Gesture-based Interaction: Concept Map and Application Scenarios

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Abstract—Nowadays the new interaction forms proposed tend not to be limited by graphic interfaces and make human computer interaction . Nowadays, Human-Computer Interaction (HCI) is not limited by Graphical User Interfaces (GUIs). There is a tendency to make it more natural and human. This paper presents a novel interaction approach within the scope of gesture-based interfaces, and some practical consequences of adopting this approach. Thus, we redefine the concept of gesture based on the sum of three interrelated concepts (the Para-language, the Body language and the Sound language). The relationships among these concepts are expressed in a conceptual map through parameterized links. Finally the article shows how the combination of the link parameters yields to the definition of a specific application scenario. The result of the identification of these scenarios opens new horizons towards the identification of new ways of gesture-based interaction.

Keywords—Human-computer interaction; gesture-based interfaces; User information access information.

I. INTRODUCTION

Interactive systems are undergoing deep changes as consequence of today's technological development. Up to recently, every effort was focused on developing Graphic User Interfaces (GUIs) where the User Centered Design (UCD) criteria was predominant. However, the concept of interface has gone beyond the limits set by GUIs, making its way to the so-called Human User Interfaces (HUIs) [1].

The high complexity of the technologies currently used in the field of Human-Computer Interaction (HCI) may be attributed to the dramatic changes, which have newly defined our relationship with technology. These changes have encouraged us in the search to identify new application scenarios, with user gesture sensitive devices.

This article provides some conceptual tools to understand the high complexity of the interaction in current systems. More specifically, we propose the widening of the *gesture* concept as the sum of three other concepts (non-verbal

communication types): *Para-language*, *Body language* and *Sound language*.

The proposal itself embraces the form to systematize a multiplicity of possible scenarios basing on concept structure -using concept maps- that define the gesture (non-verbal voluntary communication), for subsequent parameterization of these elements (using tables of parameters) in a method of extension of the basic information presented and the user information, contextualized in the said scenarios.

The rest of the paper is structured as follows: Section II presents some related works showing different approaches to interaction in gesture-based applications. Section III describes our study on the concept of gesture-based interaction and its representation in a concept map and in parameter tables. Section IV presents the result of the concept parameter combination included in the concept map. It also shows, using examples, how to identify new scenarios and new interaction forms. Finally, conclusions are presented, also explaining future works being currently undertaking.

II. RELATED WORK

Saffer [2] states that a gesture is any physical movement, which a digital system can detect and be replied to, with no assistance from a traditional leading device. A sound, nodding one's head or even winking may be considered gestures. Thus, one of the current problems in context-aware applications is gesture recognition. If we manage to use the user intervention by means of his/her Body and Sound language, we will have the possibility to create new interfaces the user can interact with in a natural and human form with the physical environment; that is, our purpose to make the environment interact (be restructured) depending on the user will be fulfilled. In this sense, we should also mention the works performed by Moggridge [3], Tidwell [4] and Norman [5] [6].

The research on creativity and innovation on HCI is also exposed in Shneiderman's works [7] [8] [9]. In the field of tangible interfaces we highlight the work of Ishii [10].

In [11], Sellen et al. write on the end of the stability of interfaces, meaning that computers cannot be defined any more with reference only to a single interface, but rather to different interfaces or even to no interface at all.

Following this approach, which intends to dispense with the user interface, there are some examples of novel interaction that may well illustrate the relevance of the proposal presented in this paper.

In the design and usability Blog MakeMeMinimal, the 3D graffiti is presented as the innovative usability prototype [12]. 3D graffiti is based on gesture interaction for graffiti creation in 3D whose canvas is Augmented Reality. Another example is the commercial product Panasonic's Interactive TV Wall [13], which uses gesture interaction based on the user movements facing the screen/wall. An interesting example of interaction based on tactile gestures by means of the printing and its duration is the multi-touch screen Crazy Multi-Input Touch Screen [14].

III. STUDY OF THE CONCEPT OF GESTURE-BASED INTERACTION: A CONCEPT MAP

Flusser [15] states that "gestures are body movements, which express an intention". In this section, the gesture concept will be extended, describing also our proposal of gesture-based interaction. Non-verbal communication is communication performed using cues and signals with no syntactic structure. There are three different types: Para-language, Body language and Sound language. Through the addition of these three new concepts, the concept of gesture can be extended.

