Developed of Chameleon Shape for Kinetic Transforming Shape

[1]You-suk Kim, Eun-seoSong, Sung-dae Hong

Abstract: Background/Objectives: This study describes the production of kinetic sculptures through linear actuators and special frame designs to express the transition between geometric shapes. The transformation of geometric shapes such as cube and quadrangular pyramid is organically progressed, and through this, to express the beauty of the original form. Methods/Statistical analysis: We designed a telescopic type linear actuator, designed a driving part for it, and fabricated a telescopic frame to show the surface of the shape. The use of a microprocessor for fast encoder control and a communication protocol for controlling each module were made. In addition, a unique frame structure has been created to express the motion of the expanding and contracting actuator in three dimensions. Findings: Each telescopic linear actuator module has a length of 1m, extends up to 2m and has a lifting power of about 5kg. A real-time programming tool can be used to organically command each transformation so that each module can be controlled at 1-cm intervals through a communication protocol. The ball joint and telescopic frames are designed to accommodate the motion of each actuator and can represent the transition between geometric shapes. Improvements/Applications: The Chameleon shape is a kinetic fixture, designed to represent basic geometric shapes such as cube and quadrilateral, and to organize each transition. There is a high possibility of developing into a kinetic display or a new type of physical expression device.

Keywords: shape shifting installation, kinetic display, physical display, morphological transition, shape deformation

I. INTRODUCTION

The Chameleon shape is a kinetic fixture that represents a complete 3D transformation in the 2.5D method of traditional pin-screen[1] physical displays[2].The Chameleon surface[Fig 1] is a 2.5D physical display, designed for a variety of performances and media facades. It has a stereoscopic movement on a flat or curved surface using about 400 telescopic type actuators and a special shrinkable screen[3]. It is a large media platform for multi-projection on the screen to reproduce more realistic contents[4].

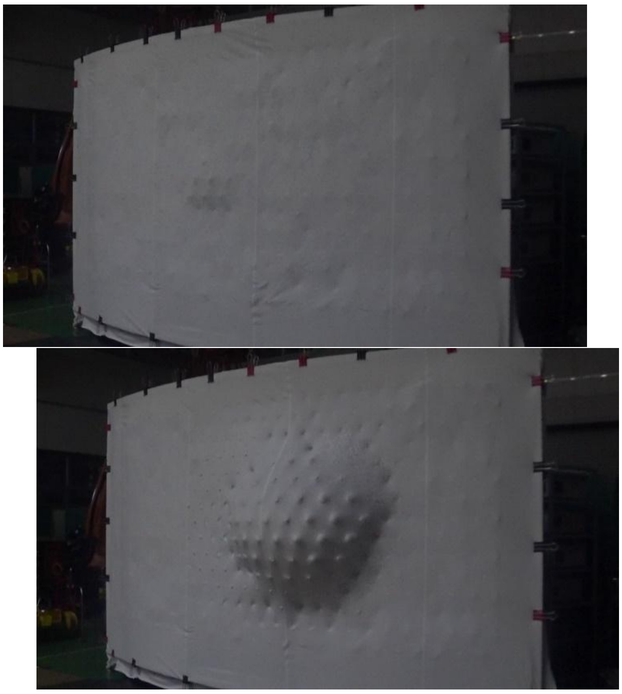

Fig 1. Chameleon Surface Hardware Testing

However, the chameleon surface has a 360 degree viewpoint because it is a structure that only forms a depth reduction based on a plane. In order to complement these points and pursue more fundamental beauty, I came to the idea of chameleon shape. The Chameleon shape is a nine-telescopic stereoscopic sculpture, which primarily embodies the transformation of cubes and quadrangular pyramids. Each geometric shape is a morphological minimal unit that forms a solid. The conversion between these geometric objects represents the structure of the module as the smallest unit that constitutes an object. Through the morphological transformation of these modules, the virtual form is projected into the actual space.[5] Without the use of such actuators, a typical representation of the works at the form of the transition to spring from a variety of perspectives is the Dark Matter of the Troika[6,7].

Dark Matter is one of Troika's perspective sculptures series which is shown in Fig 2, which is an installation that looks like a circle, hexagon, or rectangle depending on the viewer's position. Troika refers to this as realization of objects implemented on a computer. The chameleon shape is not meant to be a change from the point of view, but to illustrate the process in which the form itself changes. It is not dependent on the point of view, but the changing object is in reality, so the audience can feel the same change from any point of view.

