**Review Paper - Image Acquisition**

**1. Boosting Unsupervised Dorsal Hand Vein Segmentation with U-Net Variants - mdpi Mathematics**

The text discusses the challenges in detecting dorsal hand veins and proposes a robust segmentation system for accurate identification. It emphasizes the use of near-infrared (NIR) light for better visualization of veins, particularly in obese individuals. The proposed system involves a two-phase approach: an initial unsupervised segmentation using traditional image processing, followed by refinement using supervised convolutional neural network (CNN) segmentation. The goal is to assist medical professionals in precise needle placement for procedures. The main contribution is the automatic segmentation of dorsal hand vein NIR images, aiming to improve accuracy without relying on manual labeling. The paper showcases an experimental improvement from a Dice score of 90.65% to 95.11%, demonstrating the effectiveness of the proposed methodology. The focus is on segmentation rather than detailing the specifics of image acquisition.

**2.Personal Authentication Using Hand Vein Triangulation and Knuckle Shape - IEEE**

In this work, the acquisition of hand vein images using near-infrared (near IR) imaging is explored. A low-cost near IR camera, typically used for surveillance, is employed for contactless image acquisition. The near IR illumination, generated by LEDs, is evenly and circularly located around the camera, peaking at a wavelength of 850 nm. The camera is fixed at the base, and the expected distance between the user's hand and the camera is experimentally set to 21 cm for optimal acquisition.

Volunteers are requested to present their folded right hand (palm dorsal surface) near the imaging window during the acquisition process. The near-infrared illumination is absorbed by the haemoglobin in the blood vessels, including arteries and veins. Due to differences in absorption and scattering coefficients between blood and surrounding tissues, dorsal vein patterns appear darker. The higher scattering coefficient of blood causes more incident infrared illumination to change its path within the blood than in the surrounding tissue.

The acquired hand vein images exhibit noisy gray-level vein profiles along the direction perpendicular to their length. Despite variations from vein to vein, the average profile is approximated as Gaussian, with vein widths in the range of 30–50 pixels. Detecting the edge points of vein patterns involves locating zero crossings of the second derivative of gray-level profiles. However, due to sensitivity to noise, preprocessing such as averaging is employed. The two-step process of Laplacian of Gaussian is found to be effective in localizing venous structures in the acquired hand vein images. Representative image samples and vein profiles are provided to illustrate the methodology.

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Some key points related to performance metrics, image acquisition, and near-infrared (NIR) imaging include:

Image Quality and Visibility: The clarity of subcutaneous blood vessels varies across individuals due to physiological factors, affecting the accuracy of vein structure extraction. The poor visibility of veins can lead to spurious or missing minutiae points, degrading system performance.

Average Number of Minutiae: The passage mentions the average number of minutiae extracted from low-quality images, with a distinction between ridge bifurcations and endings. It notes that spurious ridge endings are more prominent than bifurcations due to image noise.

Triplets and Threshold Selection: The extraction of triplets is discussed, and the selection of a threshold in the matching process is highlighted as a compromise between computational complexity and achieving genuine matches.

Conclusion and Comparative Summary: The conclusion discusses the proposed hand authentication approach using vein triangulation and the simultaneous extraction of knuckle shape biometrics. The experimental results, including an equal error rate of 1.14%, are deemed promising. A comparative summary of prior work in hand vein authentication is presented.

Considerations for Imaging Setup: The passage suggests that the imaging setup is developed for cooperative users in an indoor environment and may not be suitable for uncooperative users. Limitations related to fixed focus and sensitivity to changes in imaging distance are mentioned.

Future Work: The passage suggests potential improvements, such as incorporating auto-focus in the imaging setup and using more sensitive near-infrared cameras for outdoor usage. The combination of hand vein and knuckle shape features is considered promising for biometric-based personal authentication.

In summary, while the passage provides insights into challenges related to image quality, acquisition, and performance metrics, it does not explicitly mention specific details about the use of near-infrared or far-infrared imaging.

**3. Review of palm vein recognition - IET**

Yes, the passage provides information about palm vein recognition systems, focusing on various aspects such as image acquisition, preprocessing, feature extraction, and matching. In particular, it discusses the principle of palm vein imaging and the methods used for image acquisition.

