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A study of non-meaning hand motion in conversation through the Body motion Analysis

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Abstract

In showing human body motion, it is not difficult for computer graphics to show a motion with a designated meaning or to show the motion of the meaning exaggeratedly. However, it is relatively difficult for computer graphics to show a daily human body motion without any meaning in real life. The reason lies in the animation technology. The animation technology adopts understandable motion or the special individuality that can identify the character to express the intention of the character. However, when people are talking, there will be not only the motion and character expressions that are understandable but also some daily motion with ambiguous intentions and meanings. It can assume that these motions are also necessary in showing human body motion by computer graphics. The study observed the human body motion during the speech and classified these motions by each part of human bodies. The human body motion during the speech varied based on their different body parts. The study carefully observed the hand motion and the motion of "touching bodies" in particular. Among the motion, those unconscious, habitual motion, which didn't reflect the meaning of the speech in particular but often appeared in the communication, belong to the non-meaning motion. After consulting the content of the speech, the conducted research on the meaning of hand motion and found out that the initial motion is made to express the content of the speech but the later motion have nothing to do with the speech and are just repeated motion similar to the previous motion, like the motion of "waving motion". Therefore, the later motion belongs to non-meaning motion too. It is worth mentioning that this kind of motion are in connection with upward, downward, left and right motion. These motions are divided into 12 patterns based on their expressions in anatomy. In order to find out the actual motion, the study adopted the measurement system to calculate the distances of the body motion during the speech through experiments, and compared the distances of hand motion produced by each body parts. And the study took advantage of image processing to obtain the tracks of hand motion, and decided to see the non-meaning motion through the tracks.

Keywords: Non-verbal, Human body motion, Communication, Speech, Non-meaning, Hand motion

1 Introduction

In human communication, information senders pass information to recipients by symbols like languages, text and images. And they accomplish the aim of communication by understanding and sharing the meanings of these symbols. It can assume that the symbols used in human communication include text or images, gestures and expressions. The symbols can be generally divided into the "verbal" form which transmits the content of communication through human voices or text and the "non-verbal" form which transmits the content of communication through diagrams or images, motion, gestures, expressions, eyes, pose etc. Languages such as English, Japanese and Korean take advantage of human voices and writing to restrain the nations of the same culture in describing things based on grammar. In addition, besides voices, languages also refer to sign languages expressed by hand, special writing like mathematic symbols, and the programming language used in computer technology such as the C programming language or the Java. The "non-verbal" form includes the diagrams or images describing the shapes and states of items, the body motion or gestures, expressions,

eyes and postures. In addition, the "non-verbal" form also includes the pitch of the voice, the speed or fluency of voice and the tone of voice. Among them, some are used to express meaning independently by actions of limbs and gestures, and, however, most are used to express meaning with "verbal". As for the meaning of "verbal", for example, the "Expressions of feelings" like happiness, sorrow, fear, the "expression of quantity" like their shape or amount and size, the "Instructions" of direction or position and the yes or no answer to questions, the human body motion as supplementary means can make the communication smoother. On the other hand, the physiological phenomena such as yawns, sneezes and coughs, or the individual habitual motion of human body such as folded arms, touch on hair and touch on the nose or mouth are very common in communication although they don't directly reflect the meaning of "verbal". Thus, we can see that the human body motion, which belong to the "non-verbal" form and are used with the "verbal" form, can be divided into the motion with meaning and the motion without meaning. The two types of motion play different roles in

human communication and are relatively important transmission elements [1].

The study focused on the study of hand motion among all human body motion during human communication. The study observed the human body motion during the speech and classified the motion of each body parts. The study focused on the frequently moving hands in particular, and grasped the meaning of hand motion by consulting the content of the speech so as to find out the motion having nothing to do with the content or non-meaning motion [2, 3]. In order to further find out the actual motion, the study adopted the measurement system to calculate the distances of body motion during the speech through experiments, and compared the distances of hand motion produced by each body parts. And the study took advantage of image processing to find out the tracks of hand motion, and decided to see the non-meaning motion through the tracks.

