

Seeing eye to eye on iris recognition

Part II

by Ravi Das

After the 9/11 terrorist attacks in 2001, the use of biometrics increased dramatically as a means of positively verifying and/or identifying an individual. For iris recognition technology, which has been around for quite some time, the most notable growth was also achieved in the last decade. In recent years many new iris recognition technologies have evolved, and the number of vendors in the market has grown significantly. In this two-part article, Ravi Das discusses what iris recognition entails.

The first part of this article in issue 41 of the Journal discussed, among other things, the physiological structure of the iris and the methods involved in traditional iris recognition. In this issue, the article continues with:

- Recent advancements in iris recognition.
- Market applications.
- Advantages and disadvantages of iris recognition.
- Final conclusions.

Recent advancements in iris recognition

During the last decade, the patents which fuelled the growth of iris recognition technology were held by just one company: Iridian Technologies, Inc. Only a few years ago, with the subsequent buyout of Iridian Technologies and the expiration of the original iris recognition algorithms patent held by Dr John Daugmann, the monopoly held over iris recognition technology was finally broken. Because of the release of this grip, much more research and development has occurred in this area of biometrics, and the number of vendors has greatly increased as well. Nowadays, there are many vendors, who all offer different types and kinds of iris recognition solutions. The primary advantage of this is that the exact needs of the customer can be met, rather than locking into just one solution and being forced to purchase upgrades over time in order to keep up with the technology.

With all of these advancements being made in iris recognition, there are three distinct trends now occurring in this area:

- The development of new technology which permits iris recognition to capture the images of irises of people in movement.
- The use of iris recognition as the prime means of security for wireless devices, especially for the smartphone.

- The use of the unique blood vessel pattern in the sclera, as a means of verifying and identifying individuals and thus providing support to iris recognition as a very viable multimodal biometric solution.

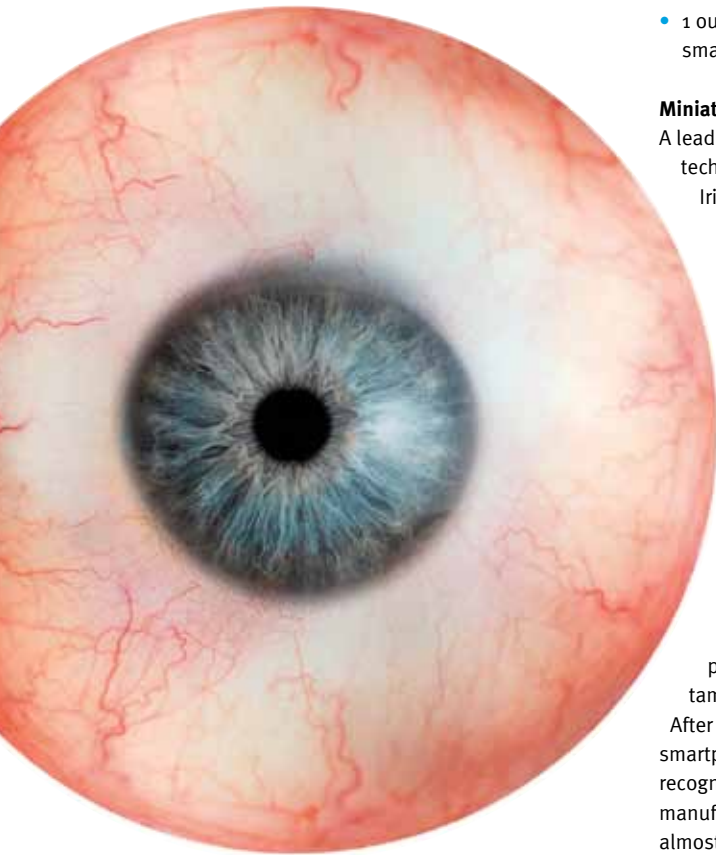
Iris On The Move

The technology used for capturing iris images of people in movement, known specifically as 'Iris On The Move', was developed by biometrics vendor SRI International Sarnoff. This cutting-edge iris recognition technology has emerged on two distinct fronts:

