Explicit Image

--- an exploration in media art

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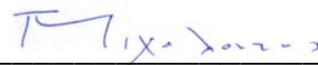Yuan Mu, Harvard University Graduate School of Design

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Contents

I.   Abstract:

This thesis conducts a series of visual experimentations by a customized drawing machine. The machine as a generalized tool together with the techniques and methods, established itself as an artistic medium. Adapted from existing electronic components and libraries, it investigates potential graphic quality, which departs from the engineering operational language of input and output. This demonstration contextualizes the project into a domain when time and intuition as embedded parameters, building up a serious of vocabulary of electronic procedures and dialogue with the tool. Potentially provides intuitive accessibility of the technological workflows, it opens up the question of how designers today situate a self-referential relation with technology in a large context of communication.

II.   Introduction:

The intention of this thesis is composed by two interest of mine: how the understanding of vision and perception effects the art world, and the technique of how to achieve it.

Human visual experience is layered with mutable range of perception, the progression of the relation between information recording from object and its representation has been developed from drawing technique till spatial augmented reality, indicates the effort of understanding human perception based on computational reading. As a person who had art history as first major, I always relate the era we are to *Mannerism* we had in western history: the time when art is carrying the mission of idealism is descending, now the tools and techniques which were produced from the previous age are becoming available to individual. This availability provides further possibility of experimentation for artistic representation and its medium. Science and market always present new tools and platforms for designers, more than before, the evaluation of design is tightly linked to the accessibility of tools. Technology, as a symbolic brush for artist, provides broad source for creativity. However, when designers

hand the control and their intuition over to technology, art form becomes debatable.

Here I would like to bring up the concept of "defamiliarization " and opens up the conversation of how we analyze it in a digital context. **Defamiliarization**, was written in 1917 by Shklovsky in his essay "Art as Technique"(Crawford 209), is "*the artistic technique of presenting to audiences common things in an unfamiliar or strange way in order to enhance perception of the familiar.*" The concept was originally used to discuss the language of poem for writer in the beginning of 20th century, later was spread into a variety of discussions of new art formats. Based on the rapid changes of technology and its impacts on art, rather than a strange representation or new formal language, **the transformative experience brought up by technological development features the art world we face today.**

III. Early studies:

1) **Thought process**

Trompe l'oeil , Noun **(French for "deceive the eye")** was defined as "visual illusion in art, especially as used to trick the eye into perceiving a painted detail as a three-dimensional object a painting or design intended to create the illusion of a three-dimensional object.", became one of my earlier inspirations of how to apply the methods for this thesis. The first stage of the experimentation is concentrated on making volumetric display device, in order to control representational medium with a simulated depth through different visual effects. It was trying to testify the method of 3d information delivery to the audience.

Due to the relatively new investigating of this technology, there is no systematic definition of the format or representation. However, it normally involve with 3 following aspects: a stable resource of projection through laser or motion graphic for exporting information; a strategy of control and articulate the information through frequence; a transparent or translucent medium display the information. The

achievement is highly rely on the specific composition of these aspects. I did a close study on the project,

"Rendering for an Interactive 360° Light Field Display" (figure.1), innovated by USC Institute for Creative

Technologies in 2007 and summarized the technological complexity.

Figure 1. Interactive 360° Light Field Autostereoscopic 3D Display

(single viewer interaction), USC ICT,2007

Based on this case studies, the progress was established as the diagram(figure.2) and decide to

approach it through the following steps: build a laser projector and experiment different input; selected a

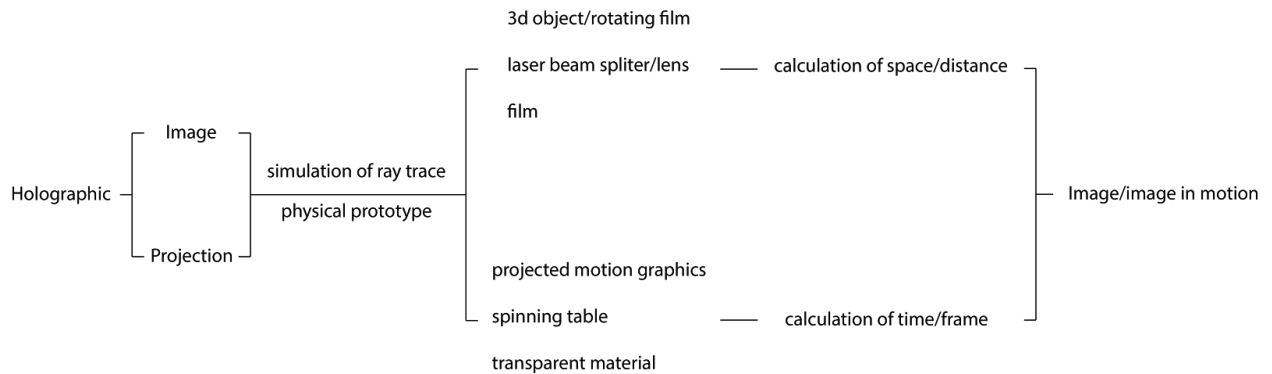medium and test the representation of the output.

Figure 2. Progress diagram of case study for volumetric display

2) making a machine

I built the first machine, the laser projector (eventually it's redefined as the first version of the drawing machine) (figure.3) and a fast spinning table (figure.4) for this exercise.
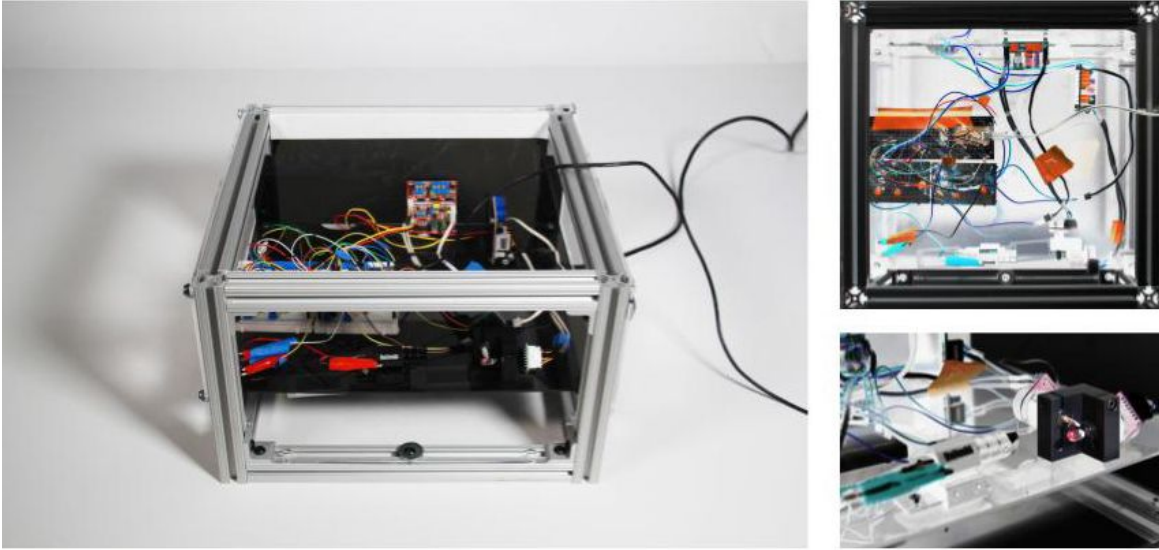

