文獻題目： HEADLIGHT:

EGOCENTRIC VISUAL AUGMENTATION BY WEARABLE WIDE PROJECTOR

头灯：以自我角度为中心視點的视觉增强可穿戴式寬域投影仪

文獻作者：笠原 俊一 (SHUNICHI KASAHARA)

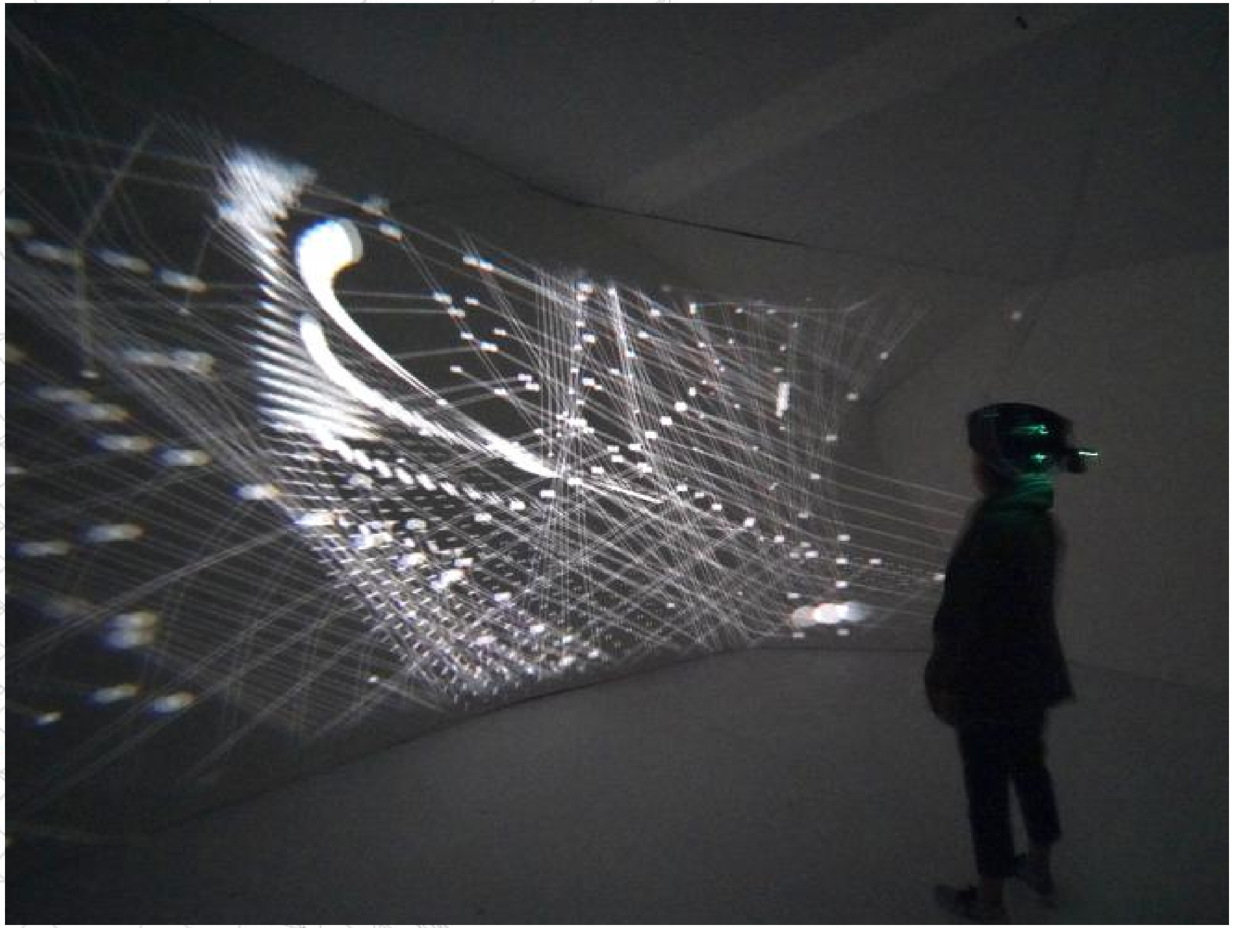
文獻來源：ACM SIGGRAPH 2018 EMERGING TECHNOLOGIES

