Autism Simulator Employing Augmented Reality: A Prototype

Shibo Qin*, Yukie Nagai*, Shinichiro Kumagaya†, Satsuki Ayaya†, and Minoru Asada*
*Graduate School of Engineering, Osaka University, Japan
Email: {shibo.qin, yukie, asada}@ams.eng.osaka-u.ac.jp
†RCAST, The University of Tokyo, Japan
Email: kumashin@bfp.rcast.u-tokyo.ac.jp

I. Introduction

In order to help people suffering from autism spectrum disorder (ASD), assistance systems have been developed with a focus on enabling ASD people to adapt to activities of daily living (e.g., augmentative and alternative communication systems [1]). However, if we reverse our viewpoint, we can develop a new concept for the assistance system: letting normal developed (ND) people experience the perceptual world of ASD people and thus understand their difficulties with recognizing the world. An open challenge is reproducing the perceptual experiences of ASD people to quantitatively assess their problems.

In a similar approach, Geisler and Perry [2] built a simulation system that reproduces glaucoma symptoms for glaucoma research. In the ASD field, a simulator has been designed to replicate ASD people's vision through the use of a computer-based visual simulation environment [3]. The system intuitively expresses ASD symptoms, more specifically auditory over-responsivity, but there is a lack of scientific support for this mechanism. In this paper, we propose an ASD simulator based on augmented reality in order to mimic the perceptual over-responsivity of ASD symptoms. For the proposed system, we are planning to incorporate scientific results from ASD research and empirical feedback from ASD participants. We expect that our approach to better understanding ASD will help in new designs for assistance systems.

II. Background and Motivation

ASD is a broad-range affliction. The prevalence of ASD in developed countries has been suggested to be at least 60 per 10,000 people; it occurs more commonly in boys [4]. ASD is often described as a social disability. Therefore, the conventional method of assisting ASD people has been to assist them with their social skills so that they can behave in the same manner as ND people (Fig. 1a). In contrast, we focus on the opposite direction—that is, to let ND people share the same experience as ASD people through simulation (Fig. 1b). We suggest that understanding ASD people's difficulties is an important first step for true assistance in their life.

ASD symptoms have been described as sensory over- and under-responsivity [5], [6]. Because communication is based on shared environmental information, we suppose that the difference in perceptual information between ND and ASD people makes it difficult to establish communication between them [7], [8].

Our objective is to construct an experiential system that uses augmented reality [9] to precisely mimic perceptual symptoms in ASD. This system not only focuses on reproducing ASD symptoms but can also change the patterns or severity along with the surrounding environment to enable us to quantitatively assess the symptoms. In this study, we hypothesize that ND people experiencing an artificial ASD perceptual system would have the same difficulty with environment recognition and taking action.

III. Basic Idea and System Configuration

We designed an ASD simulator to have three pipelined modules: input, processing, and output. Hardware devices were chosen to be connected wirelessly so that the system could be examined in scenarios involving activities of daily life (see Fig. 2).

A. Input Module

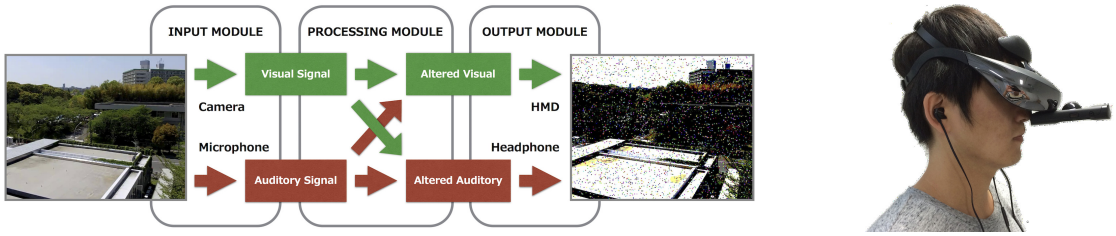
Visual and auditory signals are extracted from the environment by a camera with an embedded microphone (Logicool Broadcaster Wi-Fi Webcam). The camera is attached to a head-mounted display so that the input module can obtain a first-person view in real-time.

B. Processing Module

Visual and auditory signals captured by the input module mutually affect each other as well as are altered independently in the processing module. The pictures before and after the processing shown in Fig. 2a present an example of visual distortion cased by an auditory noise. In a silent environment without auditory noise, no visual effect is created in the image. On the other hand, in a noisy environment, visual distortion such as binarization is generated in the output image.

(a) Conventional assistance system (b) Proposed assistance system

Fig. 1: (a) Conventional method of assisting people with autism spectrum disorder (ASD). The aim is to help ASD people adapt to the normal developed (ND) people's world. (b) Proposed assistance system that alters the perception of ND people to let them share the same experience as ASD people.



(a) System configuration (b) Hardware configuration

Fig. 2: The proposed system contains three different modules: input, processing and output. The images on the left and right sides in (a) show the pre- and post-processed information, respectively. In a noisy environment, the system detects the intensity of the auditory signal and then applies a corresponding quantity of visual effects (e.g., high contrast and dotted noise) to the output image.

C. Output Module

In the output module, the altered visual and auditory information are wirelessly transferred to a head-mounted display (SONY HMZ-T3W) that displays the post-processed first-person camera view to the wearer.

IV. Conclusion and Future Work

This paper presented a prototype for a reality-based ASD simulator to enable better understanding of perceptual over- and under-responsivity. Our hypothesis is that differences between ASD and ND people's perception causes communication problems. With regard to the computation, we employed techniques of augmented reality to reproduce their perceptual experiences.

In the future, we intend to test our prototype with ASD participants and incorporate their comments to improve the scientific plausibility of our system. For example, an interaural time difference will be implemented as it is a known ASD symptom. We also intend to let ND participants experience the ASD simulator and check whether ASD-like behavior occurs. We believe that the ASD simulator will help people better understand the ASD and facilitate other ASD research avenues as well.

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