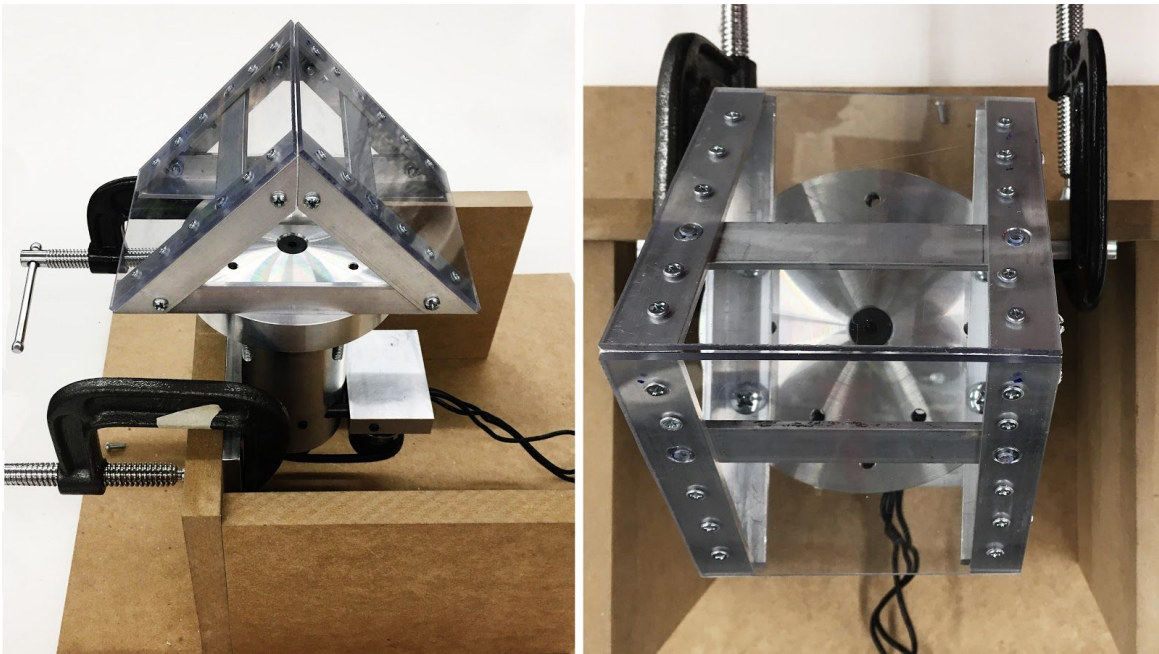Figure 3. Locust, the first version of my drawing machine

Figure 4. Spinning table, motor part built by Burton LeGeyt in GSD Fablab

The progress of the is modified on a instructable open source "*Arduino Laser Show With Real Galvos*", and here is all the components I choose (figure.5) :

- s10 t-slotted aluminum extrusion, 1' x 8 + 6" x 4
- s10 series 2-Hole Inside Corner Bracket, 1" x 1" x 20
- s10 series BHSCS & T-Nut, 20 sets
- 1 / 8 " acrylics
- an Arduino Nano
- a USB cable
- 20Kpps galvos with driver cards
- a 220V or 110V power cord
- MCP4822 DAC (a cheap dual channel 12 bit DAC)
- a red laser pointer
- some crocodile/alligator clips
- a breadboard or prototyping PCB
- jumper wires

Figure 5. Components for build the machine

The intention for building this machine is have a controllable light/image source. Laser, as a binary light source created after 20th century, provides direct communication for turning it on and off. Moreover, the artificial feature of the light gives infinite focal points, the image won't lose its quality during the increasing of distance.

I used the library in source for driving the galvanometer and communicate with the DAC, replaced the graphic part for experimenting purpose. The first round of test is uploading the vertices' position to arduino and switching among different parameters for getting different graphical language. Based on the balance between numbers of interpolation points and how long the laser should wait on each point, the linearity the vector line quality gives an interesting result which indicates the control of switch and stop in microseconds. Since it's not a common procedure for pixel based image processing, it produced its own characters as an expansion of time manipulation. It's valuable as a practice to reform the project and narrow it down to the direction of drawing, as well as a test for getting familiar with necessary electronic components and their limitation. Based on this study, I decided to improve the hardware for a bigger line budget, concentrated on exploring the possible way to manage data for visual programming.

All experimentations are hard to capture through still image, the illustration below is an example of how the same geometry would be represented in this content(figure.6). Please follow my website for all the videos regarding to the full project.: https://www.yuan-mu-design.com/galleryex/
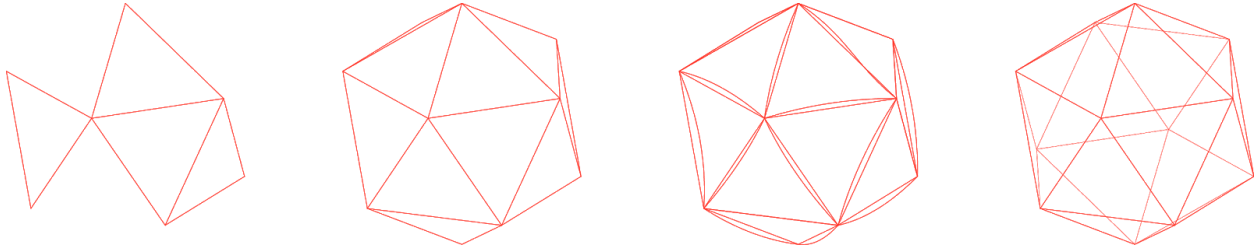

Figure 6. Illustration of how time would effect on the representation of same geometry.

