



Future of biometrics

Abstract

Biometrics as a branch of industry, science and technology exists since about 20 years. Its size is about 1 billion Euros. Problems and questions having to do with automatic people recognition are attracting more and more scientists and technician. And, although many devices already exist and/or are being proposed, it is certain that biometrics is still in the early stages of its history. This paper will be an attempt to forecast the future of biometric technologies and applications.

As such, I will try to identify and describe both possible markets and new technologies that can already be predicted from present trends.

I. Why biometrics – possible future markets

Reading currently published papers and information about biometrics, one can think that the main reason for applying biometric solutions is security. This perspective is supported by politicians, spreading the message that biometric technologies can help in the fight against terrorism, help locate criminals, etc. This is not fundamentally wrong. Indeed, if automatic devices for identity recognition were more prevalent in locations such as airports, police stations and other areas that are sensitive or involve high concentrations of public activity, they would surely make the life of criminals and terrorists much more difficult.

However, there are many reasons to believe that biometrics will change the life of people in near future mostly because its use will be much more convenient than other techniques in use today for individual identity authentication. This is already apparent today, especially in connection with applications such as physical and logical access control, transportation, and also in the financial industry.

In this presentation I will try to specify new possible markets, with emphasis on markets that will – from my point of view – have the largest impact on future societies:

- 1. Authentication.** It is reasonable to expect, that in a relatively short time, all personal documents will contain some form of biometric

data. Moreover, in time, we could expect that all such documents will no longer be needed, because, in every instance where this type of authentication would be necessary, biometric readers will be connected to the location via network. This would allow a comparison with stored data to be used in lieu of documentation.

2. Access and attendance control. In the relatively near future, biometrics will certainly gain increased acceptance in all kinds of access and attendance control applications. We can expect to see biometrics used for these applications in homes, offices, computers, machines, devices, etc. In fact, this will be probably the largest market for biometric technology in terms of the amount of devices installed. However, for the most part, the use of these devices will only replace existing access control methods and technologies, providing increased convenience and security. There will be no need to carry keys, identity cards, personal documents, etc. Furthermore, this implementation of biometrics will add to the overall security solution: precluding the possibility of theft or unauthorized use of equipment/technologies. Biometric devices will offer new quality to security solutions, but not necessarily new market opportunities or potential.

3. Travel control. For a variety of reasons, there is an increasing requirement to have people traveling via planes, ferries, and even trains to be individually registered, with interim checks at multiple locations. Today these requirements are being driven mostly by security concerns, visa regulations and other such reasons. And, because the amount of people traveling is already large and predicted to increase at significant rates, all organizations involved in the management and control of mass transportation industries are very interested in the rationalization and automation of necessary procedures. This is especially the case in International Civil Aviation Organization. The pressure caused by the growing number of passengers is surely one of the largest reasons for the introduction of biometric passports, visas and other controls/documents. This organization recommends very clearly, that “Contracting States should incorporate biometric data in their machine readable passports, visas and other official travel documents, using one or more optional data storage technologies to supplement the machine readable zone, as specified in Doc 9303”¹,

4. Financial and other transactions requiring authorization. In applications having to do with money it is already apparent, that money in physical form (bank notes and coins) is being replaced more and more by virtual forms of financial transactions – digital transactions via data base entry. Today this happens in form of credit or bank cards, pocket electronic money, etc. However, it is clear that, in most cases, the physical card is not important, because money has an owner and can be

¹ http://www.icao.int/cgi/goto_m.pl?/icao/en/download.htm#Misc

directly connected to a person. Spreading of biometric authentication in the economic sector (i.e. banking and trade) will decrease the need for physical objects, such as cards – since virtual money can be directly connected to a person (or to the legal person). This will result in a significant change both in the behavior of people, but also in the abilities that governmental organizations will have in their surveillance of money movements (financial transactions).

I would expect two possible developments in response to this situation. First, the attitudes of people can be against the sole use of virtual money or they can also try to change the tax and economic systems to allow them to live exclusively with virtual money. The second development, or solution, will evolve over a longer period of time, but is significantly better. That is, the possibility to authorize all legal transactions through biometric mechanisms will make many of these operations much easier and more convenient.

