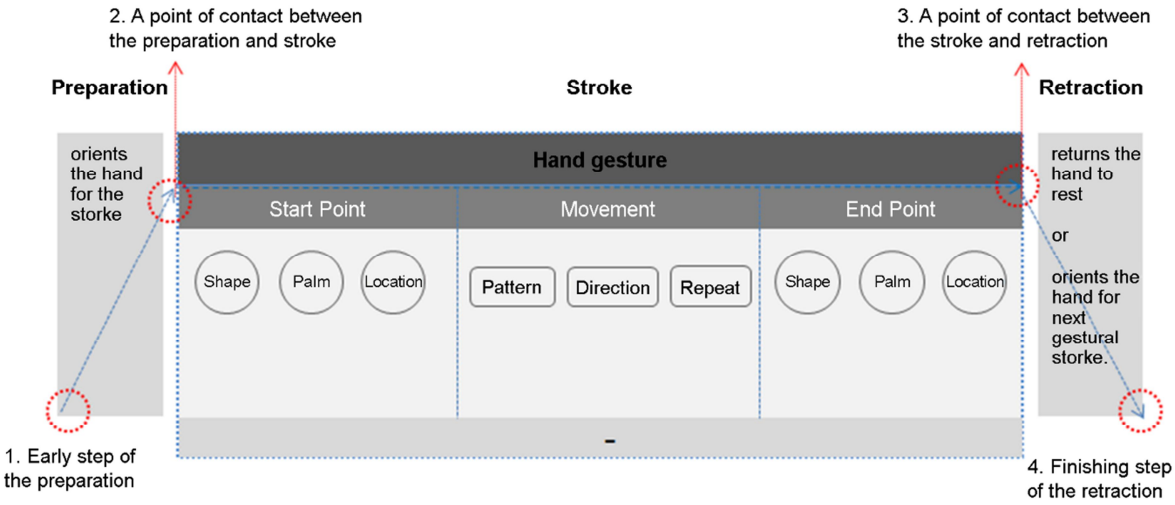

Figure 4. Framework for sign language interaction

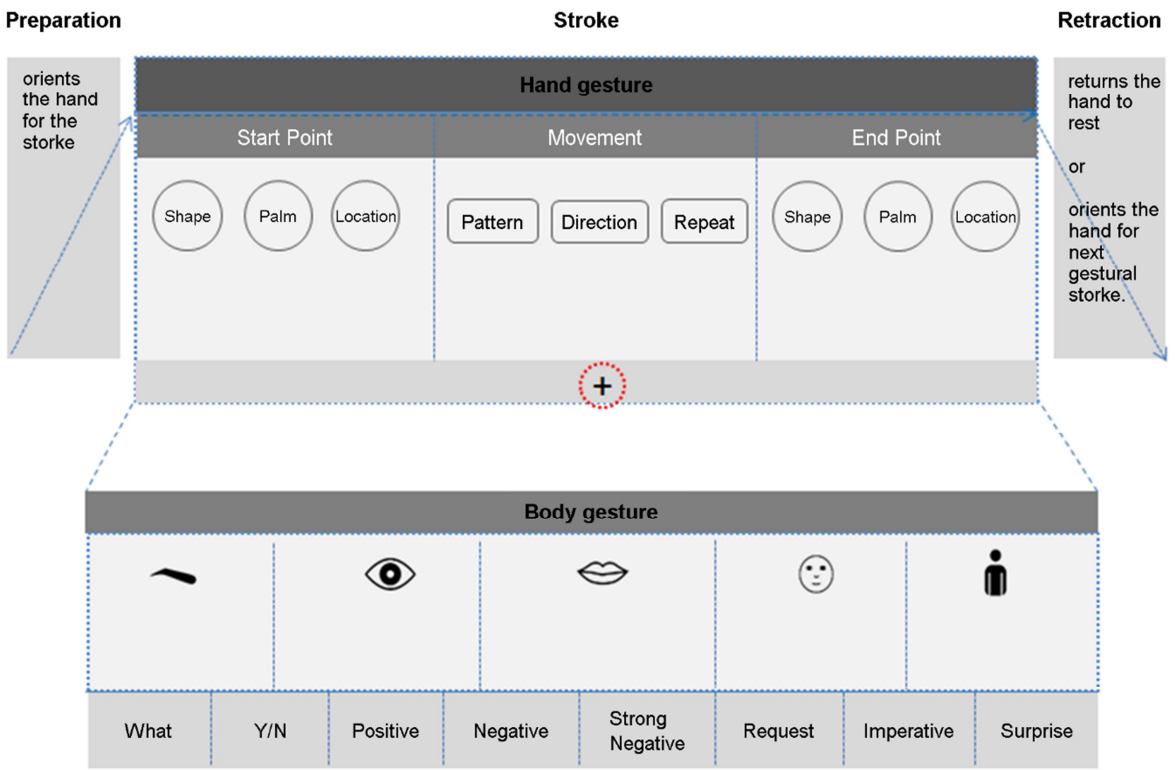

Figure 5. Framework for sign language interaction with non-manual signals gesture

4. Case Study using Sign Language Interaction Framework

This study applied sign language sentences, since the utilization possibility of sign language structure and framework set above needs to be identified.

The Korean sign language has a different grammatical system from the Korean language. Therefore, the first sentence of sign language for "having a good time", is expressed as "good+time+have", and actual action is shown in Figure 6. This sentence has three individual hand gestures for each sign language word, and thus, this study structuralized continuous actions as shown in Figure 7.

Figure 6. "Have a good time" (KSLD, 2015)

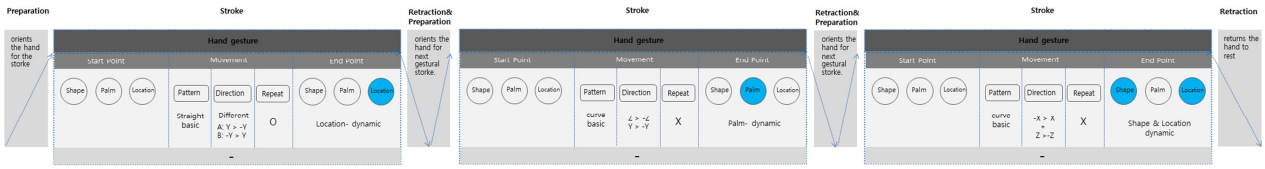

Figure 7. "Have a good time" framework for sign language interaction

The sign language action for "good" is the action of opening thumbs, index fingers and middle fingers of both hands, and moving up and down not mutually meeting at both sides of the chest. This action is the pattern in which only the location of hands change and the hand shape and palm direction are maintained in terms of gesture from the starting point to the ending point, and "location-dynamic" applies. In doing so, the hand movement pattern becomes "straight-basic", and two hands have different compound directions. Also, one hand moves from Y axis to -Y axis, and the other hand moves from -Y axis to Y axis, based on chest, and a structure of repeated movement occurs. At the end of the gesture of meaningful "good" in the retraction stage, the speed is clearly reduced so that it is distinguished from the gesture of "time" performed next (Figure 8).

"Time" is the sign language action composed of two hands. This action is to raise one hand for which the tip of open hand is raised toward outside, and the other hand's thumb and index finger are put on the open palm, and the index finger is turned outside. Therefore, together with initial stage's strong movement performed, when the gesture "time" starts, only the location of hands change and the hand shape and palm direction are maintained in terms of gesture from the starting point to the ending point, and "palm-dynamic" applies. In doing so, the hand movement pattern becomes "curve-basic" and the hand moving in the heterogeneous shape (Only one hand has movement, and the other hand becomes static state), despite two hands gesture, moves from Z axis to -Z axis, and from Y axis to -Y axis, based on chest, and it is the gesture without repeated movement (Figure 9).