2 Related works

In the study, the model built by adopting digital data to form the shape and motion of human body in the image is called the virtual human. The virtual human body shown by computer graphics is widely used in TV programmers, entertainment, medical treatment and education. In order to show the motion which are coordinated with the actual situations, the research still continues. In showing human body motion, it is not difficult for computer graphics to show a motion with a designated meaning or to show the motion of the meaning exaggeratedly [4, 5, 6].However, it is relatively difficult for computer graphics to show a daily human motion without any meanings in real life. The reason lies in the animation technology. The animation technology adopts understandable motion or the special individuality that can identify the character to express the intention of the character. However, when people are talking, there will be not only the motion and character expressions that are understandable but also some daily motion with ambiguous intentions and meanings. It can assume that these motions are also necessary in showing human body motion by computer graphics.
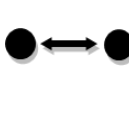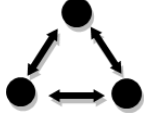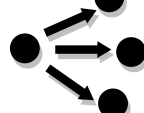
3 Observations of Human Body Motion during Communication

(1) Human Body Motion Classified Based on Communication Types

We imagine that the types of communication between humans should include the one-to-one bidirectional corresponding relationship between the information sender and the information recipient, the corresponding relationship within a group, and the one-to-many relationship such as more unidirectional speeches and lectures (Table1).

Table1. Type of communication

	Type1	Type2	Type3

Graphic			
Relation	one-to-one	bidirectional	one-to-many relationship
Conversation Relation	Conversation of two people	Conversation of mutual	Conversation only alone
Example	Talking, telephone, Chat	Conference members Symposium members	Presentation speakers Symposium presenter

The type 1 refers to the one-to-one bidirectional communication, such as the communication between only two persons by talking, telephone and Chat. This type is common in chats between close friends as well as in talk Broadcast program. The type 2 refers to the group communication, which can be seen in an occasion when people in a group of more than three persons exchange their views. This type is common in the places where multiple persons are talking with each other, such as meetings and symposiums. The type 3 refers to the one-to-many communication which is unidirectional. This type is common among the hosts of meetings or the speakers or lectures who speak alone in meetings and symposiums.

The three types are divided according to the number of participants of the communication, the relationship between persons and the role of speakers. The study observed and studied the relative human body motion during the communication.

(2) Observation Survey of Human Body Motion during the Speech

① Purpose of the Survey

The survey observes the human body motion during the speech and classifies these motion based on different human body parts.

② Subjects and Methods of the Survey

The subjects of the survey include persons starred in the eight programs which are "News", "Weather Forecast", "Sports News", "Symposium", "Wide Show", "Shopping TV", "Food TV" , "Variety Show", "Quiz Show" and "Talk Show", who are divided into the following. They were equally divided into groups for the survey according to the types of communications and their different postures (Table2).

Table2. Classification of a target with Pose and communication type

	Sitting	Standing
Type1	Talk Show- Emcee Talk Show- Guest	Food TV- Emcee Food TV- Guests
Type2	Sports News- Announcer Wide Show- Emcee	Variety Show - Guests Shopping TV - Guests

	Wide Show- Guests Quiz Show- Guests Symposium- Guests	
Type3	News- Announcer Symposium- Presenter	News- Reporter Weather Forecast- Emcee Weather Forecast- Reporter Sports News- Reporter Variety Show - Emcee Shopping TV-Emcee Quiz Show- Emcee

The method of the survey was to observe the human body motion of speakers in the videos of the 10programs and to record the motion based on different body parts.

③ Survey Result

The survey targeted the bidirectional, group-type and unidirectional subjects with standing and sitting postures, and observed their human body motion during the speech. However, the human body motion during speeches of different types didn't have any special parts and the posture of the body except the legs didn't have any special parts either. Therefore, it suggests dividing the motion based on communication types rather than the body parts (Table3).

Table3. Classification of Human Body Motions during the Speech

Body parts		Motion
Head	**Eyes**	Looking /Looking away.
	Eyebrows	Raising/ Knitting
	Neck	Tilting Waving(Weak) ● Shake up and down ● Shake from side to side
Upper Body	**Chest, Shoulders**	Lean body forward/back Waving(Weak) ● Shake up and down ● Shake from side to side
	Arm, Hands	Touching ● Touching bodies ,accessory ● Scratching bodies ● Rubbing bodies Waving(strong) ● Shake up and down ● Shake from side to side Crossing, Holding, Clenching
Lower Body	**Hip**	Swaying (Standing)
	Leg, Foot	Crossing (Standing, Sitting) Shaking (Sitting) Putting feet on chairs(Sitting)

The human body motion of speakers during their speeches included the motion of heads, hands, elbows and legs which

can be seen immediately, and the motion of eyes, shoulders, backs and hips which are not easily to be observed. The motion of crossing legs, shaking feet and putting feet on chairs when speakers are sitting and the motion of standing with crossed feet, standing on one foot and swaying hips when speakers are standing were all related to postures and couldn't be deemed as the motion related to the content of their speeches.