- The Para-language refers to the elements, which accompany linguistic emissions and constitute non-verbal clues and signs, which contextualize or suggest different interpretations of the linguistic information. It is characterized by voice intensity or loudness, speed of emission of the statements, pitch (and intonation variants and syllable duration) and finally, crying, laughter, rhythm, fluency, control of respiratory and articulatory organs, etc.
- The Body language is understood as the type of language developed using gestures but with the particular distinctive characteristic of using the body (trunk), the extremities and the head to be developed; on these grounds, there would be different parameterized concepts, which are:
 - Orientation based on body pose, that is, at the moment in which body, face and extremities interact in an unidirectional or multi-directional manner.
 - The Proximity refers to whether gesture interaction must be performed parameterized in relation to closeness, distance or indetermination.

- The Pose or Form depends on its pose or form, with motion or without it.
- The Speed defines whether interaction is performed rapidly or slowly.
- The Expression is the body pose expression of the user during the intervention; there could be an infinite number of expressions, but we have parameterized them in: Complicity, Honest, Clear, Doubt, Happy, Sickly, Rational, Intimate, Relaxed, Social, Lunatic, Calm.
- The Sound language can be defined as the type of language developed using gestures but with the particular feature of using sounds as well. Its characteristics are: volume, Pitch and Speed. The concepts conforming Sound language are:
 - The Emotional element would be the equivalent to the expression in Body language, depending on our sound intervention at the moment. Thus, the interaction may vary depending on the following elements: complicity, honesty, sound cleanness, doubt, joy nuances, sickly nuances, rationality, intimacy, calmness, social, lunatic, relaxed nuances, etc.
 - The Context sound is referred as the sound context of the context of our sound interaction: the way it will be, whether just a single sound or along with by more sounds.
 - The Internal sound is parameterized in relation to the sound elements, which can be a melody, music, some noise and in general anything that could be a sound and at the same time silence.
 - The External sound It is parameterized in the same way as the Internal concept.

To be able to express the widening of the Gesture concept, we have elaborated a concept map. From this map, we have derived a concept tree that defines a descriptive model showing the ramifications and relations among concepts. As consequence, we can observe that there are no concepts, situations, parameters or contexts, defined individually or not related to the rest. The concept map proposed for gestures is shown in Figure 1.

Let us now move down our level of abstraction and pass from a conceptual level to specific cases starting from the combination of the parameters studied at that conceptual level. For that purpose we are going to show the concepts included in the map in three tables, which will help us analyze all possible combinations.

In this paper, we will focus on the parameterization of the concepts that form Body Language and Sound language. Table I shows in detail Body language parameters on innate or natural gestures, which are put before Body language on acquired or learnt gestures; the table includes the concepts - which have been previously explained- constituting Body

Figure 1. Concept map

language: Orientation, Proximity, Pose/form, Speed and Expression, taking into account the possible values implied by those concepts and the part of the body used in each case.

Table II shows the parameters of Body language concerning acquired or learnt gestures and presents the same structure as Table I previously explained.

Finally, Table III presents the parameters of Sound language concerning natural gestures. This table logically presents a different structure from the previous tables; thus, it can be observed that Sound language is composed of the concepts: Emotional, Context, Internal and External.

IV. IDENTIFICATION OF APPLICATION SCENARIOS

Let us show now how a huge number of application scenarios can be obtained in a systematic form with gesture interventions using different combinations of the parameters shown in the tables of Body language and Sound language. With this systematic generation of scenarios, we can obtain unusual scenarios, which otherwise would be complicated to imagine. These scenarios, in turn, will allow the identification of existing ways of interaction as well as many new forms.

In order to perform the mentioned combination to expand parameters, we need to create a table containing Body language and Sound language parameters in the columns. By changing one or more parameters in each row, a specific scenario can be obtained

A. Quantification of map parameters

Before performing the mentioned combination expansion we need to state clearly and quantify the possible values for each parameter.

In this subsection the possible values of the parameters of the tables of Body language and Sound language separately. We will need to establish whether the parameters of each category are mutually exclusive and the range or set of values that can be used.

The parameters from the original tables to be combined are described in Figure IV.

