The Micro Motion of Ambient Surrounding — An Exploration of Techno-Biophilic Design

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The Asian Conference on Arts & Humanities 2020
Official Conference Proceedings

Abstract
Biophilia hypothesis was devised by Edward O. Wilson(1984), being based on evolutionary psychology, which suggests that "people have the innate tendency to focus on life and lifelike processes". So far, the development of the theory has been invested in many different fields, which proves that it is helpful for human physical and mental health. It has also attracted attention in the field of architecture and interior. The mainstream is the planning and configuration of "actual natural" such as the introduction of natural light, vegetation walls, and plant decorations. In recent years, facing the development of information technology and the Internet of Things, people have become inseparable from their digital lives. It seems push you and me farther away from the nature. Excessive Internet dependence and addiction have caused people to become detached from the real environment and cause mental illness. However, can Biophilia return to our lives through digital technology? Sue Thomas (2015) devised a concept of "Technobiophilia", which is "the innate tendency to focus on life and lifelike processes as they appear in technology". This study is based on the above review to sum up that the development of digital technology can be a resistance or a help while facing the biophilia, and the key point is how it coexists and awakens the importance of people's perception of the ambient environment. And based on the research, this study explores the distance and relationship between nature and people through projected images.

Keywords: Technobiophilia, Biophilic Design, Attention Restoration, Affective Ambience, Non-Rhythmic Sensory Stimuli

1. Introduction

Biophilic design is an environmental design with concern of human's love of living system and has received increasing attention as a design philosophy in recent years. So far, the development of the theory has been invested in many different fields, which proves that it is helpful for human physical and mental health. This paper briefly reviews the development from biophilia to technobiophilia and explores the distance between nature and people in the digital age by design implementation.

The structure of the paper as follows (Fig.1). In section 1 ,a background review of biophilic design. In section 2, a discussion and design concept is proposed. Section 3 is experimental work including data acquisitions, classification, analysis and examinations. Section 4 presents the conclusion and future works extensions.

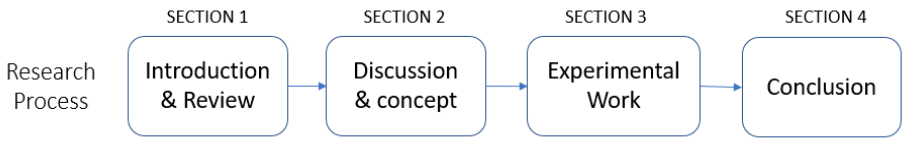


Figure 1: Paper structure.

1.1 Biophilia to Technobiophilia

The word biophilia was first used by the social psychologist Erich Fromm and it means "love of life or living systems". Then in the 1980's,the term was introduced and popularized as a hypothesis by Edward O. Wilson. He suggests that "people have the innate tendency to focus on life and lifelike processes" (Edward O. Wilson,1984).Based on evolutionary psychology, this tendency is necessary for survival live in the wild where was a mainly sensory world dominated by critical environment feature. Such as :light, sound, odour, wind, weather, water, vegetation, animals and landscapes. Our skills and aptitudes learned is closed association with natural system and processes. And it enhance human abilities and benefit about our emotional, problem-solving, critical-thinking, constructive abilities. Biophilia provided instrumental in enhancing human body and mind and became biologically encoded during human evolution.

However, as the human population stabilized and there was time to develop increased intellect and strengthened physical dominance, the pressing need for high levels of biophilic sensitivity dropped away. For thousands of years it has remained with us as a 'weak' biological tendency. But in recent centuries the coming of industrial society has increasingly failed to sustain it and as a result it has begun to decline into latency.

In digital age, there is a view that whether digital technology can be a resistance or a help while facing the biophilia. Due to the technological advancements, the popularization of cars and more time spent inside buildings disconnect people from nature. While everything can be done with the phone in the pocket and people do not have to disconnect from the digital to stay connected to their surroundings.in other words, people spend more time in the digital world and It seemingly means that they are pushed more farther away from nature.

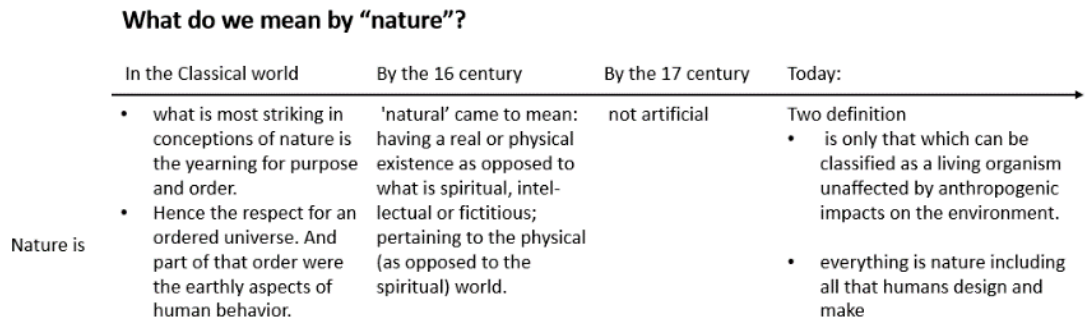
Some of the biophilic activities urges people to reconnect with nature by turning of the digital device, placing indoor plants at home or taking a trip into the nature environment. These are based on a hypothesis that technology is opposite to nature.However, facing the irreversible trend of digital life and the technology addiction, it is time to rethink of it and find the possibilities which technology can help.

