The Journal of Laryngology & Otology (2008), ***122***, *199–200.*

doi:10.1017/S0022215107000096
Printed in the United Kingdom
First published online 1 August 2007

Short Communication

Real-time video recording of eye movements – an inexpensive system

R Nandi, A Pajaniappane*, R Palaniappan†

Abstract
Analysis of eye movements is essential for investigating vestibular disturbances. Video-oculography, although expensive, is a valuable and sensitive tool that allows accurate estimation of eye movements. We describe a simple and inexpensive method of recording as well as analysing eye movements using a commercially available miniature digital video surveillance camera and an MP4 digital media recorder.

Key words: Nystagmus; Vestibular Function Tests; Eye Movement Measurements

Introduction

Assessment of the vestibulo-ocular reflex has been the cornerstone of vestibular function testing. Historically, electronystagmography has been widely used to record eye movements. However, although useful, electronystagmography has certain limitations such as the necessity to adequately prepare the skin prior to electrode placement, repeated calibration, sensitivity to myogenic activity, inadequate vertical eye movement recording and inability to record torsional eye movement. Video-oculography, on the other hand, yields very reliable information with regard to horizontal, vertical and, in the case of three-dimensional recording techniques, torsional eye movements. With the use of infrared cameras, video-oculography systems can record adequately in total darkness, although, obviously, video-oculography does not help when the eyes are closed. Video-oculography systems are increasingly being used as a sensitive technique to record eye movements in response to vestibular stimuli.

Commercially available video-oculography systems are generally more expensive and few hospitals can afford to invest in these. We describe an inexpensive and clinically useful method of recording eye movements with the use of a commercially available digital video camera and MP4 digital recorder, inspired by the second author AP. Our system has the advantages of simplicity of construction and a clinically adequate method of recording eye movements. It also allows for later review of the recordings made.

Method

A commercially available wireless surveillance video camera (specifications in Table I) is mounted onto a head band using a simple device that allows for adjustments in the distance between the camera and the eyes (Figure 1). The camera is small (2×2 cm in size), light weight and mounted on a swivel mechanism that allows it to be rotated in such a manner that it can focus on each eye individually, or adjusted further away from the head for simultaneous recording of both eyes (Figure 2). It has its own power supply in the form of a commercially available '9V' battery that is easily housed on the headband. The camera is connected to a low-priced commercially available MP4 digital recorder (JDX Portable Media Player in this instance) (JDX, Hongkong, China) via a wireless receiver (Figure 3), which then records the images. Captured images could be replayed on the device itself, viewed on the television or uploaded on to a computer for more detailed analysis if required. Our unit is far less expensive and can meet most clinical requirements in the absence of a commercially available more expensive video-oculography kit.

Discussion

Video-oculography is a modern, sensitive tool for eye movement recording and analysis. It is based upon the use of a small camera that captures images of the eyes and digital image processing which allows movements of

TABLE I
CAMERA SPECIFICATIONS

Camera specifications	
Image pickup	1/3
TV system	PAL/CCIR NTSC/EIA
Definition	380TV Lines
Scan frequency	PAL/CCIR:50 Hz NTSC/EIA:60 Hz
Minimum illumination	1LUX
Output power	10 mW
Output frequency	2.4G
Camera power	DC +5V/8V
Transmission distance without blocking	50 m–100 m
Received power	DC +9V/12V

From the Department of Audiological Medicine, Great Ormond Street Hospital, London, the *Intensive Care Unit, Milton Keynes General Hospital, Milton Keynes, and the †Department of Audiological Medicine and Neuro-otology, Royal National Throat Nose and Ear Hospital, London, UK.
Accepted for publication: 15 May 2007.

FIG. 1
The essential components of the inexpensive video-oculography system.