As shown in Table IV, the concept of Body language is composed of seven parameters: orientation, proximity, pose or form, speed, expression, gesture type and place. Let us now examine the possible values for each parameter listed:

Table I
BODY LANGUAGE OF NATURAL GESTURES

Gesture. Non-verbal communication				
Body language				
Innate / Natural				
Interventions		Body	Extremities	Head and neck
Orientation	Multi-directional	Move-hips	Move arms	Move your neck
	Uni-directional	Turning back	Bend your knees up	Open your mouth
Proximity	Close	Getting closer	Touch the screen	Tilt head
	Un-determined	Intermediate distance	Separated	Move neck
	Far	Distant	Close (at your sides)	Put head backwards
Pose/Form	Stopped	Standing	Frontal feet	Fixed look
	Movement	Jump on your way	Move wrists	Nod
Speed	Fast	Running	Move fingers	Deny
	Slow	Walk	Move your elbow	Wink
Expression	Complicity	Move your body closer	Crossing fingers	Nod
	Honest	Straighten body	Hands out	Look directly
	Clear	Straighten body	Arms open	Open look
	Doubt	Turn, leave, come back	Move shoulders	Doubtful look
	Happy	Cry from happiness	Walk dancing	Smile
	Sickly	Hunched back	Hunched shoulders	Look down
	Rational	Bend over body	Walk upright	Touch your chin
	Intimate	Dancing	Play with your hands	Stern look
	Lunatic	Body in tension	Stiff arms	Startled look
	Calm	Sitting slowly	Relaxed hands	Relaxed look
	Social	Sitting on the floor	Hands out	Look forward
	Relaxed	Making slow movements	Move hands slowly	Move neck slowly

- Orientation: multi-directional and unidirectional. These are exclusive values.
- Proximity: close, intermediate and far. These are exclusive values.
- Pose/form: stopped and movement. These are not exclusive values. For instance, someone may be stopped without displacing, but changing the position of an extremity.
- Speed: fast and slow. These are exclusive values.
- Expression: complicity, frank, clear, happy, rational,

Table II
BODY LANGUAGE OF ACQUIRED GESTURES

Gesture. Non-verbal communication				
Body language				
Acquired / Learnt				
Interventions		Body	Extremities	Head
Orientation	Multi-directional	Greet several people	Shake hands	Turn your head
	Uni-directional	Reverence	Point	Fixed look denoting interest
Proximity	Close	Bother	hugging	Cover your mouth when yawning
	Un-determined	Move closer to greet someone	Raise your hand to greet someone	Scratch your head
	Far	Say good bye	Say bye with your arm	Raise your head in greeting, from a distance
Pose/Form	Stopped	Sitting down	Cross hands	Leaning your head on the wall
	Movement	Getting closer/away	Move toes	Move eyebrows
Speed	Fast	Swing hips	Wave with your hand	Shaking the head
	Slow	Move your back slowly	Laying down	Move cheeks
Expression	Complicity	Hug	Crossing fingers	Winking
	Honest	Straighten body	Hands out	Look forward
	Clear	Have a relaxed attitude	Relaxed arms/shoulders	Look directly
	Doubt	Shrug your body	Shrug your shoulders	Raise your eyebrows and stern look
	Happy	Jumping	Raise arms	Open your mouth
	Sickly	Shrugged body	Shoulders down	Sad look
	Rational	Body upright	Stretched arms	Head up
	Intimate	Laying down	Touch your hair	Suggestive look
	Lunatic	Stiff body	Move shoulders fast/stiff arms	Eyes wide open
	Relaxed	Sit down slowly	Hands in your pocket	Relaxed look
	Social	Body sitting down	Crouching down	Nice look and smile
	Calm	Relaxed body	Relaxed arms/shoulders	Relaxed look

lunatic, doubtful, sickly, intimate, relaxed, calm and social. These values are not exclusive.

Table III
SOUND LANGUAGE OF NATURAL & ACQUIRED GESTURES

Gesture. Non-verbal communication			
Sound language			
Innate / Natural			
Acquired / Learnt			
Interventions		Personal	Environment
Emotional	Complicity	Whistle some-one	greetings
	Frank	Assent/Nod	Assent/Nod
	Clear	Assent	Assent/Nod
	Doubt	Make noises with your mouth closed	Clear your throat
	Happy	Guffaws/laugh	Laughter
	Sickly	Puff/snort slowly	Complain
	Rational	Assent/Nod	Nod/ Assent with a mouth sound
	Intimate	Whisper	Whisper
	Lunatic	Shout	Scream
	Relaxed	Make soft sounds	Make soft sounds
Context	Social	Make a hubbub	Make a hubbub
	Calm	Sigh	Sigh
Internal	Alone	Whistle	Environment sounds
	Accompanied	Whistle	Blow
External	Silence	Hiss	Hiss
	Sound	Clap	Cheer
	Silence	Hiss	Hiss
	Sound	Clap	Cheer

Table IV
PARAMETERS OF BODY AND SOUND LANGUAGE

Body language						
Orientation	Proximity	Pose/Form	Speed	Expression	Type	Place

Sound language					
Emotional	Context	Internal	External	Type	Scope

- Type: acquired/learnt and natural. These are exclusive values.
- Place: body, extremities and face. These values are exclusive.