IX.   Precedence

The first precedence I would like to introduce is Marcel Duchamp's Rotoreliefs (*Optical Disks*), published 1953. Duchamp used the decorated discs made to spin on a turntable to create the depth perception and the illusion of 3D through adding one degree of freedom, integrated mechanical operation into art form(figure.7).

Another reference aligns with my project would be the *Time/Energy Structure of the Electronic Image* by Woody and Steina Vasulka(figure.8), it produced exclusively with the Rutt/Etra Scan processor in 1974 - 5.Within the control of particular electronic component, the technique of glitch could be developed further for new visual result: when there is shifting happens, you get the shearing effect; when there is a bad signal, you have noise, because not all the pixel getting the right signal. The glitch happens here reveals the function of its mechanical approach.

The video of *Quake on an oscilloscope*(figure.9), *2014* presents a more related visual language related to thesis itself .In this experience, the observer lose the illustration of the reality, instead we

appreciate the usage of the engine. As an extension besides the fact of hardware & software intervening, it elevates the difference for image production from vector graphics to raster scanline. Vector graphics, offering a direct visual experience through signal, the physicality of the medium is embedded in motion. The interfering with the medium is also different, when you getting closer to a projection, the image is replaced by the impression of pixel; vector line somehow represents the motion which is fast enough to be perceived by the viewer.

Figure 7. Marcel Duchamp, *Rotoreliefs* (*Optical Disks*), with 40rpm

1935, published 1953

Figure 8. Woody and Steina Vasulka, 1974-5

time/energy structure of the electronic image,

Figure 9. *Quake on an oscilloscope*(figure.9), *2014*

V.   *Further exploration*

The further exploration of the project is concentrated on 2 parts: upgrade the hardware to push the potential quantity of data; optimize the communication of sending and reading data. The basic workflow is using grasshopper as an interface build data buffering between computer and arduino, sending the information from grasshopper as string of text file through a usb cable to arduino, then read it in order to drive the motor through digital analog converter. Meanwhile, texting different projection surface to analyze the artifacts within or without prediction(figure.10).
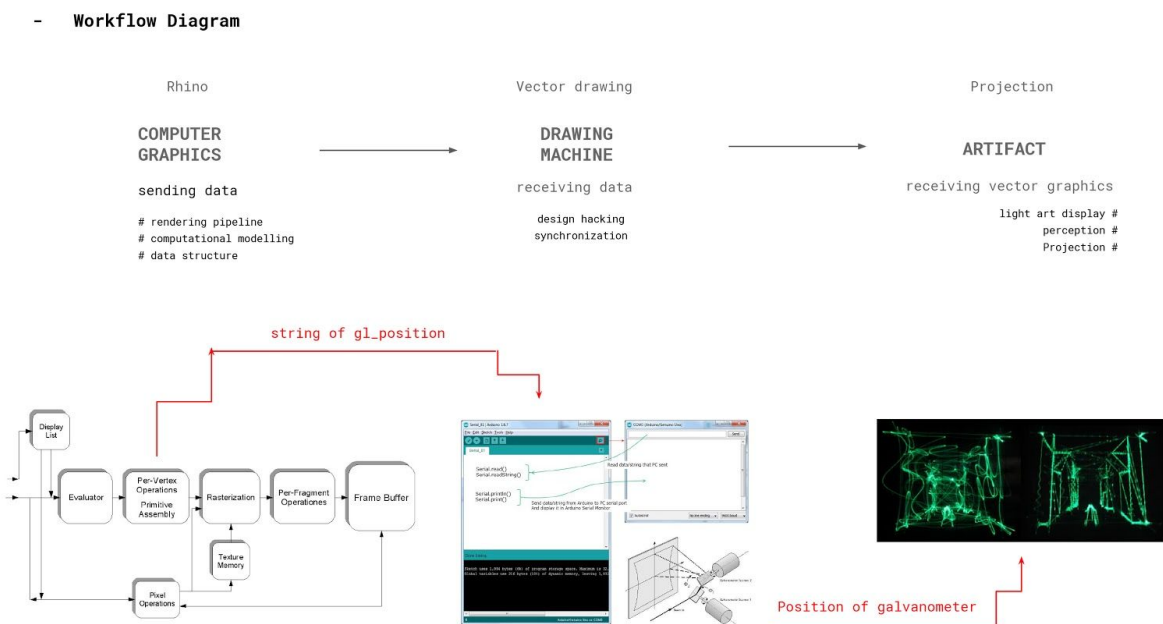
- **Workflow Diagram**

Figure 10. Workflow diagram

The important goal I want to emphasize here again is **the digital production of image in this project is chosen to use the language of vector graphics in order to have low level access to both hardware and digital ends. It's a transparent way to present a personal journey for approaching the technique of "defamiliarization".**

It's <u>Not</u> about describe or illustrate reality.

