Sensory Illusion beyond Real Haptics

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Keywords: Haptic, Illusion, Neuro Science, Design, VR

ABSTRACT
'DigitalHaptics™' is the world first invention of illusionary haptics technology, developed originally by AIST based on Neuro Science. It realized many miracle haptics such as Pushing, Pulling, Texture, and Softness in the Air, and theoretically enables the almost all kinds of haptic feeling, as the same as visual composition of RGB.

1 INTRODUCTION

Recently, Haptics is being expected as the innovative key technology in the various application field such as entertainment, IT, automotive, medical, welfare, and especially in XR/VR/AR.

Exactly now, paradigm shift can be seen like rising above the water surface, from the legacy alarming haptics use (ex. mobile), to the realistic haptics use in actual (ex. UX). For example, display, operation device, switching device, and speaker in automotive field has been changing from analog to digital, as same as the turbulent period of digitalization have passed through, in the previous applicant and information terminal.

In that situation, the attractive topic to innovatively renewal the legacy devices is Digital Haptics Technology (DigitalHaptics™）.

There is a story 'Success on Kinesthetic Force Feeling means King of Haptics', because the realization of Kinesthetic Force Feeling (hereafter, Force Feeling) in the midair was very difficult comparing with tactile feeling. Actually, Force Feeling was very significantly sensitive and strict to device's size and power consumption, especially in consumer product.

Clearance of the problem on Force Feeling means the significance in haptics, similar to the invention of blue LED for three primary colors.

The solution have been being proposed slowly, for example, variety of special waveform patterns produce the exciting effect on the haptics, especially kinesthetic force feeling such as pushing, pulling force feedback, which actually doesn't exist physically. The effective phenomena of pattern was being searched based on neuro science for more than 20 years and has been invented by AIST originally to be registered as fundamental haptics patents broadly (3DHaptics™).

That exciting effect of the sense was driven by the non-linear waveform pattern, through sensory non-linearity. Those patents cover all the waveform pattern except a sinusoidal wave (sine wave), for example, accelerated and decelerated waveform, compound of sine wave of different frequencies, modulated waveform, and which also covers the technology of haptics illusion.

That haptics technology (DigitalHaptics™） which realized expressive full realistic haptics by specific characteristics using these waveform patterns. Figure 1 (Right) shows '4D Space Navigator' which is the world first haptics device enables interactive input and output of haptic information in space, by reproducing the feeling of three primary feeling using with 9 axis information of position and posture, and haptics database.

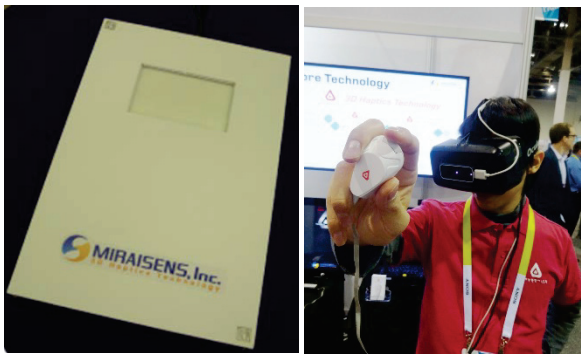

Fig. 1 Digital Haptics Era,
Haptic Feedback Touch Panel and Controller

2 HIGH DEFINITION REQUIRE IN MARKET

The physical characteristics of vibration and force depend on physical rule such as the force generation by changing momentum and Newton's 3rd law of motion (action and reaction force).

The all haptic interfaces such as Grove-Type, Grip-Type, Wrist-Type, Shoe-Type, and Vest-Type, which use the technology reproducing physical amount of vibration and force feedback, can't be free from the strict limitation and the problem of device size and power consumption.

The reproduction of physical amount, and the reproduction of sensory amount are quite different meaning. The representation based on reproduction of

sensory amount is now focused on world-widely in many fields, especially in illusionary application and digitalization fields.

Fig. 2 Sensory Reproduction Haptics based on Neuro Science Hannover Messe CeBIT2017, Germany

In the actual action of touching and operating, 1) Pressure Feeling for reaching and getting to touch, 2) Position Information and Haptics Feeling to recognize the shape and condition of surface, and 3) Kinesthetic Force Feedback Feeling to recognize the presence and viscous & elastic condition of inside the object, are very important.

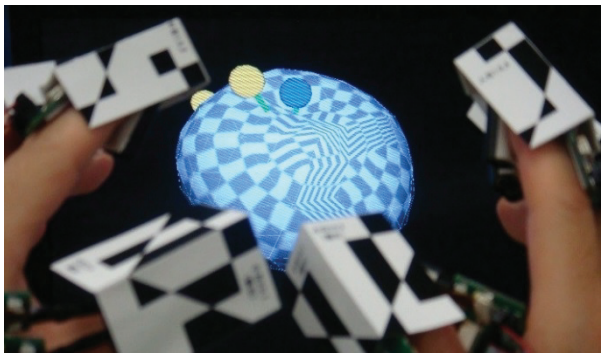

FIG. 3 Presence And Operation Feeling With Haptics (I³SPACE X, AIST)

3 LIMITATION OF PHYSICAL REPRODUCIBILITY

Almost all of the non-grounded-base-type haptic devices can't make external force feedback feeling enough.