The study observed the motion of Upper Body especially the hand motion. The motion is divided into the common motion of "touching bodies" and the motion of "waving hands". The motion of "touching bodies" were often done by one hand, including the motion of touching (scratching, rubbing) the hair or the eye, nose, mouth and jaw. However, these motions are habitual motion so even speakers themselves couldn't realize these motions. The motion of "waving hands" one hand or both hands towards the right, left, up and down sides were common in explaining the detailed content of the speech and expressing feelings. Especially when both hands were moving, we could see that actually one hand had more motion but the other hand just had the motion of bending the wrist. Moreover, besides the hand motion, we could also see motion of shrinking back shoulders, bending down and stretching the back. We can assume that these motions are like the motion of lower limbs, which are for correcting postures. The survey observed various human body motions during the speech and classified the motion based on different body parts. The survey found that, among all human body motion during the speech, the hand motion was more than the motion of the other body parts. The motion of "waving hands" and the motion of "touching bodies" are especially common. Among them, the motion of "touching bodies" is habitual motion which is unconscious, non-meaning motion. On the other hand, the survey found that the common motion of "waving hands" is the motion related to the speech content and the expressions of feelings. Therefore, the study decided to record the speech content and conducted a detailed survey of this motion through the following survey.

(3) Observation Survey of Hand Motion during the Speech

① Purpose of the Survey

The survey to find the hand motion unrelated to the speech content.

② The subjects and method of the survey

The subjects of the survey were one female and nine males who are 30 to 60 years old and appear in the video with more persons chosen from the TV program videos obtained in the previous survey. The minimum time one motion when a guest to speak at the preliminary survey is the maximum time is 1.25 seconds was 2.1 seconds. This survey extracted 3 seconds of 100 video were reviewed by the relationship between speech and motion.
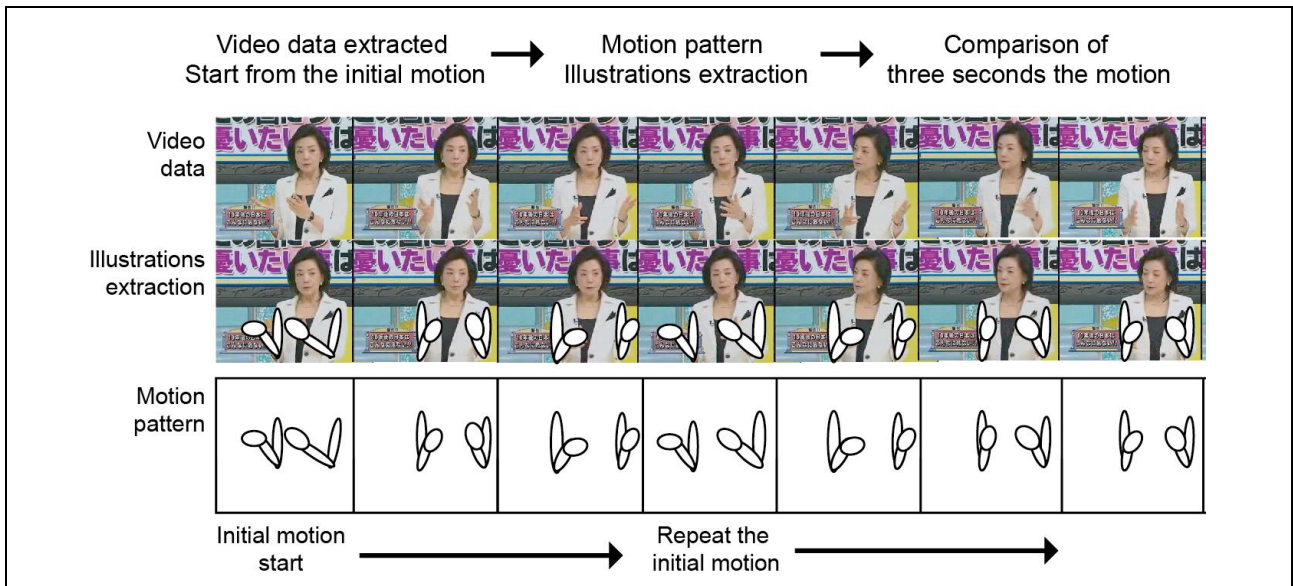
Figure1. The motion positions and compares the motions by using the video data