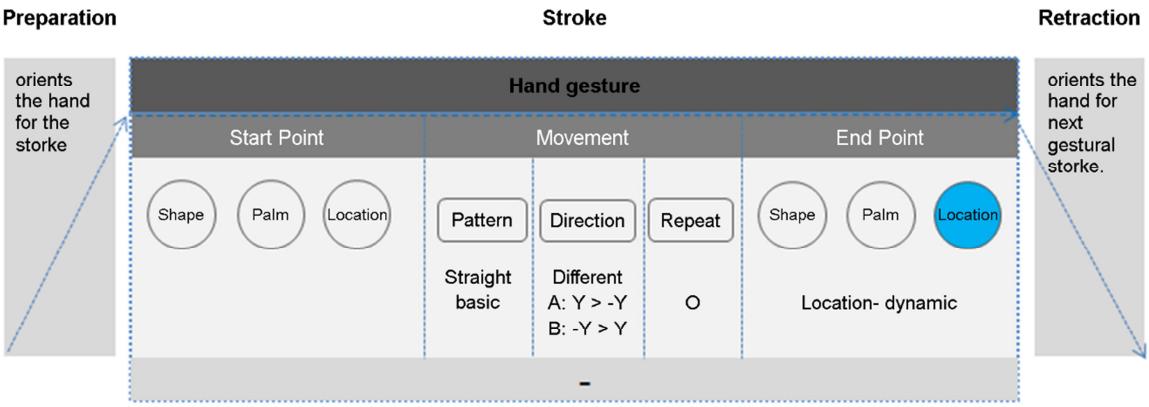

Figure 8. "Good" Framework for sign language interaction

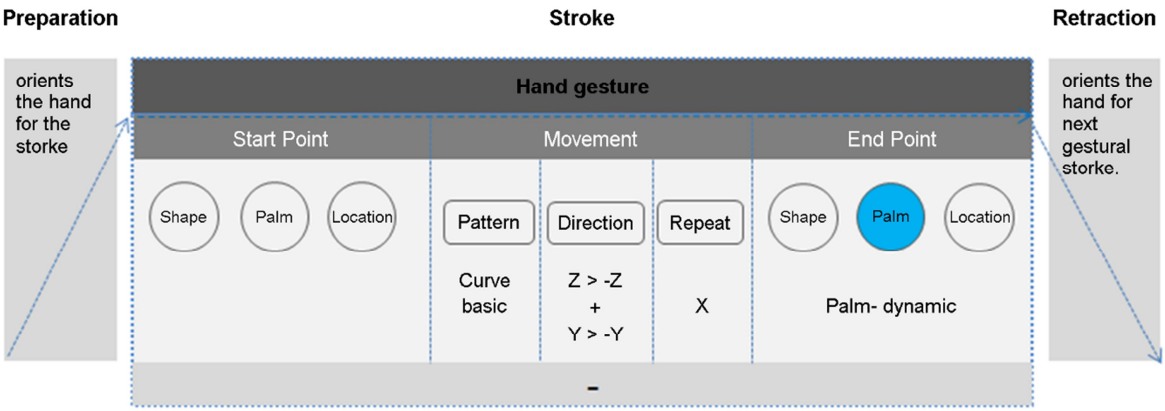

Figure 9. "Time" Framework for sign language interaction

The sign language action for "have" is the action clenching a fist, while the open hand raised for right hand's fingertip is headed toward outside to left from the sign language user's left. This is the pattern in which only the shape and location of hands change, and palm direction is maintained in terms of gesture from the starting point to the ending point, and "shape & location-dynamic" applies. In doing so, the hand movement pattern becomes "curve-basic", and the waist's reference point direction moves from -X axis to X axis and from Z axis to -Z axis, and it is the gesture without repeated movement (Figure 10).

Second, the sentence, "Does father come?" was applied to the framework. This sign language has changed its meaning from the action as shown in Figure 11, "Father comes" to "Does father come?" by adding non-manual signal, an interrogative, "come?" to the gesture, "comes" (Figure 12). Namely, it has the hand gesture "Father + comes" and other gestures except hands, and therefore, this study structuralized it as shown in Figure 13.

The sign language action "Father" is to open only index finger, put it on the right side of the sign language user's nose, and then fold the index finger, open thumb and put it forward. Therefore, this is the pattern that the hand direction, palm shape and hand location are all changed in terms of gesture from the starting point to the ending point as sign language action of "Father", and "all-dynamic" applies. In doing so, the hand movement pattern becomes "curve-basic", and direction moves from Y axis to -Y axis,

