

# Dancing Skin: An Interactive Device for Motion

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**Abstract.** Dynamic skin with its complex and dynamic characteristics provides valuable interaction device for different context. The main cause is the motion design and its corresponded structure/material. Starting with an understanding of skin/thus dynamic skin, we move to motion samples for case studies for unleashing the design process of motion in dynamic skin. The problem is to find a pattern of motion in dynamic skin. How to penetrate architectonic to cause the cortex to produce motion and we penetrates various types of street dance movement for motion design. This systemic skin construction can be a reference for building basic structure of folding form type skin and joint, developing motion which it needs, also provides dancer an interface that can interchange with other far-ended dancer through the Internet, regarding as a new manifestation and perform way for the street dance and its dancers.

**Keywords:** Dynamic skin, Motion, Folding form type, Street dance.

## 1 Introduction

Dynamic skin with its complex characteristics provides valuable interaction device for diverse context. However, most of dynamic skin designs, while pioneering the movable and interaction design are making specific cases either in interaction or architectural design. The main cause is the motion and its corresponded structure with material.

### 1.1 Dynamic Skin: From an Architecture Component to a Movable Interface

Originally, skin in architecture is a partition or façade that will reflect and protect habitants and their activities behind the skin. With movable technology such as robotic researches, a physical object has an ability to move and change its own shape according the material and surrounding contextual information. This creates a possibility for allowing the skin not only be partition but also a movable object [1]. Thus, a new type of skin with motion is developed called *dynamic skin*.

The maturity of sensor technology made that the surroundings can sense what people act that create an interacting behavior between people and their environment. It improves people's daily live and made it more convenient. With sensor technology, the dynamic skin has the capability to not just move but also react to the habitant around it[2]. This creates a new interaction within space.

## 1.2 Dynamic Skin Design Process

The concept of dynamic skin is simple but its design process is tedious and complex. Firstly the motion of a desirable dynamic skin needs to be defined and sometime preset. Then we use specific forms of dynamical skin just to show different design and its corresponded motion. Basically, there are two types of form of dynamical skin: unit cell organization and folding form, which will be introduced in some details in next section. After the type of form is determined, structure design then begins. Consequently, we had to test material and select specific Actuator and supported information to skin to create motion of skin. An ideal interactive skin should be combined with units as follows: 1) action joints and structure units, 2) sensor, and 3) actuator.

## 1.3 Motion in Dynamic Skin Design

With the characteristics of dynamic skin, motion is the essential part of dynamic skin design. Most of cases we found design their special motion based on the objectives of skins. According to the two types of skin forms, the design of structure of unit cell organization and folding form were very different. The motions of unit cell organization were more simply, they were not making influence from each other, and copy large number units to be a skin. The motions of folding form should design the structure connecting to each other, these structures influenced each other by action, and they could show variety of motion by just one structure. However, how to make a folding form structure that has variety motion the motivation of this research. In addition, finding a good example of motion will provide enough information for us to understand the motion of dynamic skin.

## 1.4 Street Dance as a Motion Paradigm for Exploring the Dynamic Skin Design

For finding possible motion example, street dance with its strong and direct movement is selected as our example of study. Street Dance is one of the most important dancing activities of teenager; it originated from Brooklyn in USA early 90s. The residents danced free on street, show their attitude of live by dancing. Dancers show every kind of dance poses by extremities and show the wave and variety motion of street dance. The motions of extremities of dancer were cooperated with every joint of human body, just like folding form skin that should use structure to make skin motion and do different motion again.

## 2 The Problem and How We Approach

From motion, we need to design out the appropriate construction. Most of cases are specific tailor-made structure with corresponded motion design. The problem of this research is to find a pattern of motion in dynamic skin design. Will there be patterns and how these motions affect the design outcome of dynamic skin and what are the design process focusing on the motion movement of dynamic skin?