文獻網址：HTTPS://DL.ACM.ORG/DOI/10.1145/3214907.3214926

SEMINAR

報告者：孟 昕　　指導教授：許素朱　　報告時間：2020.03.31

國立清華大學跨院 藝術與科技組



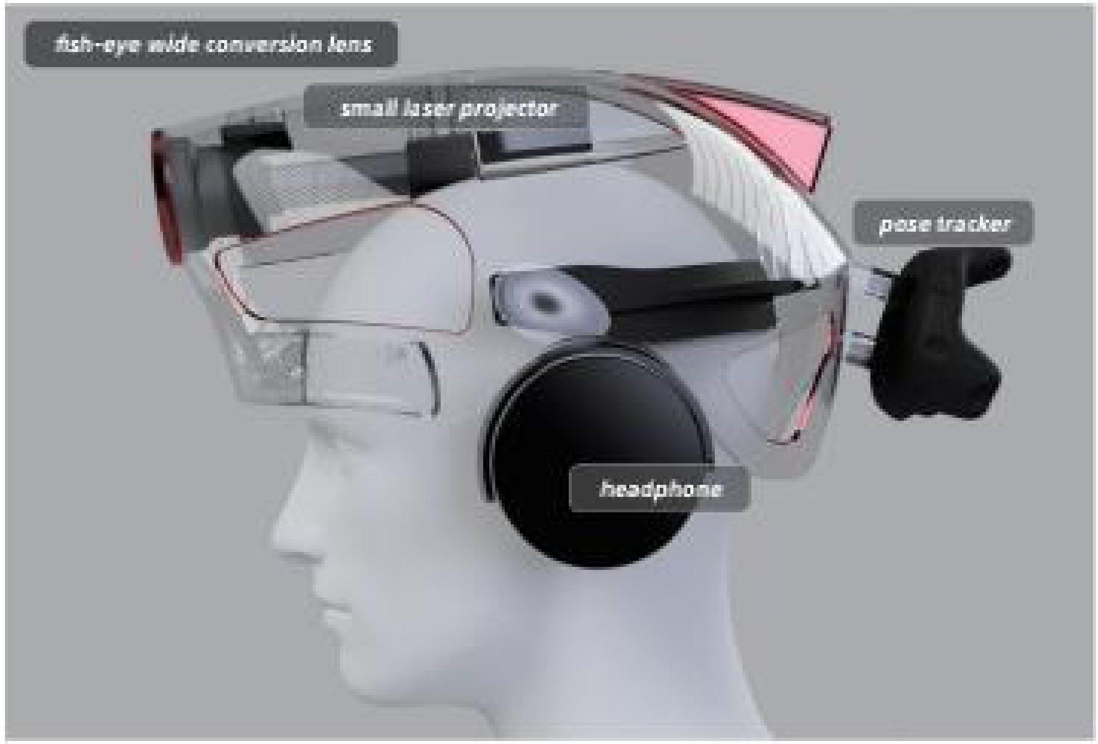
ABSTRACT

Visual augmentation to the real environment has potential not only to display information but also to provide a new perception of the physical world. However, the currently available mixed reality technologies could not provide enough angle of view. Thus, we introduce "Headlight", a wearable projector system that provides wide egocentric visual augmentation. Our system consists of a small laser projector with a fish-eye wider conversion lens, a headphone and a pose tracker. HeadLight provides projection angle with approx. 105 deg. horizontal and 55 deg. vertical from the point of view of the user. In this system, the three-dimensional virtual space that is consistent with the physical environment is rendered with a virtual camera based on tracking information of the device. By processing inverse correction of the lens distortion and projecting the rendered image from the projector, HeadLight performs consistent visual augmentation in the real world. With Headlight, we envision that physical phenomena that human could not perceive will be perceived through visual augmentation.

視覺增強對在真實環境中不僅具有展示資訊的潛力，而且能夠提供給物理世界的一種新的感知。然而，現有的混合現實技術無法提供足夠的視角。因此，我們推出了“headlight”，這是一個可穿戴的投影系統，能夠提供廣闊範圍的以自我為中心的視覺增強設備。

關鍵字：頭戴式投影儀，混合現實，增強現實，視覺增強，知覺。


HEADLIGHT



該系統由一個小的鐳射投影儀，一個魚眼廣角轉換鏡頭，一個耳機和一個姿勢跟蹤器組成。
headlight可以提供投影視域角度大約為：水平方向105度；垂直方向55度（從體驗者角度參考垂直角度）。
在該系統中，基於設備的跟蹤資訊，使用虛擬攝像機來呈現與物理環境相一致的三維虛擬空間。

通過對透鏡扭曲進行反向校正，並將投影儀渲染後的圖像投影出來，Headlight在現實世界中實現了圖像一致的視覺增強效果。
借助Headlight，我們設想人類無法感知的物理現象可以通過視覺增強來感知。