③ Survey Result

Through the exploration of the corresponding relationship between the speech content and the motion, we could see that the hand motion during the speech were to show "The movement of object", "The forms of object", "The indication of object" and "The space", "The size", "The direction" (Table4).

Table4. Speech content analysis result of 100 images

Speech content	Sample sentence	Result 1	Result 2
The movement of object	Fast, Slow, Run, Walk , Upward, Sideward, Rhythmic, Downward, etc.	21%	68%
The form of object	the shape of one´s~ be round in~	16%	74%
The indicate of object	This, That, Here, There The results are indicated~ Research indicates that~ etc.	18%	92%
The direction	Right , Left , Top, Under ~in the opposite direction ~in the direction of~ etc.	13%	94%
The space	There is lots of~ There is no place to~ There isn't much space~ etc.	11%	64%
The size	Larger, Small, Long, Short It is too big. etc.	19%	88%
Other	Onomatopoeia, mimetic word, Indefinite uncertain	2%	0%

* Result 1: Image proportion
* Result 2: Strengthen content proportion of each image

However, most of the hand motions were to supplement and strengthen the content rather than directly expressing the meaning of the content. Moreover, among the motion, the initial motions were often repeated many times. In other words, they are like the motion of "waving hands" towards the right,

left, up and down sides mentioned in the above survey. The relationship between this motion and the speech content was not found so they could be regarded as repeated similar motion just caused by the flow of language and the rhythm of voice. All the motion of "waving hands" in the 100 scenes could be seen even if we didn't hear the speech. Through the comparison of the speech content and the motion, it can be interpreted that the initial motion owed the intention but the later motion didn't directly relate to the speech content and intention (Figure1). The later motions were just repeated motion similar to the initial motion. Therefore, the later motion after the initial motion very likely belong to the non-meaning motion set out in the purpose of the study. Therefore, the motion of "waving hands", which are repeated similar motion, are simplified and put forward as a motion pattern. Moreover, considering that the motion of "waving hands" is in connection with motion directions, the motion patterns were explained based on their expressions in anatomy [7].