Based on folding form type, a system called *Dancing Skin* is implemented with six steps: (1) interviewing the street dance dancer in advance, (2) analyzing dancer's

extremities and basic street dance movement, (3) designing folding form style of skin as the cortex construction, (4) giving correspondence between cortex's joint and dancer's extremities, and (5) formulating rules on corresponding also (6) putting this system in action, using Computer vision, Hear beat sensor, Distance Measuring sensor to detects dancer's movement, heartbeat, body position, and use it as input data for the system.

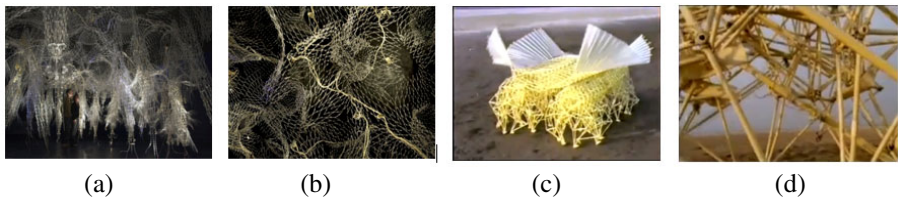
Dancing Skin provides the dancer to interflow with the wall by oneself, and obtains dance inspiration. It can also make interchange with the far-end dancer through the Internet, to produce more dance inspirations and cortex's motion.

### 3 Analysis

In folding form type, how to penetrate architectonic to cause the cortex to produce motion, even the whole structure to change, not only just simplex motion. In order to understand how to design the skin of folding form mode, let the skin have multiple motions, and penetrates various types of street dance movement as the research for motion design. To reach the goal above, we carry on to the following analyses and correspondences.

#### 3.1 Motion in Dynamic Skin Structure Design

In this part we will discuss references of motion in folding form skin mode also look for the important factor in motion. The Fig. 1 (a)(b) is the Hylozoic Soil [3] designed by Philip Beesley in 2007, the architectonic was reticulate interconnected transparent joint as Fig. 1(a), using the electric capacity sensor and the shape memory alloy driver, and causing the structure to perform periodically like feather as Fig. 1(b). The Fig. 1 (c)(d) [4] is the Beach animal by Theo Jansen, using lumber framework also making massive joints, start motion by wind power to let the installments walk on the beach as Fig 1(d). From the cases above, we found that the ideal structural design of folding form skin utilizes joints as link; the interaction of joints can produce chain-reacted motion.



**Fig. 1.** The Hylozoic Soil (a), (b). The Beach animals (c), (d).

#### 3.2 Street Dance Motion Gestures and Corresponded Motion Feedbacks

The analysis on the gestures of street dance motion is conducted via interviewing seven dancers with 2-7 years of dancing experience. The interview is conducted in face-to-face for collecting data in the later analysis. The gestures of each dancer are also recorded and interviews are based on exploring the gesture movement.

Based on the data collected, we divided the dancer's body into four parts of discussions and analysis: (a) Chest: The basic body part utilization for street dancer, chest movement makes the body to have height fluctuation, for dancer to display the rhythm, chest movement can be break down into four main movements: up, down, circle left, circle right. (b) Bottom: Link of main body part, upper and lower limbs, many movements must match with bottom in order to be smoother, these movements can be divided into: forward, backward, left, and right. (c) Hand: Hand movements increase visions of the dance, which divided into: Stretch out, retract, and wave. (d) Foot: The most nimble body part in dancing, the footstep movement can increase bounce and sprite in street dancing that divides into: slides, lifts, kicks, treads, cross, opens and closes five parts.

### 3.3 Chain-Reacted Motion with Interactive Behaviors

In the mode of folding form skin, motion is produced by continual influence, like the transmission of wave, starting from the front and passing on the back end, the reaction between dancer and skin shown in Fig. 2, so when the dancer is dancing, one's body uses the same way to achieve movements. The analysis of interactive behaviors is collected based on two conditions: single dance and battle-of-dance.



