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印刷物への映像重畳による視線誘導に向けた基礎検討

A Study on Overlaying Modified Images onto Unmodified Prints towards Implicit Visual Guidance

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概要: 本研究では、ユーザに気づかれない視線誘導を実空間で行うことを目的とした映像重畳手法の検討を行う。人の視覚の特性から、視野内の色彩や形状を制御することで視線誘導を行う事が考えられる。本研究では、彩度変化に基づくターゲット発見のタスク完了時間と錯視現象に基づく形状知覚の距離依存性について予備的検証をおこない、手法開発の方向性についての議論を行った。今後はユーザの視線を本人に気づかれることなく介入することができる手法開発を目指す。

キーワード： Visual Guidance, Behavioral Change, Projection Mapping, Saturation, Glass Pattern

1. Introduction

In the information age, there are countless ways to receive information. There are visual, auditory, olfaction, and even sensational. However, many environments require absolute silence and minimal distractions. Places such as galleries, exhibitions, operating rooms, and care facilities prohibit loud noises and vital alerts to maintain a serene or focused atmosphere. While standard solutions like text messages and phone calls are often used, we explored the possibility of employing faster and more straightforward methods suitable for environments demanding muted communication.

This research focuses on visual senses since the beginning of civilizations, such as flags, traffic lights, and notification icons. The reason behind this is the human's natural attraction to bright colors[1]. In addition, movement is an essential factor in visual perception, as humans have naturally developed motion estimation[2]. In this case, movement is limited to active motion and includes perceiving stationary motion phenomena, for example, the glass patterns[3]. We can combine the benefits of both characteristics to enhance visual guidance within the space that requires fewer distractions. We can combine the benefits of both characteristics to enhance human spatial perception.

In everyday communication, there is always a sender and a receiver. Encoding and decoding messages is where noise usually occurs[4]. As a result, the challenge in some existing communication methods is that there are always noises that affect the quality of the message delivery.

The most effective and brutal way to avoid mixing noise into the messages is to limit the delivery methods, in this case, using only colors. This research investigates overlaying visually modified images onto unmodified prints to alter human spatial perceptions, aiming to provide a novel communication method that adheres to the constraints of these sensitive environments.

2. Concept

The end goal of this design is to create a visual assistant system that allows users to select, manipulate, and alter their environment. In the ideal condition, the primary input method is eye gaze, and the projection will be used as an output method. In addition, this design can free people from using heavy headsets since all input and output are nature-gazing. Furthermore, this method of altering surroundings can become mindless[5], which can be used in multiple real-world use cases to aid people's life and work.

2.1 Modified Projection onto Unmodified Prints

First, two foundational materials for this research are printed media and projectors. To set up a basic experiment environment, a projector projects an image onto the printed version of the image, this was inspired heavily by the Deformation Lamps in 2015 [6]. In the early stage of the experiment, an A0-sized top-down image of grass fields was used to test the visual appearance. As the experiment progressed, A1 and A2 images were used as well. The content of the images was also changed depending on the purpose of the experiments.

2.2 System Architecture

We design the system architecture to achieve the above-mentioned concept, which includes both software and hardware in the Fig. 1. On the software side, an image is input into the processing pipeline. The software changes the image's saturation, rotation angle, and offset value. On the hardware side, a projector projects an image onto the printed material. In addition, an industrial-grade printer prints the images.

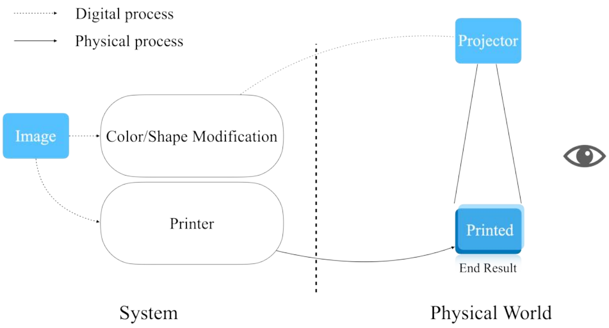

図 1: System architecture

3. Prototype

3.1 Color Manipulation

In this experiment phase, a crowded desktop view is printed on A0-sized paper, and only a partial of the image is lighted up by the projector in the Fig. 2. To mimic a more realistic scenario, the post-note stickers on the laptop are lit up to draw attention from the receiving user.

図 2: Colorization on the part of the printed image: (left) color projection on monochrome print (right) selective color projection on monochrome print with highlighting on post-note with yellow

3.2 Shape Manipulation

The first stage of the prototyping phase is to verify the glass pattern. An image of AI-generated grass is projected onto a printed version. The printed version of the image is then slightly rotated clockwise while the center of the image remains the rotation center.

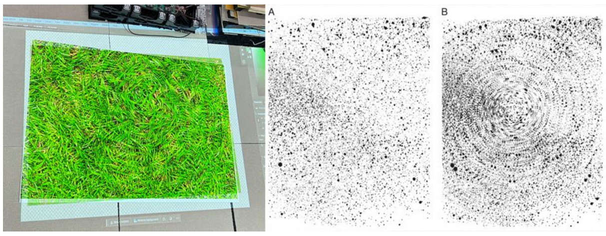

図 3: (Left) Shape perception manipulation using Glass Pattern projection. (Right)Photos of Glass Pattern from [3]

Since the visual phenomenon of the glass pattern is verified in the first prototyping phase, the second stage uses an image of a bookshelf. This makes the experiment similar to a real-world scenario, where people usually lose their focus of sight when looking for a book on the bookshelf. In this experiment, the printed image is also rotated clockwise, and the center of the image remains the center of the rotation.