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You-suk Kim, VR Future Fusion Center,Seokyeong-ro, Seongbuk-gu, 02717 Republic of Korea

Eun-seo Song, VR Future Fusion Center,Seokyeong-ro, Seongbuk-gu, 02717 Republic of Korea

Sund-dae Hong, Corresponding author, associate Professor, Dept. of Film and Digital Media of Seokyong University,Seokyeong-ro, Seongbuk-gu, 02717 Republic of Korea

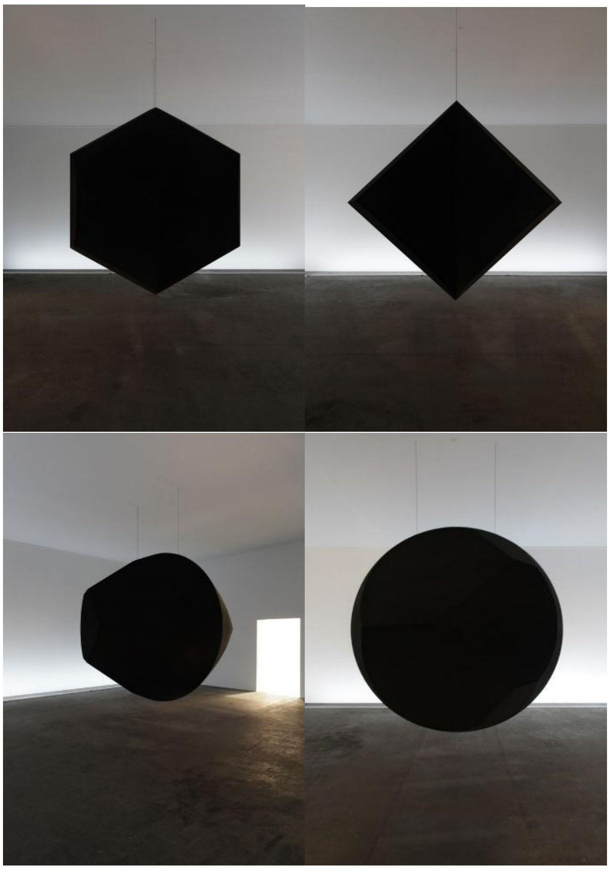


Fig 2. Troika – Dark Matter 2014

II. CHAMELEON SHAPE

The Chameleon shape is made through several frame designs. The structure of the nine telescopic linear actuator modules was designed, and the frame structure was designed considering the layout that best suited to express each shape. It is initially designed for a structure that can be combined with the direction that the tree can support to make the frame from the wood material[Fig 3].

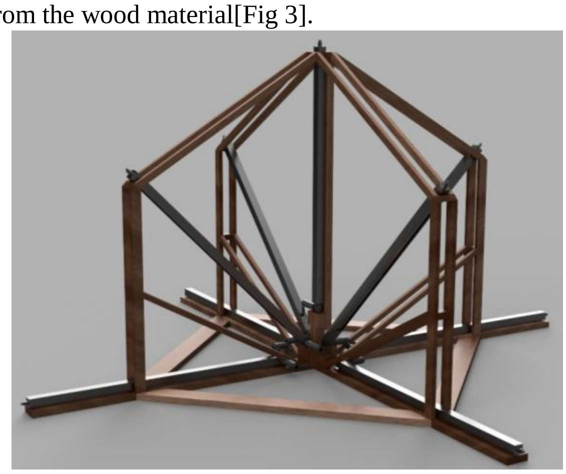


Fig 3. Wooden Frame Design

However, in order to compensate for the weight of the telescopic linear actuator, vibration during operation, and trembling, it was redesigned by steel material. The structure of the Chameleon shape made of iron is designed to be disassembled and assembled[Fig 4] so that it has mobility and has no vibration or distortion. It also maintains a minimum structure so that the telescopic frame does not interfere with the transition between forms.

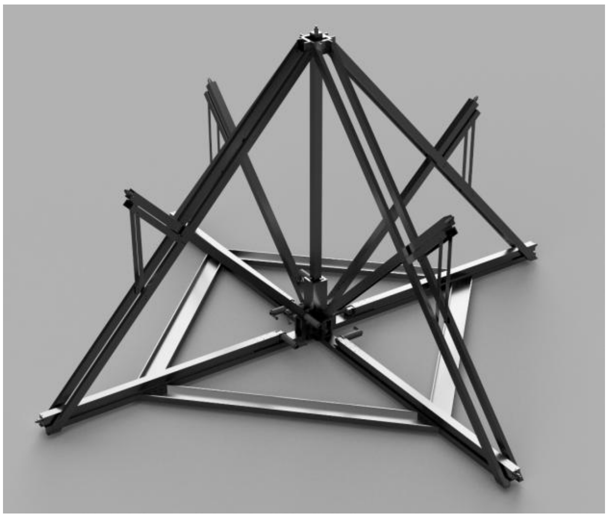
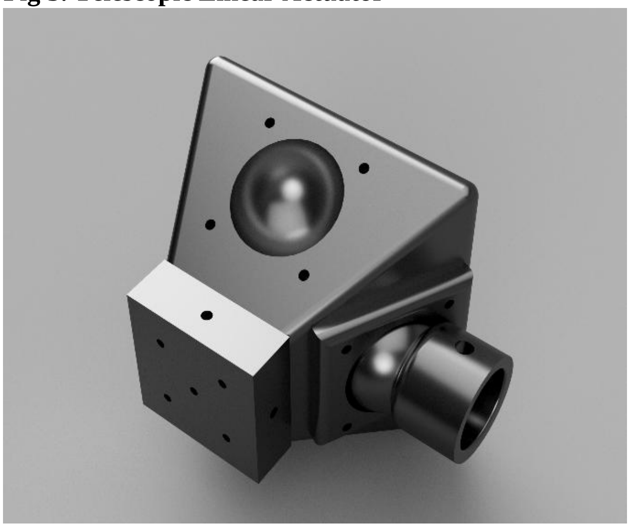