- *The use of e-Gates at major international airports*
All a passenger needs to do is stand in front of a specialised gate which is equipped with iris recognition technology, have their iris scanned, and within seconds - after a 100% verification - they can enter the country of their destination. This technology is robust enough that up to 30 passengers can be verified in just one minute, and their irises can be scanned from as far as three meters away.
- *Verification 'at a glance'*
Where with traditional iris recognition technologies an individual has to stand directly in front of an iris scanner, with the new technology they can stand 15 feet away from the camera, glance into it and have their iris scanned. This type of solution can process up to 12 individuals per minute, in a rapid fire succession method. This solution can be used both outdoors - under all types of weather conditions - and indoors in office-based environments, primarily as a second layer of security, thus replacing the technologies which have been dominant until now: traditional hand geometry scanners and fingerprint recognition devices.



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Smartphone security

The next big technological advancement for iris recognition is that of smartphone security. Essentially, the smartphone is becoming an extension of both our personal and professional lives. We rely upon smartphones for just about everything we do. This can range from keeping in touch with our contacts and checking corporate email to making online purchases (mobile or m commerce). Thus, the need for a high level of security comes into demand, and not just using primitive security mechanisms such as a password and PIN. Just consider some of the following statistics which dictate the need for iris recognition technology on smartphones¹:

- At the time of writing, there are almost 6 billion smartphone users, which translates to almost 90% of the world's population.
- The use of smartphones to conduct business transactions is growing at a speed three times greater than conducting business transactions via traditional methods.
- In 2011, smartphone transactions totalled over USD 240 billion, and they are expected to exceed USD 1 trillion by 2015.

- 1 out of every 8 smartphone users uses their smartphone to purchase airline tickets.

Miniature camera

A leader in the development of iris recognition technology for smartphones is a vendor called Iritech, Inc. The company has developed a miniature iris recognition camera which easily fits into the top of the smartphone. A mirrored lens placed over the camera will help the smartphone user to look straight into it to get the iris properly aligned. A LED near the camera is added to provide the best possible illumination under any kind of lighting. To log into the smartphone, all the user has to do is point the camera towards their face, and look straight into it. The camera takes a photo of the iris, and verification will take place in just a matter of seconds.

The primary advantage of using iris recognition for the smartphone is that if it is ever lost or stolen, the smartphone is permanently 'locked', meaning that it cannot be tampered with by someone who has intercepted it. After all, it takes the unique iris features of the smartphone owner to unlock it again. The iris recognition camera and LED are installed at the point of manufacturing, and the costs associated with it are almost negligible to the smartphone companies.

Scanning of the sclera

Although not a direct development in iris recognition per se, a new breakthrough eye recognition technology is that of scanning the sclera. The sclera is the white of the eye, which contains numerous blood vessels, just like the retina (see figure 1). These blood vessels are distinct, and can be seen when looking at your eyes in the mirror. These blood vessels, which are embedded in the tissue of the sclera, can only be captured with a special camera. As each individual has a unique pattern of blood vessels in the sclera, this can be used as a means to confirm the identity of a particular individual. However, a major difference between scanning the sclera and iris recognition is that with the former, the individual has to move their eyes from left to right and back in order to capture the complete blood vessel pattern, whereas with iris recognition no movement of the eye is needed; all that is required to capture a robust image is a straight angle shot of the iris.

Five distinct steps are involved with the scanning of the blood vessel pattern in the sclera:

1. Image capture: the blood vessel pattern in the sclera is captured.

Figure 1

The sclera contains numerous unique blood vessels, which can be used to confirm the identity of a particular individual.

2. Segmentation: four regions of the sclera are broken down and analysed, during which the eyes have to be moved from side to side.
3. Image enhancement: the blood vessel pattern images are extracted from the sclera and further enhanced; colours are segmented and filtered out, and the blood vessels are measured.
4. Feature extraction: the unique features of the blood vessels in the sclera are extracted. Some of the variables here include the texture of the blood vessels and their relative position from within the sclera.
5. Matching: the enrolment and verification templates are compared in order to determine the degree of similarity; such comparisons include distance measurement, robustness analysis, and the use of neural networks.