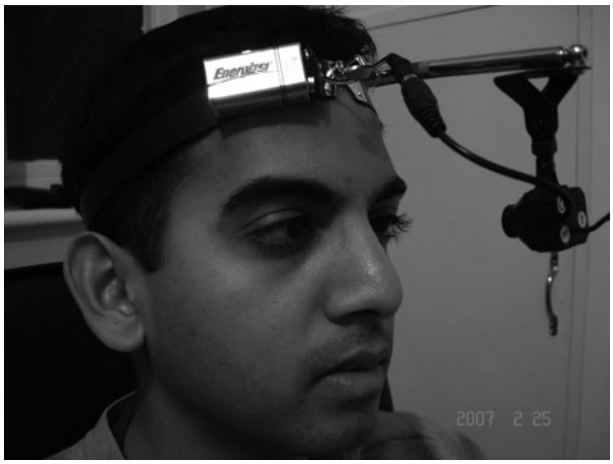

FIG. 2
System in situ for eye movement recording.

the eyes to be adequately assessed. Computational methods extract eye movements from the video images. Two-dimensional video-oculography systems yield information about horizontal and vertical eye movements, while three-dimensional video-oculography systems additionally give information about torsional eye movements.[1] Advances in computer technology have led to the formulation of necessary image processing software so that video-oculography systems are now more accessible and can be based on personal computers.[2]

Video-oculography systems use an image contrast paradigm (where the pupil is dark compared to surrounding eye structures) in order to compute eye movements. Analysis of the structure of the iris is additionally used in three-dimensional systems for highlighting torsional eye movements.[1] Fluorescent markers affixed to each eye have also been used to construct a mathematical matrix to compute eye movements.[3] Compared to the accurate research tool of scleral search coil used to measure eye movements, video-oculography is almost equally reliable for measurement of three-dimensional human eye movements.[4]

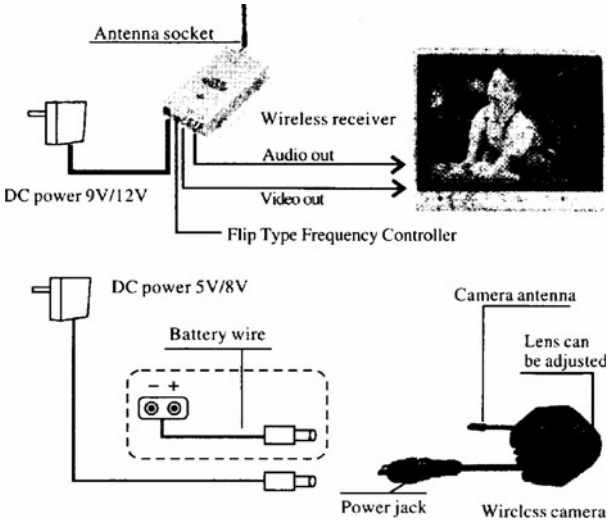

FIG. 3
Blueprint for setup of the system.

Simple observation of eye movements is more accurate compared to electronystagmographic records in situations such as caloric testing.[5] A method of recording eye movements in clinic should prove useful for patient review and teaching. While a formal video-oculography system may be more accurate in quantifying eye movements, the system described here has the advantages of being relatively inexpensive, easy to construct and efficient in recording both monocular and binocular eye movements in response to vestibular stimuli.

References

1 Wuyts FL, Furman JM, Van de Heyning P. Instrumentation and principles of vestibular testing. In: Luxon LM, Furman JM, Martini A, Stephens D eds. *Textbook of Audiological Medicine, Clinical aspects of hearing and balance.* London: Martin Dunitz, 2003;717–21
2 Sakatani T, Isa T. PC-based high speed video-oculography for measuring rapid eye movements in mice. *Neurosci Res* 2004;**49**:123–31
3 Migliaccio AA, Macdougall HG, Minor LB, Della Santina CC. Inexpensive system for real time 3 dimensional video-oculography using a fluorescent marker array. *J Neurosc Methods* 2005;**143**:141–50
4 Imai T, Sekine K, Hattori K, Takeda N, Koizuka I, Nakamae K *et al*. Comparing the accuracy of video-oculography and the scleral search coil system in human eye movement analysis. *Auris Nasus Larynx* 2005;**32**:3–9
5 Baloh RW, Solingen L, Sills AW, Honrubia V. Caloric testing. 1. Effects of different conditions of ocular fixation. *Ann Otol Rhinol Laryngol* 1977;**86**(suppl 43):1

Address for correspondence:
Dr R Nandi,
52 Blenheim Road,
London, SW20 9BB, UK.

Fax: 44 207 813 8261
E-mail: rajnandi@doctors.net.uk

Dr R Nandi takes responsibility for the integrity of the content of the paper.
Competing interests: None declared