From a view of the definition changes of nature(Fig.2), we can understand the way people treated nature. In today's definition, cyberspace can definitely be seen as a natural phenomenon. Sue Thomas who mention this argument and devised a concept of "Technobiophilia", which is "the innate tendency to focus on life and lifelike processes as they appear in technology" (Thomas, S.,2015). She give a conceptual comparison of nature space to cyberspace and sensory exploration ability of people in unknow world (Table 1). In these points of view, it seemly gives a positive way to help biophilia return to our lives in digital age.

"cyberspace" vs. "nature space" in the framework of biophilic design

	biophilic design's two basic dimensions	cyberspace
physical space	organic or naturalistic characterized by shapes and forms reflect an affinity with nature in one of three ways: 1. direct contact with nature 2. indirect experience 3. symbolic or vicarious experience	Dissimilarity: Physical sensory Similarity: **Represent** :symbolic or vicarious experience is also can be represent in cyberspace.
Spiritual space	• place based or vernacular design and it relates to buildings and landscapes: • connect to the culture and ecology of a locality or geographic area. • the spirit of place	Similarity: • **Placelessness**: cyberspace is actually about the absence of place and it is talking about the separation of the built environment from its biocultural context • **sense of presence**: the advent of virtual space has brought about a different kind of placelessness which in fact is an essential element of virtual experience, and one which does not so much negate physical space as replace it with an equally potent sense of presence.

Table 1: Comparison of cyberspace and nature space. Based on Thomas, S. (2013). Technobiophilia: Nature and cyberspace.



Fieger 2: What do we mean by nature. Based on Thomas, S. (2013). Technobiophilia: Nature and cyberspace.

1.2 human well-being : Restorative Environment and Directed Attention Fatigue

In digital age, cyberspace is everywhere in our life circle, which changes the lifestyle of people and cause illness. It is true that stress, overwork and depression are regarded as the main cause of health conditions known as illness of modern civilization. Since more than half of things can be done online, excessive internet dependence and addiction have caused people to become detached from the real environment and caused the experience of mental fatigue. In a bid to combat the difficulties, Attention Restoration Theory proposes that exposure to natural environments encourages more effortless brain function, thereby allowing it to recover and replenish its directed attention capacity. According to Kaplan et al., the natural environment have four properties which can provide the restorative effect: Extent, Being away, Soft fascination , and Compatibility(Kaplan, R., & Kaplan, S. ,1989). And an integrative framework is proposed that places both stress and directed attention in a larger context of human-environment relationships (Kaplan, S. ,1995).

	involuntary attention.	Voluntary attention(directed)
Meaning	Natural attention	Need make an effort to avoid distractions and to focus on the task.
Example situation	often without any intervening deliberation	hard work of forcing yourself to maintain focus on something that is not at all interesting.
The function in biophilia	is probably an ancient adrenaline-fueled response to external alerts and it is necessary for survival in a wild world.	- allows us to concentrate in the face of continuous distractions as well as helping us to control and inhibit our behavior in situations - essential for effective functioning

Table 2: Involuntary attention vs. voluntary attention. Based on Thomas, S. (2013). Technobiophilia: Nature and cyberspace.

Regarding to attention, there are two kinds of attentions: voluntary attention and involuntary attention(directed attention), definition depended on whether it requires effort to maintain. Each attentions play important role in human information processing (Table 2) and the attention shifts constantly occur in life. Its fatigue was caused by long-term maintenance of single attention. The conceptual idea of restorative is rhythm for temporary relaxation which is to switching between voluntary and involuntary attention in a period of work. In fact that it is easily to

achieve in the past by circadian rhythm but hard for modern people who spending even all the time indoor, excessively constant and static environment, in which make them miss the sense of nature rhythm. This situation is exacerbated by the cause of modern environment and the fast and compact lifestyle. To rediscover the nature rhythm of attention and restoration, Sue Thomas proposed a conceptual model illustrating the rhythm of switching formula and mention the potential of tiny interval for each shift in attention time periods(Thomas, S. ,2013).