At the present time, this technology, of which the company EyeVerify is the primary vendor, is being primarily used on smartphones, in a manner similar to that of iris recognition. Thus, the scanning of the sclera can serve as an excellent and very robust two-factor level of security (also known as a multimodal approach) for smartphones, along with the use of iris recognition. The bottom line is that since the sclera surrounds the iris, this two-factor approach can work very quickly in a rapid fire fashion. As the other biometric multimodal solutions require different modalities, the verification

and/or identification of an individual can take much longer, relatively speaking.

Market applications of iris recognition

As a result of the technological breakthroughs described above, iris recognition now cuts across all realms of market applications. As in the past decade the iris recognition technology was held in a monopolistic grip, it only served a very limited number of market applications, and consequently customer acceptance and the belief in its viability were very low. Also, at that time, iris recognition technology was very expensive (USD 3,000-5,000), thus posing a much bigger obstacle in its adoption rate. Today, the price has come down substantially, which has helped to boost its acceptance by customers very quickly. Iris recognition has now become a dominant player in a market where traditionally only hand geometry recognition and fingerprint recognition were around.

In table 1, a number of iris recognition market applications are described.

In the following two real-world examples, iris recognition is being used successfully.

Case study Physical Access Entry: Auburn University

Auburn University is a major educational institution in the United States which covers 1,841 acres, has 427

Table 1 - Market applications

Market application	How iris recognition is used
Logical Access Entry	Gaining access to servers, corporate networks and intranets.
Physical Access Entry	Gaining access to secure areas in a facility or place of business.
Time and Attendance	Accurate time reporting and actual hours worked by employees.
Critical Infrastructures	Maintaining control of nuclear power plants, oil refineries, large scale military installations, as well as government facilities.
Airports	Everything from confirming a passenger's identity as they make their way through the security checkpoints to reading their e-Passports before they disembark at the country of their destination.
Seaports	All of the maritime activities, including securing marine terminals, and 'high consequence' facilities such as oil and gas storage, chemical, intermodal, and port operations.
Military Checkpoints	Securing areas such as military bases, air force bases, and naval bases.



buildings, and has well over 30,000 students, staff, and faculty. The university's athletic facilities allowed for people to enter these premises with traditional access cards. However, as many of these cards were lost or stolen, the costs of replacing them were escalating drastically. As a result, university officials turned to biometrics for an alternative solution. At first, hand geometry recognition was chosen, but it did not succeed over time for two reasons:

- The technology could not accommodate the large hand size of some of the athletes.
- Hand geometry recognition could not take into account the hand swelling of the athletes after an exhaustive workout.

Because of this, iris recognition was chosen as the next alternative. So far, it has proven to be very successful, because the students, faculty, and staff just have to merely glance at the iris recognition system, and up to twelve people per minute can be verified quite easily. Even if the end user is wearing (sun) glasses or contact lenses the image of the iris can still be captured in great detail. Auburn University is the very first educational institution to implement an iris recognition system for this type of specific market application².

Case study Time and Attendance: Union Pacific Railroad

Union Pacific is the largest railroad company in North America. It is 151 years old, has 33,000 miles of railroad

track, and serves 23 states in the United States. In early 2001, voice recognition was implemented in an effort to drastically reduce call centre costs. While this has proven to be successful, another solution was needed to address the time and attendance needs of the company's railroad worker gangs. These are the mobile labour work groups which are dispatched throughout the Union Pacific railroad network to provide improvements and regular maintenance to all of the railroad tracks. Their jobs are very labour intensive, operating in harsh environmental conditions and extreme weather cycles.

These railroad worker gangs work extremely long hours. In order to keep track of the hours worked, manual methods such as roll calls were used, but this greatly escalated the fear of worker fraud. Hand geometry as well as fingerprint recognition were looked at as viable solutions for the time and attendance needs. But because of railroad worker union policies, and the fact that the job is so laborious that it can actually even alter the physical appearance of the worker's hands, iris recognition was looked at as the next viable solution, and was picked for three primary reasons:

1. It is well suited for the harsh railroad environments.
2. It meets the relatively low needs and provides for a high level of performance of this particular labour work force.
3. It provides for a very effective method to quickly identify workers.

So far, 40 iris recognition-based time and attendance units have been deployed by Union Pacific. The time/attendance data are processed locally, and then subsequently uploaded to central servers which can track labour data very quickly and easily. The obvious benefits are the quick payroll calculations which can be achieved, and the greatly reduced administrative costs³.