Fig 4. Steel Frame Design

Now let's look at how to control the structure and hardware of each part. First, we will look at the actuator module first, and secondly, we will describe various design processes for designing the frame to expand and contract. Finally, we examine the structure of the software and the real-time control process for organically driving each module.

2.1. Telescopic Linear Actuator

Fig 5. Telescopic Linear Actuator



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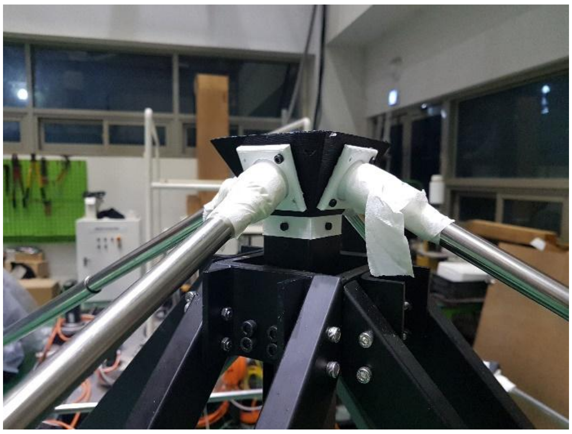

Fig 6. Ball Joint Module, Installed Structure

The telescopic linear actuator[Fig 5] has a frame length of 1000mm and is designed to be able to expand to 1000mm. It uses a 24V 60W DC motor and has a torque of 5kg. It has enough power. It has precise and less vibration motion through LM guide and timing belt structure. It is designed to enable position control with precise distance by attaching encoder of 512 steps per revolution. In order to prevent dropping of the encoder step due to the low speed of the existing Arduino 8-bit MCU[8], the encoder drop is prevented by using Teensy which uses the 32-bit MCU[9], and accurate position control is possible. Each module is connected to 24V SMPS, 200W motor driver and Teensy board, so that it can be controlled by communication.

2.2. Telescopic Frame Design

The telescopic frame is composed of a ball joint module and a rod, so that it can be flexibly stretched and rotated when each type is changed. The ball joint module was fabricated by 3D printing and the rods were constructed using 2T and 1.7T stainless steel pipes[Fig 6]. Telescopic frames are needed for multi-projection screens in the future. It was designed to prevent sagging of the shrunk screen and to naturally form the edges of each geometric shape. For more organic forms rather than polygonal geometric shapes, flexible materials such as rubber strips are possible, not just solid stainless materials.

2.3. Software Design

The software can be divided into two parts: the communication part and the positioning control part. First, the communication section has three hardware serial ports because each of the nine modules is equipped with a teensy board. The individual connection speed has a speed of 260400bps for smooth movement, and it operates by receiving ID, distance, and torque information from the master board. In addition, each module transmits the ID and the current position to the master so that it can be controlled in real time. When looking at the height, the chameleon shape consisting of one actuator at the first stage, four at the second stage and four at the third stage has a separate ID so that each stage can be controlled simultaneously. In order to eliminate the delay caused by the serial communication, the group ID is separately designated in addition to the individual ID. Each protocol has a start bit and an end bit, and is constructed by parsing and distinguishing data.

Using the max / msp jitter[10], a real-time programming environment, each module is controlled in units of cm. max / msp jitter is connected to the master teensy board and supports serial communication to control each module, and provides a quick and smooth experiment environment when prototyping. The following[Fig 7] is the code for the computer part created using max / msp jitter, and it shows that it is simple and simple structure.

