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Future of biometrics

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 proposed it is sure, that biometrics is at the beginning of its history. This paper will be a trial to forecast the future of it.

I will try to specify and describe both possible markets and new techniques, that can be already predicted today.

I. Why biometrics – possible future markets

Very broad use of biometric devices in future world is assumed.

From this point of view I agree with the vision, presented in many sf movies and books, where the future world is full of such devices.

And they will be to find in following markets:

1. Authentication. It is to expect, that in a relatively short time all personal documents will contain biometric data. Later it is to expect, that all such documents will be not more needed, because at every place, where authentication will be necessary, biometric readers connected via network to the place, where a comparison with stored data can be done can be used.

Biometrics can offer a really good and quick working authentication, that cannot be offered by people performing this job today

2. Access and attendance control. Biometrics will surely gain acceptance in all kinds of access and attendance control: in homes, offices, computers, machines, devices, etc. This will be probably the largest market from the point of view of the amount of installed devices, but all this devices will only replace already existing ones, giving more convenience and security. Nobody will need to carry with him keys, cards, personal documents, etc. And it will also add security: not possible will be to steal such things, to use them in an unauthorized way.

Biometric devices will offer new quality, but not new possibilities.

3. Travel control. Many reasons are causing, that people traveling with planes, ferries, even trains should be individually registered, checked at many points, etc. Today mostly security concerns, visa regulations etc. are causing this. And because the amount of people traveling is large and will surely grow significantly already in the near future, all organizations having to do with such mass transport are interested in rationalization and automatisation of necessary procedures. This is especially the case in International Civil Aviation Organization. The pressure caused by growing amount of passengers is surely one of the largest reasons for introduction of biometric passports, visas and other documents.

Passenger control functions in public transport will be much quicker and easier to perform, if biometric devices will be broadly used.

4. Financial and other transactions requiring authorization. In applications having to do with money it is already visible, that money in physical form (bank notes and coins) will be replaced by virtual form – data base entry. Today this happens in form of credit or bank cards, pocket electronic money, etc. But it is also visible, that in most cases the card is not important, because money has an owner and can be directly connected to a person. Spreading of biometric authentication in banking and trade will cause, that such physical objects as cards are not more necessary – virtual money can be directly connected to a person (or to the legal person). This will cause a significantly change not only in behavior of people, but also in the possibilities, that governmental organizations will have in surveillance of money movements. I would expect two possible developments as the reaction to this situation: people can be against the solely virtual money and they can also try to change the tax and economic system in the way that they can live with only virtual money. The second solution will come later, but is significantly better.

The possibility to authorize all other legal transactions with biometric means will make many of such operations significantly easier, secure and more convenient.

5. Remote voting (authorization). It seems that the most important change in the society will be caused by the creation of a fully new market for biometric devices – I would call it **remote authorization**. Already existing and future developments of networks together with biometric solutions that works through networks will create the possibility to authorize transaction (to vote, to make decision) without the need to be personally at the specified place. This is partially possible today, but for example in the

case of large scale elections not realistic until appropriate biometric solutions will not work properly. From my point of view it will be necessary to develop new devices, but the same devices can be also used for any others purposes –as computers accessories, access control devices, etc. But it is sure, that the devices, which are in use today, cannot give the guarantee to recognize a person, which is available only through network. The risk of betraying them is too large.

Significant changes in political systems can be expected.

After properly working devices exist and are not costly, the possibility of remote voting (decision making) can cause a major change in all democratic societies: The idea of direct democracy can be realized in a large scale and work at low cost. Necessary democratic decisions can be made practically every day - even in large societies. It is only a speculation today, but I would think, that this perspective can lead to the largest change in the social life, which can be caused by biometric technologies – to the change in political system and power structures - it will be not more necessary to have representative democracy.

In association with changes in banking and money transfer techniques remote voting and authorization can significantly influence political, economical and tax systems: the control of money transfers will be easier, it will be also easier to compete "black economy", but this can also cause, that people will be much stronger interested in controlling politicians in the questions of spending taxes and lowering the cost, caused by the function of their governments. Remote voting will give them thispossibility.

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.

Machines will be able to serve people as live servants – they will "know" their individual needs.

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.

This is a fully new possibility of controlling man's actions, not given today.

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 than 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:
Only acoustical technologies are available for voice recognition. Ultrasound can be used for many other cases: for fingerprint recognition it is used already, it is possible to use acoustical holography for shape recognition of hand, face and other body parts, and for tracking of movements. The advantage of this technique can be the possibility of direct 3D evaluation. Vein recognition is naturally possible too, together with analysis of internal structures of the man's body.

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 really 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, art of typing**.**
d. Voice.
e. Iris, retina, features of eye movements.

f. Face, head – its shape, specific movements.
g. Other elements of head, such as ears, lip prints.
h. Gait.
i. Odor.
j. DNA.
k. ECG
l. EEG

Imaginable today:
Body shape recognition.
Investigation of internal structure of body parts and its living structures.
Analysis of other electrical and magnetic fields, created by man's body or of its reactions to such fields.
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 to do it:

- 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 ob 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.

Thank you for your attention

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Wroclaw, 2008.04