The survey observed the images. Differences may occur due to the camera angle in projection and body sizes. Therefore, in order to solve this problem, the survey created 3D standard models, put forward the pattern of non-meaning motion and explained the motion (Figure2, 3).
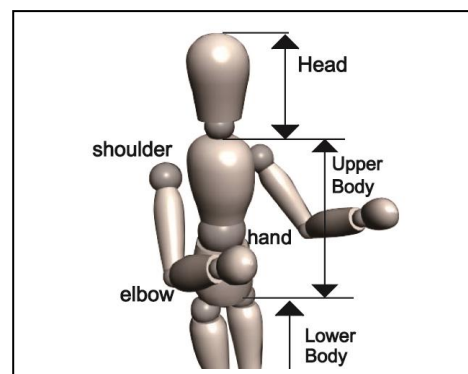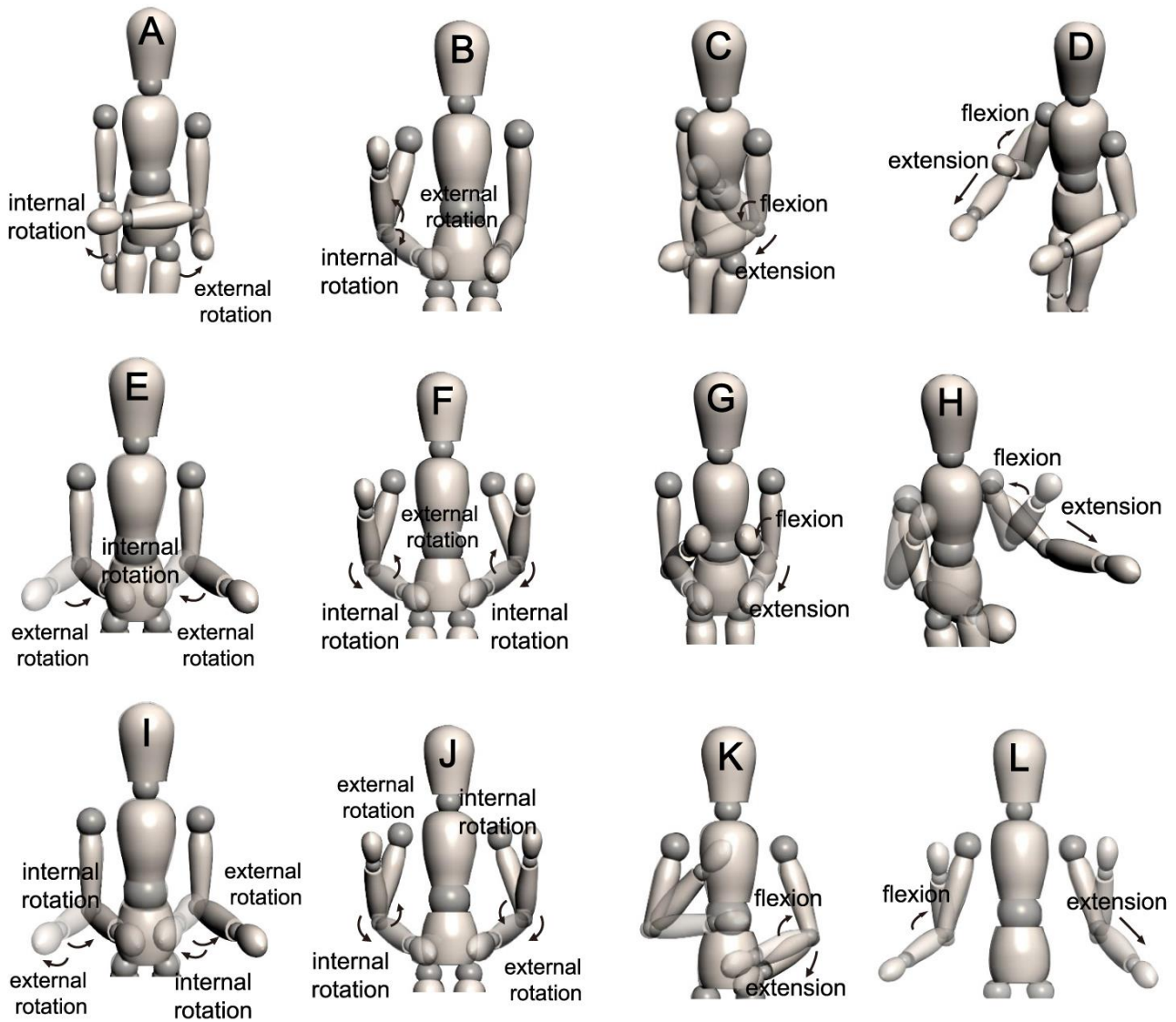

Figure2. 3D standard models

Figure3. The 12 patterns of meaningless motions and the commentary

A	One hand and Motion of internal rotation and external rotation(Left and Right)	**B**	One hand and Motion of internal rotation and external rotation (Top and Under)	**C**	One hand and Motion of flexion and extension (145° or less)	**D**	One hand and Motion of flexion and extension (90 ° or less)
E	Both hands and Motion of External rotation and external rotation, Internal rotation and internal rotation (Left and Right, Symmetrical)	**F**	Both hands and Motion of External rotation and external rotation, Internal rotation and internal rotation (Top and Under Symmetrical)	**G**	Both hands and Motion of flexion and extension (145° or less, Symmetrical)	**H**	One hand and Motion of flexion and extension(90 °or less, Symmetrical)
I	Both hands and Motion of Internal rotation and external rotation (Left and Right ,Opposite direction)	**J**	Both hands and Motion of Internal rotation and external rotation (Top and Under ,Opposite direction)	**K**	Both hands and Motion of flexion and extension (145° or less, Opposite direction)	**L**	Both hands and Motion of flexion and extension (90° or less, Opposite direction)

The 12 patterns of non-meaning motion can generally be divided into the four single-hand patterns from A to D and the 8double-hand patterns from E to L. Moreover, according to the bending angle of elbow, the outward and inward rotatory

angles ranging from 0-90°, the bending angles ranging from 0-145°and the stretching angles ranging from 0-5°were all added in the scope of normal activities. Meanwhile, according to motion directions, the classification of motion based on

symmetric relations was put forward such as bilateral symmetry and longitudinal symmetry.