1) geometry test

Before started buffering data, I tried to test how fast the motor could rotate by communicate with drive directly through uploading drawing by simple geometric function.
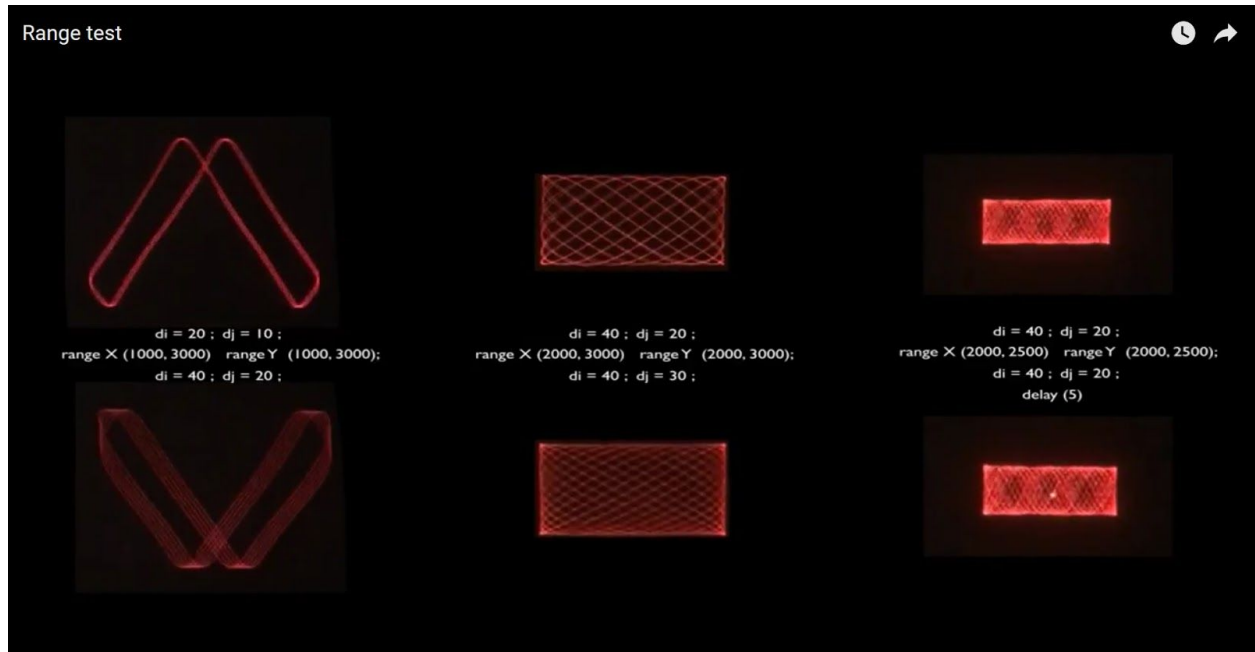
● Range test (figure.11)

Figure 11.Range test

Here I started drawing a diagonal line and send a simple function, then giving slightly shift for the time of x and y position. In the recording video, 3 sets of comparisons are conducted with 3 different sets of factors: the same ratio of position with incremental larger number; the same number with different drawing domain; the same drawing domain with different time of delay. The results are parallel shown the increasing density of lines, represents from line drawing quality to surface, further with the indication of drawing path by adding delay. Since time between the sending the signal and observer perceiving the drawings are so tightly integrated, the motion of multiple lines co-exist within human perception. As a simple test without complex design for the context, it opened up the expectation of how fast the motor and the driver could collaborate, and the variety of results it could produce by changing smaller parameters in the same constrain.
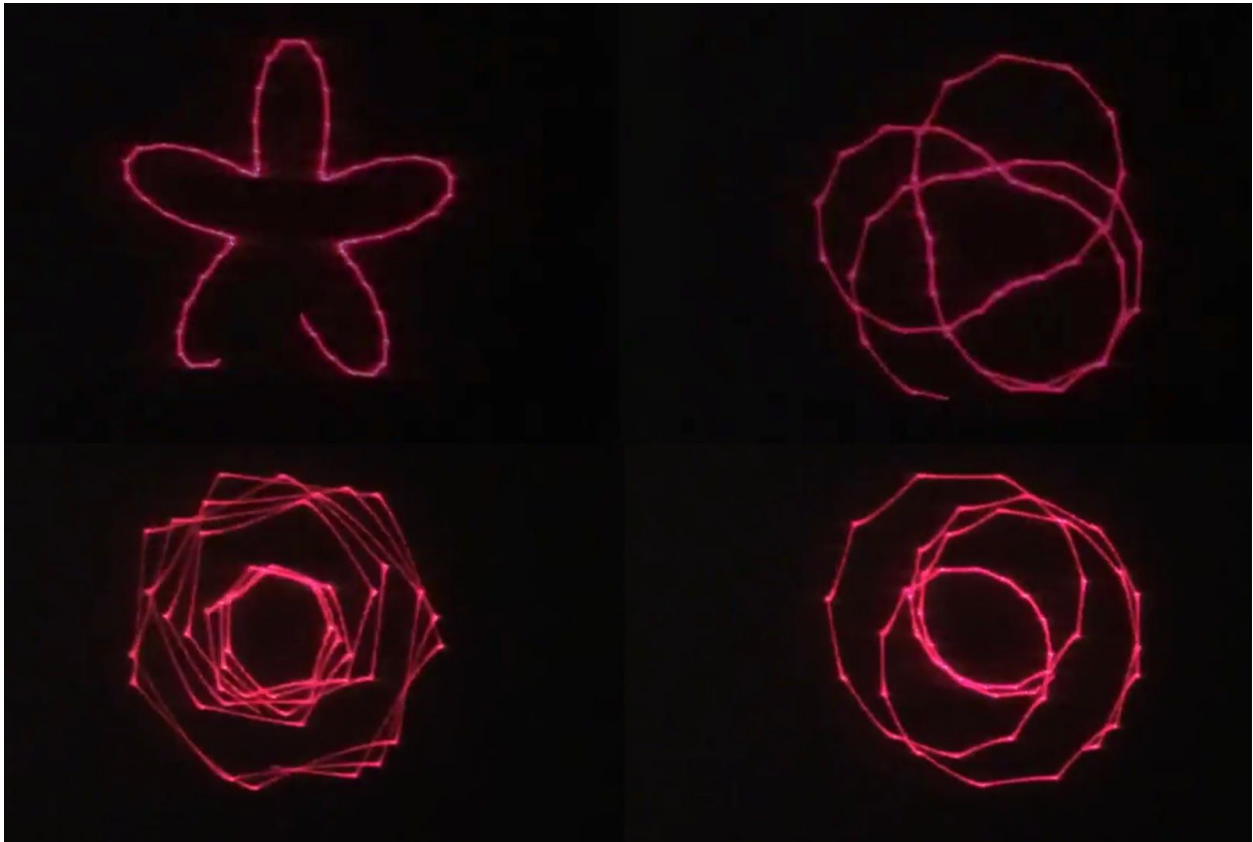
- Loop test (figure.12)

Figure 12. .Loop test

There is a large amount of curve function have been tested through the drawing process, besides the increasing complex of the geometry adding variables for each parameters of its own, one more layer of control was added here. By define the length of the loop, the repetitivity of drawing is determined by how long it needs to be and how fast it could be. In the image above, it shows that within 2 sets of loops, when sending time is 10 time faster and 5 times faster, if seeing through the real life demonstration or video recording, besides the changing of density and complexity, momentarily, there is a very fast overlapping when both images in one set would draw the same result. As soon as time slipped, the difference of the repetitivity is rapidly increasing, it would be seen as complete different drawings .