Here are some key points related to near-infrared (NIR) imaging and image acquisition:

1. \*\*Principle of Palm Vein Imaging:\*\* The palm vein imaging principle involves using near-infrared (700∼900 nm) light. Haemoglobin in the palm vein vessels absorbs more near-infrared light compared to the surrounding tissues. The resulting vascular shadows create the palm vein image.

2. \*\*Palm Skin Layers:\*\* The palm skin has three layers: epidermis, dermis, and subcutaneous layer. The NIR light penetration depth is estimated to be 3.57 mm, offering higher contrast for subcutaneous veins.

3. \*\*Imaging Methods:\*\* There are two imaging methods for palm veins - reflection and transmission. The reflection method, where the target part is illuminated from the front, is more commonly used due to its practicality. The transmission method, where the target part is illuminated from the back, requires intense NIR light and is less common.

4. \*\*Image Acquisition Devices:\*\* The passage discusses different palm vein image acquisition devices, including details about cameras, light sources, portability, contact vs. contactless methods, the presence of pegs or docking, and containers for hand placement.

5. \*\*Comparison of Image Acquisition Devices:\*\* Various devices from the literature are compared based on appearance, corresponding image, camera type, light source, and image method.

6. \*\*Wavelengths:\*\* The passage mentions that wavelengths of 850 and 940 nm are more popular for the active light source in palm vein imaging devices.

7. \*\*Public Databases:\*\* Several public palm vein databases, such as CASIA, PolyU, VERA Palmvein, and PUT, are mentioned. These databases provide a range of palm vein images for research purposes.

8. \*\*Challenges with Databases:\*\* The passage notes limitations in existing databases, such as the limited number of people in the datasets and the challenge of enlarging databases with improved imaging devices.

In summary, the passage provides insights into the principles of palm vein imaging, the methods used for image acquisition, and considerations for choosing wavelengths and imaging devices, including the importance of near-infrared light.

**4.A survey on dorsal hand vein biometrics - Elseveir**

Yes, the passage discusses the image acquisition modes for DHV (Dorsal Hand Vein) recognition, particularly focusing on different criteria and electromagnetic spectrum categories. Here are the key points related to image acquisition:

1. \*\*Acquisition Modes According to Electromagnetic Spectrum:\*\*

   - DHV images are typically captured using infrared imaging.

   - The electromagnetic spectrum is subdivided into several regions, including near-infrared (NIR), short-wavelength infrared (SWIR), mid-wavelength infrared (MWIR), long-wavelength infrared (LWIR), and far-infrared (FIR).

   - DHV image acquisition modes are divided into FIR-based, NIR-based, and multispectral-based methods.

2. \*\*Principle of FIR Imaging-based Methods:\*\*

   - FIR imaging relies on the fact that a human body emits infrared radiation. Veins, having higher temperatures than surrounding tissues, can be highlighted using thermal imaging.

   - FIR imaging does not require external lighting as it uses the infrared radiation emitted by the objects.

3. \*\*Principle of NIR Imaging-based Methods:\*\*

   - Haemoglobin in the blood absorbs NIR light, and deoxygenated haemoglobin in veins absorbs NIR differently from oxygenated haemoglobin.

   - NIR imaging, when combined with an NIR light source and sensor, renders veins visible as dark structures against a bright background.

4. \*\*Comparison Between FIR and NIR Imaging:\*\*

   - FIR imaging is sensitive to environmental and body condition changes.

   - NIR imaging is more tolerant to such changes and is preferred in recent research due to lower costs and better stability.

5. \*\*Acquisition Modes for NIR Imaging:\*\*

   - NIR-based DHV acquisition has two modes: transmission mode and reflection mode.

   - In reflection mode, the CCD camera and the illumination LED array are on the same side. In transmission mode, the LED array is under the palm, and the CCD camera is above the back of the hand.

6. \*\*Acquisition Modes According to Touch or Touchless:\*\*

   - Acquisition modes can be divided into touch-based and touchless-based methods.

7. \*\*Acquisition Modes According to Hand Pose:\*\*

   - Acquisition modes can be classified into open hand mode and clenched hand mode.

The passage provides insights into the principles of FIR and NIR imaging for DHV recognition, the advantages of NIR imaging, and different acquisition modes based on these principles and criteria. It doesn't explicitly mention far-infrared (FIR) acquisition devices but provides information on FIR imaging principles.