(4) Survey

The two observation surveys could find the motion of their body parts while speakers are talking and classify the motion. Meanwhile, among the common hand motion, the unconscious habitual motion of "touching bodies" have nothing to do with the speech content but are repeated similar motion just caused by the flow of language and the rhythm of voice. Therefore, the present writer believes that the repeated similar motions are non-meaning hand motion during the speech. However, the motion in the survey was obtained by observing videos so it is relatively difficult to measure correct hand motion. Therefore, the measurement system was used to find the quantitative data of actual hand motion and the experiment was carried out.

4 Analysis of Human Body Motion during the Speech

Through the experiment, the study uses the measurement system to calculate the distances of body motion during the speech, and compares the distances of hand motion produced by each body part. In addition, the image processing is used to find out the motion tracks and the tracks are analyzed.

(1) The Subjects and Method of the Experiment

The subjects of the experiment are five male college students in their 20s.

The experiment method: when two people were having a conversation, one person (the subject) knew nothing about the experiment and acted naturally and the other person (the experimenter) was limited to fewest activities and made the subject listen to him as much as possible.
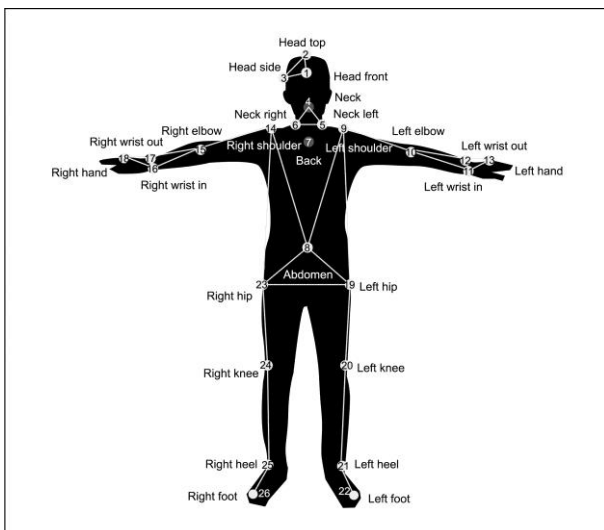

Figure4. The name of the marker attached to the body

26 markers were attached to the body of the subject with his chest as the center, 3 markers on his head and neck respectively, 1 marker on his back and belly respectively, 5

markers on his right and left wrists respectively and 4 markers on his right and left feet respectively (Figure4). When the two persons were talking, the distance between them was within 2 meters and their talk lasted for 5 minutes. Within the 5-minute talk, the data of one minute when the human body motion occurred frequently were analyzed. The the content of the conversation includes the questions related to the subject raised by the experimenter and the subject's words related to the questions.

(2) The Measurement System of Hand Motion

The used "Motion Analysis Corporation Raptor-cameras" for measuring the motion of the hand. In order to measure human body motion correctly, 14 cameras were put around the subject to get the data at 120 frames per second. The data was edited by Cortex2.0 software (Figure5).
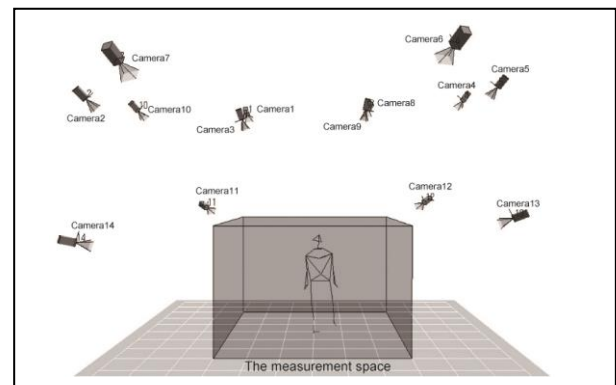

Figure5. Motion Capture System with 14 cameras in the measurement space

(3) Analysis of Tracks of Human Body Motion

In order to realize the quantification of data of human body motion, the motion tracks of the markers on the body were analyzed. Calculate the 3 vector displacement displacement difference of each frame and marker, and find the distances of the motion tracks of the markers through accumulative data.

