Heartbeat Attached to Personal Identification

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Abstract

Monitoring the achievements of other scientific fields and to implement their results – such as, for example, 3D imaging systems or the possibilities of DNA based personal identification methods – into its own toolkit is one of the priority tasks of law enforcement and its personal responsibility forces, in order to support successful completion of its everyday duties. Measurement of the electric functioning of the human heart is one of these new scientific achievements that may give a lead on credible and reliable identification of a certain person. The application possibilities of this procedure in the fields of safety engineering, personal and primarily law enforcement should definitely be subject of criminalistics analysis. This study aims to introduce the application possibilities of electronic signals generated from the heart rate and the results of measured heartbeat from the aspects of law enforcement.

Keywords: *personal identification, heartbeat, EKG, law enforcement, monitoring*

1. Introduction

The need to identify our fellow-men is as old as the establishment of human communities, however, many centuries have passed until the need for recognition that was already part of everyday relations has turned into reliable and credible for of personal identification in the areas of law enforcement and security technology. Using methods and technical instruments for the identification of relevant persons that may 'infallibly' verify the identity of the given person has gradually become an issue of priority. For long, possibilities of fingertip image or fingerprint analysis have prevailed in this field, however, DNA analysis has slowly displaced these procedures from the priority spot. Of course, development has not stopped, moreover, upon the scientific results achieved by exploiting the benefits of the digital world several new possibilities have been discovered, such as the analysis of the venous images, facial thermography and iris or retina scan. We may admit that application of such measures can primarily be attached to security engineering and technology, first of all, in relation to data security issues. Application possibilities of other research accomplishments and instruments may gain rationale for law enforcement and public security as well. This study shall introduce two procedures that may support credible and reliable identification of certain persons in the not too distant future.

Recognition that the human heart, the heartbeat and electronic working of the heart show characteristics that can be uniquely attributed to each individual, therefore,

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they may be suitable for biometric identification dates back to several decades of scientific research.

Medical science has been examining the heart for quite a long time, but it has only been a little more than a decade ago when researchers have become certain that the electric signals of this vital organ prove to have characteristics uniquely specific for every single person, furthermore, such characteristics are relatively constant, they can also be subject of quality examination and recordings, therefore, they are suitable for the purpose biometric identification. EKG is present in every individual, it is difficult to fake, it can not be 'forgotten' neither can it be 'left'. Due to these characteristics using EKG recordings for the purpose of biometric identification procedures has gained grounds in the past few years. Let's just imagine, that we are able to identify ourselves with our own inseparable, constantly present heart without having to be involved in any special interactions during our usual everyday activities, replacing several and individual technical instruments used at the present. Heart based biometric research activities concentrate on the heartbeat, the electronic signal generated by the rhythm of the heart, in other words the electrocardiogram (EKG or ECG)[1]. Heartbeat based personal identification as a new biometric identification technology is expected to simplify the use of our technical surroundings, therefore it shall probably ease our everyday lives both in the fields of law enforcement and security engineering. The technical possibility of personal identification based on the analysis of the rhythm of the heart may effect most aspects of our lives, such as shopping, finances, work proceedings or even health care supplies. Nevertheless, this new biometric identification possibility shall not only serve consumer society but it shall also offer further perspectives for law enforcement authorities and facilitate the completion of law enforcement tasks. This study shall further examine the possibilities and limits of the new biometric technology based on the uniqueness of the human heartbeat, it explores its benefits, while, at the same time it attempts to establish recommendations for its utilization by the law enforcement and penitentiary services.