These exercises are very hard to describe accurately through language or still images, **temporarity,** has being always recognized as a double-edge sword for video art, inevitably featured in

this project as well. For more interesting and compelling test recording, please check my website:

https://www.yuan-mu-design.com/galleryex/

2) projection surface test

This group of tests mainly focus on the demonstrate the character of laser as a light source never lose the intensity through distance and the artifact it will produce on different surface or volume. The transparency of material introduces unexpected quality for laser light, the major tested samples are a few lenses, mosquito net and strings, acrylics with different thickness and hatch pattern. The results shows that when light transmits through those material, the thickness matters more than I predicted. When the material is thick enough to have certain volume, it diffuses the light and blurs out entire image. The image (figure.13) below shows the contrary of projected drawing go through a 5 sequence of panels made by 1/ 4" acrylics, mosquito net on 1/16" , and 1/16" acrylics.
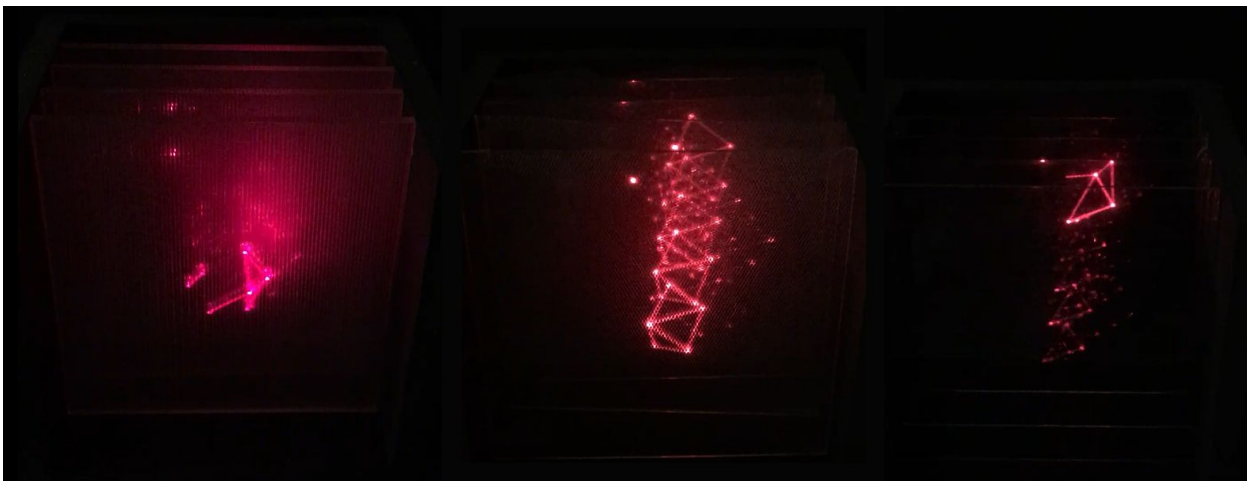

Figure 13. the projected drawing go through a 5 sequence of panels made by 1/ 4" acrylics, mosquito net on 1/16" , and 1/16" acrylics

The final display was set up based on the selective result after material testing. The sequential panels of 1/16" acrylics with the diagonal hatching grid from ¼" to 1/16" spacing represent the most interesting result. The information of drawing is gradually appearing on the panel based on the density of the grid as screen surface. The demonstration in a dark room shows a very close effect as the drawing
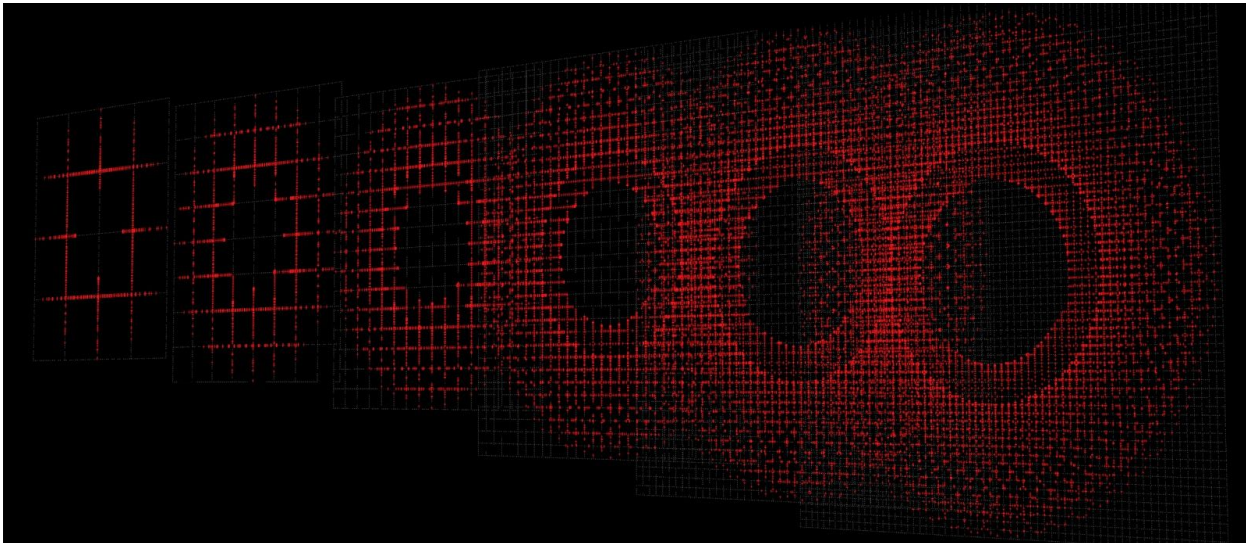
illustrated below (figure.14).

Figure 14. Analysis of ideal visual effects of drawing travels through acrylics panels with different hatch patterns.

3) data buffer

After the first data buffer was established between c# component in grasshopper and arduino, the limitation of the hardware started showing its disadvantage. Since the first machine built on arduino Nano, the memory is quite limited shorten the numbers of point I can upload as well as the strong impact on the delay when image is changing from one frame to another. When the uploading of interpolation points on the drawing is more than the memory could handle, or the time of the change is too fast, the drawings shows as an incomplete figure with partly delay during updating. Even though it still produces certain aesthetics under this constrain, I would like to have a better control for the effects and understand the potential of its visualization. So I decided to make the second machine.