$$\text{Trajector} = \sum_i \sqrt{(x_{ij} - x_{i(i-1)})^2 + (y_{ij} - y_{i(i-1)})^2 + (z_{ij} - z_{i(i-1)})^2}$$

i : marker name
j : frame number

(4) Analysis Result

The motion distance of each body part of the five subjects is shown by the graph (Table5). As for the human body motion of the five persons during the one minute speech, the study calculated the distances of motion tracks of different body parts. The results showed that the motion distances of their elbows, wrists and hands were greater than the motion distances of the other body parts. The motion distance of the left hand was greater than that of the right hand. The motion distances of the wrist and palm were especially greater. The value of the elbow was slightly greater than the other parts. However, the value of the shoulder was basically similar to that of the other parts. The motion track images and motion distances of the hand motion of the subjects were presented

here (Figure6).

Table5. Motion distance of each body part of five subjects the graph
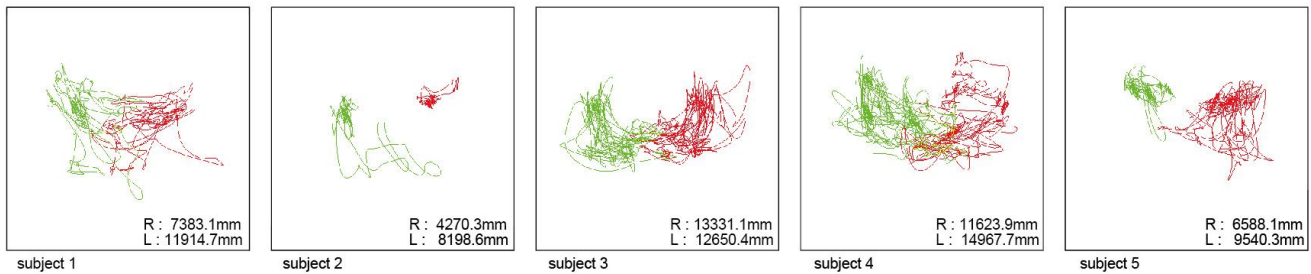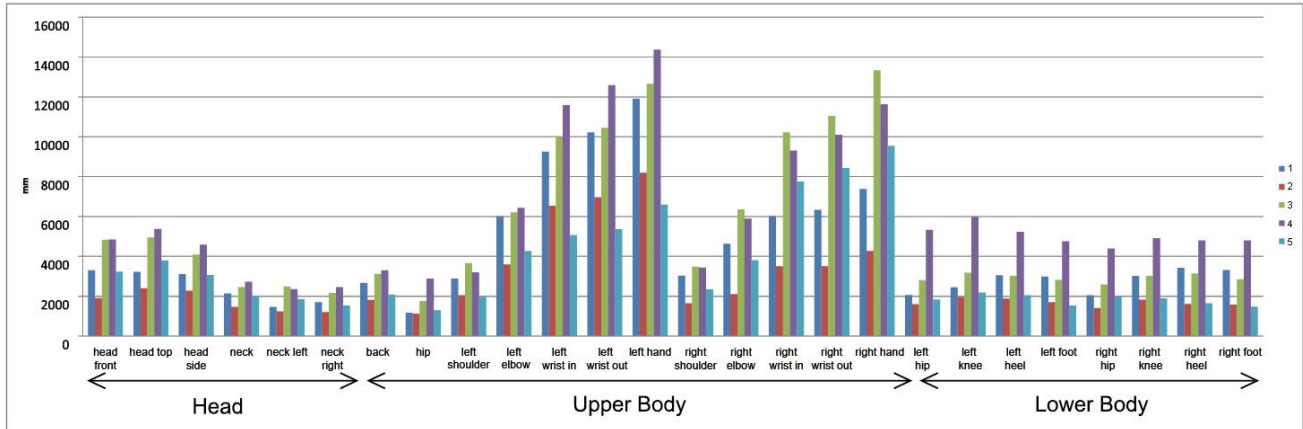
Camera : Top Veiw
Right Hand : Red Color, Left Hand : Green Color