4. Preliminary User Study

To collect more usable information about the two methods of projection, both methods were experimented with volunteers. The volunteers were mostly in their twenties to thirties, with veritable eye sight conditions.

4.1 Experiment1: Colorization

To test how decolorization can affect the user's sight of focus, a game-like program is created in the Fig. 4. The game is set on a background image of a sakura flower with randomized desaturation rate in the Fig. 5, and the volunteers need to find a growing fully saturated circle in the image. The time of how long the volunteers can find the circle will be recorded with the background desaturation rate. According to the hypothesis, the time to find the circle will decrease with the desaturation rate.

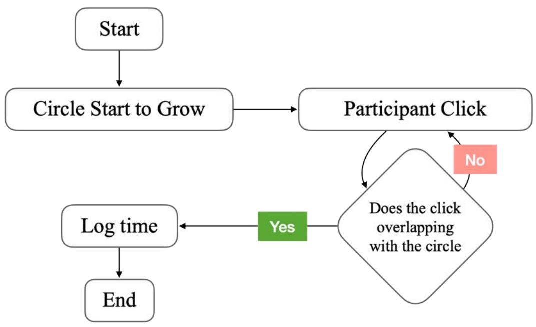

図 4: Colorization Experiment Flowchart

Result and Discussion

We can observe two major groups in our data in the Fig. 7. The first group, with 10 percent desaturation, has

図 5: Desaturation from 0 percent to 100 percent

test subjects taking 3 seconds to spot the growing circle. The second group, with around 50 percent desaturation, also has subjects taking 3 seconds to notice the circle. Therefore, we can assume that a desaturation range of 10 percent to 50 percent is the sweet spot for maintaining the aesthetics of the original image while making the changes noticeable enough for people to detect the difference. According to the data we collected.

図 6: Result of Four individuals

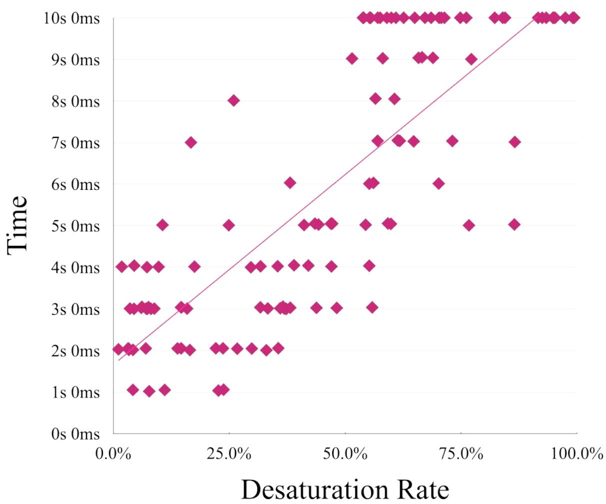

図 7: Result of all Users

4.2 Experiment2: Distortion

First, each subject is asked to view the image from different distances. This questionnaire aims to measure

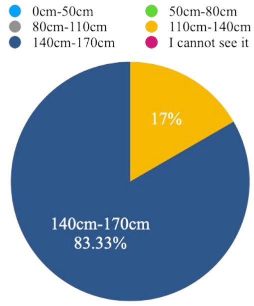

図 8: Result of all survey participants

the best viewing distance for the A0-sized glass pattern images. As a result, most subjects think the glass pattern is most visible at 140 cm to 170 cm distance in the Fig. 8. Second, each subject is asked to review if they can detect the rotational effect caused by the glass pattern. Fifty percent of the subjects agree that they can detect the rotational visual phenomenon, while thirty-three percent disagree. Third, each subject was asked to review the discomfort caused by viewing the glass pattern, and fifty percent felt uncomfortable.

5. Discussion

5.1 Projection onto 3D Object

In our experiments, we experimented with a printed image on paper as a projection target, while our research aims at altering spatial experience in life spaces with everyday objects. Towards this goal, the next steps would be inviting projection mapping method and technologies to accommodate 3d objects with complex shapes (e.g. a table with messy stationary) as a projection target. The advanced color correction method would play an essential role in effective color perception alternation.

5.2 Implicit Behavioral Intervention

The implicit manipulation of spatial color and shape would benefit behavioral change programs. For example, shape manipulation could help color-blind people integrate into normal life or help manufacturers in an EXPO better guide the audience to product highlights.

5.3 Integration with Gaze Tracking

Using head tracking is the last phase of prototyping in the Fig. 9. At this stage, the MediaPipe plug-in for Touch Designer is used to achieve head-tracking. The software can detect users' facial features; in this specific case, it tracks ears and the nose. It draws a line from each ear to the nose and calculates the average angle from both lines to get the nose pointing direction.

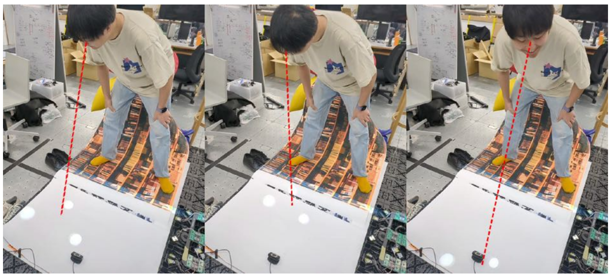

図 9: Preliminary trial for dotted projection following user's head movement

6. Conclusion

In this study, we found that people with regular eyesight can detect visual change in the background with 10 to 50 percent desaturation. We also found out that people can view the motion changes phenomena at average body height distance. We think further work will be beneficial from combining color and shape manipulation with real-world use cases on the findings of this study.

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