Give a comparison of the temporary relaxation rhythm to natural phenomena, there are similarity in the concept of intermittent. The motion of natural phenomena such as wind blowing or leaves swaying are stochastic and ephemeral. Catie Ryan give a terms of Non-Rhythmic Sensory Stimuli to illustrate this kind of nature connections which can bring biophilic help for reduce stress and improve productivity. Research shown that the brain processes the movement of living things in a different place than it does of mechanical objects and the perceive movement in the peripheral view much quicker than straight ahead and these help for adjustment of visual focal lengths periodical and momentary(Ryan, C.,2015).

Although biophilia might be a fragile sensibility, it does appear to be essential to human health, productivity and well-being. Researches show that biophilic areas can help cognitive performance, stress reduction, emotion and mood enhancement and the human body. A table proposed by Terrapin Bright Green(2014) illustrates biophilic design pattern versus biological response which supported by rigorous empirical data. It's restorative benefits has been generally accepted to a certain extent.

1.3 Biophilic design criteria review

For the purposed to detailed understanding of biophilic design, this chapter discussed different perspectives of spatial practical application in nearly 10 years (Table 3). The Specific guidance for biophilic design first from Stephen Kellert (2008) who has set down a framework in which is dimension, element and attributes. There are two basic dimensions and the first one is an organic or naturalistic dimension meaning shape or form reflect the human affinity for nature. The second one is a place-based or vernacular dimension meaning a sense or spirit of place. Then it can be practically related to six design element and 70 attributes.

Based on this framework, the biophilic design principles were proposed : Sue Tomas (2013) in a technobiophilic view promotes more biophilic activities and the carness of surroundings. Nikos A. Salingaros (2015) in a view of the biophilic effect that with humans' experience and sum up 8 points: light, color, gravity, fractals, curves, detail, water and life. Kellert (2015)gives a more detail research in a view of humans' experience with biophilic attributes and the discussion divides into three sections: direct experience, indirect experience and experience of space and place(Kellert, S., & Calabrese, E. ,2015). Then based on this research the publishes *14 Ppattern of Biophilic Design* which is more practical design principles to assist designers in their practice work(Kellert, S., & Calabrese, E. ,2015).

Regarding to biophilic design, the mainstream design suggestions are still more about the planning and configuration of "actual natural" such as the introduction of natural light, vegetation walls, and plant decorations.

2008 Dimensions, Elements and Attributes of biophilic design (Kellert etc.)	2013 Technobiophilia (Sue Tomas)	2015 8 Points of Biophilic Effect (Nikos A.Salingaros)	2015 The Practice of Biophilic Design (Stephen Kellert)	2015 14 Patterns of Biophilic Design (Kellert etc.)
Dimensions • Organic or naturalistic: reflect the human affinity for nature. • Place-based or vernacular: a sense or spirit of place.	**Indoor** • Pay attention to the view from the window • Ornament • Use indoor plants to your advantage • Connect with animals • Consider biophilic computer kit	**8 points** • light, • color, • gravity, • fractals, • curves, • detail, • water, • life	**experience & Attributes** • direct experience: actual environmental features • indirect experience: representational • experience of space and place: spatial features Integration of parts to wholes、Mobility and way finding、Culture and ecological attachment to place	**14 Patterns** Nature in the space • Visual Connection with Nature. • Non-Visual Connection with Nature. • Non-Rhythmic Sensory Stimuli. • Thermal & Airflow Variability. • Presence of Water. • Dynamic & Diffuse Light. Connection with Natural Systems
Elements • Environmental features • Natural shape and forms • Natural pattern and process • Light and space • Place-based relationship • Evolved human-nature relationship				Nature analogues • Biomorphic Forms & Patterns. (Symbolic) • Material Connection with Nature. (Materials and elements from nature) • Complexity & Order. (Rich sensory information)
Attributes • Roughly 70 attributes(table 1-1)				Nature of the space • Prospect. • Refuge. • Mystery. Risk/Peril

Table 3:Biophilic design criteria review.

To sum up, biophilia is not only an inner tendency of lifelike systems but an ability helping people explore the unknow world. Compared cyberspace to spiritual space, there are both placelessness and sense of presence. To some extent, cyberspace is like a 'substance' realization of the spiritual space. Since we concept a space often they come as much from received culture as from objective spatiality; and we often describe the cyberspace using a tern or concept of physical world. The role of biophilia in cyberspace might even be possible that in recent decades our forays into the new territories of cyberspace have reawakened and stimulated the biophilic tendency.