Figure6. The motion track images and motion distances of the hand motion of the five subjects
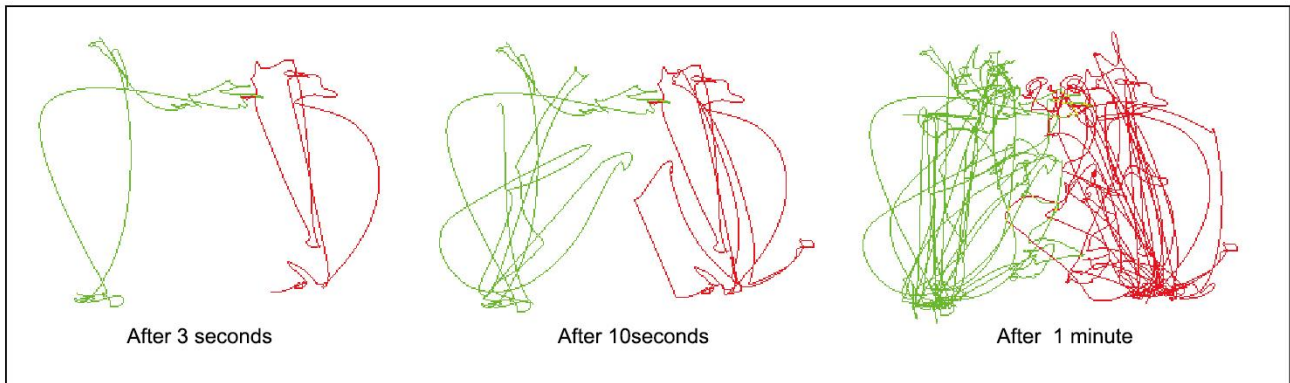

Figure7. The time series data of hand motion tracks

Observed the five images of the hand motion tracks within one minute; and the images subject1, 3 and 4 represented the symmetric composition of both hands. The images subject3 and 4 were great in motion distance and the composition of tracks was also bilateral symmetry. On the other hand, the angle of elbow is above 90° in the image subject2 with more motion in y-axis and there are also habitual motion of touching the face. The image subject5 mainly presented the motion of a single hand (Figure7). The time series data of hand motion tracks were found here. In order to grasp non-meaning motion during the survey, the study compared the speech from the initial track of hand motion to the hand motion track of one minute later with the image. The content of the initial speech was the "description of the bow shape"; and 10 seconds later, the content was about the "method of using the bow". One minute later, the content was different from the initial content and was the "topic between friends". According to the image and the speech content, we can see that, one minute later, the initial hand motion track was repeated several times. Therefore, compared to the motion related to the speech content, the motion were non-meaning and definitely belonged to the repeated, similar, non-meaning

motion.

4 Conclusions

The study focused on the hand motion of the human body motion during people's verbal conversation. And the purpose was to find the motion without any intended meaning.

Firstly, the study observed the human body motion during verbal communication. The study surveyed the human body motion and hand motion during the speech. The survey 1 classified the human body motion during the speech based on different body parts and described the motion: some motion are obvious, like the motion of heads, hands, elbows and feet; and some motion were not easily to be observed, like motion of eyes, shoulders, backs and hips. As for the common hand motion in classification, the present writer believed that the motion of "touching bodies" are unconscious habitual motion and are also non-meaning motion even though the motion are made during the speech. The survey 2 studied the hand motion which is common in human body motion during the speech. As for the hand motion during the speech, in order to explore their intentions, the study recorded the speech content and compared the hand motion based on the content. The result has shown that most of the hand motion during the speech was to supplement and strengthen the content rather than directly expressing the meaning of the content. And most of the strengthened and supplemented motion was the initial motion during the speech. The later motion was just the repeated initial motion and was a non-meaning motion. The repeated motion was very similar to the motion of "waving hands" which were common in the survey of observing the human body motion during the speech. Considering that the motion are in connection with upward, downward, left and right motion, the present writer simplified and classified the motion, analyzed the motion and put forward 12 patterns of non-meaning motion based on their expressions in anatomy. Finally, in order to find the actual motion, the study found the motion distance of each body part through experiments and compared the motion distances. The study conducted the image processing, found the motion track images of time series, and confirmed that they are non-meaning motion by comparing them with the speech content. The present writer believes that the non-meaning hand motion is very common in people's daily conversations, and is very important as symbols in transmitting information. Therefore, while showing the virtual human body motion by computer graphics, we need to use these non-meaning motions during actual human conversations as an important transmission factor.

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