Computational Methods for the Early Detection of Diabetes

Herbert F. Jelinek
Charles Sturt University, Australia

David J. Cornforth
University of New South Wales, Australia

INTRODUCTION

The incidence of diabetes is increasing, and is expected to exceed one million people in Australia by the year 2010. Diabetes is currently diagnosed after the onset of symptoms. At this stage, detection of complications is a key intervention point in reducing the associated personal and community burden. These include eye, heart, kidney, and foot disease, which in many instances can be treated with good outcomes, provided the disease process is recognized early. In Australia, both national and state governments acknowledge the disadvantage faced by rural people in availing themselves of all aspects of diabetes management, from screening to regular assessment, education and health care (Colagiuri, Colagiuri, & Ward 1998). Therefore, the challenge that is the focus of this article is the early detection of diabetes complications associated with vision and cardiac function, with the eventual aim of providing a screening service that can be used in a rural or regional environment.

BACKGROUND

Complications associated with diabetes often remain undetected for quite some time, especially in rural regions, but are often what alerts health care providers to the presence of diabetes. Vision loss, cardiovascular disease, and foot amputations are the most often occurring outcomes of diabetes. Early detection of blood vessel changes associated with retinopathy, cardiovascular disease, and foot complications is important for timely treatment, to prevent or delay the occurrence of these complications and improve the quality of life for individuals with diabetes. Regular health screening that includes eye and cardiac function assessment has the potential to reduce the high costs on the health care system associated with diabetes, and to reduce the disparity in health care between rural and urban communities by providing timely feedback to those at risk.

Currently, regular screening provides an opportunity to discover people with unidentified diabetes and with subclinical eye and heart complications. Extrapolation from data obtained from eye health initiatives indicates that interventions that relieve or prevent complications associated with diabetes are highly cost effective (Lee, Lee, Kingsley, Wang, Russell, Klein, & Warn, 2001).

Universal screening is both feasible and cost effective. It delays complications, and younger patients have a longer time to benefit from early identification. In spite of this, diabetes screening is far from universal, especially among rural and regional populations. However, recent reductions in the cost of health technology and an increase in the availability of computing equipment, coupled with advanced data processing techniques, offer new opportunities. These include the ability to detect complications earlier, make screening faster, more accurate and cheaper, and to remove access barriers faced by those in rural and regional communities. This article focuses on two aspects of screening that could benefit from automation using computational techniques: diabetic retinopathy (DR), and cardiovascular disease.

DR is a condition in which the retina has suffered damage due to the complications of diabetes. DR could be significantly reduced by simplifying the procedure used to identify the condition and ensuring that early eye examinations become routine for diabetic patients. Damage to the eye associated with DR is the commonest cause of blindness in the working age population in developed countries. Yet, 98% of people with vision loss can be treated effectively provided the pathology is detected early (Lee et al., 2001). Automated assessment of retinal health allows community screening programs
Computational Methods for the Early Detection of Diabetes

Computational Methods for the Early Detection of Diabetes in a Rural Context

Advances in computational methods that may be of use in rural settings involve two main areas: DR, and heart rate variability (HRV). Both of these rely on the fact that diabetes affects the cardiovascular system. Both aim to provide methods that can be applied easily and cheaply in a rural setting.

Analysis of Diabetic Retinopathy

The assessment of retinopathy has been enhanced by the ability of regional clinics to make quality photographs of the retina that can be then sent to remote ophthalmologists for assessment. This has recently been expedited using digital photography and improvements in digital communication. The best quality images are obtained using fluorescein photography, where the contrast is enhanced by using a dye injected into the bloodstream. This, however, is invasive, and much research has been conducted into processing of nonfluorescein color images using computational techniques.

The scope of DR covers a wide range of pathologies that are amenable to automated identification including:

- Microaneurysms (Jelinek, Cree, Worsely, Luckie, & Nixon, 2006; Cree, Olson, McHardy, Forrester, & Sharp, 1996).
- Hard exudates and cotton wool spots (Dua, Kandiraju, & Thompson, 2005).
- Haemorrhages (Singalavaniya, Supokavej, Bamroongsuk, Sinthanayothin, Phoojaruenchanachai, & Kongbunkiat, 2006).
- Arteriolar narrowing and venous dilatation (Wong, Shankar, Klein, Klein, & Hubbard, 2005).

Automating the assessment of changes in the retina can be carried out using mathematical techniques. These techniques can be applied to the estimation of blood vessel diameter changes and quantify the appearance of microaneurysms and haemorrhages in the early stages of retinopathy, as well as new vessel growth in the advanced stages of DR. Of interest has been the correlation between blood vessel diameter changes in the eye that is not only associated with diabetes, but is also an early indicator for cardiovascular disease and stroke (Wong et al., 2005). For the automated assessment of most of these, the optic disk needs to be identified. This facilitates, for example, macula location, false positive localization of hard exudates, and vessel tracking.
5 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the product's webpage:  
www.igi-global.com/chapter/computational-methods-early-detection-diabetes/12951?camid=4v1

Recommend this product to your librarian:  
www.igi-global.com/e-resources/library-recommendation/?id=1

Related Content

The Benefits and Challenges of Using Mobile-Based Tools in Self-Management and Care  

The Black Box Myth: Artificial Intelligence's Threat Re-Examined  
www.igi-global.com/article/the-black-box-myth/219209?camid=4v1a

Privacy Challenges in the Use of eHealth Systems for Public Health Management  
www.igi-global.com/article/privacy-challenges-use-ehealth-systems/43913?camid=4v1a

Laparoscopic Skills Simulator: A Gradual Structured Training Program for Acquiring Laparoscopic Abilities  
www.igi-global.com/article/laparoscopic-skills-simulator/136982?camid=4v1a