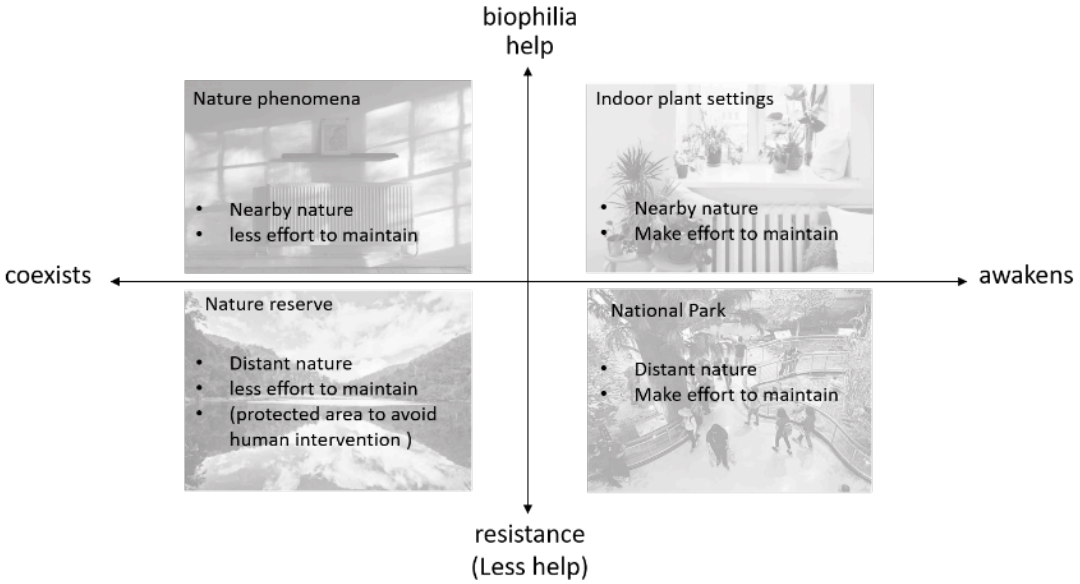
In recent years, biophilic design has received increasing interest from architecture and interior around the world. Two global building rating systems are promoted incorporate biophilic design directly; these are the WELL Building Standard, and the Living Building Challenge. Regarding to biophilic design criteria, the performance and design method are more emphasized on the using of 'actual nature' such as nature light and real plants. It's still a lot more.

2. Discussion and design concept

In the face of digital life, there are two basic issue should be concern in technobiophilic design: awareness of physical surroundings and experience duration .This study explore that the distance between people and nature. This section discuss the Biophilia in two perspectives: physical space and spiritual space. Regarding to the distance in physical space, it is more concerned to the sensory of real world which is various from indoor plants setting to the reserve nature park. The plant environment is nearby or far from people's daily life circle. The key point to experience of biophilia is that whether people approach these environments actively or passively.

Regarding to the distance in spiritual space, it is more concerned to a feeling or impression which are various from nature phenomena to artificial lifelike form or

motion. The key point to experience of biophilia is subject's bionic authenticity which can awaken people to nature. With regard to the role of technology, whether it can be a help or resistance is more concerned about how much people value biophilia. Since technology assists people's life, the biophilic areas can be divide into different situation according to living condition and sensory stimulation. Fig. 3 demonstrate the concept.



Fieger 3: Situation diagram. A quadrant with people as the centre, the vertical axis is the degree of biophilic effect, and the horizontal axis is the present of biophilic area.

First quadrant: The biophilic area is placed in people daily life circle and need people make effort to maintain. Which is such as indoor plants setting or balcony garden. These kinds of settings usually need better lighting conditions facilitate plants growth. The technical strategies can be in ways of improving growth environment conditions or watering reminder.

second quadrant: The biophilic area is placed in people's daily life circle and people can make less effort to maintain, such as landscape paintings, interior decoration with natural materials or window view, natural light and shadow. These settings are usually form by planning and decorating in advance. The technical help can be in ways of represent. The technical strategies can be in ways of bionic image design or sensory experience design etc.

Third quadrant: The biophilic area is generally placed far from people's daily life circle and people deliberately distanced from them to maintain their growth autonomy for the sake of diversity development, such as national parks or nature reserves. Since ordinary people are not allow to enter without permission, the experience of biophilia from there is less. The technical help can be in ways of video or photo recording and spreading. The technical strategies can be in ways of photograph or video recording and spreading.