2. Heartbeat based identification in security technology

It is reasonable to consider how the unique electronic signals of our own hearts may be attached to our credible self-identification or to any technical instruments used in our daily routine? Is this method acceptable for the purpose of credible self-identification, can it be an assistance in the use of our tools or can it effectively increase secure protection of our data? Expansion and popularity of wearable gadgets like smart bracelets monitoring daily activities or smart watches seems to be unstoppable in guiding a healthy living, communication or attached to a separate digital unit or mobile phone. From day to day, more and more tools are available for keeping track of biometric data, such as pulse, blood pressure, in order to follow one's health during either sport activities or during rest. Moreover, our heart may beat slower or faster it does not really matter from the aspects of the electronic characteristics of the heartbeat. In fact, it is more about the shape of the waves and of the image of the electronic signal when

[1] N. Akhter, S. Tharewal, V. Kale, A. Bhalerao, K.V. Kale, *Heart-Based Biometrics and Possible Use of Heart Rate Variability in Biometric Recognition Systems*, Advanced Computing and Systems for Security Volume 1, 2016., pp. 15-26.

exposed by the heart. From here, it is only one step away to transfer the measured biometric data to a code and to create a device that is able to code the data and able to communicate with other digital gadgets. What are the advantages of the procedure? If we use EKG, our unforgeable, unforgettable and unleavable special characteristic to identify ourselves through technical devices we may also gain access to several other electronic devices. Contrary to a security card (pass) or a PIN code, the method's reliability is secured by the fact that this data can not be left, stolen, transferred, forgotten or forced. The device (wristband) called 'Nymi' uses exactly this specification of the product, not just keeping track of the user's own heartbeat, but uses EKG to authenticate and confirm its owner's identity then transfers the EKG to a specific key or password that can be used to unlock and access other electronic devices2. Rapid development of such technical instruments clearly overshadows the notable, but easily forgettable identification methods, even those that actually meet security standards, however, at many occasions they are based on rather complicated passwords (PIN codes) that are often difficult to be memorised but easy to forget.

If we simplify the technology, the individual's own heartbeat can be transferred into a unique security code that shall function as it were a special key allowing access to different digital devices. Authentication to this wristband is only required once a day, placing a finger on the screen, whereas the device confirms that it is being worn by its authorised owner upon the monitoring of the person's heartbeat signature (analysing EKG signals). Upon this, the wristband shall be able to communicate with and log onto any electronic system or service used by its owner. The designers of Nymi believe that this procedure shall put an end to such well known methods as computer passwords and phone PINs. Moreover, it may replace other items of everyday life as car keys, home keys, credit cards, pass cards or, in certain cases even valets[3].

Contrary to other solutions mentioned earlier, the great advantage of this procedure still in its infancy is that it uses our unforgettable, unforgeable and unstealable biometric data, therefore it is a much safer form of user identification. Identification upon the heartbeat remains accurate, regardless of any anxiety, raise of the pulse, faster or slower heart beat rates due to the fact that the beat of the heart looks exactly the same, regardless of the speed, yet, notably, there is a certain failure rate of the tracks. However, we may conclude that the biometric data monitored by the wearable Nymi device allows reliable identification[4]. Each time we want to use the fingerprint authentication app of a phone, we have to make sure that we touch the screen with a clean, dry, non-greasy finger held at certain angle and surface in order to secure successful log in. In comparison, if the authorised person once wears the Nymi he is continuously authenticated and does not have to worry about his personal identification until the gadget is worn[5].

However, heart disease or a former heart attack may limit the accuracy of the application, and according to our present knowledge this technology can not provide sufficient safety. Nevertheless, as for the chances of future utilization of continuous personal identification based on electronic signals of the heart may effect several aspects of everyday life, such as travelling, catering sectors or car industry.

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[2] https://www.wired.com/insights/2014/06/heartbeat-may-soon-password/ 2021.02.08.
[3] https://www.wired.com/insights/2014/06/heartbeat-may-soon-password/ 2021.02.08.
[4] https://www.wired.com/insights/2014/06/heartbeat-may-soon-password/ 2021.02.08.
[5] https://www.wired.com/insights/2014/06/heartbeat-may-soon-password/ 2021.02.08.

