新一代安全可靠用於非侵入式糖尿病監護的視網膜圖像系統
An Innovative Secured Retinal Imaging System for Computer Aided Non-intrusive Diabetic Care

利用高性能眼底相機實現非侵入式糖尿病視網膜病變檢測，並通過有效的無損數據嵌入提供信息安全以及個人隱私保護的新型醫學圖像系統

A novel medical imaging system performs non-intrusive detection of diabetic retinopathy with a high-performance fundus camera and provides information security and privacy protection by effective lossless data embedding

隨著生活變得富庶，都市人患上糖尿病的人數日漸增加，因此，低成本而大規模的普查對了解不同種類的糖尿病併發癥，從而找出及時、有效、便捷的檢測變得越來越重要。然而，傳統的血糖檢測方法並不能為糖尿病視網膜慢性並發癥提供非侵入式的監護。

通過研發分級視網膜眼底圖像分析，和無損數據嵌入方法並結合高性能的眼底相機，理大成功開發出一套突破性的電腦輔助檢測系統，有效地以非侵入式的檢測和監控方法來記錄糖尿病視網膜病的變化，系統同時能完善保護病人私隱資料。相信此系統定必成為另一重要的病理檢測技術。
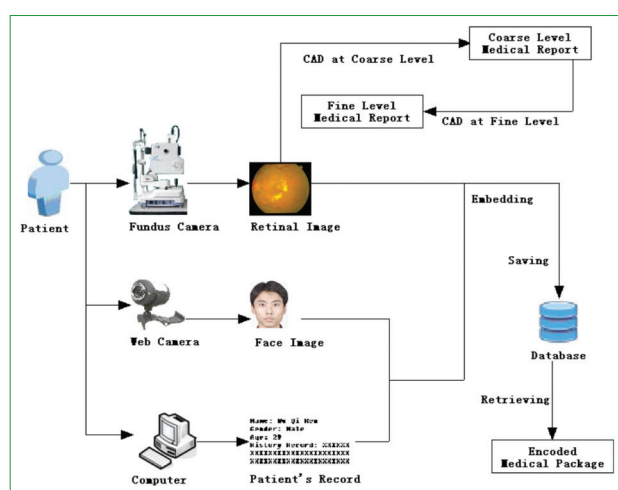

Figure 1：視網膜圖像系統結構圖
The structure of the new retinal imaging system
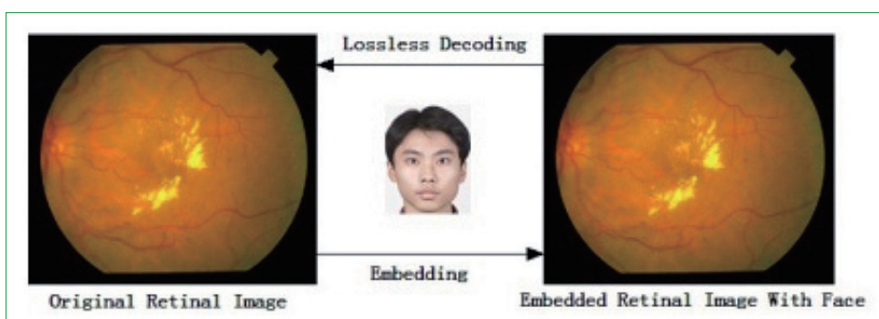

Figure 2：無損數據嵌入實例
An example of lossless data embedding: Embedding a face image into retinal image for privacy protection

With the increasing population of diabetic patients worldwide, it is crucial to detect various diabetic complications timely, efficiently and conveniently for large-scale screening at low cost. However, the conventional blood glucose testing does not provide the progress status of diabetic chronic complications such as diabetic retinopathy (DR) for non-intrusive diabetic care.

By developing new approaches to hierarchical retinal image analysis and lossless data embedding associated with a high-performance fundus camera, we have invented a computer aided detection (CAD) system to achieve non-intrusive DR screening and monitoring with privacy protection. The comprehensive performance assessment of our prototype demonstrates its feasibility for effective diabetic care with wide applications and excellent potentials.

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專利申請編號及國家：61,469,824 (美國)

特 色 與 優 點

- 獨特的光學設計大大改善新型眼底相機的照明歸一化和位置對準
- 通過多特徵提取和由粗到細的病變檢測，以層次化方法對視網膜圖像進行有效分析
- 基於小波的無損數據嵌入新方案實現信息安全和隱私保護

應 用

- 新型有效的視網膜圖像分析軟件與高性能眼底相機相結合具廣泛的臨床應用，不僅眼科醫生可用於對眼睛的護理，而且其他醫療專家也可用於包括衛生保健和遠程醫療的各類普通醫療務
- 無損數據嵌入的新技術有效完善多媒體和資訊安全等方面的處理

獎 項

- 2009年國際在線視網膜病變檢測挑戰賽 - 第二名
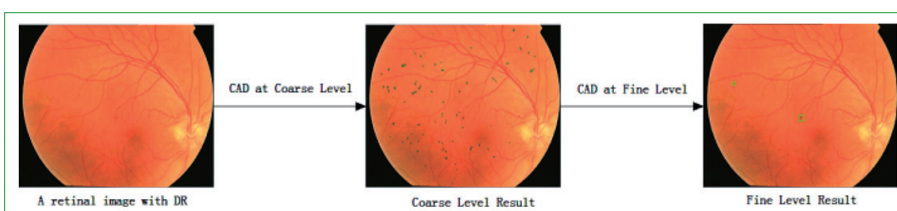- 第39屆瑞士日內瓦國際發明展 - 評審特別嘉許金獎(2011年4月)
- 羅馬尼亞克盧日納波卡科技大學-優異發明獎 (2011年4月)

Figure 3：視網膜病變分級檢測示意圖
Illustration of hierarchical detection of retinopathy

Patent Application No: 61,469,824 (US)

Special Features and Advantages

- Special optical design for a new model of fundus camera for lighting normalization and position alignment
- Hierarchical approach to retinal image analysis by multiple feature extraction and coarse-to-fine lesion detection
- Wavelet based scheme for lossless data embedding to facilitate information security and privacy protection

Applications

- The new effective retinal image analysis software in conjunction with the high performance fundus camera has wide clinical applications not only by ophthalmologists for eye care but also by other medical specialists for general health services including healthcare and telemedicine
- The new algorithms for lossless data embedding will have significant contribution to information technology ranging from multimedia to information security

Awards

- The Second Place of SPIE Medical Imaging'2009 International Competition - Retinopathy Online Challenge (ROC'2009)
- Gold Medal with the Congratulations of the Jury -39th International Exhibition of Inventions of Geneva, Switzerland (April 2011)
- Diploma of Excellency from The Technical University of Cluj-Napoca - Romania (April 2011)