15 - C00

学外秘

Blood Vessel Detection in Color Forearm Images

13022144　クェユーヤン（計測システム工学研究室）

Quek Yu Yang (Instrumentation Systems Engineering Laboratory)

*Keywords* : ridge detection

１．Introduction

We are developing an autonomous blood flow measuring system using laser speckle pattern. Laser is directed at blood vessels under the skin to induce light scattering by blood while a camera attached to the tip of a robotic arm is used to capture the resulting speckle pattern. The captured speckle pattern can be used to infer various information about the blood flow including the pulse rate. Thus a blood vessel detection system is needed to position the camera and the laser source correctly for accurate measurement.

Normally, blood vessel is detected under infrared light since it is absorbed by blood vessels, resulting in darker lines when captured by a camera with IR pass filter. However, to avoid attaching an additional camera to the robotic arm, an algoritm to detect blood vessels under visible light is needed. Various approaches (probabilistic approach, machine learning) are considered but this necessitates the acquisition of prior data about blood vessels (pixel intensities and their coordinates). To acquire such data, the idea is to first capture an image containing blood vessels with an IR pass camera and obtain the coordinates of blood vessel pixels. Then, an identical image is captured with a regular camera and the blood vessel pixels can be extracted using the coordinates. This paper summarizes the methods and results for obtaining the blood vessel pixel coordinates in an image taken with an IR pass camera.

２．要　旨

2.1 Ridge detection

We introduce a (*p,q*) coordinate system which corresponds to the principal curvature directions at each point. The blood vessels which form ridges in the image function can be characterized by

(1)

where *L* is the image function.

2.2 Scale space

To separate valleys from different scales, we will introduce a scale parameter *t* which is the variance of the Gaussian filter used to convolute with the image. The larger the scale *t*, the more heavily smoothed is the corresponding image. This can be visualized as a 3 dimensional structure where the *x* and *y* axis are the coordinates in an image and the *t* axis is the scale. When the ridge detection method in 2.1 is applied to extract the ridge coordinates from this 3D structure, the valleys will sweep out a surface which is referred to as the ridge surface.

2.3 Ridge strength

We’ll also introduce a ridge strength measure that will maximize at the scale corresponding to the size of the valley. There are three measures introduced in the paper by Lindeberg but we’ll be using the γ-normalized maximum absolute principal curvature which consists of the magnitude of the principal curvature multiplied by a normalizing variable that changes with scale. This normalization is necessary because as *t* increases, the magnitude of the principal curvature will decrease. For complete scale invariance, γ is set to .

(2)

Points that satisfy the following equations are the maxima points that indicate the appropriate scale at the corresponding coordiates.

(3)

2.4 Ridge saliency

Any connected set of points in the 3D space described in 2.2 that satisfy equations (1) and (3) are defined as a ridge. To extract the most significant ridges and to remove noise, a ridge saliency measure that can be used to compare ridges is necessary. For the ridge strength measure adopted in this paper, the saliency measure is

where the scale space ridge is projected onto the image plane .

2.5 Results

２・６　自発的学習の行動結果

|  |  |
| --- | --- |
| ４月 | コンピュータビジョン学習 |
| ５月 | コンピュータビジョン学習 |
| ６月 | 論文調査，アルゴリズム作成 |
| ７月 | 論文調査，アルゴリズム作成 |
| ８月 | 論文調査，アルゴリズム作成 |

３．むすび

　全体の構成や前章の項目などは，研究テーマや進捗状況により，適宜，調整，整理してまとめて下さい．

参考文献

1) http://www.jsme.or.jp/conrule.htm#kakikata

2) 日本機械学会，執筆要綱，改定第９版，(1994), 5−10, 日本機械学会．