5. Remote voting (authorization). Perhaps the most important change in the society will result from the creation of an entirely new market for biometric devices that I call **remote authorization**. The merging of existing and future networking developments with biometric solutions will allow people to have the opportunity to authorize a wide range of transactions (e.g. voting, purchasing, accessing, decision-making authorizations, etc.) via the network, from remote locations. No longer will they be required to personally present at a given location in order to authenticate a specific action. Indeed, this is a capability that is partially possible today. However, the viability of remote authorization on a large scale, such as public elections, will not be realistic until appropriate biometric solutions are operating without the major shortcomings that plague existing biometric solutions.

From my perspective, it will be necessary to develop new, more robust and capable devices. However, the same devices can also be used for many others purposes, such as computers accessories, access control devices, etc. Even so, it is certain that the existing devices that are in use today cannot provide the degree of accuracy necessary to recognize a person whose biometric identity is only available through a distributed network. The risk of betraying them through identity theft is much too large. However, after more accurate, reliable and cost-effective devices are developed that are not constrained by shortcomings associated with existing technologies, the potential for authenticating remote transactions, such as voting (decision making) can drive major changes in all democratic societies – that is, the idea that direct democratic participation by the public can be realized on a large scale and work at low cost.

Necessary democratic decisions can be made practically every day at minimal cost, even in large societies. The possibility of low cost remote voting by the public will not only open up the potential for increased

participation, but also for increased frequency in voting activities. It is only speculation today, but I would think that this perspective can lead to some of the largest changes in democratic societies – all facilitated by the introduction of accurate, reliable, high speed biometric technologies that enable remote authentication (voting, et al.) at minimal cost. The corresponding changes in political systems and power structures will provide the potential to have a more representative democracy.

In association with changes in banking and money transfer techniques remote voting and authorization can also significantly influence economy and tax system: the control of money transfers will be easier, it will be also easier to compete within the “black economy”, but this can also result in people with a much stronger interest in controlling politicians regarding the questions of spending taxes and lowering the cost incurred by the operation of their governments.

The possibility to authorize any transaction remotely will surely cause additional changes in other transactions that require such authorization, which currently implies a personal contact. This is also something that will have impact on life in the near future – it will minimize, or eliminate the need for many personal contacts. Such operations will be easier and can be done automatically (by machines – without clerks operating them, as it is done today).

6. Use of automatic working devices. With the help of biometrics it will be easier to track the actions of user of any devices and machines, adapt their functions to his needs and to demand his liability for actions caused. I assume that this can slowly change many areas of life and create a large market for devices that are able to recognize their users and react according to their needs. The development of such machines began already, some devices are working, other are proposed as ideas: The main goal of this development is the creation of machines able to recognize their user or people doing something in their vicinity. This feature can be very important for work in factories, offices, hospitals, for use of cars, home appliances, etc. In all such cases it may be important or convenient, that the machine “knows” who is using it (or try to do it, but shouldn’t). This allows automatic adaptation to the needs of people, but also tracking of their actions and reacting in the case of misuse. Such a feature means naturally, that actions of people will be associated by machines, that can be more useful, more convenient to use, but also allows to control, eventually improve the actions of people. These kind of biometric functions do not require (in most cases) a very high degree of secure recognition, but will require techniques, that are called today multimodal biometrics: face, voice, gait and habits recognition and probably much more. It is already visible today that such functions will be implemented in many devices, because of the convenience, that they are offering. In industrial environment the importance of their use will grow with the percentage of automatic devices. Their use will also offer

significant advantages: quicker reaction to the user for example in the form of establishing the environment that suits to the person, actual using the device. It can be a seat that is adjusting its position to the needs of the user, but also the computer desktop, loudness of the speaker, etc. This offers not only a convenience, but also a time gain: adjusting such functions requires some time that must be not lost, if automatically done by the machine. It allows also implementing such functions for correction of specific errors, often made by the user, use of shortcuts that can be adjusted individually. Broad use of such technologies will also support the development of automatic shops and other facilities that can be now operated without employees. I think, that this kind of devices will be developed slowly, with growing amount of functionality and in the future will cause, that many machines will be able to recognize the needs of their users automatically, becoming more and more able to serve people in the similar way as live servants.