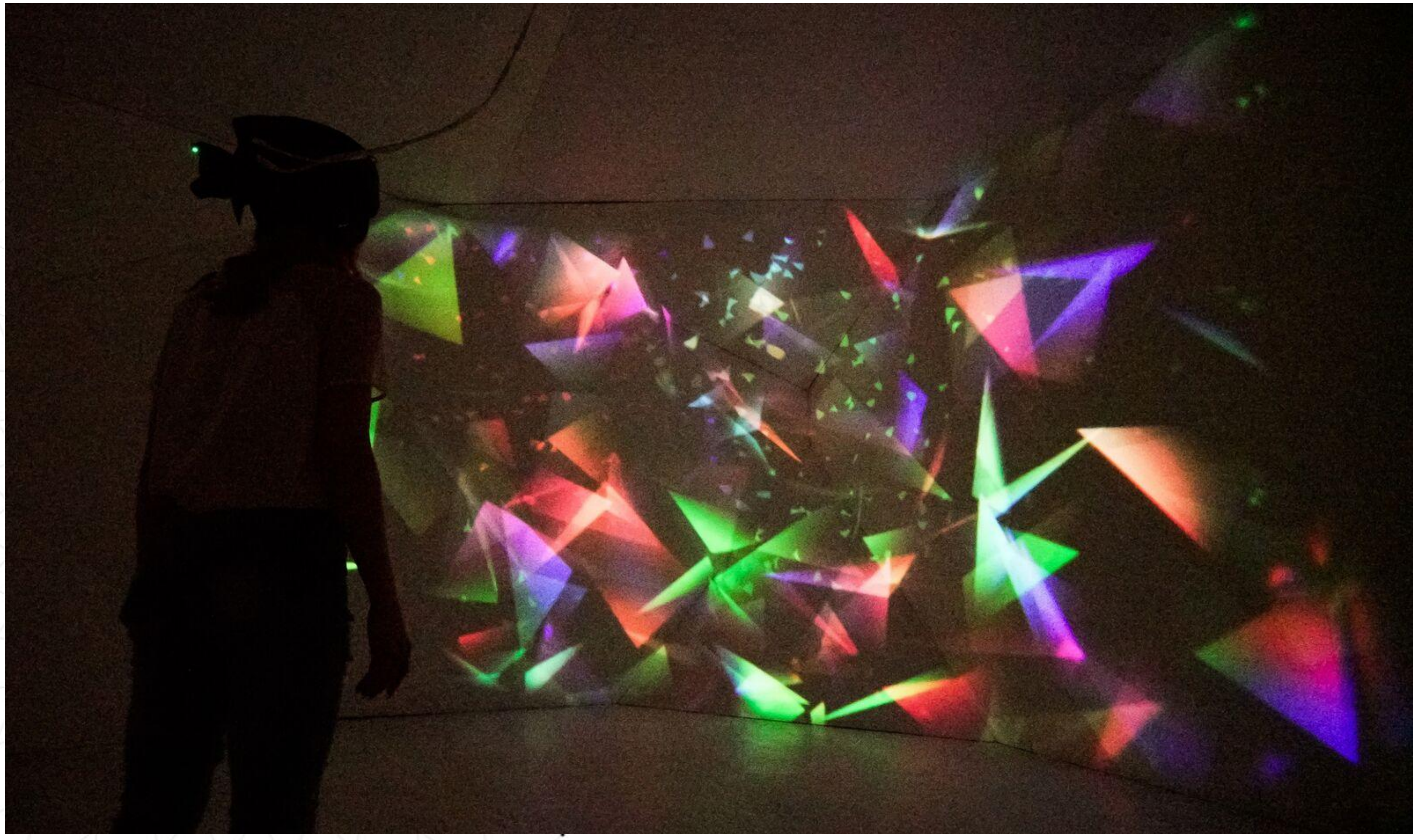
作品論述 (ART STATEMENT)

1 INTRODUCTION

Visual augmentation has a lot of potential including providing additional information of real world, mixed reality entertainment in the real environment. Moreover, making invisible information visible for human will lead us to extend our perception itself. However,especially optical see-through glass as the most possible technology for visual augmentation, it's field of view is limited up to approx.35deg, which would be enough for providing information but not enough for immersive visual augmentation. As another potential technology, projection mapping enables immersive visual augmentation which aligns the real world. However, projectors are usually installed fixed position and not able to provide visual augmentation from the point of view of users. While previous research using wearable projector has been studied, the field of view was limited to narrow-angle [Harrison et al. 2011; Mistry and Maes 2009].

Then, we introduce a wearable wide-angle projector system called "Headlight" which allows us to augment egocentric visual environment. This is a head-worn system consists of a laser source small project with a wide conversion lens, a headphone and a pose tracker for the virtual reality system (Fig. 1). HeadLight enables wide angle visual projection from the point of view of user up to approx. 105 deg. horizontal and 55 deg. vertical, which covers a large field of view of human. The image of the projection is synchronized with the user head position and rotation. By providing three-dimensional data of the environment, HeadLight system allows us to see the augmented visual environment which aligns with the real world.

作品論述 (ART STATEMENT)



視覺增強具有很大的潛力，包括提供真實世界的附加資訊，**在真實環境中進行混合現實**。此外，使不可見資訊可見,會引導我們擴大自己的認知範圍。

然而，特別是光學透鏡作為最可行的視覺增強技術，它的視域角度**被限制**在大約35度，這種範圍可以提供資訊，但不足以進行沉浸式視覺增強。

作為另一項潛在技術，**投影映射**可實現與**真實世界“對齊”的沉浸式視覺增強**。但是，投影機通常是已安裝的固定位置，無法提供**從用戶的角度**來看的視覺增強效果。而以前的可穿戴式投影儀經過研究，視野被限制在狹窄的角度，Headlight則涵蓋人類的廣闊視野。投影的圖像與用戶頭部的旋轉所處的**位置同步**。

通過提供環境的三維數據，HeadLight系統讓我們看到**與現實世界相一致**的增強視覺環境。

作品論述 (ART STATEMENT)

2 HEADLIGHT SYSTEM

2.1 Wide angle projection
A LED source projector usually requires the focus adjustment to provide a sharp image on the surface in the real world, hence, we employ a laser source projector which can be used for any distance with shape image. However, normal projector only provides limited field of view for projection. For instances, MP-CL1 which we employ for HeadLight provides 42.1deg for horizontal and 23.4 for vertical. We then attached a fish-eye conversion lens on the projector which enables much wider projection image with the diagonal angle up to 140 deg, minimum angle in horizontal 105 degree and vertical 55 degree (Fig. 2). The conversion lens produces strong distortion in the projected image with pincushion shape. Thus we model this distortion based on a fisheye model distortion. In addition, attaching the convention lens shifts the principal point of the projector. We calibrate these parameters in advance. Then the distortion coherence is also used to render the output image to compensate the pincushion distortion (Fig. 3).