Nowadays, the issue of data security places an excessive burden on business enterprises. In parallel, technological disadvantages of using passwords appear to be an ever so pronounced issue. If that is the case, it is arguable, how can companies simultaneously keep the safety of their data and secure that their authorised personnel can access systems and information of key importance at the same time. Continuous (permanent) identification might be the solution, even by monitoring the authentication and right of access to data. But it is feasible that the employee sits down to his laptop and all his files just open up by themselves, since his computer confirms the device coding the electronic signals of his heart and authenticates the user. As he leaves the computer (leaves the office) the applications close up again so no one can sneak in and access confidential information. The authorised person may log in from any other place and does not have to use keys or pass cards, as he does not have to worry about PIN codes or changing any complex passwords often difficult to memorise or keep in mind[6].

From a consumer point of view, permanent identity may allow the user to access his vehicle and remember his preferences, for example, where he headed or what he listened (what are his habits and preferences)[7].

To sum it up, permanent and reliable identity is the priority recommendation (offer) of Nymi. Certainly, different electronic and digital systems and services do not have to recognise the heartbeat or EKG as biometric data. Analysis of such information is the task of this device. The Nymi shall identify its user if the user's heartbeat complies with the recorded pattern by the gadget. Then it shall send a 'yes' signal or in other words a code of confirmation data to other supplies (systems), emphasising the fact personal data has been transmitted. In comparison, it represents a significant alteration from the examination process of fingerprints or retina scan of identification purposes. The Nymi shall only function upon the heart pace of the registered individual. By all means, the presence of the living authorised individual is required for the usage of the device, so, for example, if the wristband gets stolen and can not be hacked, since it is not possible to copy or to steal the heart. Further benefit of the application that it does function in the dark, contrary to other facial recognition systems[8].

3. Law enforcement aspect of personal identification upon the heartbeat

Everyone has a unique heart and similarly, our beat of the heart is unique as well. Acknowledging this fact, researchers have developed a technical device called 'Jetson' for the Pentagon that recognises the unique 'cardiac signature' by infrared light. Analysing the technology we must emphasise that it can identify people from a distance and not only upon direct contact. At present, this distance is 200 meters, yet, it can be increased depending on the quality of the laser used. Further benefit of the device that it is able to complete measurements of 95% accuracy on individuals wearing heavy or thick

[6] I should like to take note that the empolyer is also able to monitor the employee unwittingly through the system based on heart pace identification, he may indirectly observe the employee's state of health, and on the other hand, he may check the employee's course of work upon his heart pace, thus in case of low pace he may even delegate more tasks to the employee. Source: https://www.adatvedelmiszakerto.hu/2015/03/a-biometrikus-azonositasadatvedelmi-kockazatai/.

[7] https://www.wired.com/insights/2014/06/heartbeat-may-soon-password/ 2021.02.09.

[8] https://www.wired.com/insights/2014/06/heartbeat-may-soon-password/ 2021.02.09.

clothing or garment covering their bodies, for which they use a technique called laser vibrometry. It works by detecting the changes in reflection of infrared light caused by blood flow[9]. Of course, in case of greater coverage like if a valet placed in the inside pocket of the clothing the technique's efficiency rate is lower. The device works at an infrared amplitude invisible for the human eye[10]. Measurements take a few seconds, so the efficiency rate of the device on a moving target is still significantly limited[11]. One of the most important advantages of the heartbeat analysis based identification is that it can not be changed, and the factors of visual circumstances, facial hair, hats, (sun)glasses, scarfs or other elements of clothing do not confuse the results[12]. Presumably, heartbeat based identification will overrule the identification processes based on voice, fingerprints, facial scan in the future, our heartbeat shall be sufficient enough[13].

Today's threat of terrorism and the issues of migration raise new questions regarding surveillance and reliable identification of individuals. Many times, traditional methods, for example fingerprints or DNA comparison can not be used with sufficient accuracy, due to the fact that they require direct contact when taking samples or because they are expensive or time consuming. In the not too distant future it is possible to set up and establish a registry based on the unique electronic characteristics of the heart, providing credible identification process passively, from a distance, not requiring the cooperation the target person. The need for the establishment of such database is supported by the idea, that this technology allows relatively fast, passive or even covert monitoring even on broad masses of people, furthermore, the method may be used on a random scale, a spot check or a screening technique and not only as a targeted procedure. The tracked information can be compared to the registered data parallel, almost without a waste of time and in case of a match, immediate notification can be forwarded. In case of mass events, parades, sport events, demonstrations, political assemblies it is a possible way to monitor the participants and facilitate the recognition of the searched individuals as well their extraction from the crowd. Using this method may increase the safety of the protected person and support the prevention of possible terrorist attacks. In this case, changing facial features does not help hiding in the crowd. We often experience that individuals formerly expelled from the country or those foreigners previously rejected to enter the country attempt to come back or enter into the country with fake or forged documents.