7. Action control. At the last place I would specify a market that can be seen as a part of previous ones but it has special features and can require specific devices: In the case of potentially dangerous devices it is necessary or would be good to control the use of them - to prevent that unauthorized people can use them or to track, who has used them in a specific situation. This is the case with cars, that shouldn't be used by people without driving license or drunken, with dangerous machines, that must be used by people with appropriate knowledge, a special case are weapons: it would be very good if every weapon could be used only by authorized person. This would make the use of plundered weapons impossible, but also allow to track, who has used a specific weapon for a crime. This market is specific, because biometric devices for action control must have special features: in the case of weapons they must react in real time (probably quicker than 0.1 second). In practically all cases they must be integrated in such elements as handles, triggers, steering wheels... In some cases they must also be able to recognize the condition of the user and eliminate for example drunken car drivers.

It is surely not possible for me to specify all possible markets for biometric devices, which can emerge in the future. I would be grateful any other idea, that I have not included here.

II. Technologies for biometric devices

Now we will try to consider, which technologies can be used for biometric purposes. This outlook is based on technologies that can be proposed now, based on actual physical knowledge. It is not possible to predict further development of physics and I will not try to do it.

To make this outlook easier, possible technologies will be divided in areas, according to the physical method used and then according to the elements or functions of the body, taken for the recognition:

Methods, that can be used in biometric devices

A.Optical technologies:

Such technologies are used in fingerprint, hand shape, face, iris, veins and also in all other cases, where optical parameters are interesting. Special case is iris and retina recognition – there is no other possibility to make contact less iris or retina recognition. Another special case are techniques for remote temperature sensing. This can be done only with infrared cameras. In all other cases different techniques are possible too.

B.Acoustical technologies:

Presently the only acoustical technologies that are available are used for voice recognition. Ultrasound technologies are also in use for biometric applications, but on a very limited scale. Given the proper design approach, ultrasound can be used in many other applications, in addition to the existing fingerprint recognition devices. Indeed, a much more versatile implementation of ultrasound scanning for biometric applications has already been demonstrated in a proof of concept prototype. Subsequent testing indicated the possibility of using acoustical holography for shape recognition of hand, face and other body parts, as well as for tracking movements.

The resultant technical approach capitalizes upon the inherent power and capabilities associated with conventional ultrasound technologies that are currently used in medical applications. It has the advantage of providing a direct 3D evaluation of biometric attributes, such as fingerprints, palm-prints, bone structure and vein recognition with analysis of internal structures of the subject's body (e.g. fingers, hands, limbs, etc.). Heretofore unprecedented capabilities, such as persistent authentication, liveness detection and the fusion of multimodal biometrics using a single core technology is now possible through ultrasound. Along with these capabilities, it will be possible to achieve user enrollments approaching 100%, with FAR and FFR approaching zero.

C.Microwaves:

As far as I know, they are not used in biometric devices now, but especially THz- waves can be used in the future. The ability of this waves to propagate through clothes can allow to use them for body shape recognition. Microwaves are also used for movement tracking.

D.Capacitive sensors:

Sensors reacting to local capacity changes are used for finger recognition. It is possible to use capacity sensors for tracking movements.

E.Pressure (tactile) sensors:

Such sensors are used for fingerprint recognition, but also for movement tracking (for example signature recognition).

F.X- γ - or particle rays technologies:

Their use is not realistic today, because the amount of energy required for techniques would prohibit their use in biometric devices as too dangerous for people. But such possibility cannot be excluded in the future. The development of the technology can especially in the case of x-rays cause, that the use of this technology will be possible. All such techniques can allow to analyze the internal body structures.

G.Magnetic fields:

Magnetic fields are especially interesting in connection with tomography. It is a technology that from today's point of view can be considered as unrealistic, but further development of it can cause that especially for the investigation of body parts, such as finger or hands the use of it cannot be excluded. More realistic seems to be the use of specific reaction of man's body to changing magnetic fields. Such techniques can be surely considered as realistic, although it is not easy to tell, if they will be useful.

H.Electric fields:

Man's body is surely reacting to electric fields and creating them. Both phenomena can be used for recognition. Today it is only partially the case in capacitive fingerprint sensors, but there are much more possibilities that can be used. It is not possible to tell now, if this possibilities will occur as useful for recognition of people.