Since the connection between the computer and the master board does not require a fast speed, it maintains a generous serial buffer using 9600 bps. The upper part is a part for transmitting the distance specifying the quadrangular pyramid and the cube by the group ID, and is designed to be repeated at 15 cm intervals starting from the initial setting of 5 cm. Delay 100ms is used to reduce errors in the serial data, and at the upper right is a code that allows you to change the mode once every 15 seconds. The lower part is created so that each ID can be individually controlled. We used the numeric box to set the ID, distance, and torque, and we continuously tested the completeness of the motion through individual control. Since the module is designed to be capable of various presentation through the above structure and capable of both sequential control and integrated control, various conversion methods can be changed in real time in the geometric type conversion process

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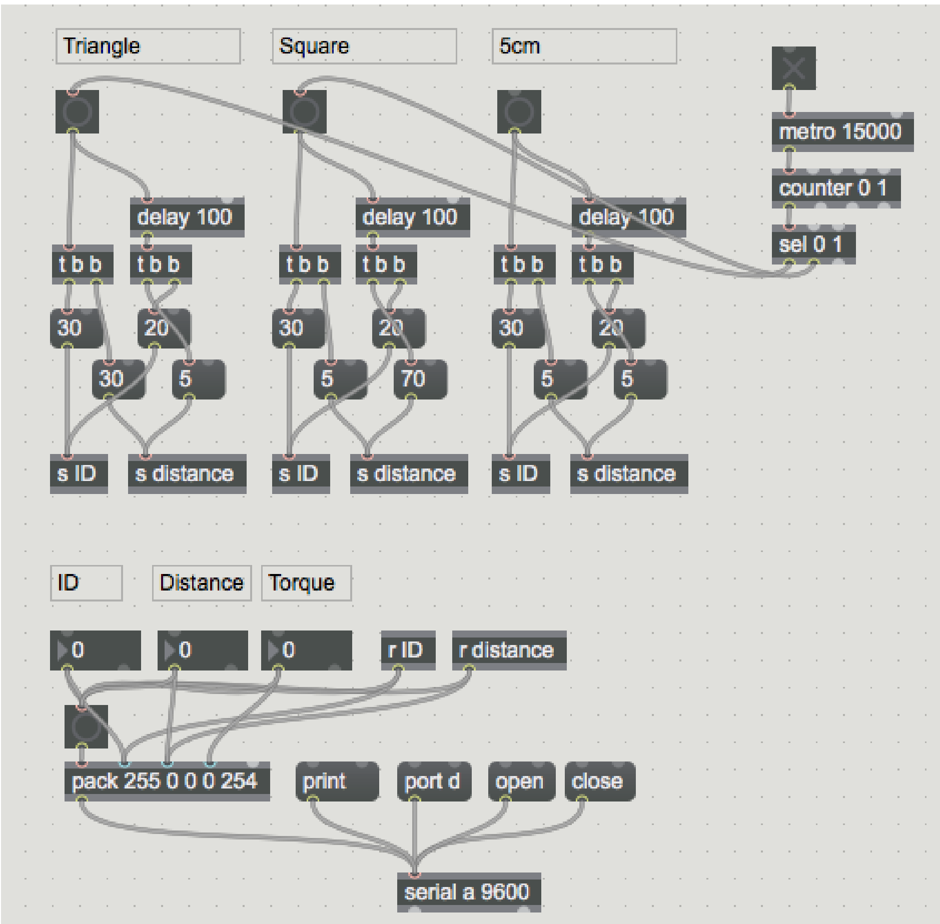

Fig 7. Realtime programming Environment using max / msp jitter.

III. RESULTS AND DISCUSSION

Fig 8. Installed Structure and Actuator Operating Modules

As shown in the above image[Fig 8], both the ball joint module and the telescopic frame were mounted, and the actuator module was driven. As a result of the execution, we obtained some speed difference and improved ball joint due to the load between the actuators. The ball joints will be modified to recognize that the angles of the bar and joint interfaces need to be modified in case of two stages, and in case of speed difference, the current 1cm step communication configuration is modified to 1mm step, try to calibrate in the direction of adjustment. In addition, the actuator drive module is manufactured using a breadboard for rapid prototyping. However, after the stabilization operation, a separate board is manufactured and completed.In addition, the company plans to use a specially-made screen with strong elasticity, but plans are underway to maximize the visual effect by using black light instead of each ball joint module with a stretchable fluorescent cloth. It is believed that the display of the process of slowly varying the shape of the luminous body in the dark can increase the possibility of display effect and display.

IV. CONCLUSION

The kinetic installation work, which is a physical display like a chameleon shape, is designed to give different visual effects by using the theme of volume sense and shape transformation in the movement-oriented kinetic art characteristic. Respectively. In the case of this chameleon shape, though it is a structure with a strong artistic tendency, it can be utilized as a physical kinetic display that can be installed in a media façade or an open space by utilizing such technology and contents. In order to make more various types of transformation and transformation, we can construct a smooth shape by adding more vertices and more vertices on the ground.

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