VI.   The second machine

I named both of the machine after their sound, cause it is a indication during demonstration, the pitch and intensity match the complexity of drawing which often got lost during recording due to the background noise. The first one is named *Locust*, since its rough appearance and the way how chaotic of the sounding remind me that insect.

The second one is named *Cicada*, with a compact design as well as the delicate look, it represented stronger design intention as well as referring to a way of well regulated sounding (figure.15).

Figure 15. The compact design for the second machine, Cicada.

I tried to use tenssy to replace arduino Nano to improve not only memory size also the clock speed, however, the fast speed cause problem and crash the interface during the rapid uploading. This feature further on, it's one of the major reason for glitch even with other board. At the end, I decide to use arduino Mega to only increase memory which improved the quality of drawing much more and service its purpose. I also designed and soldered the circuit board and added the ventilation patterns on the side. With almost ¼ size of the first machine, the second one is quite stable since everything is fixed in place, and way easier to be carried around.

Test different categories of drawing potential on the second machine became the main task for the late part of this project. For the content, I mainly choose human face or figure in space as an abstract representation for the drawing itself. The priority here is improve the technique of drawing rather than representing the subjects, I would prefer to have a complete stage for the current result when the journey of project is reaching to the stage of its "Archaic period", leave the development of its content as the narrative as a extension to the Mannerism.

The main improvement here is data optimization and tuning of the gain of the galvo. Through writing the glPosition in hexadecimal number rather than integer, it saves the memory space and increasing the speed and precision during updating. On the other hand, gaining power of the motor distorted the image on X/Y axis, which squeeze diagonal line into a loose curve. Since the usage is industrialized but not common, the collaboration between the code and the hardware took me quite a long time to reach a deeper understanding and more controlled result. Besides the predictable problems of workflow, the balance between data uploading time from grasshopper interface to the moments of sending it to motor are all in microsecond, when the update is too fast, the misalignment cause glitch for a short period which mostly would recover after the reader speed catches up.

