BelliesWave:
Color and Shape Changing Pixels Using Bilayer Rubber Membranes

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Figure 1: *BelliesWave*

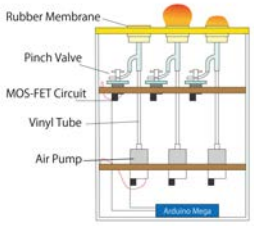

Figure 2: *A Basic Principle of Color and Shape Changing*

Figure 3: *MultiColor Pixels*

1 Introduction

Light-emitting displays such as a liquid crystal display or a projector are common display devices in our daily lives which present information by changing each pixels color at high speed. Meanwhile, the amount of research regarding displays or pixel expressions with material substances are increasing: a flat display expressing information by controlling the materials color [Hashida et al. 2011], and a volumetric display with three-dimensional information such as height or volume using kinetic constructions [Follmer et al. 2013]. In this paper, we propose a new dynamic display called BelliesWave (Figure.1). BelliesWave has substantial pixels, which can transform both its volume and color dynamically by using their materialities.

2 BelliesWave

We explain technical contributions of this research. First, we developed a new expression method that can present both volume and color information simultaneously. In this system, we use rubber membranes that change color when blown up (Figure 2). Each membrane consists of two different colored layers, one on the inside and the other on the outside. At a regular state, only the outer layer is exposed and the balloon appears as a single color. When it is blown up, the inner layer will gradually become visible through the outer layer, and the balloon will turn into a gradient mix of both of the layers.

Second, we have developed a new display system which presents color transitions through volumetric changes in each pixel. In the current implementation, we neatly arranged 19 of these automoving membranes on a plane to create our original display. It is novel that this system can change information by adjusting the material colors of each pixel as well as their volume, not by light emission as in usual LCDs. Air pumps are used to send air into the drum-like frames. Pinch valves are applied to open and shut the branch tube and store or release air from each pixel. BelliesWave can inflate each pixel separately or move the pixels in specific patterns like a wave or a spiral. By managing the pumps at an interval of seconds and controlling the volume with the valves, we are able to create rhythmical color transformations on the display.

Third, by applying this mechanism, we propose a multi-color volumetric display (Figure 3). If we use a membrane which has a specic pair of layer colors, it is possible to make RGB rubber pixels. We have coated balloon rubber with white latex to created tree types of pixels which have a outer layer of white and a inner layer of red, green or blue. When applying these rubber sheets in this system the displays surface will appear to be white at first, until the pixels swell and reveal the inner layers color. By combining these 3 pixels, we can express RGB color information. In the future, we believe, by controlling the volumes of these RGB pixels, BelliesWave will be able to output multi-color information.

3 Conclusion and Future Work

We implemented the system as stated above, and enabled the display to express various information. The remarkable element of BelliesWave is that it ordinarily appears as a at plane surface, however it can present both volumetric information and multicolor information. We are considering that the pixels of BelliesWave system can be embedded into different types of surfaces such as tabletops and walls. The appearance of swelling membranes resemble tiny bellies and they tempt the viewers to touch or poke them. For future applications, we are planning to make our display interactive by linking it with gestures or tangible inputs.

References

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SIGGRAPH 2014, August 10 – 14, 2014, Vancouver, British Columbia, Canada.

ACM 978-1-4503-2958-3/14/08