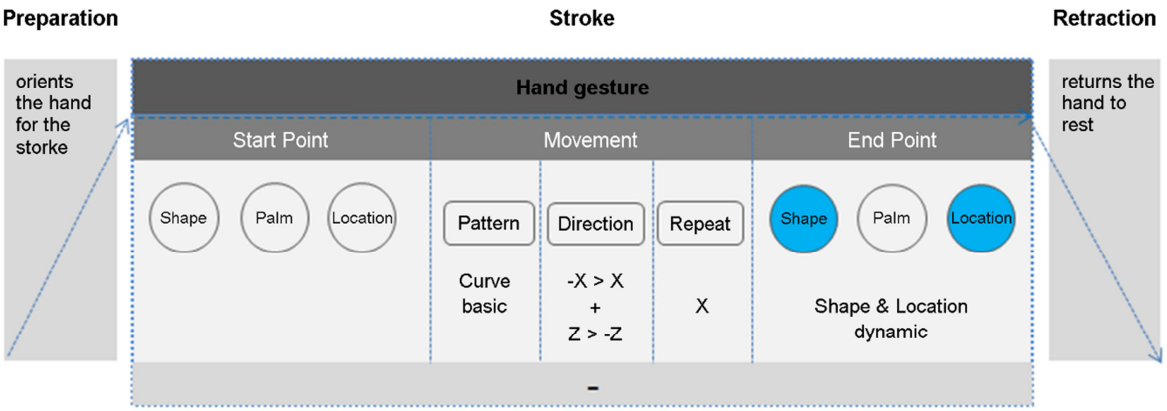

Figure 10. "Have" Framework for sign language interaction

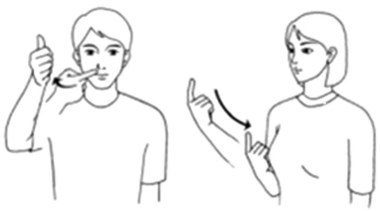

Figure 11. Father comes. (KSLD, 2015)

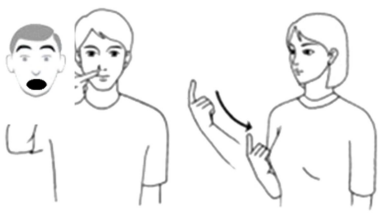

Figure 12. Does father come?

and then moves to Z axis, based on nose reference point. In the retraction stage, at the end of the meaningful "Father" sign language, speed is clearly reduced so that it can be distinguished from the gesture "comes?" performed next (Figure 14).

"Comes"? is the sign language action for "comes", and an action that only index finger opens and arm extends in the direction of opened palm, and pulls it toward the body of the sign language user, and an action that eyebrows are raised, mouth is opened, face is put forward occur together, and therefore, a Yes or No question sentence is made. Together with initial stage's strong movement performed, when the gesture "comes" starts, this is the pattern in which hand location changes, but hand direction and palm are maintained in the gesture from the starting point to the ending point. Actually, "location-dynamic" applies here. In doing so, the hand movement pattern becomes "curve-basic", and the direction moves from Y axis to -Y axis and from Z axis to -Z axis, based on waist reference point with extended arm. Concerning the non-manual signals' other gestures except hands, eyebrows go up, mouth opens, and face moves upward, and therefore, a Yes or No interrogative sentence is established (Figure 15).