Pursuing the introduced techniques may also aid the screening of multiple crossing of the border with changed data, the illicit movements of individuals related to migration or immigration. The heart beat based identification device developed by New York State University of Buffalo also proves the significance of the heart beat based personal identification method that is substantially more efficient than facial detection with its accuracy rate of 98%, however, this radar generated instrument can only be used from a maximum distance of 20 meters[14].

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[9] https://newtechnology.hu/a-szivveres-lehet-az-uj-ujjlenyomat/ 2021.02.09.

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4. Significance of heart pace based analysis at the penitentiary institutions

Penitentiary (Bv.) institutions have a special place amongst law enforcement institutions. For such institutions reliable and 24/7 continuous personal identification is elemental. In order to secure viable heart beat based personal identification in these institutions the implementation of a centralised and also local databases of "cardiac signatures' that can be updated on a daily basis is a crucial issue. The existing central registry held by the Bv. should be amended with the specific characteristics related to the cardiac functions of the detainees.

With regards to the present legal regulations of Hungary we may find that the provisions on data protection do apply to the characteristics of the hearts electronic functions, prevailing rules allow the management and registration of such data, whereas the cardiac biometrical characteristics of the detained person shall be handled as personal data. At the present, in accordance with the provisions of Section 28 (1) of Act CVII of 1995 on the law enforcement system detaining Bv. institution shall keep a local, while the National Headquarters shall keep a central registry on the following data of the detainee

- the detainee's personal identification data, Hungarian social security number and photograph;
- permanent address;
- personal identification number;
- data and documents necessary to complete the tasks of law enforcement expressly stipulated in this Act and those necessary for the detainee's practice of rights;
- documents of the criminal procedure and of other procedures – court, prosecutor's office, notary public and administrative procedures – related to the detainee, that must be forwarded to the Bv. organisation in accordance with the provisions of law.

To sum it up, the records held by the hold the following data of the prisoner:

- personal data of the detainee,
- data on the legal title and term of the detainment,
- data related to procedures and actions of the international assistance in criminal matters effecting the detainee,
- law enforcement data (deprivation of personal freedom, involuntary treatment in a mental institution, forced measures, detention),
- data related to the proceedings of the judge responsible for penitentiary affairs,
- data related to the detainee's health treatment and emergency treatment,
- personal and witness protection data, data related to the protection program and data related to the placement and content of special signs,
- data of official correspondents of the prisoner[15].

Personal identification upon the heartbeat at the Bv. may be classified in accordance with its goals:

- personal identification of the prisoner prior to the detainment,
- identification of the convict for the purpose of monitoring and observation after the admission.

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[15] A. Müller, *Kommentár a büntetés-végrehajtási szervezetről szóló 1995. évi CVII.* törvényhez Bvszt. 28ához. [Commentary on CVII of 1995 on the penitentiary organization].

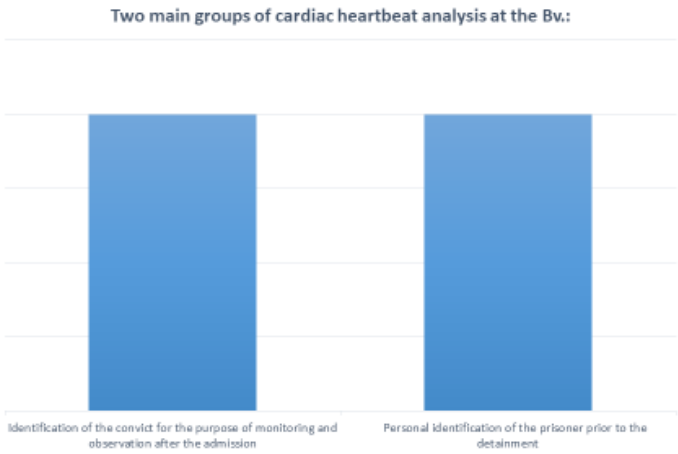

Illustration 1. own model
Two recommended groups of heartbeat analysis at the Bv. institute