This process demonstrated also typical problem for robotic motion. If you send only lines in you won't get a smooth path since motor always need to stop when there is a sharp turn. **Hektor,** the portable spray paint output device for computers in collaboration with engineer Uli Franke by Jurg Lehni for his diploma project in 2002 is one of the best example intersects with this project. The performative aspect of the machine is not a one to one relation, certain design or operation directly link to the result. In my case, you can see from the facial expression drawing collage (figure.16), the center square shows vector line from Rhino, the one on the left shows the ideal result I want to achieve. The rests are different stroke languages I got during collaboration process. Compared to the ideal one which has a bright light dot on each turning point, the other drawing has more cornered turn and and making those images have a hand drawing aesthetics. Compared to Hektor robot which the has the unrealistic side of the spray painting but also keep the nature of the paint itself, the gestural quality of my images regards to the line and points oder. When one part of geometry is complete and move to the next one, the fuzzy lines in-between shows draw order. The shadow drawings of the face(figure.17) illustrate that with a pre-set and sorted drawing path, the amount of crossing-line effect could be avoid, in order not to lead to a misreading of the figure. Moreover, certain delay happens to freeze part of the image when it's updating from frame to frame, as collage of the video of a figure walking up to staircase(figure.18), the left drawing in the middle row, there seems are 2 figures but it's actually the split figure appear at the same time with its delayed image for a short period of time.
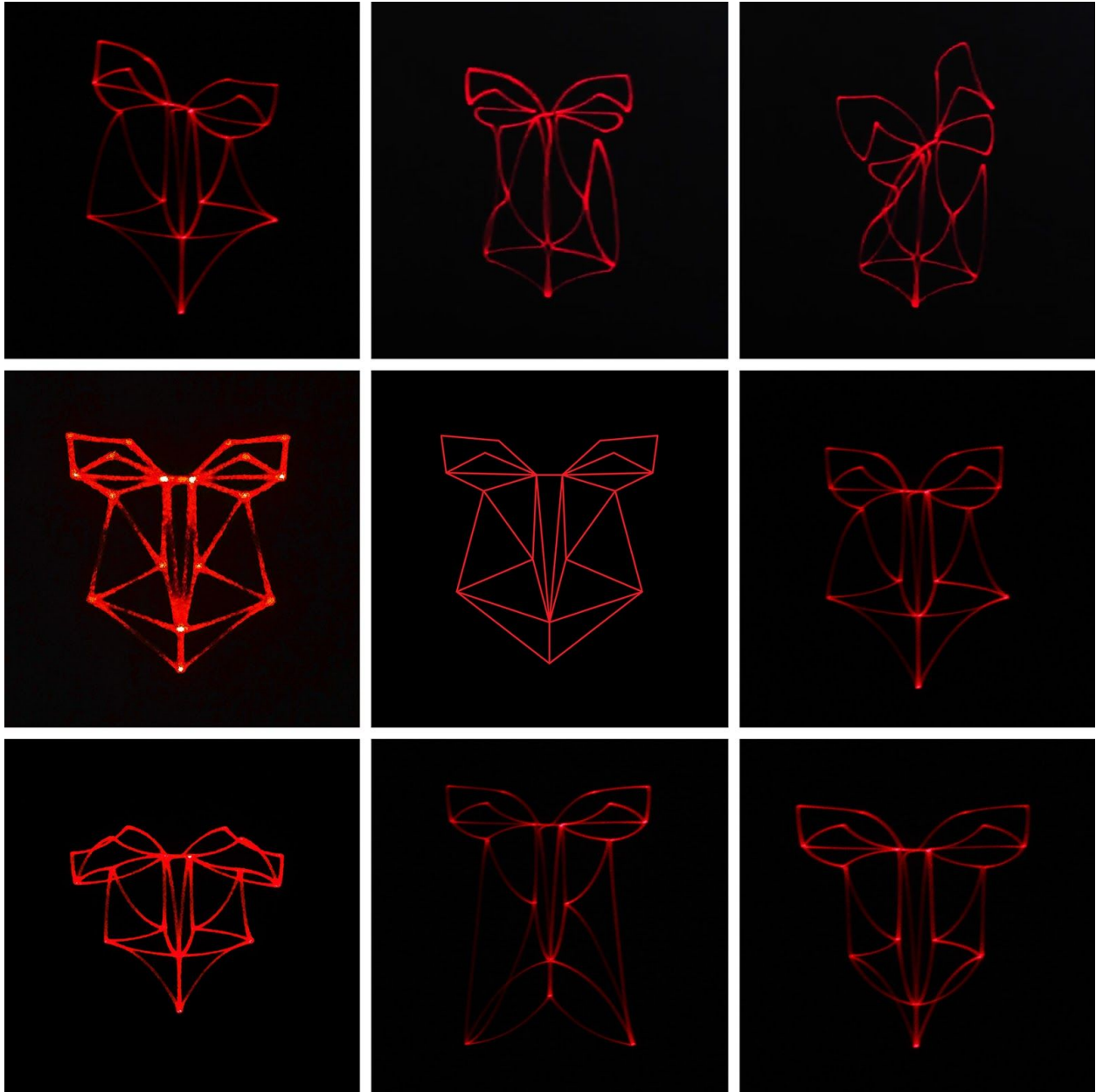
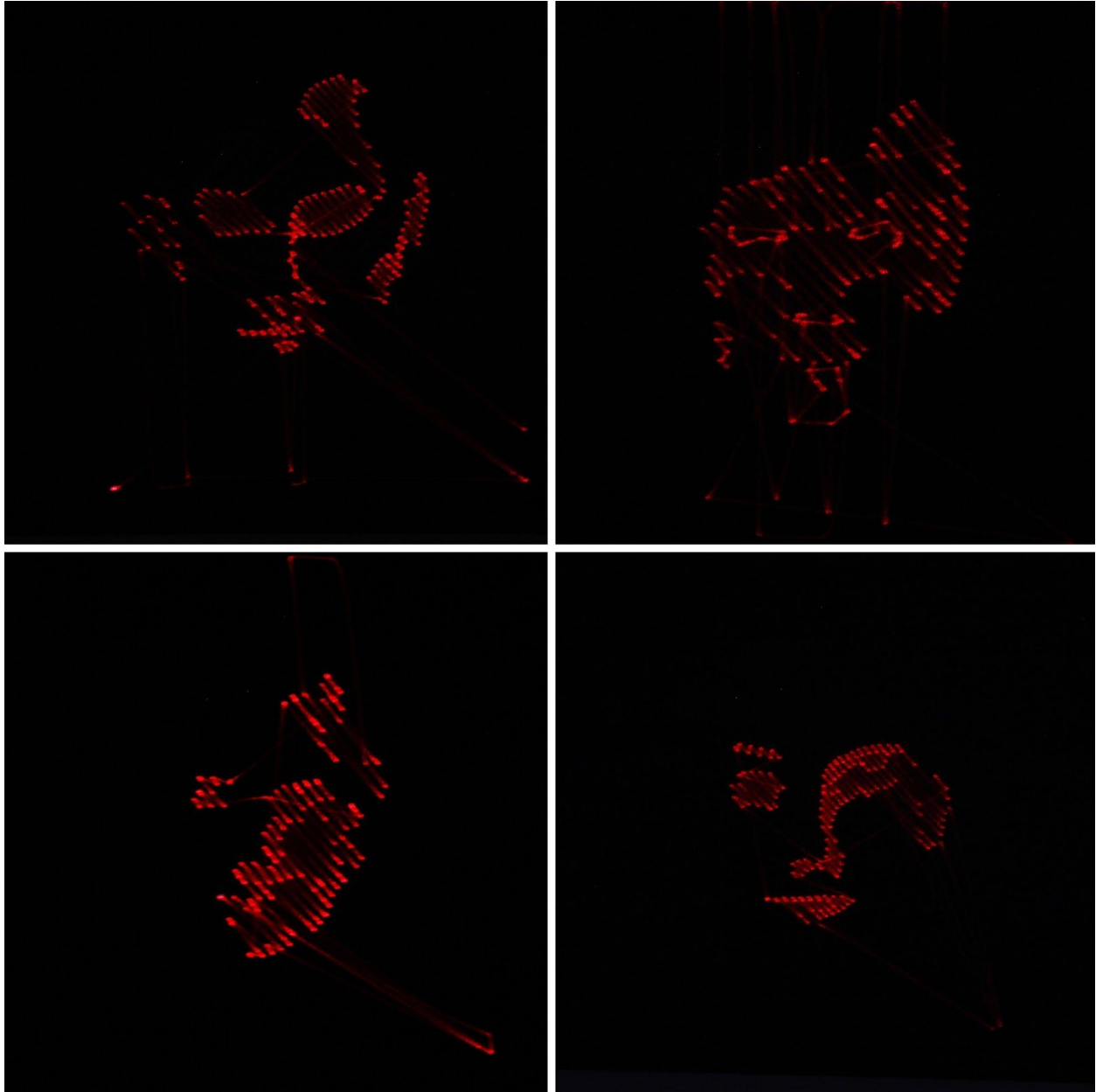Figure 16. Facial expression collage

