

# A Computer Vision Tracking System for Pigmented Skin Lesions

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Abstract

**Background:** Many dermatologists advocate total body photography for high-risk patients of cutaneous malignant melanoma (MM). The wide-area skin photographs can help identify newly-appearing, disappearing, and changing pigmented skin lesions (PSLs) and follow their evolution. However, handling these skin photographs manually is time consuming and error prone with large inter and intra-rater variability. In this work, we develop an end-to-end automatic computer vision system for PSL tracking.

**Objective:** Our objective is to design an automatic software system that assists dermatologists in managing patients' skin images that contain lesions. The software will automatically locate the lesions, track them across time and identify newly appearing/disappearing lesions.

**Methods:** Our system is based on a 3-step algorithm: (i) landmark (LND) detection, (ii) PSL detection, and (iii) PSL matching. We start by automatically detecting a set of eight anatomical LNDs (left and right neck, left and right shoulder, left and right armpit, and left and right hip), which restricts the image search area during the second PSL detection step and encodes the anatomical spatial location of lesions; a feature critical for lesion matching. With every new patient image, the PSLs are detected automatically and are then input to the PSL matching phase, which calculates the correspondence (matching) between the detected lesions and identifies newly appearing (or disappearing) ones. The lesion matching step is performed by a feature learning approach using a high order Markov Random Field optimization framework.

**Results:** We evaluated our automated system on 194 images (97 pairs) of human back digital color images with isotropic resolution of 0.25 mm/pixel. The image pairs were captured in a three year interval. Ten fold cross validation was performed for the different steps in our framework. To the best, of our knowledge, we are the first to perform automatic LND detection on skin back images. The numerical results indicate that the LND detection error of our method falls within the typical localization variability amongst human observer (~1 cm). Regarding the PSL detection and matching steps, our method achieves 87% and 90% accuracies, respectively, which outperform the state of the art.

**Conclusions:** We presented an end-to-end automatic PSL-tracking system, which is important for early skin cancer detection and image management. Our next step is developing a polished GUI-based software system for use by collaborating dermatologists (beta testers) and collecting feedback on performance and utility within a clinical workflow for flagging disappearing or newly appearing PSLs.

**Keywords:** pigmented skin lesion (PSL); tracking; matching; skin back image; landmark detection; PSL detection.