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Artworks: **WAVO: an interactive ball to express light waves with Wave equation**

Abstract:
WAVO consists of a PoSC micro-computer, an accelerometer and a 16x16 matrix LED and express moving waves with LED. These waves are calculated by Wave Equation in real-time. Therefore, people can feel beautiful moving of lights which this equation makes. Yet, people can enjoy wave interaction as WAVO has an accelerometer. Interacting with people, this art work notices them fascinating aspects of mathematics.

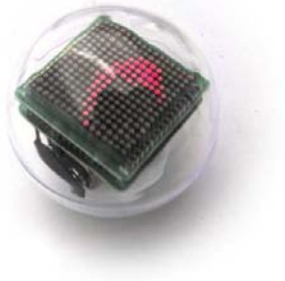

Fig.1 WAVO

I'll put them all (6 pieces) such as the following picture. I'm going to stay the exhibition space as long as I can.

Fig.2 Exhibition Example

A space to install a 1.5 m x 1.5m table. It isn't need a big space because just putting 6 pieces of 8cm diameter capsules on a table. If possible, floor is soft surface such as carpet mat because I'm a little worried about falling WAVOs when audiences touch them.

Topic: Art

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WAVO: an interactive ball to express light waves with Wave equation

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Abstract

WAVO is an interactive ball to display a wave with LED touching by audiences. Wave is calculated with Wave Equation. This pieces had already been shown in many places. And not only ordinal people but also a mathematician gave a comment. As the result, mathematic visualization is important to see equations work certainly. Additionally, making mathematics as art has an advantage to show ideal phenomena of equation to ordinal people effectively.

1. Introduction

WAVO is an interactive ball to display a wave with LED touching by audiences. Wave is calculated with Wave Equation.(Fig.1) It consists of a PSoC micro-computer (CY8C29466), a 16x16 matrix LED (C-2AA0SRD), an accelerometer (KMX52-1050), a 4-16 line decoder (74HC154), 330 Ohm resisters, a 5 voltage 3-Terminal regulator and a switch. All parts are on two stack circuit boards. A matrix LED is put on the upper board. The other parts are put on the lower. And, there is a 9 voltage cell battery at the bottom. This battery acts a role of the weight, so that WAVO swings like a pendulum when an audience pushes it on a table. In a 16x16 matrix LED the anode common side (row) is controlled in PWM connected to a PSoC micro-computer, and the cathode common side (column) is connected though a 4-16 line decoder for dynamic drive blinking. The LED can display 16x16=256pixels, 32 steps of brightness updating 30 frames per second. The colour is red only because there was no other matrix LED in this proper size except it. An accelerometer which gets an audience's action is connected to a PSoC micro-computer. A clear sphere capsule is made from acrylic. This has been selected the proper case for aesthetics.

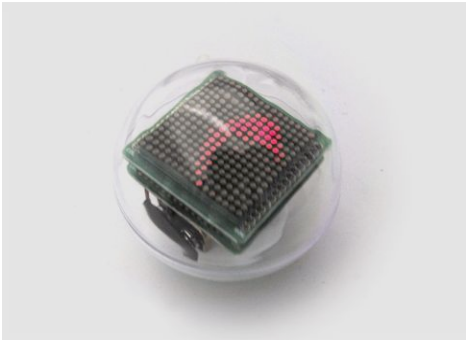

Fig 1: WAVO

2. Related Works

Moriwaki's "Rayo=Graphy" [1] is a big board hanging on wall, attached many LEDs and light sensors in a grid pattern. Each LED turn off if there is a light and turn on if not. Therefore, an audience's shadow shines when he/she stands in front of it.(Fig.2)

Kimoto's "Imaginary·Numbers" [2] is computer graphics generated dots made with one of non-liner dynamics formulas. We can see wonderful images generated by numbers. (Fig.3)

Hiruta's "Mr. Rolling" [3] is a 80 mm diameter cylinder displaying a human abstract character on a red LED. This abstract character, "Mr. Rolling" is animated comically in the cylinder. Once an audience pushes it, it rolls like a car wheel and "Mr. Rolling" begins to run inside like a hamster. (Fig.4)

Fig 2: Rayo=Graphy[1]

Fig 3: Imaginary·Numbers[2]

Fig 4: Mr. Rolling[3]

3. Wave Equation

Wave equation is a partial differential equation which describes the diffusion of waves. Wave equation in two dimension is expressed as follows; [4]

$$\frac{\partial^2 u}{\partial t^2} = v^2 \left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} \right) \quad (1)$$

In WAVO, there is a virtual dot which moves on the matrix LED surface sensing a tilt with an accelerometer. The micro-computer calculates wave topological values made by this dot with Wave equation. Then, WAVO expresses the light water surface mapping wave values to LED brightness.

4. Interview with Mathematician

Not Only ordinal people but also a mathematician who researches Nonlinear Wave Equations appreciated WAVO. He mentioned that he had a confident about reliability of Mathematics.

As he said, "Mathematics is considered just in an ideal world. And mathematicians are interested in not making new equations but certifications to combine equations."

It means mathematicians can deal with any phenomena even from the end of universe to the beginning of time. However they can't certify their equations works in the real world because they can't see these phenomena in their real eyes. Therefore, they have a confident when something real to simulate with equations works certainly.

5. Art and Mathematics

Mathematics expresses all phenomena. They are not only physical dynamics in our daily life. It can expresses the vision of end of universe, the beginning of time and so on.

Basically, however, it is so difficult to imagine them in our vision because mathematics just uses “number”. Visualization is one of good way to understand the result of calculation. It may be enough to certify equations. Additionally, showing mathematics as an art piece helps to imagine it for not professionals but ordinal people well. WAVO has shown the ideal wave phenomenon with an accelerometer effectively. This effect is one of advantages about the art with mathematics called Generative Art.

Acknowledgement

I'd like to say thanks to Dr. Hiroyuki Takamura, my colleague who researches Nonlinear Wave Equations, for the interview.

Fig 5: Exhibition

References

[1] Moriwaki, H., rayo=graphy, 1580x2700(mm) (1990).

[2] Kimoto, K., Imaginary·Numbers, Kousakusha, (2003).

[3] Hiruta, S., Mr.Rolling, 80x80x50(mm) (2007).

[4] Sudo, S., Physical Mathematics One Point vol.9, KYORITSU SHUPPAN CO., LTD, (2002).