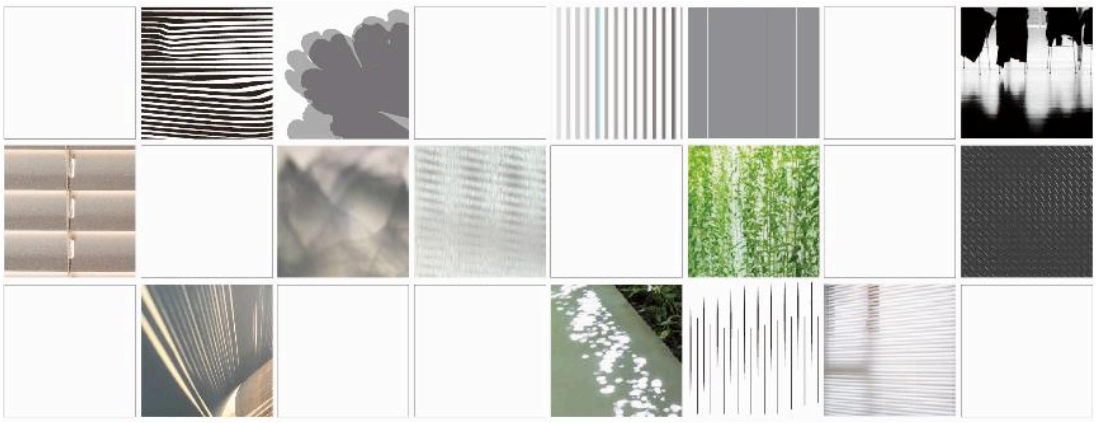
Fourth quadrant: The biophilic area is placed nearby people daily life circle and need people make effort to maintain. Which is such as community park or street tree. These kinds of settings are part of urban and easy access. The technical help can be in

ways of video or photo recording and spreading. The technical strategies can be in ways of photograph or video recording and spreading.

Each quadrants show the advantages and inherent limitations in which technology can take over. There are amounts of research having focused on quadrants 1, 3, and 4, and the quadrant 2 remains still in progress.

The follow sections base on the quadrant 2 and further explore the visual effects and restorative experience of the micro-motion ambience through design analysis and implementation. The design concept aims to build an ambience media with the temporary relaxation rhythm and the display inspired komorebi, the natural phenomena.

Fig. 4 show this design concept image board.



Fieger 4: concept image board

2.1 Design methodology and related case study

Regarding to the design of visual peripheral awareness, The following paragraphs are cases study from three directions: design issue and concept, display of lighting design and motion analysis methodology.

design issue and concept

The design of presenting information in ambient medias settings such as ambientROOM (MIT Media Laboratory, 1980) proposed a interface of space which can display personal information in physical ambience through light, sound and movement. Aim to explore the peripheral awareness in computing, the project classify messages and correspond to ambient media cues with different level attention. Hello.Wall (2005) display media wall with dynamic aesthetic patterns, conveying the idea of transforming the daily space into a social place where people can meet and interact by the used of the dynamic ambience. Lighting design with sensory experience exploring inspire from life experience and emphasis of nature phenomena to enhance the emotional connection of users. Design projects such as Bright Blind(2007, Makoto Hirahara),Hidden Senses Concept project(2014, Sony design group) and komorebi (2017, Leslie Nooteboom, Royal College of Art) not only

represent natural enviernment but also led us aware a subtle emotions in our innate tendency to ambience.

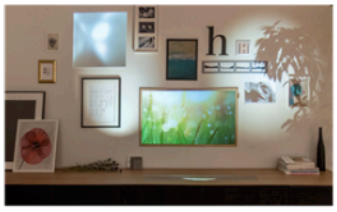
			
Case	2007 **Bright Blind** By Makoto Hirahara	2014 **Hidden Senses Concept project** By Sony design group	2017 **komorebi** By Leslie Nooteboom, Royal College of Art
Goal	Facing the lack of indoor sunlight and aim to represent the natural experience.	It is a smart home concept aim to change the IOT information as companions in life.	Facing the lack of indoor sunlight and aim to stimulate natural experience.
Design method	Imply the image of a window with daylight by a hidden light source of electroluminescent slats lit	represent visual experience	Represent the nature shoadow motion by projection
Similarity	- sensory experience and display in lighting design - Design element come from life experience to enhance the emotional connection of users		

Table 4: Case study of design issue and concept.

Display of lighting design

About the usage and transformation of lighting and shadow, Artist Anila Quayyum Agha is known for her innovative use of laser technology to cut lace -like designs into her installations, which create intricate and bold shadows when lit from within. Artist Fabrizio Corneli who uses mathematical calculations to produce his stunning shadow sculptures. What's fascinating about his art is that you wouldn't even know it existed when the lights are turned off, and only when the lights are switched on do the silhouettes takes form to create beautiful pictures upon the adjacent walls.

Motion analysis methodology

Motion capture techniques have come to the rescue since they preserve the distinctive "signature" of the real movement. And an interface to producing emotional animation is achieved by applying elementary techniques from signal processing. This paper's approach is related to several other research efforts: Kenji Amaya et al. proposed a method to produce emotional animation from neutral, expressionless motion by motion-capture, procedural, physically-based and keyframe techniques. And in a view of temporal texture recognition, the method is based on the experience of static image analysis and combines with optical flow analysis and other expressions. Doretto, G. et al. analyze images sequences of moving scenes solely as visual signals and interpret the image data to recreate and extrapolate it.