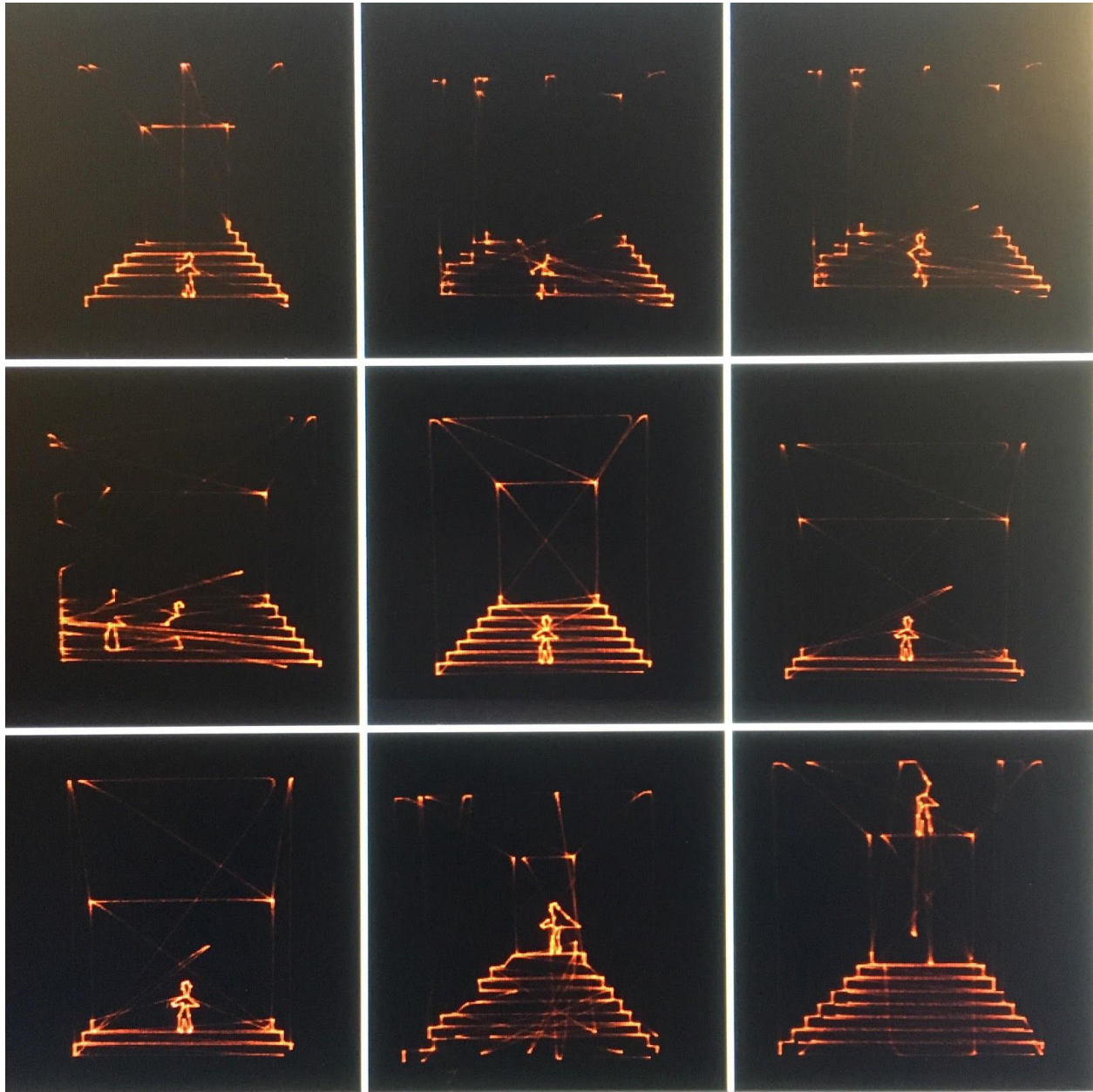Figure 17. Collage of shadow drawing represented by hatching

Figure 18. collage of the video of a figure walking up to staircase

You can see the drawing takes place when it's change from frame to frame, it's all perceived by human eyes even with the flicker effect caused by oscillation. It could not always be captured by camera with full quality of sound and image as the exposure time also add one more fact for this relevant rapid and complex experience.

VII.   *Conclusion*

The production of image always describing how it be made in contrary of highly developed image processing technique. The artificial feature of the laser light along with its reaction to the signal, reveals the functioning of the medium rather than being a imaging device for producing naturalistic quality. It presents two temporalities of the animation : from frame to frame when data updating and the tracing path for the drawing. Within human perception, it's intervening between sound and the sequential images, provides an individual experience of defamiliarization in the time of digital technology.

Bibliography:

1. Witt, Andrew. *Design Hacking: The Machinery of Visual Combinatorics.* Log No.23, pp.17-25 ,Anyone Corporation, 2011.

2. Shklovsky, Viktor. *Art as Technique.* Crawford, 1917.

3. Geng, Jason. *Three-dimensional display technologies.* Advances in Optics and Photonics Vol.5, Issue 4, pp.456-535, OSA Publishing, 2013.

4. DeLanda, Manuel. *A Thousand Years of Nonlinear History.* MIT Press, 1997, Cambridge

5. DeLanda, Manuel. *Philosophy and Simulation: The Emergence of Synthetic Reason,* Bloomsbury Academic, 2011

6. Luhmann, Niklas. translated by Eva M. Knodt, *Art as a Social System (Meridian: Crossing Aesthetics),* Stanford University Press, 2001

7. Gombrich, E.H. *Art and Illusion. A Study in the Psychology of Pictorial Representation.* London: Phaidon 1960

8. Stella, Frank. *Working Space*, Harvard University Press, 1986

9. Rowe, A. *Designing for Engagement in Mixed Reality Experience that Combine Projection Mapping and Camera-Based Interaction,* Digital Creativity, Oct 2013, Page 1-14, Routledge, Abingdon, United Kingdom

10. Nam,J. *A Technology Study on Projection Mapping for Dynamic Object Tracking*, Journal of Arts and Imaging Science, 2015, Vol:2,iss 4

11. Belhumeur,P.N. Hespanha, J.P. Kriegman, D.J. *Eigenfaces vs. Fisherfaces: recognition using class specific linear projection,* IEEE Transactions on Pattern Analysis and Machine Intelligence, Volume:19, Issue:7, Jul 1997,

12. Bingham, E. Mannila, H. *Random Projection in Dimensionality reduction: Applications to Image and text data,* ACM, 2001

13. Azuma ,R.T. *A Survey of Augmented Reality*, Presence: Teleoperators and Virtual Environments, Volume 6, Issue 4, MIT Press, 1997

14. van Krevelen, D.W.F, Poelman R. *A Survey of Augmented Reality Technologies, Applications and Limitations*, The International Journal of Virtual Reality, 2010, 9(2):1-20, IPI Press, Austria

15. Kaufmann, H. Schmalstieg, D. Mathematics and Geometry Education with Collaborative Augmented Reality, Computer Graphics, Volume 27, Issue 3, page 339-345, Elsevier, 2003

16. Bimber, O. Raskar, R. *Spatial Augmented Reality,* CRC Press, 2005,

17. Joo, H. Smith, R. Thomas, B. Park, J. Spatial augmented reality based tangible CAD system, Proceedings of the 18th ACM symposium on virtual reality software and technology, 10 December 2012, pp.207-208, New York

18. Geroimenko, V. *Augmented Reality Art: From an Emerging Technology to a Novel Creative Medium*, Springer International Publish, 2014.4, Joseph A. Matteo. Volumetric Display . *Lecture notes for the Applied Vision and Imaging Systems class at Stanford University*,16 March 2001

19. Blundell, B.G. *3D Displays and Spatial Interaction: Exploring the Science, Art, Evolution, and Use of 3D Technologies,Volume I: From Perception to Technologies,* Walker & Wood Ltd. 2011

20. Van Orden, K. F. and Broyles, J. W. *Visuospatial task performance as a function of two- and three-dimensional display presentation techniques*, Displays, *21*(1), 17-24. 2000