In the course of the detainee's admission to the Bv. institution, the convict's identity must be checked, further, during the checking procedure the Bv. institution shall take over the data a held on the convict in the criminal registry of personal identification data and photograph images in accordance with the data stipulated in the admission documents and shall compare them with the data included in the documents forwarded as the grounds of the admission[16]. However, the monitoring procedure might reveal difficulties due to the lack of documents or otherwise if the detainee has identified himself with forged documents. Therefore, the analysis of a unique characteristic of the certain person suitable for reliable confirmation of his identification would be reasonable, alongside with the facts included in the simply checkable documentary and photograph registry. The method of examining of the heart's electric system introduced in this study earlier seems to be just suitable for this purpose. It would be sufficient to record the heart pace of the suspect during the criminal procedure, than again during the admission process if it was not completed under the criminal procedure. At the admission the convict's pace data could be compared to the formerly recorded 'cardiac signature' database, allowing comparative monitoring of the personal identity upon multiple grounds, avoiding that a different person would enter the penitentiary institution or a person other than the convict would return to the Bv. institution after a temporary leave and finish the legally binding term of detention instead of the true convict.

Also, it would seem reasonable to implement the heart beat monitoring device at different sites and spots of the institution for surveillance purposes of the convicts, or the biometric identification device could be implemented in the existing wristbands of the convicts. By these means, movements, activities and even the medical status of the convicts could be followed, or certain convicts could be continuously monitored by a wearable bracelet. Presently, detainees do wear a Near Field Communication (hereinafter referred to as NFC) chip supporting their identification in the zones and cells[17]. The

[16] 1995. évi CVII. törvény a büntetés-végrehajtási szervezetről 89. § (1) (2).

[17] J. Schmehl, *A Büntetés-végrehajtási Szervezet megújulásának áttekintése a hatályos Bv. törvény szellemében, Egységesítés, eredményesség, e-rendszerek alkalmazása a büntetés-végrehajtásban, Beszámoló egy kiemelt feladat végrehajtásának állapotáról* [n overview of the renewal of the Penitentiary Enforcement Organization in the effective Bv. in the spirit of the law, Unification, effectiveness,

new biometric identification method could supplement or replace the NFC chip, since it would actually identify the detainee instead of the chip of the wristband. In accordance with the provisions of Section 145 (1) of Act CCXL of 2013 on the Execution of Punishments, Measures, Forced Measures and Detention for Misdemeanours (Bv. tv.) the following security actions may be pursued against the detainee:

- security separation,
- placement to security cell or zone,
- using instruments constraining movement,
- using electronic remote monitoring instruments,
- using electronic surveillance instruments or surveillance devices,
- search,
- security check, security examination and security survey,
- ordering locking up the doors,
- suspension of certain rights.

Upon regulatory authorization the members of the law enforcement shall be entitled and obliged to pursue all actions necessary to maintain and restore the order, in order to seize any and all actions harming or endangering the safety of the Bv. institution[18]. (Illustration No. 2.)

Illustration 2. Security actions

The Act expressly and explicitly stipulates the security measures that can be pursued by the members of the law enforcement organisation, which should be amended the new instrument of 'cardiac signature' monitoring, as in using the identification analysis of the heart's functions could support the maintenance of the order of law enforcement and the safety of penitentiary institutions. For these purposes, legislative recognition of this new technical achievement could probably be beneficial.

Bv. officers serving at the different zones of the penitentiary institution could continuously monitor the location, movements of the detainees by using the heartbeat

application of e-systems in the execution of sentences, Report on the status of the implementation of a priority task], Börtönügyi Szemle, 2019/1, pp. 98.