In this paper, to represent the nature motion of komorebi, design issue and concept will focus on visual sensory experince and display in lighting design (Table 4). The motion analysis based on the method of geometry features .

3. Experimental Work

To capturing micro motion in nature ambience, the section take komorebi, nature phenomena of sunlight streaming through the trees, for case study in a design analysis. The experimental work includes three parts as follows:
1.Observation : Observed in komorebi and collect the nature phenomena video in a period of time(30/FPS, in 1 minutes) and take A and B as experimental observation objects .
2.Motion analysis: analyze image sequences of moving scenes to capture motion data.
3.Generation : interprete a signal amounts to inferring a model

Part 1: Observation

In part 1, observed in komorebi, sunlight streaming through the trees, the natural phenomena was a regular simple harmonic motion which result from the flow of gases and the structure of plants. The shape of light patch and shadow through branches and leaves is temporal change and irregular shapes present a therapeutic visual experience.

The testing experiments take place in a room without window and project different atmosphere from static image project to slightly motion in the background. With aim to explore the performance of outdoor projection, result show that slightly motion in the background is better(Fig.5-6). The next experiment tests the effect of different kind of outdoor circumstance in a slight nature motion, and try projections in different directions and ranges. In the reading or working condition, the motion in background atmosphere setting may be a interference when the ambient media appears closed to main visual range of direct attention.

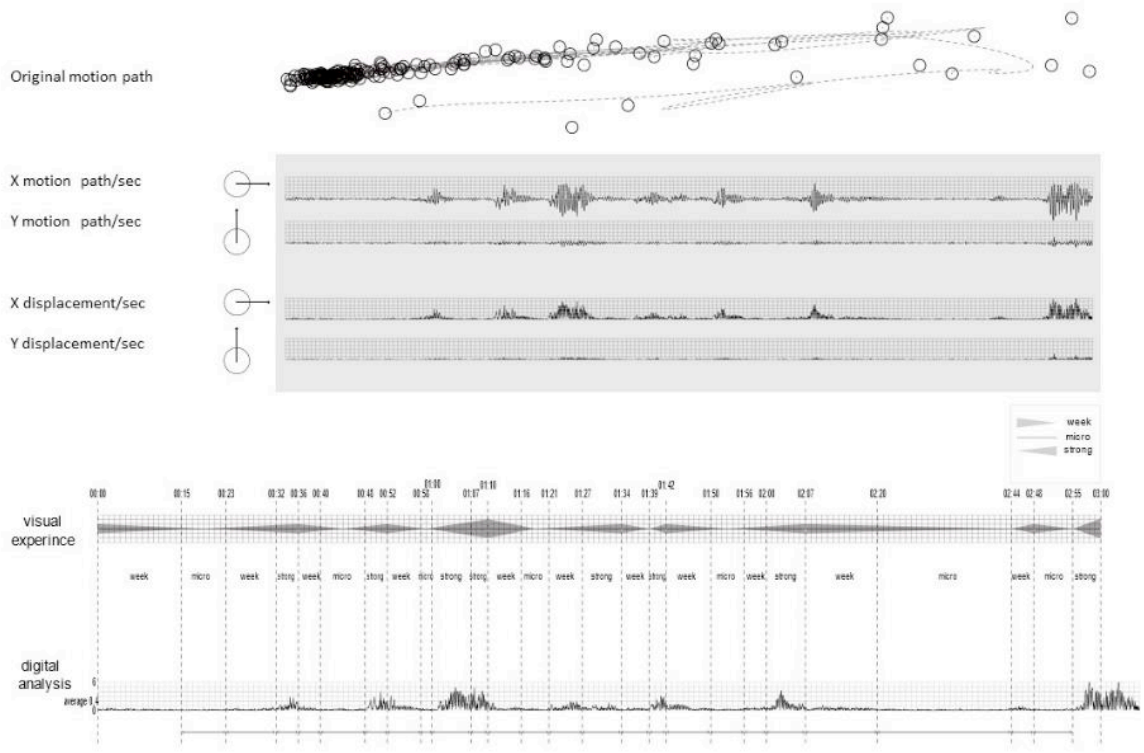
Fieger 5: The testing experiments of outdoor projection.

Fieger 6: The testing experiments of outdoor projection.