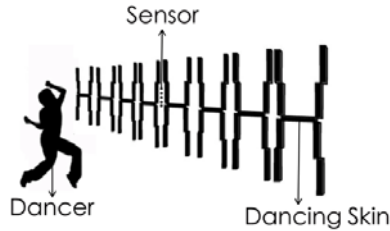
Fig. 2. The dancer and dancing skin

The consequential motion is analyzed from the interviews of above in addition to the information available on the web for the group or battle-of-dance. For example, a series of reaction on a single dancer is based on the gesture or action that dancer acts, such that the dancer made a wave movement starting from chest pass down to the bottom; the skin may also achieve such motion through the joints and reach the same kind of motion. The system is designed base on interaction between using dancer's continuous body movement for the skin to produce the same motion.

## 4 Implementing Dancing Skin

Dancing Skin is the prototype implemented for testifying the working concept and gathering the process information desired for studies. We used human joints and street dance extremity to design a skin that can dance, made skin approach variety motion mode. The Fig. 3 is the system interface diagram shows the concept of interaction

between dancer and skin. We linked wall and wall through Peer-to-Peer, so that dancers at different places can communicate with others via skin and provide more motion onto the skin.



**Fig. 3.** Dancing Skin interface diagram

#### 4.1 System Design

Dancing Skin is comprised of (a) Input: Gathering data detected by optical sensor, heartbeat sensor, Distance Measuring sensor for classification and rule base; (b) Operation processing: After processing sensors classification, and comparing with functions, produces motion information from skin in advance; (c) Output: After obtaining the information, using the skin controller to pass on to the act actuation motor, enables the cortex to achieve motion. (Fig. 3)

When dancer starts dancing, the input sensors to detect the dancer's body, dividing into optical sensors, heartbeat sensor, distance measuring sensor1, distance sensor2, distance sensor3, the optical sensor will take the detected images using Classification to the processing unit finding the corresponding movement information, and start comparing to the numeric detected by other sensor. When other sensor detected information from second heartbeat sensor, the dancer's palpitation will affect the motor in area A of the skin, the louder the heartbeat, the bigger angle the motor transfer, and more obvious cortex motion to become. After receiving data from the heartbeat sensor, it will continue to match the next faction that is, using distance measuring sensor1to detect dancer's hand position, however, when sensor can not detected any hand information, it will skip to the next faction until all the factions have done matching and pass on the information above to the skin controller in output unit, then separate into different act, driving each part of the motor according to different sensor value, changing the motor's running angle, for skin to start motion.

#### 4.2 Components

The skin is on the basic of H shapes and constructed by eight H (Fig. 4). The H shapes construction is divided into upper and lower limbs, corresponding to the four body parts with joints: hand, chest, bottom and foot, to simulate the motion directions. The joints are single direction joint and double direction joint. Single direction joint is situated at the top and the bottom end of the structure that can move back and forth. The double direction joint situated in the middle of the structure, which connected the

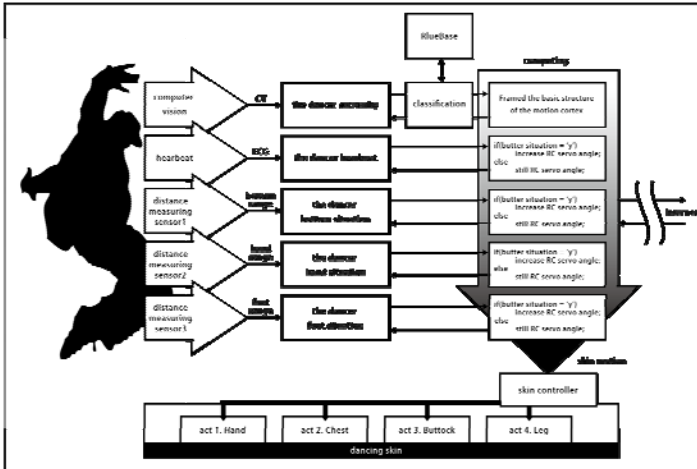


Fig. 4. The system diagram of dancing skin

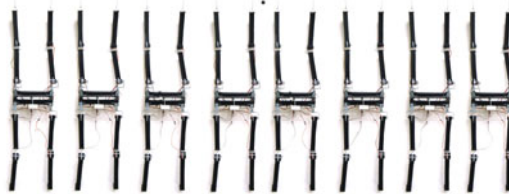


Fig. 5. The dancing skin entity

top to bottom with four junctions, this joint have the ability to move from front to back, right to left two directions, movement through these two kind of joints, causes the skin to has motion as Fig. 5.