2.1 廣角投影儀

LED 光源投影儀通常需要對焦調整，才能中提供一個清晰的表面圖像，因此，我們使用鐳射鐳射投影儀，它沒有對距離和形狀圖像的限制。

但是，普通投影儀僅提供有限的投影視域。例如，我們使用的MP–CL1用於Headlight，水平方向42.1度，垂直方向23.4度。然後，我們在投影儀上安裝了魚眼轉換透鏡，使投影儀的對角線角度達到140度，水平方向105度，垂直方向55度(圖2)，這樣就實現了更寬的投影圖像。

魚眼轉換透鏡產生具有枕形形狀的投影，使圖像失真並變形。因此，我們基於魚眼模型失真對該失真進行建模來補償失真（圖3）。

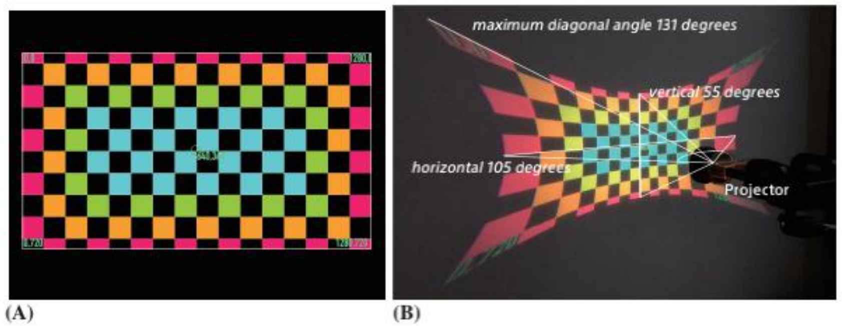


Figure 2: A laser projector with a fish-eye conversion lens provide wider projection. (A) shows checker board pattern output image for projector. (B) shows actual projector output at a screen plane.

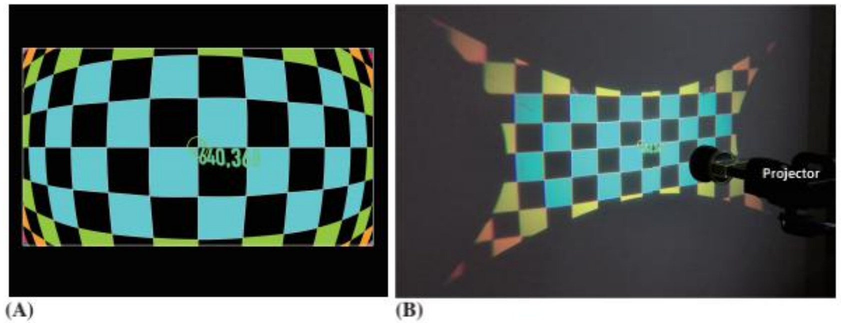
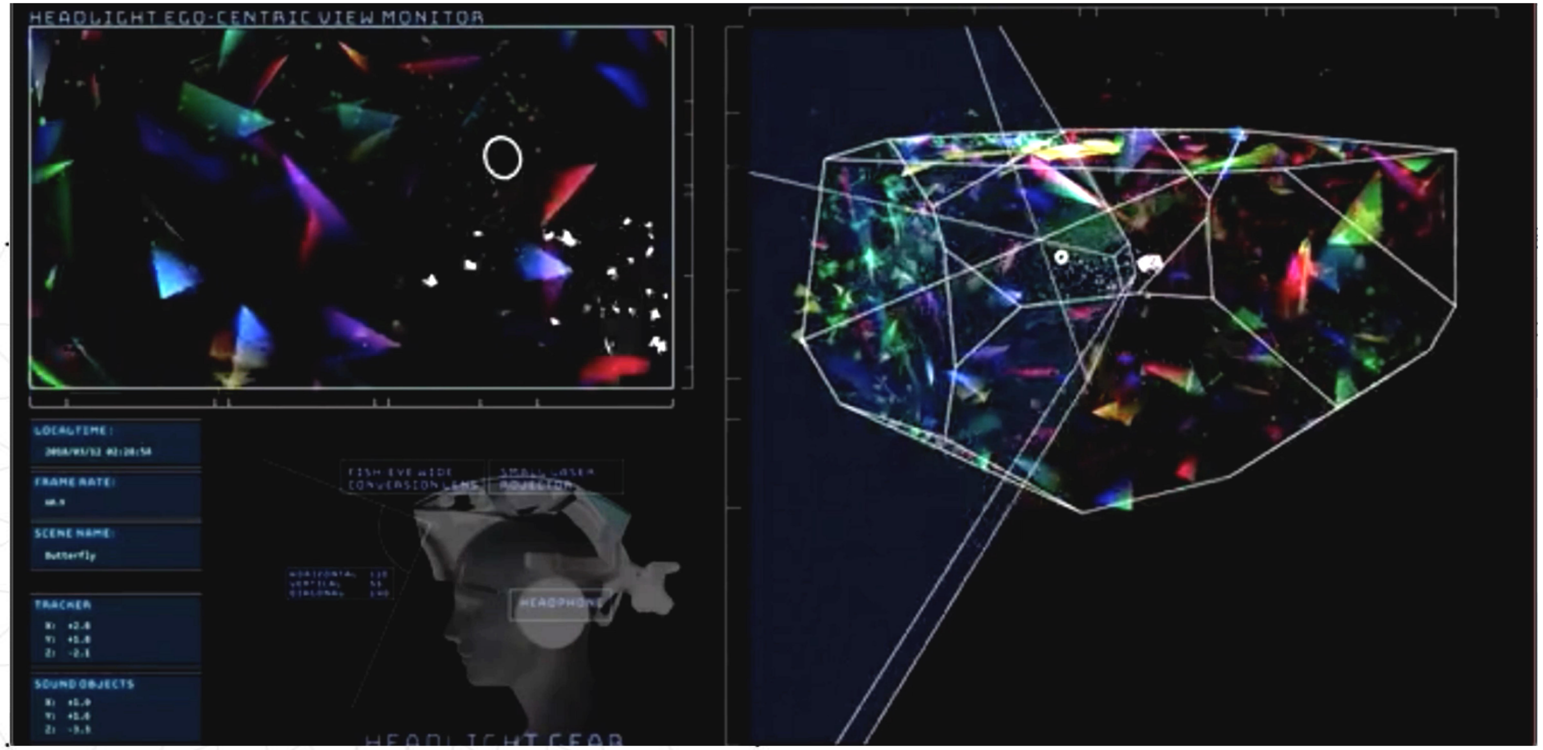