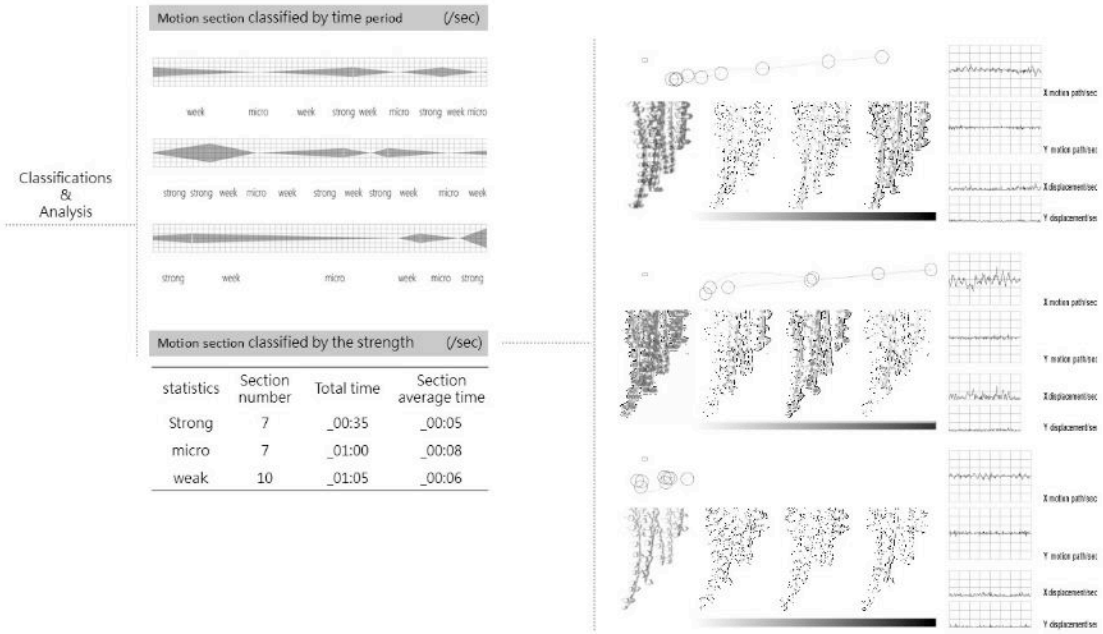
Part 2: Motion analysis

In part 2, A method to represent a lifelike motional background setting from natural visual experience is proposed. This method can be divide into two parts: decompose the motion image into unit by visual analysis and translate the motion displacement to visual attention experience. The analysis approach is as follows(Fig.7-9):

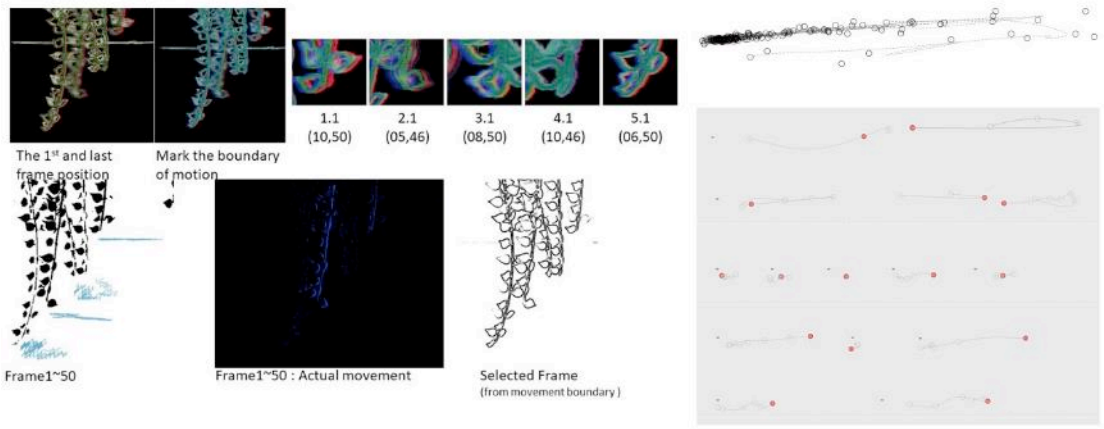
1. Film the motion of plant subjects performed with a period of time and capture the motion data by Adobe After effects, an video production software.
2. Classify the motion data into section by visual experience and tine period.
3. Analyze the motion data of displacement component, edge detection and the image brightness.
4. Translate the visual attention to motion displacement and apply the data to a geometric form.



