Handmade Infrared Rays Complementary Metal Oxide Semiconductor (IR-CMOS) Camera for Recording Eye Movements

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Abstract: *Objective*: It is important to observe eye movements in order to evaluate peripheral or central vestibular disorders in dizzy patients. An infrared rays charge coupling device (IR-CCD) camera is now widely used in daily practice. The technical advantage of a complementary metal oxide semiconductor (CMOS) now allows us to develop an inexpensive handmade camera for carrying out nystagmus recordings.

Methods: We developed a handmade IR-CMOS camera at a reasonable cost of less than $150. The costs of a small IR-CMOS camera, scuba diving goggles, an AC adapter, an audiovisual (AV) cord, and a plastic board with a thickness of 0.5 mm were $60, $60, $10, $10, and $10, respectively. It takes almost an hour to assemble the camera. We recorded eye movements using this camera.

Results: The image obtained using this inexpensive handmade camera was clear and highly comparable to that obtained using a conventional IR-CCD camera.

Conclusion: The handmade IR-CMOS camera is inexpensive, easy to develop, and can be effectively used in daily practice. In future, with technical developments in electronics, we intend to develop a more compact and high-quality camera for recording eye movements.

Keywords: Infrared rays, CMOS, eye movements.

INTRODUCTION

Conventionally, Frenzel glasses [1] had been used to examine nystagmus and dizzy patients. Recently, an infrared rays charge coupling device (IR-CCD) camera is widely used in daily practice [2-5]. However, since this camera is expensive, not all doctors have it. The technical advantage of a complementary metal oxide semiconductor (CMOS) now allows us to develop an inexpensive handmade camera for carrying out nystagmus recordings.

MATERIAL AND METHODS

In order to record eye movements, we developed handmade goggles at a reasonable cost of less than $150 using all the commercially available materials. These goggles were equipped with a small IR-CMOS camera. This camera was SS2000BLM (Kyoritsu, Osaka, Japan). The specification of this camera is that it has a total pixel of 542 (horizontal) × 492 (vertical), a resolution of 380 TV lines (horizontal), and a weight of 25 g. The scuba diving goggles were Quarts 2 mask (Black/Black) (AQUALUNG Japan, Knagagawa, Japan). Costs of each of the materials that include a small IR-CMOS camera, goggles, an AC adapter, an audiovisual (AV) connection cord, a and plastic board with a thickness of 0.5 mm were $60, $60, $10, $10, and $10, respectively. First, bilateral lenses of the goggles were detached. These lenses were replaced with a black plastic board. The design of the plastic board for the left eye is shown in Fig. (**1**). Then, the AC adapter was connected to the power supply. The AV output was connected to a video deck and then to a TV monitor using an AV cord.

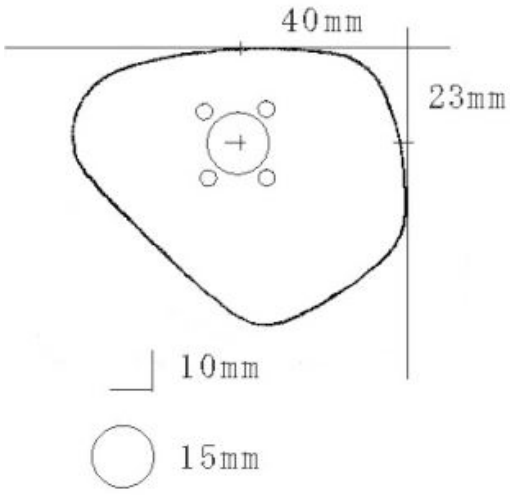

Fig. (1). Design of a lens of the left eye. Design of a lens of the left eye is shown. The holes shown are created using a drill.

RESULTS

It took less than an hour to assemble the camera. The weight of the camera with the goggles was 200 g. Fig. (**2**) shows the developed handmade goggles. Fig. (**3**) shows the result of recording the eye movements using this camera. The obtained image was clear. The quality of the image

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obtained using this camera was highly comparable to that obtained using a conventional IR-CCD camera. This camera also has a small microphone, and it is possible to record voice simultaneously. The weight of the camera with the goggles was only 200 g, which was sufficiently light for daily use.

Fig. (2). Photograph of the CMOS camera with the handmade goggles. CMOS camera is securely equipped on the scuba diving goggles.

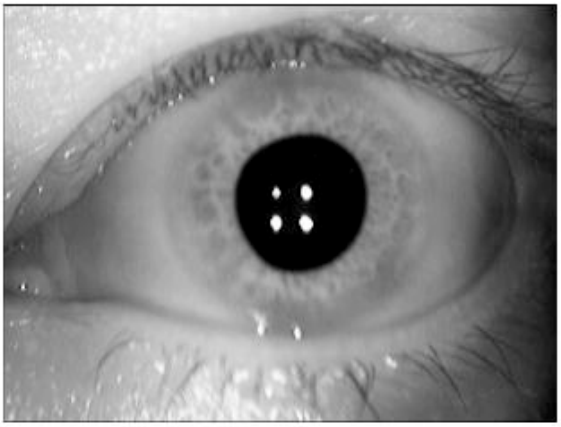

Fig. (3). Result of recording eye movements. Quality of the image obtained was almost same as that obtained using the conventional IR-CCD camera.

DISCUSSION

The CMOS camera is not only small but also inexpensive with a low electronic consumption. This camera can be easily purchased *via* the Internet. It is very easy to assemble this camera, and a layman who does not have any knowledge of basic electronics can also assemble it.

CONCLUSIONS

The CMOS camera is a high-quality camera, and it can be effectively used in daily practice. In future, with technical developments in electronics, we intend to develop a more compact and high-quality camera for recording eye movements.

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