[18] Section 145 (1) of Act CCXL of 2013.

identification system, moreover they might be able to draw conclusions on the emotional and mental state of the prisoners as well. Heartbeat analysis does not only assist the continuous identification of individuals, but it might give a reflection on the detainee's behaviour, or to any differences from their usual behaviour such as excitement, stress, threat in cases of fights, usage any toxic material, that is other negative factor can also be detected. Sudden increase of the pulse may suggest that the perpetrator is experiencing a certain psychological or physical impulse (for example, the perpetrator is participating in a fight), but also, on the other hand it may imply to a health issue, or even to a coronary disease. Heartbeat analysis can support the maintenance of the order of law enforcement and the safety of penitentiary tasks at Bv. institutions. It may also be considered as the measure monitoring, whereas its benefit are shown on the following chart.

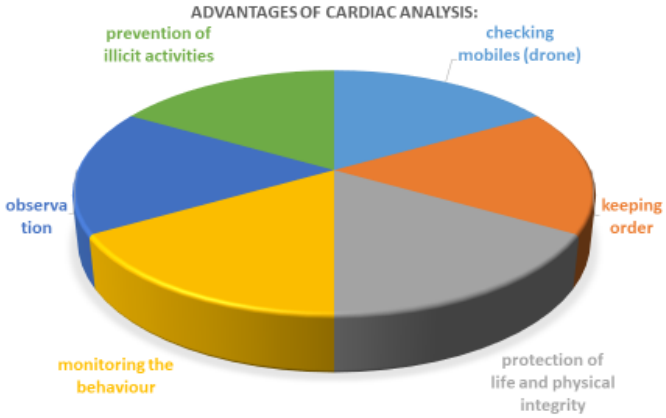

Illustration 3. own model
Advantages of cardiac analysis at penitentiary institutions

Provided to secure the order of penitentiary institutions we may detect several advantages of cardiac analysis. It allows the identification of the convicts 24/7 inside the institution. Their exact place and location can detected, their movements can be followed, for example

- at the facilities commonly used by the convicts,
- at the courtyard or in the corridors of the Bv. institution,
- in the security zones, in order to prevent criminal offenses, misdemeanours, misconducts or other illegitimate actions,
- in solitary confinement or correction facilities,
- in transfer vehicles,
- in order to prevent suicide, self-destructive behaviour, for the protection of life and physical integrity.

It may be used in the cell or during the term of separation of the detainee who previously attempted to commit suicide or any self-destructive action against his own well-being, furthermore on those who carry a high risk of suicide or self-destructive behaviour. Even more so, expansive application may also be possible for the purpose of identification of individuals staying by the outside walls and gates of the Bv. institution or on visitors, comparing the result to the data of the registry. Drones can be also equipped with the new technology, monitoring the facilities of the institution from the air, and may identify and monitor the individuals staying in the area. Although no visual information is

captured on the monitored person upon the heartbeat analysis, therefore, neither personal rights, nor any aspects of intimacy are harmed, judicial regulation of this sort of surveillance should be taken into consideration.

5. Summary

Due to its numerous advantages, the usage of the newest technical devices based on the method of heartbeat analysis and coding the heart's electronic functions is predicted to become more and more common in the future. Most probably such biometric technical innovations as Nymi, for example, shall reform the use of the everyday devices and gadgets of our lives by several means, since our hearts, likely to our iris signatures or fingerprints are also unique, but, contrary to other measures our 'heart prints' or 'cardiac signatures' can be identified passively, from a distance[19], by, for example the 'Jatson' device developed for the Pentagon that does not even need further facial recognition. Since personal identification does not require the actual cooperation of the person or persons targeted with the identification the application of the technology can not only be visualised in an open manner. Upon the heartbeat analysis border control, identification and capturing of criminal offenders, terrorist and monitoring of the convicts should be much simpler. The new technical method is expected to support law enforcement tasks as well in the future, facilitating to secure the order of law enforcement and the prevention of criminal offenses, misdemeanours, misconducts or other illicit actions

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