Figure 3: Head light system generates the output image to compensate the pincushion distortion. (A) shows inverse distorted output image for projector. (B) shows actual projector output at a screen plane.

作品論述 (ART STATEMENT)

2.2 Rendering projection image for visual augmentation

The head worn device including the projector is tracked with pose tracker (HTC Vive Tracker 1) to get rotation and translation motion. Then the projector pose matrix can be acquired from tracker pose matrix with the pre-calibrated transformation between the tracker and the projector. Once the projector pose matrix is calculated, the computer graphics scene is rendered using this pose matrix to get mixed reality view image. The computer graphics include the three-dimensional data such as a building 3D model or point cloud data of real world environment. The final output of the projector is produced by using distortion process as we described before.



2.2 渲染投影圖像以增強視覺效果

頭戴裝置包括投影儀，是通過姿態跟蹤器(HTC Vive tracker 1)跟蹤佩戴者姿勢，實現旋轉和平移運動投影同步的。

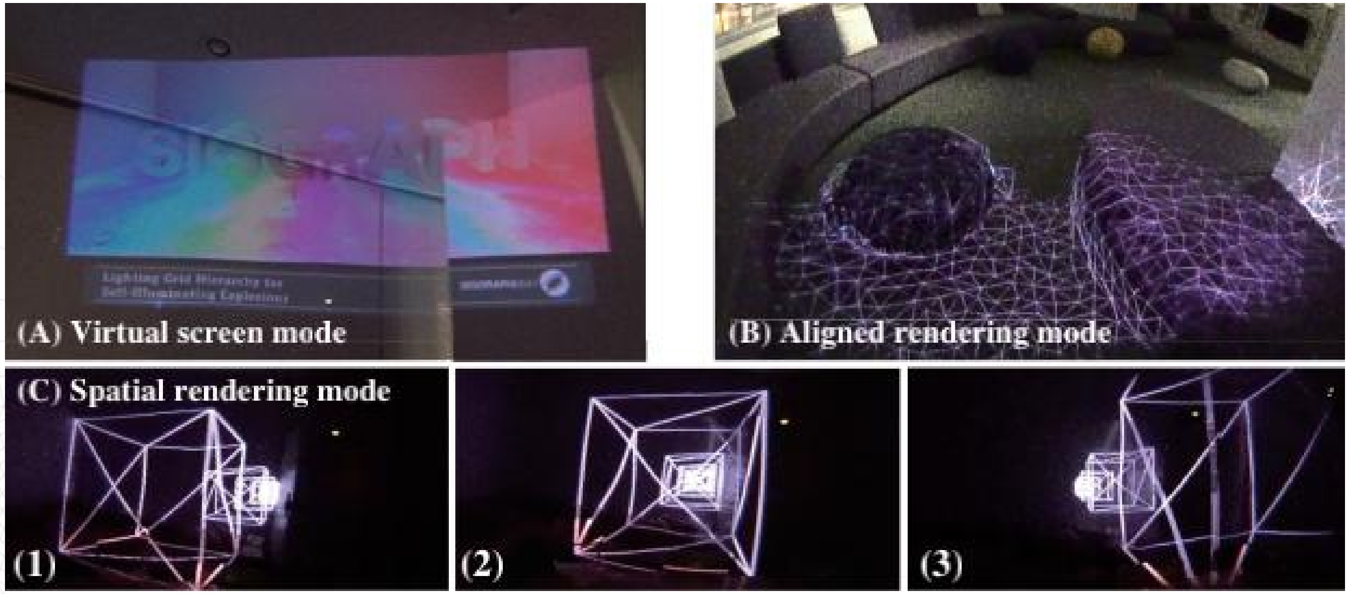
通過跟蹤器和投影儀之間的預校準轉換，**從跟蹤器的位姿矩陣中獲得投影儀的位姿矩陣**。計算出投影儀位姿矩陣後，利用該位姿矩陣對電腦圖形場景進行渲染，得到混合現實視圖圖像。

