IDENTIFICATION USING FINGER VEIN PATTERN

Finger vein authentication is a new biometric method utilizing the vein patterns inside one's fingers for personal identification. Finger vein authentication verifies a person's identity based on the lattice work of minute blood vessels under the skin. **Vein patterns are different for each finger and for each person. Further as they are hidden underneath the skin's surface, forgery is extremely difficult.**

These unique aspects of finger vein pattern recognition set it apart from other forms of biometrics.

The Principle

Vein authentication uses the vascular patterns as personal identification data. Veins and other subcutaneous features in the human hand present large, robust, stable and largely hidden patterns. The deoxidized haemoglobin in the vein absorbs light having a wavelength in the near-infrared area. When an infrared ray image is captured only the blood vessel pattern containing the deoxidized haemoglobin are visible as a series of dark lines. Based on this feature, the vein authentication device translates the black lines of the infrared ray image, and then matches it with the previously registered pattern of the individual.

The pattern of blood vessels is captured by transmitting near-infrared light at different angles through the finger. The light is partially absorbed by haemoglobin in the veins and the pattern is captured by a camera as a unique 3-D finger vein profile. This is turned into a simple digital code which is then matched with a pre-registered profile to verify an individual's identity. Even twins are said to have different finger vein patterns! Because the veins are inside the body, invisible to the eye, it is extremely difficult to forge and impossible to manipulate. The gruesome possibility that criminals may hack off a finger has already been discounted as the blood would flow out of a hacked off finger, making authentication impossible.

The Technology

Capturing the image

Finger vein recognition works by shining invisible near-infrared light through the finger. The infrared light is absorbed by the haemoglobin of the blood in the veins. Since haemoglobin strongly absorbs infrared light, the best images are obtained by shining light *through* the finger. The light source is placed above the finger, with the sensor below as seen in figure 1. The result is an image of the unique pattern of veins which can be captured by a sensor placed below the finger.

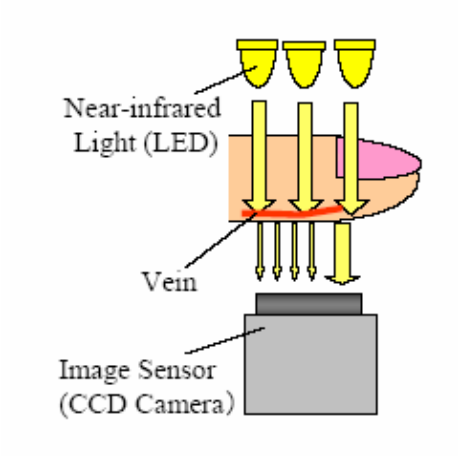

Fig. 1 Capturing the finger vein pattern

Fig. 2 Typical finger vein reader

For some applications users may prefer to place their finger on the device rather than inside the device. In such a case a "side-illumination" technique is employed as can be seen in figure 3. This technique combines the advantages of using transmitted light with the advantage of having an open and user friendly device (figure 4).

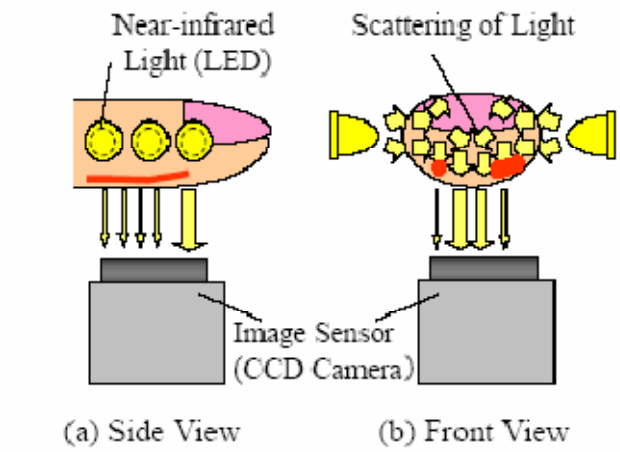

Fig. 3 The side-illumination technique

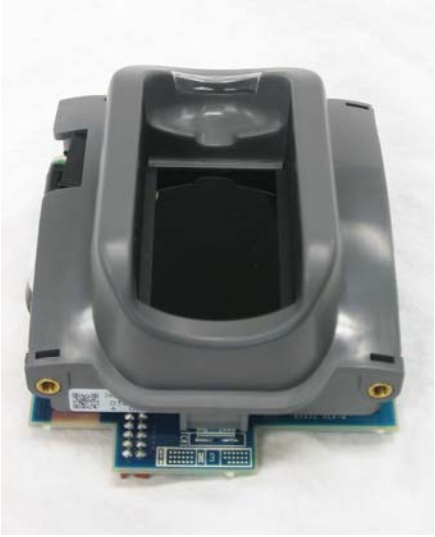

Fig. 4 Typical Embedded Finger Vein reader

Such a device could be incorporated into a wide range of applications. To enable the finger vein device to cope with a wide variation in finger size and operating environment the light source intensity is adjusted adaptively. This enables the optimisation of image contrast and detail, and the minimisation of noise — an important issue due to the very high sensitivity of the image capture CCD.

Authentication

There are four stages in finger vein authentication:

1. Capture of the finger vein image pattern
2. Normalisation of the image
3. Feature pattern extraction from the image
4. Pattern matching and outcome decision

Figure 5 shows a block diagram of these stages. **In stage 1 the sensor captures finger vein images**, as described above, and passes them to the CPU memory. The CPU in turn dynamically adjusts the brightness of the infrared LED to optimise the image quality.

