EDITORIAL

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Applications of biometrics, histometrics and cytometrics in deep learning

David Tjahyadi[1*], Edy Parwanto[2]

[1]Department of Histology, Faculty of Medicine, Universitas Trisakti, Indonesia
[2]Department of Biology, Faculty of Medicine, Universitas Trisakti, Indonesia

*Corresponding to:
David Tjahyadi, Department of Histology, Faculty of Medicine, Universitas Trisakti
Kyai Tapa Street, Kampus B, No.260
Grogol 11440, Jakarta-Indonesia.
davesaboch@trisakti.ac.id

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The term biometry is intended to apply mathematics in biology, while biometrics is individual identification and authentication based on their specific biological characteristics. The application of biometrics has been carried out, among others, on animals and humans. Biometrics on the Savanna Nightjar (*Caprimulgus affinis*) was carried out by measuring the length of the wings, tail, body, belly, and tarsi.[1] Currently, person identification has been done with face recognition technology, and fingerprint technology.[2–4]

Person identification with face recognition technology, including person reidentification, face gaze estimation, presentation attack detection, and image data mining.[2] In addition, several techniques for automatic person identification have been done, such as eye-tracking, voice recognition, and radio frequency identification (RFID). Nonetheless, the most common facial characteristics used for identity authentication.[5]

In addition to personal identification and authentication, biometrics are also used to identify and authenticate organs, tissues, and cells. The identification and authentication at the organ level measure the heart, lungs and kidneys, brains and tongue.[6,7] Previously, hand geometry was demonstrated, which involved palm thickness, palm diameter, finger length, and finger width at different locations.[8]

The identification and authentication at the tissue level were done by analyzing tissue images formed by a microscope. The quantification results from analyzing tissue images formed by a microscope are called histomorphometric, there is also a mention of histometric.[9,10] Histometric data can be obtained by routine histological examination or advanced tools such as optical coherence tomography (OCT). Of course, OCT is more practical and precise and has a better spectrum of indications for obtaining histometric data than routine histology examinations.[11] A recent study demonstrated the importance of histometric data from the cornea in patients before cataract surgery.[12] On the other hand, the width measurement of keratinized gingiva, supracrestal gingival tissue, sulcus depth, and biological width has been demonstrated.[13] The results of this study explain that histometrics is needed for diagnosis. There is no doubt that histometrics are indispensable in the medical world.

Identification and authentication at the cellular level have been carried out, resulting in cytometric data. A flow cytometer is used to obtain cytometric data, among the others.[14] A flow cytometer can determine cells' number, shape, and size. Moreover, a flow cytometer can also reveal cell surface biomarkers. It also demonstrated the quantitative measurement of cervical epithelial cells. The measurements include the cell's area, perimeter, length, width, and nuclei in the normal cervix-epithelial-cells of high-risk human papillomavirus and *Candida species* infection.[15,16] In addition, cell measurement in histological appearance is critical to quantitatively diagnosing the wound healing process.[17]

Based on the explanation above, identification and authentication are based on unique biological characteristics at the individual and organ, tissue, and cellular levels. We propose using the terms biometric for the individual level coherently from the individual level to the organ, tissue, and cellular level. The organometric indicated the organ level; histometric indicated the tissue level; and cytometric indicated the cellular level.

Analysis of biometric, histometric, and cytometric data by machines with the principle of imitating the work of the human brain is called deep learning. Nowadays, it is clear that deep learning is popular and growing rapidly. Furthermore, artificial intelligence, part of deep learning, is growing rapidly concerning its application in the real world.[18] One example of its application is to predict sperm motility automatically. In principle, sperm motility prediction is based on deep learning using sperm motility videos.

This method is fast and consistent. In the future, an automated sperm analysis is very important in investigating and researching male infertility.[19]

The computed pulmonary ultrasound images analysis is an example of a deep learning technique at the organ level. Deep learning about pulmonary ultrasound images is a promising technique to detect and diagnose COVID-19 during the current COVID-19 pandemic.[20] Moreover, the deep learning technique has also been adapted to distinguish lung cancer patients from healthy people. The Wilcoxon Signed Generative Deep Learning (WS-GDL) method was used to diagnose lung cancer.[21] Furthermore, biometric systems have been extensively applied to the electronic world. The human biometrics with the principle of "minutiae points" fingerprints stored as templates or models. The database stores "minutiae points" as user templates, so users can carry out activities to open car doors, cell phones, attendance, and others. So, fingerprint security is very important in daily life applications.[4] Supported by data from earlier studies that demonstrated the contour extraction to person identification based on finger biometrics with an accuracy of 93.33%.[3] Furthermore, biometric de-identification was also introduced. The principle of biometric de-identification is information security that integrates privacy considerations with the development of biometric systems. Domains in biometric de-identification include sensor-based biometrics, user psychological profile identification, aesthetic-based biometrics, and social behavior biometrics.[22]

We should also not forget that the personal identification was done at the molecular level, namely the deoxyribonucleic acid (DNA) level. Many techniques are used to analyze human and non-human DNA samples. Recently developed next-generation sequencing (NGS) or massively parallel sequencing (MPS). NGS allows mixtures of genomes of any species sequenced in one analysis. Various NGS technologies are available to sequence DNA.[23] In addition that the Federal Bureau of Investigation (FBI) approved DNA profiles generated by Verogen forensic technology that based on NGS technology uploaded into the National DNA Index System (NDIS).[24]

CONCLUSION

Biometrics can be applied to identifying and authentication individuals based on their specific biological characteristics. Histometrics can identify tissue abnormalities, while cytometric can be used to determine cell abnormalities. Histometrics and cytometrics are important in diagnosis, so they are indispensable in the medical world. Biometrics, histometrics and cytometrics can be used to develop deep learning, including the development of artificial intelligence.

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