電腦圖形學包含三維數據就如構建真實世界環境的三維模型或點雲數據。

作品論述 (ART STATEMENT)

2.3 Egocentric projection design

In Headlight, three design of visual augmentation can be provided by egocentric projection. In the **Virtual screen mode**, egocentric projection by HeadLight system allows user to see the projected image itself regardless of the physical surface, even with complex surfaces with different distances. In the **Aligned rendering mode**,by using three-dimensional data of the physical environment as the source of the projected video of the system, HeadLight can project computer graphics aligned with the physical environment the user is watching. In this projection mode, the projected image appears to be existed on the physical surface. In the **Spatial rendering mode**,since the HeadLight system can generate image synchronously with the head movement, motion parallax can be generated by the change of the projected image. Due to the perception of depth caused by this moving parallax, the user feels that a virtual object exists in front of or behind the surface regardless of the physical arrangement of the actual projection plane.



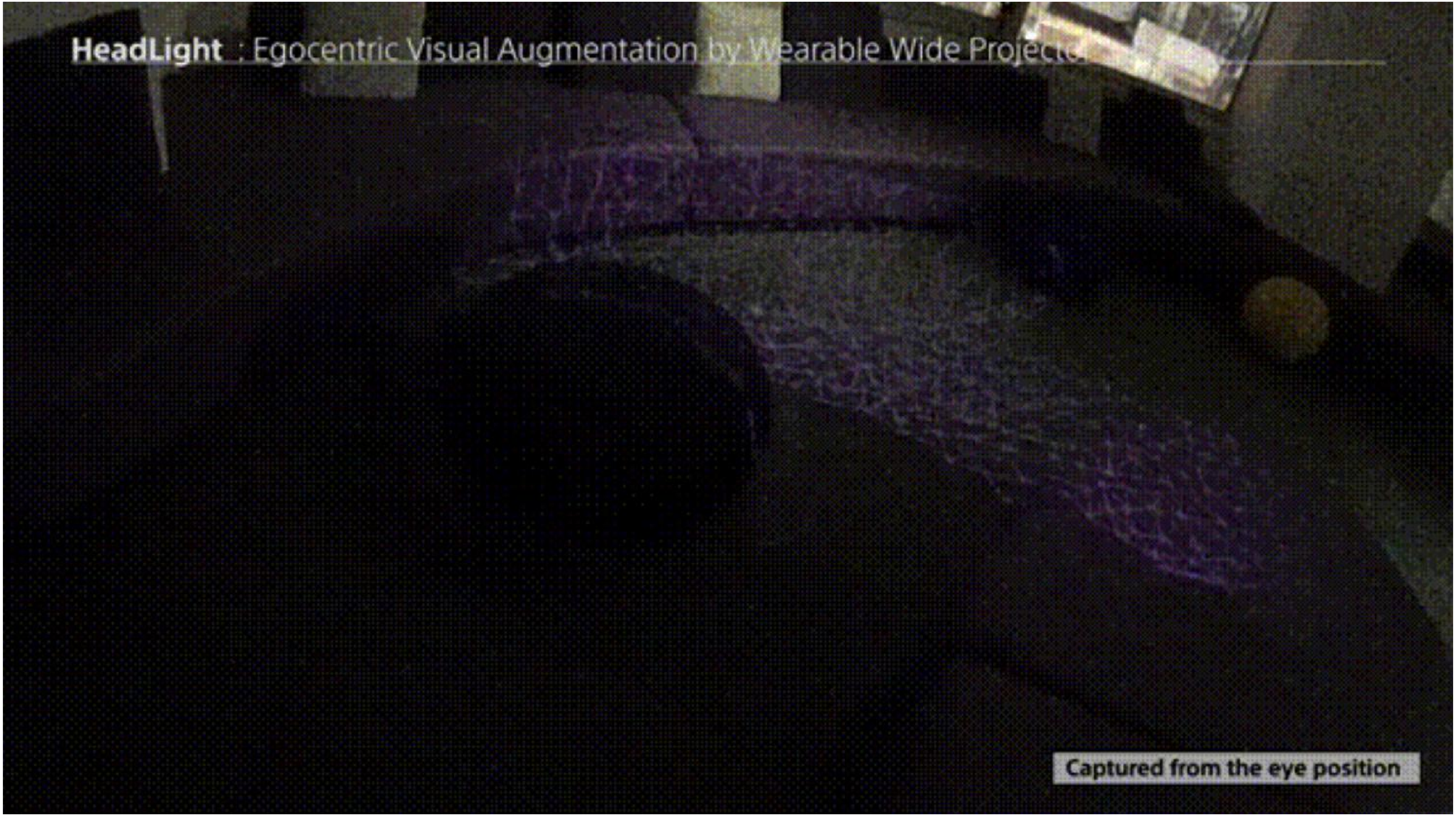
2.3 自我中心的投影设计

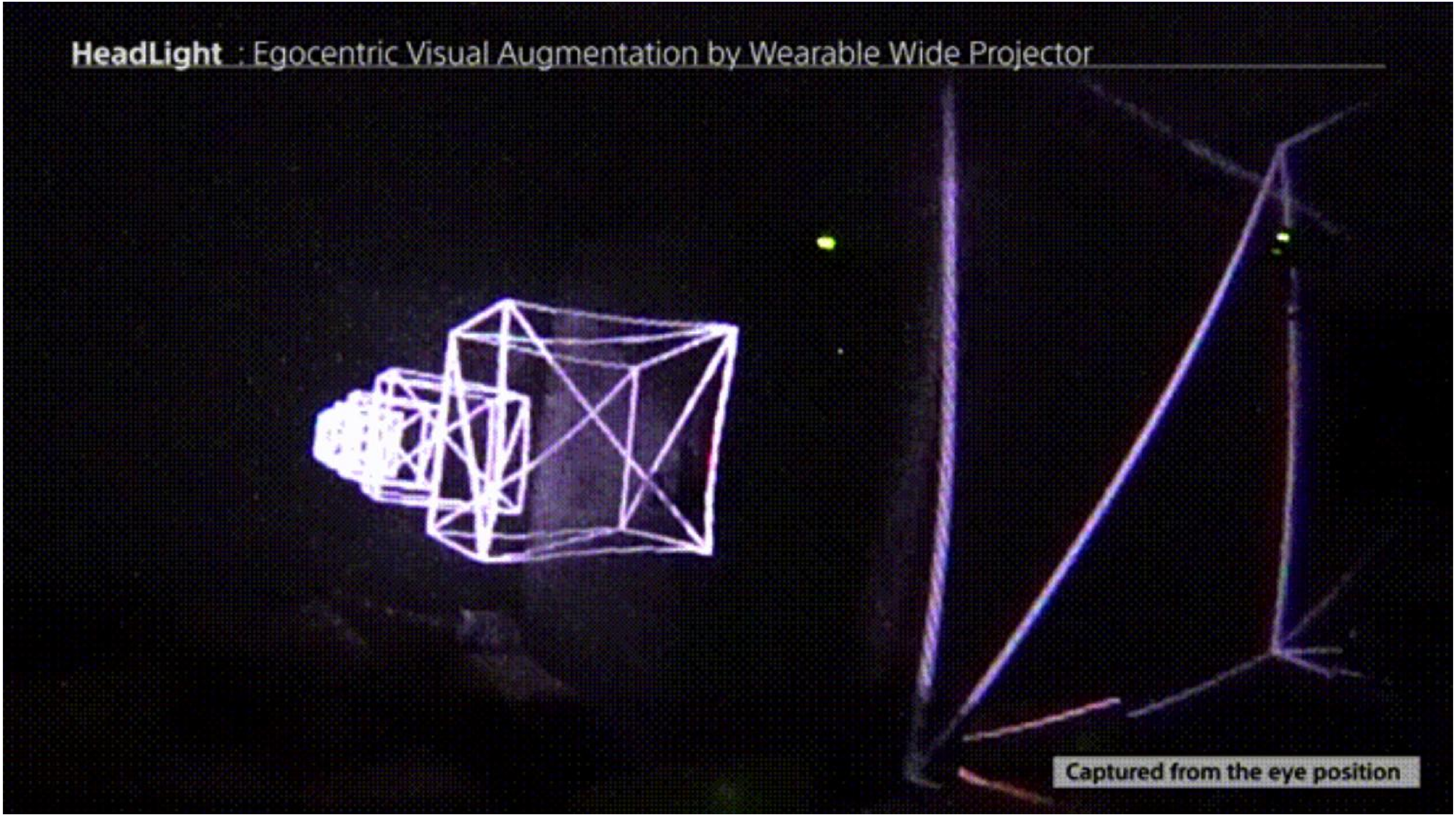
在Headlight中，通过以自我为中心的投影可以提供三种视觉增强设计。

在虚拟屏幕模式下，通过Headlight系统进行以自我为中心的投影，无论物体表面如何，用户都可以看到投影图像本身，即使是不同距离的复杂曲面。