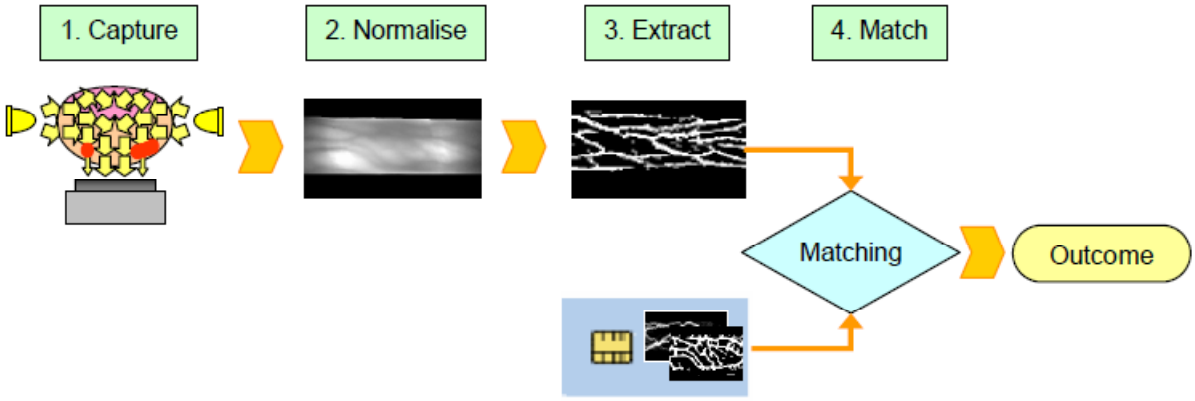

Figure 5 Block diagram of finger vein authentication

In stage 2 the finger vein image is normalised to accommodate geometric changes in position or angle of the finger. This is done by detecting the outline of the finger in the image, and rotating the entire image to normalise the slope of the outline.
Distinctive features of the finger vein pattern **are extracted in stage 3**. This is an essential step for eliminating variations in the captured data due to changes in body metabolism or imaging conditions. The result is a standard finger vein template which is suitable for passing to the matching algorithm. In **stage 4 the captured finger vein template is matched against a previously stored reference template.** If a sufficiently close match is found then the user is authenticated.
In the example above, the reference template is stored in a smart card. If a capable enough smart card is used then the matching can take place on the card itself. Alternatively, the reference templates can be stored in the finger vein device itself or on an attached PC, or elsewhere on the network.
The authentication unit includes a CPU core for all sorts of signal processing, video I/O for capturing data from the image sensor, LED power controller, and I/O controller. The authentication outcome flows through the I/O controller. Security applications such as door locking are activated by the signal from the controller.

Features – Advantages

Finger vein authentication technology has several important features that set it apart from other forms of biometrics as a highly secure and convenient means of personal authentication.

- Resistant to criminal tampering: Because veins are hidden inside the body, there is little risk of forgery or theft. Involves live body identification hence a dead persons finger will not be authenticated.
- High accuracy: The ‘False Rejection Rate’ (FRR) is less than 0.01% for the, the ‘False Acceptance Rate’ (FAR) is less than 0.0001% and the ‘Failure to enrol’ (FTE) is 0%.
- Unique and constant: Finger vein patterns are different even among identical twins and remain constant through the adult years.
- Contactless: The use of near-infrared light allows for non-invasive, contactless imaging that ensures both convenience and cleanliness.
- Ease of feature extraction: Finger vein patterns are relatively stable and clearly captured, enabling the use of low-resolution cameras to take vein images for small-size and simple data image processing.

- Fast authentication speed: One-to-one authentication takes less than one second. Moreover, the authentication device can be compact due to the small size of the fingers.

Technology Acceptance and Trends.

Finger vein products have been successfully adopted by major corporations in the fields of financial, physical and logical security in Japan and other parts of Asia. In Japan, finger vein products have enjoyed great success in the financial sector. Physical security systems (standalone or connected by server and used with a smartcard, PIN code or by itself) have also sold widely in Asia. Large buildings that house multinational firms have adopted finger vein technology for biometric entry access.

Trends

Beyond embedded applications for portable IT devices such as cellular phones, finger vein authentication will in the future likely expand into applications such as opening automobile doors with a simple grip of the handle. This technology will be applicable to home, office or car doors and will usher in a secure future without keys. The expansion of finger vein authentication applications is the miniaturization of this technology. Miniaturization enables finger vein authentication technology to be embedded in a greater variety of devices and is thus the driving force behind the expansion of finger vein authentication applications. One of the principal mechanisms behind miniaturization of finger vein authentication technology is the miniaturization of the image sensor.

Conclusion

- Some biometric characteristic like fingerprints are volatile or not fake resistant.
- In some, the collection is not user friendly.
- Finger vein recognition is not volatile. It is also fake resistant and user friendly.
- The unique aspects of finger vein pattern recognition set it apart from other forms of biometrics.
- Finger vein authentication is less expensive than iris scanning or face/voice recognition.
- The false rejection rate is much lower than with fingerprints.
- **Finger vein recognition outperforms both fingerprint and iris scan recognition systems in the aspects of high security and reliability.**