May 20th, 12:30 PM

Detection of Diabetic Foot Ulcers Using SVM Based Classification

Lei Wang
Worcester Polytechnic Institute, lwang1@wpi.edu

Peder C. Pedersen
Worcester Polytechnic Institute, pedersen@ece.wpi.edu

Diane M. Strong
Worcester Polytechnic Institute

See next page for additional authors

Title:
Detection of diabetic foot ulcers using SVM based classification

Full name of all Authors:
Lei Wang[*a], Peder C. Pedersen[a], Diane M. Strong[b], Bengisu Tulu[b], Emmanuel Agu[c], Qian He[c], Ronald Ignotz[d], Raymond Dunn[d], David Harlan[e], Sherry Pagoto[e]

Institutional affiliations:
[a]Dept. of Electrical and Computer Engineering, Healthcare Delivery Institute at WPI; [b]School of Business, Healthcare Delivery Institute at WPI; [c]Dept. of Computer Science, Healthcare Delivery Institute at WPI; [d]Dept. of Surgery, University of Massachusetts Medical School; [e]Dept. of Medicine, University of Massachusetts Medical School

Contact information:
Lei Wang, lwang1@wpi.edu, Peder Pedersen pedersen@ece.wpi.edu

Abstract:
Diabetic foot ulcers represent a significant health issue, for both patients' quality of life and healthcare system costs. Currently, wound care is mainly based on visual assessment of wound size, which suffers from lack of accuracy and consistency. Hence, a more quantitative and computer-based method is needed. Supervised machine learning based object recognition is an attractive option, using training sample images with boundaries labeled by experienced clinicians.

We use forty sample images collected from the UMASS Wound Clinic by tracking 8 subjects over 6 months with a smartphone camera. To maintain a consistent imaging environment and facilitate the capture process for patients with limited mobility, an image capture box was designed with two right angled front surface mirrors and LED lighting.

We developed a novel foot ulcer recognition system using these sample images as our test data. Instead of operating at the pixel level, we use super-pixels, resulting from the quick shift algorithm, as the basic processing units. Then a support vector machine (SVM) based classifier is trained on the Bag-of-Words histogram representation of local Scale-Invariant Feature Transform (SIFT) features found in each super-pixel. As this classifier is very specific and the resulting histogram is very sparse, we merge the histograms from super-pixels in a size-specified neighborhood into one instance. Finally, to recover more precise boundaries of the foot ulcers, we apply conditional random field techniques to introduce new constraints that allow us to reduce misclassifications that occur near the edges of objects.

Experimental results show that our method provides promising recognition results, outperforming the regular SVM-based classification as well as the sliding window based object recognition method when evaluated using the Matthew correlation coefficient (MCC). We are integrating these algorithms into the wound assessment module of our Android phone-based diabetic self-management app.