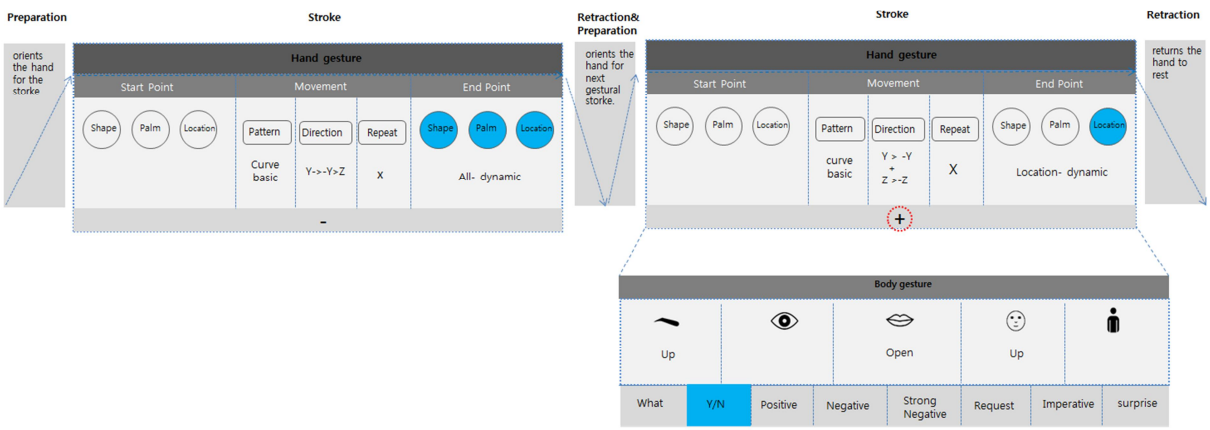

Figure 13. "Does father come?" framework for sign language interaction

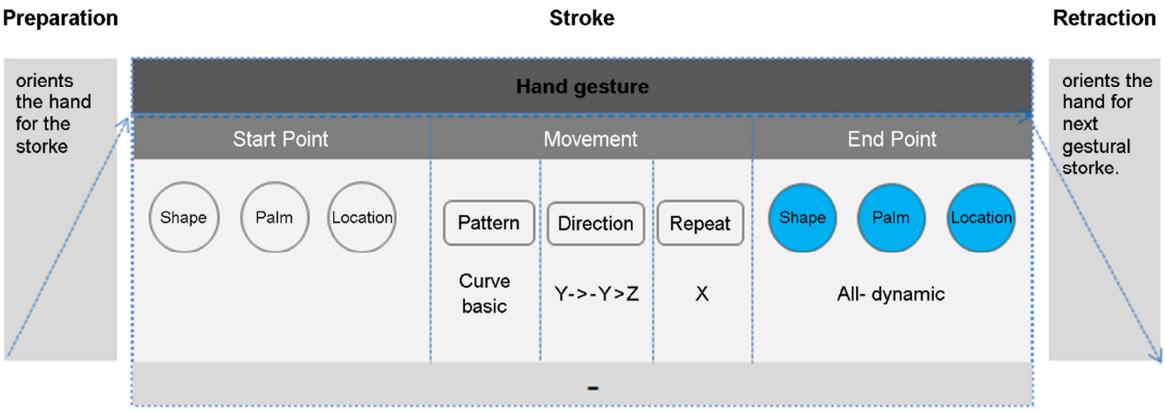

Figure 14. "Father" framework for sign language interaction

As a method presented in this paper, this study applied 25 different Korean sign language sentences to the framework by mixing sign language words composed of simp0le structure pattern. This study substituted and applied the sentences that can be used in everyday life, according to situation. Also, 92% of structuralization is possible with the framework mode proposed in this paper. Regarding 9% of lacking sign language words, there is a problem that they are not applied with the movement pattern not defined in this study. However, this structure is forecast to be revealed in a further study direction. This framework has extendibility enough to add more sign language words in addition to the number of sign language sentences applied to the framework, and application to the system that can recognize sign language is possible. The framework can also be used for system development research in various fields, based on gesture recognition.

5. Conclusion

This study structuralized the hand movement and gestures other than hands in sign language gestures by segmenting them so as to make a system that can recognize sign language. Through this, when individual gestures are inputted in the system continuously, this is a study to design the framework that can distinguish individual gestures in each meaning unit.