As illustrated in Table IV, the concept of Sound language is composed of six parameters: emotional, context, internal, external, gesture type and scope. The possible values for each parameter listed and whether they are mutually exclusive or not:

- Emotional: complicity, frank, clear, happy, lunatic, rational, doubtful, sickly, intimate, relaxed, calm and social. These values are not exclusive.

Table V
COMBINATION OF BODY LANGUAGE PARAMETERS

Scenarios	Body language						
	Orien-tation	Proxi-mity	Pose / Form	Speed	Expre-ssion	Type	Place
S1	Multidi-rectional	Close	Stopped	Fast	Calm, Rational	Acquired	Extre-mities
S2	Multidi-rectional	Inter-mediate	Stopped	Slow	Calm, Rational	Natural	Face
S3	Multidi-rectional	Far	Move-ment	Fast	Calm, Rational	Natural	Body

- Context: alone or accompanied. These values are exclusive.
- Internal: silence and sound. These are exclusive values.
- External silence and sound. These values are exclusive.
- Type: acquired/learnt and natural. These values are exclusive.
- Scope: personal and environment. These values are exclusive.

B. Combination of the parameters of the table to specify interaction scenarios

In order to simplify the table and make it easier to read, the parameters of one of the tables will be fixed and the parameters of the second table will be permuted, repeating this process twice to be able to attain permutation of the parameters of both tables. To be brief, we will only present an example of the first interaction, generating just three representative scenarios focusing in the case of an art museum.

To start with this process, the parameters of the table on Sound language will be fixed and only the parameters of the table on Body language shall be permuted.

The values fixed from the table of Sound language are: Emotional: calm, rational / Context: alone / Internal: sound / External: silence / Type: acquired / Scope: environment.

By fixing these parameters we are filtering a great amount of possible scenarios. Through them we specify that the sound will cause certain sensations of calm and rationality and that there will only be a single sound source. There is some sound inside the building where the interaction is being performed and no external sound can be perceived. Besides, the sound comes from the environment.

Once the parameters of the table of Sound language are fixed, the parameters of the table of Body language are permuted to obtain three of the most prominent scenarios. The result of such parameter combination is shown in Table V.

- Scenario S1: A high school student named Luis has decided to visit an art museum on Friday afternoon to broaden the content of his second History examination on the life of Velazquez. Luis is standing facing the work "Las Meninas" and his interest is to obtain

information on the painting. The interaction form will be using fast gestures with his extremities, he has learnt these gestures from an audio-guide located next to the entrance of the museum. Luis' expression is calm and rational.

- Scenario S2: Laura, a History teacher, visits the art museum to see the new facilities after a reform in the museum. She is located at a certain distance from the works. Her interest lies on obtaining information on the new works added. Laura's interaction form with the works will be using slow and natural face gesture, which shall not imply any effort for her. Laura has a calm and rational expression.
- Scenario S3: Once Luis has finished gathering the information he needed on the work "Las Meninas", he decides to search for more works by Velazquez. Luis is walking quite far from the works. His interest is to find works by this painter. The interaction form to search for more works will be using fast and natural body gestures, which will not imply any effort. Luis' expression remains calm and rational.

V. CONCLUSION AND FUTURE WORK

This paper can be used as a definition of meaning of gesture, both at theoretical and practical level (exemplification of multiple scenarios with the permutation of its different parameters). These interconnections generate dynamic meeting spaces with multiple implications in the field of technology (new metaphors and new forms of interaction, which imply new devices and their interrelationships).

The entire process described has been illustrated using a set of specific scenarios starting from the scenario of the Art Museum, but this technology could be tested in many other environments.

In the same way - using the concepts, tools and techniques described in this paper - it is possible to consider the challenge of defining new interaction forms based on gestures, as well as describing interaction metaphors, which enrich the intuitive comprehension of those new forms of interaction.

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