However, it is focused on the full reality of the haptics to present haptic feeling in the midair along with the human's natural behavior and operation, even the previous force feedback is mainly produced by the reaction force from the supporting system based on the ground such as robotic-arm.

On the other hand, the haptics illusion technology can reproduce touch feeling in the midair, where no object and device, to induces the three primary feeling such as 'Pressure Feeling', 'Tactile Feeling', and 'Kinesthetic Force Feeling' which generate any kind of texture feeling and reaction force feeling (Fig.). Actually, the feeling doesn't exist physically, but is induced in sensory by using non-linear or hysteric characteristics of the sense and material.

Our many prototypes were exhibited in International Consumer Electronics Show in Las Vegas. Figure shows one of the prototype 'Haptic VR'.

The prototype has realized the representation of haptics feeling beyond physical laws. Especially, Force Feeling presents touch feeling and UX realistically as if there would exit something but nothing physically.

Fig. 4 '3DHaptics VR'

4 HAPTICS DESIGN

The paradigm is getting mainstream, whose haptics design has designing approach on subjective and sensitivity.

For example, Tactile Feeling in the midair can't reproduce enough only with vibration, because realistic representation needs an appropriate mixing of Pressure Feeling and vibration feeling. That is, the haptics design is very important in the actual usage of the infinite mixing pattern to represent the UX world.

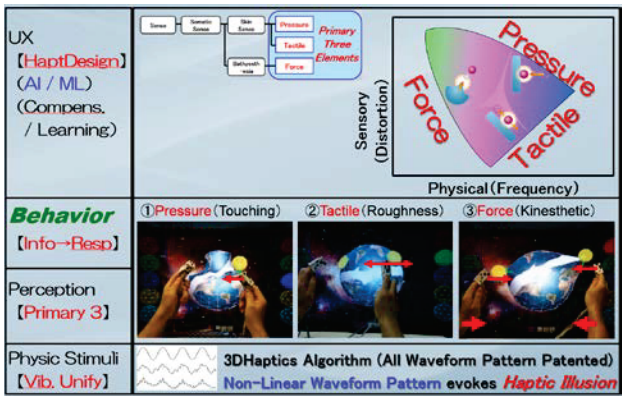

FIG. 5 Haptic Design Architecture

In the application, useful haptics development kits has released. For the example, haptics SDK released by Miraisens,.inc supports developing with the hardware, haptic database, and software with license of application and fundamental patent, which can easily detect and prove patent infringement. Figure show a digest of TECHNICAL WHITE PAPER [2] about useful information and the patents.

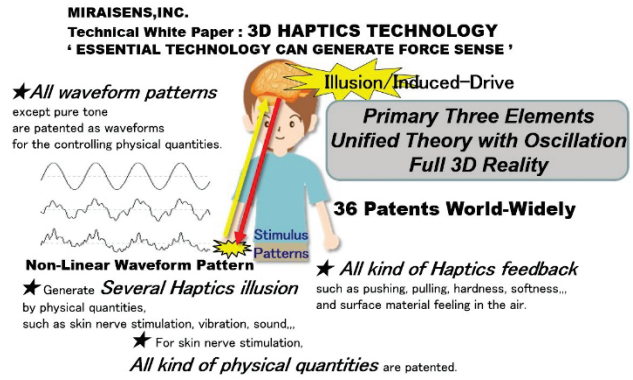

FIG. 6 Patent Portfolio, TECHNICAL WHITE PAPER

Haptic Sensory Illusion promotes the quick realization of realistic UX product and service, not only in research laboratory but also in real lifestyle. DigitalHaptics™ is the development environment system which supports the haptics designing on the concept for quick prototype developing and evaluation as a lean productization cycle.

FIG. 7 Haptic Development Environment

5 CONCLUSIONS

'DigitalHaptics™' realized many miracle haptics such as Pushing, Pulling, Texture, and Softness in the Air, and theoretically enables the almost all kinds of haptic feeling, as the same as visual composition of RGB. It theoretically enables the presentation of the almost all kinds of haptic feeling, based on the theory of three primary feelings of haptics.

DigitalHaptics™ covers patent portfolio widely and strongly and supplies industrial implementation technology and SDK tools from Miraisens, Inc. to the world, which promotes the world first commercialization of 3DHaptics UX, by supporting the developers.

REFERENCES

[1] N. Nakamura, et al., SIGGRAPH2005, Posters Article No. 92 (2005).

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