Advantages and disadvantages of iris recognition

Just like any other biometric technology, iris recognition works very well in many situations, but it also has its fair share of flaws as well. This means that iris recognition should not be relied upon as the sole means of security, but should be used in conjunction with other (non-) biometric technologies in order to yield the maximum results desired.

The advantages of iris recognition can be described as follows:

- Alongside the retina, the iris is probably the most unique biometric in terms of rich data and information. As mentioned in part I of this article,

scientific studies have shown that even identical twins have different iris structures.

- The iris is a stable biometric: its structure hardly ever changes over the lifetime of an individual, unlike other biometric technologies, such as facial recognition, in which the face can change drastically over a short period of time.
- Unlike our hands, fingers and face, the iris is considered to be an internal organ, thus it is not prone to degradation from the outside environment.
- A booming area in biometrics is that of 'Single Sign On Solutions', whereby the use of passwords is totally eliminated. The iris is fast becoming the technology of choice in this aspect, and with a single scan of the iris end users can log into their computer in less than one second.
- Iris recognition has very much proven to be useful in capturing terror suspects, and has also been widely deployed in the current War on Terrorism. Equally important, iris recognition is also being used in countries such as Afghanistan, in order to positively confirm the identity of refugees, and to make sure that they are receiving the benefits they are entitled to.

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- As the wait time at customs and immigrations has now almost been eliminated with the use of iris recognition-based e-Gate facilities, across the major international airports iris recognition has become the de facto standard for verifying passengers before they board their plane, as well as before they disembark into their destination country. Also, iris recognition is used on a large scale to verify the identities of airport workers, which is a strong need post 9/11.

The disadvantages of iris recognition can be described as follows:

- Although iris recognition has come a long way in terms of technological development, it is still deemed to be user invasive, as people are squeamish about having their irises scanned, and a possible injury occurring - even though there have not been any cited incidents. As a result, it could be very difficult to gain the full cooperation of the end user.
- Despite the fact that costs have come down substantially in recent years, implementing a full-blown iris recognition system - including the associated hardware and software - can still be quite costly, especially for small to medium-sized enterprises (SMEs).
- Given the sudden explosion of iris recognition vendors and their many products and solutions, it can be quite confusing and difficult for an SME to choose the most suitable iris recognition system, unless an outside consultant is used, which can be quite costly.
- Even today, the eyelashes and the eyelids can still be an obstacle in capturing a good iris scan of a particular individual.
- Although the technology can capture people on the move and at further distances, any sudden or excessive head movement can cause distorted iris images, or result in not having the iris image taken.
- Iris recognition is a non-contactless technology. Although this can be very advantageous in certain circumstances, it also means that it can be used in a covert fashion, without the individual's knowledge. Consequently, iris recognition has been and still is very much prone to privacy issues and claims of civil liberties violations.

Final conclusions

Iris recognition technology has truly come a long way since the beginning of the last decade. By the standards which are set forth today, the technology as it was used back then has become almost obsolete. It seems that iris recognition is growing on an almost

continuous basis, serving even more customers as well as different types of applications. When it was first made available to the public, there were very serious doubts that it would ever pick up the momentum which we are seeing today. At that time, the technology was very bulky, and of course very expensive. With only one vendor serving the marketplace, the growth of iris recognition was very stagnant.

Nowadays, iris recognition is being used all over the world, even in the poorest Asian and African countries. At present, by far the biggest markets for iris recognition are those of large scale and massive deployments. These include government uses - especially in major theatres of military operations - and heavy usage in the major international airports, focusing on the e-Passport.

The next big untapped market for iris recognition is that of serving the security needs of the small to medium-sized enterprises (SMEs), which still predominantly use the traditional biometric technologies of hand geometry recognition and fingerprint recognition. As these SME's look to upgrade these legacy biometric systems in the coming years, it is quite conceivable that iris recognition will be the next security technology to be deployed, to help further fortify and protect their mission critical assets. Finally, iris recognition will be a technology that will be around for a very long time to come, perhaps even replacing the market dominance held by the traditional biometric technologies.



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