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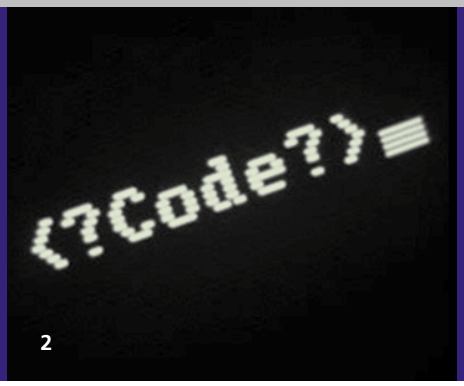

1 *Critical infrastructure.*
2 *Authentication by knowledge.*
3 *... by ownership.*

BIOMETRIC AUTHENTICATION WITH MEMS-BASED RETINAL SCANNER

Motivation

The process of globalization in economy affects the society as well as privacy. On one hand, people take advantage of growing opportunities to communicate, to access services and goods, to live and travel freely. On the other hand this liberality gives more space for beguilement, non-legal, criminal, or even terroristic activities. Consequently, societies, communities and individuals are interested in more security and care to defend themselves against these threats. In particular, critical infrastructures as exemplary shown in fig. 1 need adequate security measures.

One opportunity to improve security is to authenticate each person before allowing specific actions or getting access to critical resources. A simple approach of authentication is to own a token, e.g. a key or a personal ID card. Another opportunity is to have special knowledge like a password or a PIN code. Both means are illustrated in figs. 2 and 3. However, these solutions are not very safe: tokens may be lost or stolen, knowledge can be spied out or extorted. Banking cards combine both: the card itself acts as token, and the PIN code is needed to get cash at an ATM. However, even this does not safely protect against fakes!

Human individuality helps

One more opportunity to prove personal identity is the use of individually formed traits of the human body, so-called biometric modalities. Fingerprints or DNA profiling used in criminal prosecution are well known. Other useful methods of biometric authentication are face and speech recognition as well as the analysis of the irides or the retinae of our eyes.

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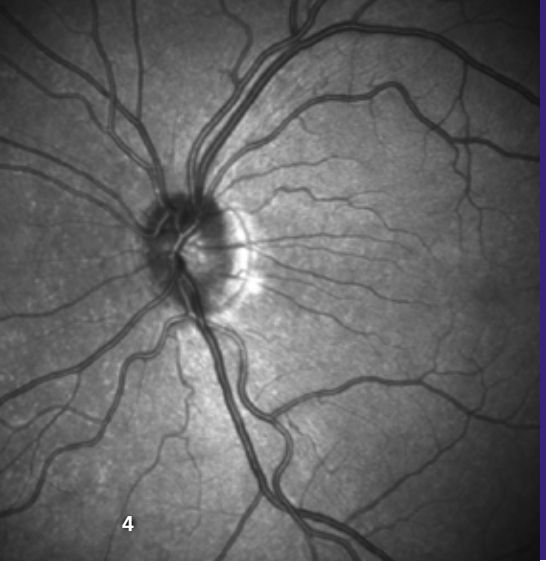

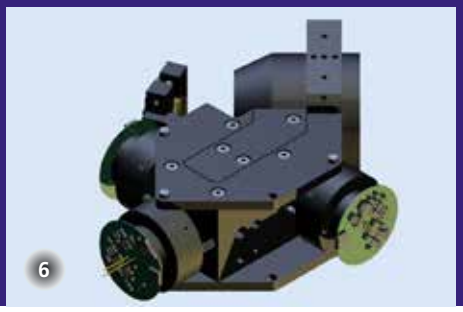

Retinal images

The blood vessels supplying every human retina form a very individual pattern which is excellently suited to biometric recognition of persons, and which is almost impossible to fake. In medicine detailed retinal images are captured by scanning laser ophthalmoscopes (SLO) which use a quickly moving laser spot illuminating the retina through the eye lens, collect the light reflected out of the eye, and reconstruct the entire image along the spot trajectory. Fig. 4 shows an exemplary retinal image taken with a SLO.

MEMS-based approach

The MEMS scanning mirrors developed and fabricated at Fraunhofer IPMS Dresden as illustrated in fig. 5 are well suited for being used in a SLO-like retinal scanner. Due to the small size and the simple driving principle of the MEMS mirrors the scanning engine seems to be feasible as a compact device to enable mobile applications. Nevertheless, the reduction of size is still a challenge because of physical limitations, the anatomy of the human eye and the high precision requirements to micro-assembly technologies.

Laser Scanning Engine

The scanning engine uses infrared laser light of 830 nm wavelength and allows about 20 µm resolution of details of the retina making also small blood vessels visible. This requires an ocular for high imaging quality considering the optical parameters of the eye. Additional optical components were needed to form and collimate the laser beam before it is directed to the MEMS and deflected through the ocular into the eye. The weak amount of light reflected from the retina passes the ocular in reverse direction and is led onto a highly sensitive photo detector. Fig. 6 illustrates the complete optical subsystem.

Image projection for user cooperation

For getting sufficient image quality with low in-motion unsharpness the user should look quietly and concentrated into the optics. This is enforced by virtually displaying symbols onto the retina with an additional modulated laser in the visible range. If the user's view fixes this symbol, the collocation of scanning device to the eye is stable enough to achieve enough image quality. The symbol projection is also useful to indicate the correct operation of the device and the success of the scanning.

Protection of health and data

The optical laser power used for scanning a retina has to be eye-safe under all circumstances. Therefore, extensive precautions have been implemented into the system to detect any failure immediately and switch the lasers coercively off at any malfunction.

Since biometric data are always related to persons they have to be handled carefully and must not be disclosed. Therefore, the retinal images are processed and analyzed by means of electronics and software inside the system, i.e. it can be used in an encapsulated manner, communicating only the result of authentication outwards.

Application and Acknowledgements

Size and weight of the current optics shown in fig. 7 are already suited to enable portable use in working environments, where increased security by biometric authentication is desirable. The electronic subsystem will be further miniaturized to fit both subsystems into a single case.

The retinal scanning device outlined here is the result of cooperation between 9 partners. The project is funded by the German Federal Ministry of Education and Research as part of the Security Research Program of the German Federal Government. The VDI Centre of Technology, Düsseldorf, acts as project executing organization.

The Fraunhofer IPMS is coordinating the project and is the major contributor in hardware development.

4 *SLO picture of a retina.*

5 *MEMS scanning mirrors of Fraunhofer IPMS.*

6 *Optic components of a retina scanner*

7 *Complete system including control electronics.*