Fieger 7: Motion analysis



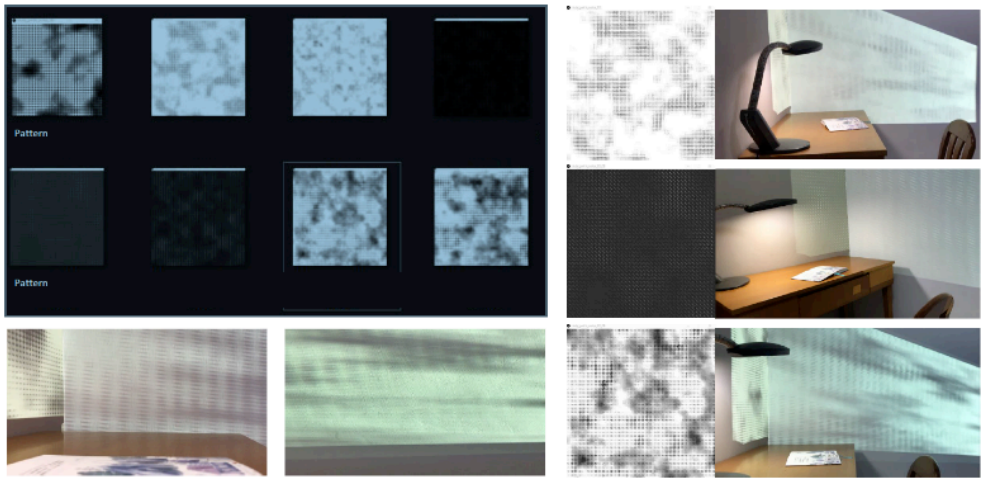
Fieger 8: The classify process and analysis.



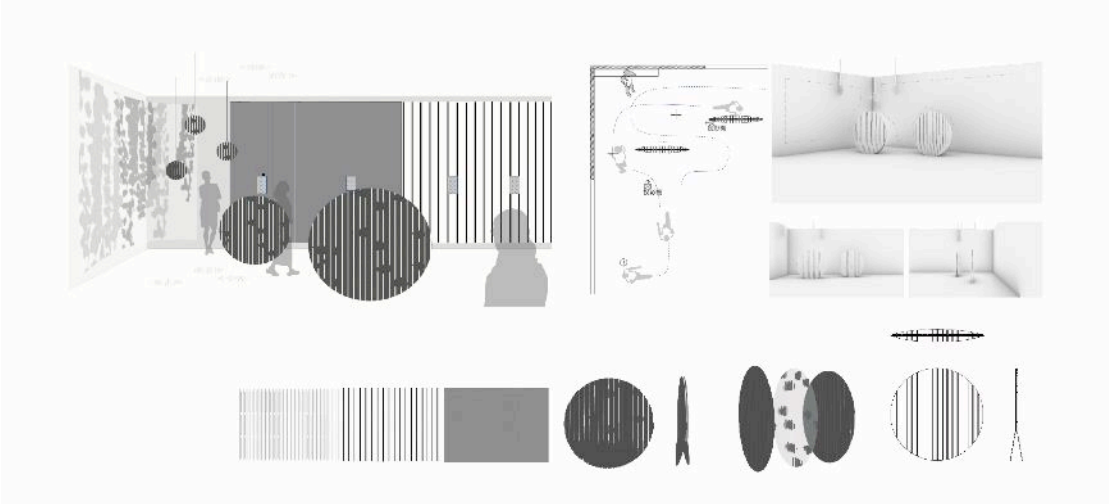
Fieger 9: Motion analysis.

Part 3: Generation

Part 3 is a prototype by projection and conceptual modelling of spatial implement (Fig.10-11). Reticular systems are in many aspects a distinct taxonomy of volumetric geometries. The composition logic of motion pattern is inspire from the concept of mask and the imaging principle of moiré pattern.



Fieger10: A prototype testing by projection



Fieger 11: A conceptual modelling of spatial implement

Summary

Based previous work, biophilia is a hypothesis of lifelike inner tendency and the biophilic design is an environment arrangement of a purpose to create restorative environment. The research perspectives of biophilia have been changed from greenery to the usage in digital world. Regarding to biophilic design, the mainstream design suggestions are still more about the planning and configuration of "actual natural" such as the introduction of natural light, vegetation walls, and plant decorations. There is a lot more.

In the face of digital life issues, there are two basic viewpoints should be concern: awareness of physical surroundings and experience duration .This study sum up a table to explore that the distance between people and nature. Then the preliminary design implementation demonstrate a performance of biophilia by using lighting design. The result shows that the role of digital technology can be a resistance or a help while facing the biophilia, and the key point is how it coexists and awakens the importance of people's perception of the ambience.

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Case study

Artist Anila Quayyum Agha :http://www.anilaagha.com/

Artist Fabrizio Corneli : http://fabriziocorneli.net/Bright Blind (Makoto Hirahara, 2007) : https://www.core77.com/posts/8223/Makoto-Hiraharas-Bright-Blind

Hidden Senses Concept project(Sony design group , 2014) : https://www.sony.net/SonyInfo/design/stories/hidden_senses/

komorebi (Leslie Nooteboom, Royal College of Art, 2017) : https://www.rca.ac.uk/students/leslie-nooteboom/

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