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Eye Tracking Method Compatible with Dual-Screen Mammography Workstation

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Abstract

In this paper a new approach is proposed to track the perceptual behaviour of radiologists when they examine mammographic images displayed on large dual clinical monitors. Zooming and panning are inevitably performed by the radiologist to examine such large images by using the DICOM viewing software. Such image manipulating movements on the target displays makes eye tracking techniques difficult to perform and also the size of the dual clinical monitors makes existing eye tracking techniques generally inadequate. Hence a method using the Smart Eye Pro eye tracker and optical character recognition techniques was designed to relate the recorded radiologists' eye gaze behaviour on the monitors to the actual zoomed and panned medical image areas. This then allows clinical studies involving radiologists interacting with these mammographic images to be successfully carried out.

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1. Introduction

Medical imaging research often examines the performance of radiologists when they examine different types of images. A fairly common behavioural approach is to use eye tracking, where the radiologist's visual search

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behavior is recorded as they examine the displayed images and information concerning where they fixated or did not fixate in the image is then linked to their performance. Typically, three types of user error are elaborated by such an approach: errors which are made where the radiologist clearly did not look at or near an abnormality (a visual search error), abnormalities looked at but not detected (a detection error) or abnormalities looked at and information reported as being detected (e.g. micro-calcifications identified) but then this information is not interpreted appropriately (interpretation error).

In general, eye tracking can be undertaken using several different commercially available systems. These are typically either head-mounted glasses or systems which are affixed beneath the medical monitor. For most medical images either approach can work well, however particular difficulties arise with mammography images due to the large clinical monitor sizes. For instance, by monitoring a radiologist's eye movements on a digital mammography image, it is possible to tease out any performance differences between naïve breast screeners and experienced breast radiologists as well as how errors occurred and why experienced radiologists perform better. Previous research has examined the visual behaviour when participants read mammographic images on a clinical dual-screen workstation[1]. This was achieved by using a head mounted eye tracker to monitor the participants' eye movements. As this study reported, difficulties can occur when using a head mounted eye tracker to examine visual search behaviour with such large displays, such as the participant's head movements may cause the head mounted scene camera to lose track of the display. Also, due to the complex set up of the digital mammographic workstation, popular remote eye trackers which can be mounted below the monitors would not be able to be configured compatibly with the dual-screen display system. That is, the large size of the dual monitors exceeds the size of the visual display that can be recorded accurately by these eye trackers.

An additional problem arises with the medical images themselves which are viewed using a DICOM viewer. Radiologists typically use zooming and panning of images to examine fine details; this is especially the case with mammographic images where often the interest is in perceiving whether very small calcifications are present and where these manipulations are a key factor. Currently popular eye trackers on the market will only allow an observers' eye gaze position to be recorded according to a fixed co-ordinate system (i.e. the clinical display) which is defined and calibrated before the actual recording takes place. Any area of interest in the displayed image is then normally defined in relation to the full image being examined. Therefore, when zooming and panning is performed, it is difficult to relate the recorded observer's eye gaze position accurately (which is based on the coordinate model defined by the clinical display) to the actual eye gaze location on the image.

Based on the above issues, a new approach is presented which optimises a current eye tracking method when a clinical mammographic workstation is used and allows for accurate eye tracking enabling appropriate panning and zooming of the medical images.

1. Experimental Set Up

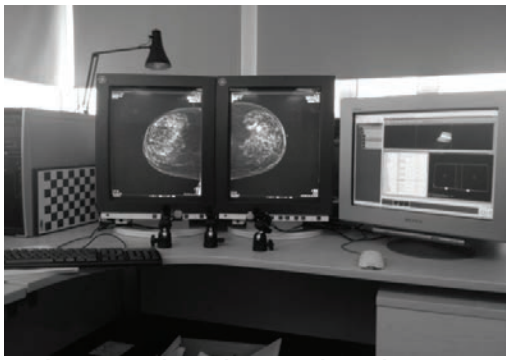

Fig. 1. GE Digital Mammography Workstation with Synedra View DICOM viewer

The workstation used was a GE Digital Mammography Workstation (Fig. 1.) consisting of a desktop tower PC with one monitor and two 5MP diagnostic displays. The hardware configuration of this mammography workstation is no different to a standard compatible PC except that a special graphic card which supports the dual-screen output