在“对齐”的渲染模式下，利用物理环境的三维数据作为系统投影视频的源，Headlight可以投射出与用户正在观看的物理环境一致的计算机图形。在这种投影模式下，投影图像似乎存在于物理表面上。

在空间渲染模式下，由于Headlight系统可以与头部运动同步生成图像，运动视差的生成可以透過投影图像的变化产生。由于这种移动的视差能感知深度，无论实际投影平面的物理布局如何，用户都能感觉到一个虚拟物体存在于表面的前方或后方。


HeadLight : Egocentric Visual Augmentation by Wearable Wide Projector
Captured from the eye position


HeadLight : Egocentric Visual Augmentation by Wearable Wide Projector
Captured from the eye position

作品論述 (ART STATEMENT)

3 LIMITATION AND FUTURE WORK

In the current implementation , since the conversion lens is mounted on the existing laser projector, the light quantity is limited. This problem would be improved by designing the projector device exclusively for Headlight. In addition, the current tracking range is limited with room-size. We expect that this restriction can be eliminated by changing to an inside out type tracking device.
With the HeadLight system, it is possible to visually express various invisible physical phenomena by immersive first person projection mapping. As an example, visualization of aerodynamics makes it possible to sensitively perceive the flow of air in the environment. As another example, by using the 3D data of the surrounding environment, it possible to induce X-ray like visual augmentation as if seeing through the other side of the wall. We envision that with this visual augmentation technology, HeadLight can provide a new sense of the physical world.