The main system brace can be put into movement of front and back and movement of right and left that can be achieved by using RC servo, combining with the joints that will actuate the skin to make changes. Choosing the suitable material also plays an important part when designing the skin. After testing the material, we use cardboard for the material of the system brace. After determine using cardboard, intersecting two cardboards as a square for connecting with the motor joint to complete the construction of skin.

### 4.3 Interaction

Dancing skin sensed dancers bodies, and then produced skin motion as feedback. Dancers also could communicate with other dancers with network. The dancerA danced and sensed by SkinA that sent data to SkinB for data comparison, the RC Servo at SkinB got data and made SkinB produce motion, made dancerB get the feedbacks from dancerA. Dancers at two place produced interaction and more Skin or dancer motions are used as a reference for interaction.

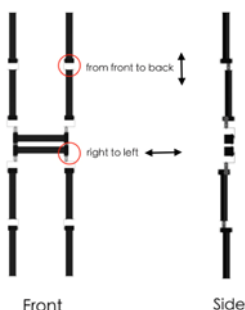


Fig. 6. The dancing skin joint move two directions

## 5 Two Scenarios

### 5.1 Dancing with Skin

Jadon was a busy office worker; he usually went off work at ten a clock in the evening. To a man who was a member of dance club at high school, Jadon still loved dance just like past, but he could not find a partner dance together after work. Jadon turned on the radio and danced to the skin. The skin started to sense the action of Jadon, then danced with Jadon. When Jadon did an open-close movement of hands and the feet, the skin body will also do a out turn so as the hand part, and then turn toward inside, as for the lower limb part's motion, the first joint of the leg part on skin will make a out turn and leading the second joint to move, too, then all turn inside again. However, when Jadon starts to make a cross step forward with his feet, the first and second of the lower limb joint on skin start to make a substantially cross step, corresponding dancer's open-close movement also display relation between skin and dancer's motion.

After a while, music which Jadon was practice at high school played. Jadon was familiar to the music and started to increase the strength of his dance step, his heartbeat became faster because of his emotion and dance step. The data all above that were sensed by sensor and made the angle of RC Servo increase, made the extent of skin motion increase. The skin motion became more and more clear until Jadon felt tired and his action became weak gradually. Jadon not bored to practice dance by himself any more, he could dance happily with skin.

### 5.2 Battle-of-Dance via Dancing Skins

Randy and Kevin was partner in dance club at high school, they always danced together. However they were hard to practice dance together since they entered college. With Dancing Skin, Randy and Kevin connect each other. Firstly, Kevin danced first, when Kevin danced was rhythmic, the extent of skin was large. When Randy saw the skin motion, he felt withdrawal because he was afraid that he could not dance as good as Kevin. So in Randy's turn, the extent of skin became smaller. Randy starts to think movement Kevin just did. Kevin did a body wave causing the skin to present a very attractive scope, so he also wants to give it a try. Randy made a

big motion from his chest down to his bottom, the first joint in the upper limb of the skin starts to move forward and finish at the last joint of lower limb, presenting a motion of wave. Randy's movement changes from small to big not only cause the response of the skin become more obvious, but also Kevin felt the message that Randy wish to send through the skin. Randy and Kevin did the communication of dance, they practiced dance together and shard the dance step of each other.

## 6 Conclusion

In this research, we combine folding form type and the street dance movement to design skin. Using human structure as reference, we discovered the relation between skin and dancer's body movement. The variation of street dancer's body can provide the skin to have diversity forms; this is also a reference for skin's motion design and knowing gearing relation of the skin's joints. We can see that the transformation between motions may penetrate through small movement, causes the next motion of the skin to be more obvious. How to design linking movement is another lesson learned, Further, This Dancing Skin construction provides a lesson for building folding form and joint, developing motion needed, also provides dancer an interface as a new manifestation and perform way for the street dance and its dancers.

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