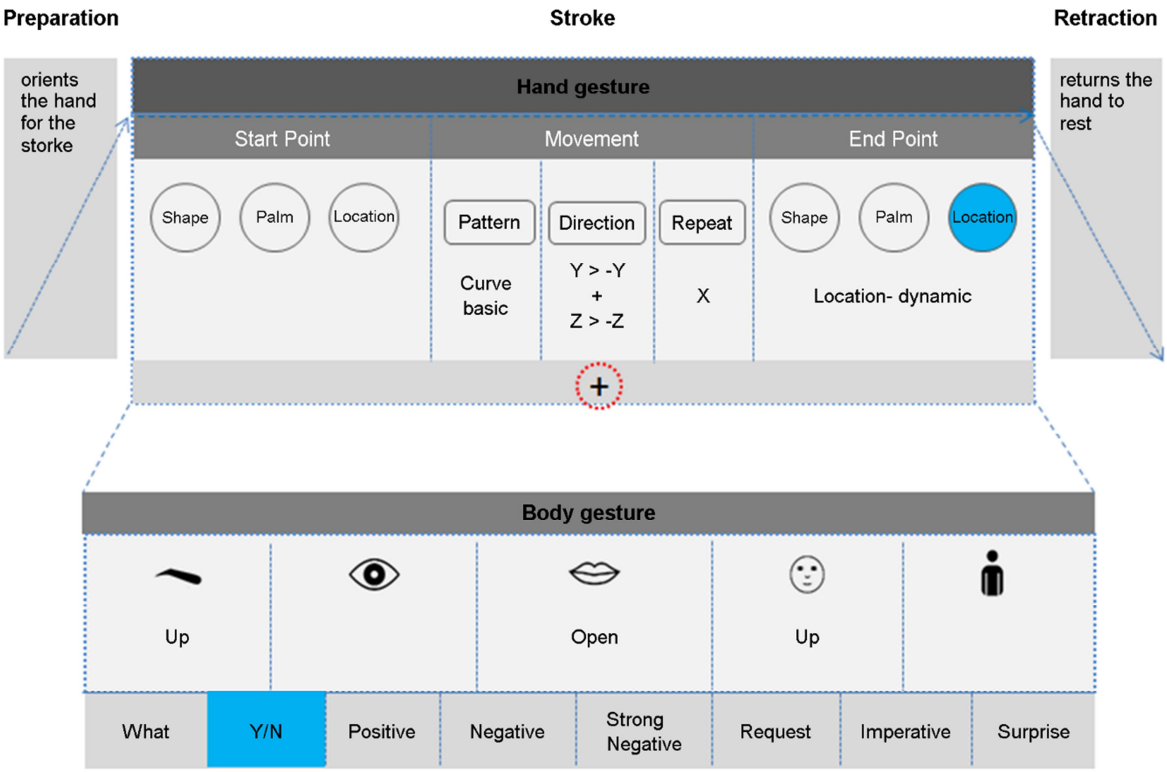

Figure 15. "Come + ?" framework for sign language interaction

The system recognizing and interpreting entire gesture actions in one unit needs high dimensional operation ability to distinguish person's gesture differences and characteristics, and relationship among similar gestures. However, when the gestures can be recognized in parallel by segmenting them, rather than recognizing the gesture in a unit, such a recognition can become a method to distinguish the delicate differences among people and similar gestures' differences faster and more easily. For this reason, efficiency can be expected in the gesture data extension and recognition of the system, if gestures are systematically segmented, and this means smooth and universal gesture recognition system environment can be made. Consequently, a structuralized system like program language is required for the system to understand intuitive gestures better.

Toward this end, this study has significance in that the study analyzed the change pattern of hand gestures' beginning and ending points, hand movement and other gestures except hands, and structuralized them in three aspects for sign language interaction. This study analyzed 700 sign language words, and carried out the following: First, eight patterns of sign language gestures were drawn, based on the change at the starting and ending points, and change patterns of individual gestures can be distinguished. Second, this study analyzed hand movement with three factors, namely movement pattern, direction and repetition, and defined 13 movement patterns and classified five directions. Consequently, the hand movement patterns existing among dynamic individual gestures can be identified. Third, this study defined 11 other gesture movements except hands, and enabled interpretation of auxiliary meanings in addition to hand gestures. Based on this, when the individual gestures of sign language words are continuously inputted in the system, this study designed a framework in which individual gestures in each meaning unit can be distinguished, and more accuracy can be enhanced in precise recognition and interpretation. As a result, sign language interaction structuralization and 92% of the individual gestures of sign language in single word structure were applied in the framework, and its utilization possibility in continuous movement situation was presented in this study.

This can be a basic system to input human's body actions in the system, and can be evaluated as a meaningful ergonomic approach and an attempt in realizing human computing.

When a system that can recognize sign language is developed through this study, the sign language interaction framework can apply. In addition, structuralized gestures are used for the database making of sign language, and automatic recognition system development, and those structuralized gestures can also be utilized for interaction gesture studies in various fields.

In the further study, generalization by applying various sign language words' gestures is necessary to enhance the accuracy of designed framework. Because, this study analyzed, centered on the sign language words in a simp0le structure, a study on gestures is needed for the meaning recognition of compound words (words combined with two and more of basic single word), and also a study on the gesture supplementation of more diverse non-manual signals is required. There can be limitation in the interpretation by applying the grammatical rules of sign language, because this study proposed, centered on the framework that can recognize the gestures of sign language, and therefore, a relevant study is also needed.

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