3.局限性和未來的工作

- 光量是有限的。
- 目前的追蹤範圍限於房間大小。

- 希望以後可以直觀地表達各種看不見的物理現象，提供對物理世界的新感覺。
  例如，空氣動力學的可視化，可以靈敏地感知空氣中的氣流。
  例如，透過環境，可能透過牆壁的另一側看到誘發X射線視覺的增強。

作者介紹 (AUTHORS)

笠原 俊一

Shunichi Kasahara

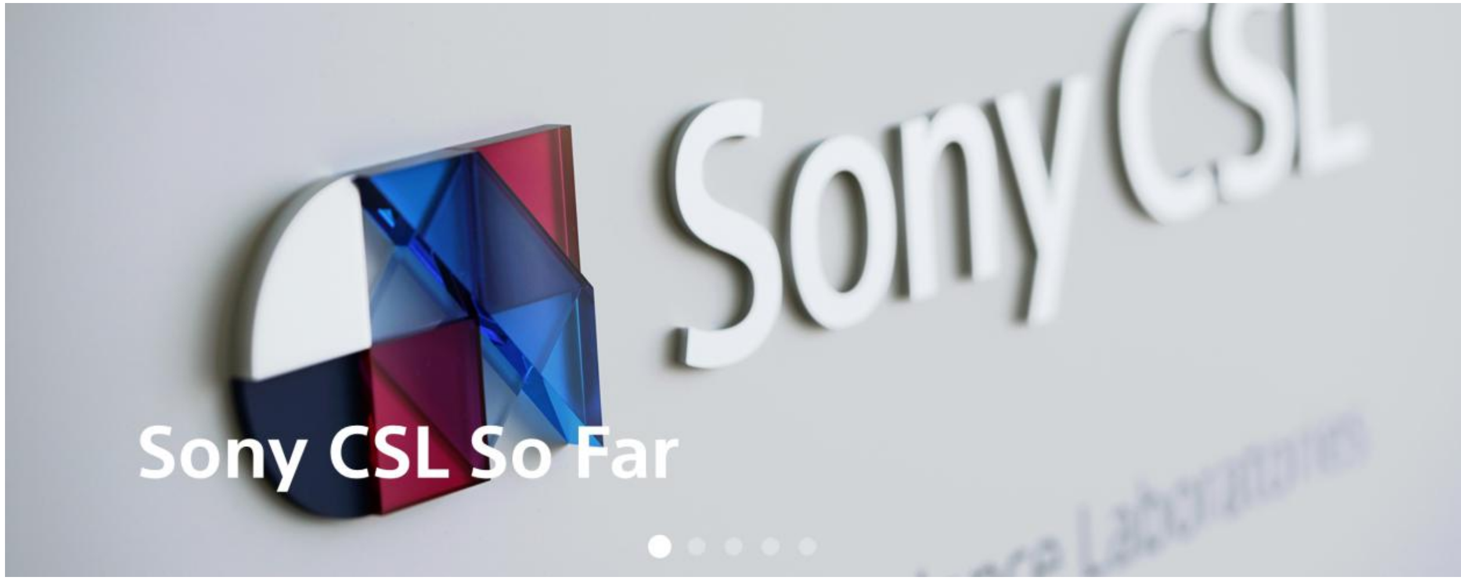
知覚は我々が持つ視覚、聴覚、触覚や運動感覚器官などの入力から意味を認識、情報として形成して、我々の判断や行動を生み出す、人間の行動の根源であると同時に、「自分」自身を形成する重要な役割を持っています。私は「Superception（超知覚）」という、コンピュータ技術を用いて人間の感覚に介入したり、人間の知覚を接続することで、工学的に知覚や認知を拡張・変容させる研究をしています。

在我們不斷發展技術進步的世界中，我設想“超知覺”可能會導致有意識地控制感知的能力，並使我們能夠以前所未有的令人興奮的方式與技術去感知，將意識和知識領域共同發展。

關鍵詞：共用經驗/感知/具體化/溝通/增強

作品相關—SONY CSL

索尼电脑科学实验室 Sony Computer Science Laboratories Inc



公司成立于1988年。
研究人员研究范围廣泛，如语言学、细胞信号、计算几何、流行病学、意识体验、人工智能、医疗保险、工厂效率、艺术、系统依赖性和社会等领域，并进行很多具有创新性的研究。
公司成员主要是一些各领域的科学研究者，从创立之初的3名科学家到2019年的30位，一直维持在较小的团队规模。
这个实验室，里面的研究人员可以自由地开发能重新定义日本社会未来的新技术，不需要去追逐创造新利润，沒有商業壓力。
實驗室的预算基本上固定在索尼总销售额的万分之一，所以CSL目前的预算是8亿日元。

個人感受與心得

切入點
以觀者為中心
影像同步
三種模式
混合現實

技術

藝術性
音樂效果
娛樂互動
體驗式客戶端模式發展

作品

喜歡
期待
關注

個人

THANK YOU FOR WATCHING