I.Chemical emissions:

Each living body produces streams of particles, which can be analyzed from the chemical point of view. This is the case with odor, and especially with particles that contains DNA or RNA strains. Disadvantage can be the ease to fool such techniques. But especially odor detection can be useful for example for tracking purposes (in the applications for the market number 6).

Body parts or features that can be used for biometric recognition

Already used or proposed:

a)Fingerprints or other elements of finger, such as veins inside.

b) Palms, its prints and/or the whole hand (feet recognition would be also possible, although not very practical in most cases).

c) Signature, measures behavioral attributes, such as pressure, stroke and time

d) Keystroke, art of typing.

e) Voice.

f) Iris, retina, features of eye movements.

g) Face, head – its shape, specific movements.

h) Other elements of head, such as ears, lip prints.

i) Gait, unique manner of walking, such as pace, width of steps and peculiar gait.

j) Odor.

k) DNA.

l) ECG

m) EEG

Imaginable today:

n) Body shape recognition.

o) Investigation of internal structure of body parts and its living structures.

p) Analysis of other electrical and magnetic fields, created by man's body or of its reactions to such fields.

q) Analysis of face and head vibrations during speaking.

In the case of devices, where authorization (local or remote) is required, it is also necessary to recognize, if the person, who will make such authorization is really willing to do it. It will require that such devices must have the ability to recognize additional actions, which can be caused only by the will expression of the person, wishing authorization. Many possibilities for such action are existing:

Signature;

Other specific movements of hand, eye or other body parts;

Voice commands.

III. An attempt to predict, which devices can occur on biometric market in the near future.

It is surely a very difficult job to try to predict new developments and because I am personally involved in such developments it is also not possible for me to be neutral. But I will try such prediction:

- Very realistic and even necessary will be the development of techniques that can recognize people, observing their behavior. One can observe, that such developments are already going on and will create a variety of different approaches, used in even relatively simple devices. So called multimodal biometric will be

used in such devices too: voice, face, and body shape recognition is to expect – all methods that can be used without direct contact. I would expect, that in a relatively short time a large amount of devices, that I have defined as belonging to the market number 6 will occur. A special role will play here the software that will be more and more able to evaluate the behavior and knowledge of people in the way similar to the way as living people are able to do it.

- The second development, which I would expect will be caused by the awareness, that already proposed devices are not able to recognize living and real biometric features and must be replaced by devices that cannot be fooled. And because I am sure, that the ultrasonic technology for finger recognition, that I have proposed is able to it, I would expect, that it will be used. Especially because it has many additional advantages: it allows the integration of sensor in existing elements, such as screens, handles, windows. It offers additional functions, such as touch screen, mouse pad, and information reader. It is also possible to use this technique for remote recognition.
- Another technique that can occur in a not very distant future will be based on acoustical holography, which uses air ultrasound. I would expect that a kind of camera will be proposed, able to measure 3D structure of the surface of any object, and even to measure its vibration. This device can be much better and cheaper, than optical devices for 3D measurements. And measurement of vibration of the face surface can cause, that fooling of voice recognition will be very difficult. Use of this technique for biometric purposes will improve the possibilities of devices, based on tracking of movements.
- It is also realistic, that further development of THz electromagnetic waves techniques and infrared visualization will add new features especially to the devices, used in public places, such as airports.
- Something that can be taken for granted will be the development of more powerful software for all kind of biometric devices. The largest impact will have this development on the devices used on market number 6.
- A real revolution will be caused by the development of devices, able to recognize people remotely, through the network, and in the way, that makes any kind of fraud not realistic. Honestly speaking I see only one possibility for the realization of such technique – acoustical holography for finger recognition.
- Another revolution can be caused by the implementation of techniques using emissions, coming from the man's body. The nearest possibility is from my point of view odor recognition, but I wouldn't exclude the possibility to measure electromagnetic fields. Sound created is surely a realistic possibility too.

Similar as in the case of my trial to predict market development, I cannot be sure, that I am able to do it in the case of technology development. If somebody has other ideas, knows, what I have forgotten – I would be grateful for any hint.

Conclusion

It is probably not only my opinion, that further development of biometric technologies will significantly change the world. This technologies can be surely not only used for making the life easier, but also for more perfect invigilation (I have not discussed this intentionally). This will be surely not hinder the development of this techniques. Almost every technology can be used for good and bad purposes – this depends only on people using it.

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