Computer-aided dental comparison for mass disaster identification

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In this work we develop an accurate algorithm to compare and match AM and PM dental records calculating a score based on different codification systems.

Keywords: forensic odontology; human identification; dental comparison; odontograms; disaster identification, artificial intelligence.

Комп'ютерне стоматологічне порівняння для ідентифікації жертв масової катастрофи

Оскар Ібанез, Гіємо Рамірез, Зіпі Кахана

У цій роботі розроблено точний алгоритм для порівняння та зіставлення стоматологічних записів на основі двух ідентифікаторів часу доби (AM та PM), обчислюючи оцінку ґрунтуючись на різних системах кодифікації.

Ключові слова: судова одонтологія; ідентифікація людини; зубне порівняння; одонтограми; ідентифікація катастроф, штучний інтелект.

Comparison of antemortem (AM) and postmortem (PM) dental records continues to be a leading method of decedent identification. This is particularly true for Disaster Identification Identification (DVI) scenarios when visual identification is not feasible or appropriate. For incidents involving a large number of individuals, the comparison of AM and PM dental records may be expedited with forensic odontological computer software that provides a ranked list of best possible matches. These programs serve as an objective means to provide dentists with a list of the most likely matches between unidentified bodies and missing persons.

Comparison of AM and PM dental characteristics can result in three different outcomes: match, mismatch, or possible match. The computer program takes this information and creates a ranking of the AM and PM comparisons which provides forensic odontologists with an objective "best-match" tool from which to undertake a more in-depth comparison of the dental records and radiographs.

Previous studies [1] found that four codes (virgin tooth, missing tooth, filled tooth, prosthetic replacement) created pattern diversity similar to mitochondrial DNA. Based on this research, it was hypothesized that computerized dental ranking software may still be effective with more simplified codes and, as a result, would have the added benefit of being more expedient to record and more accurate in ambiguous coding situations. Additionally, combining the ranking produced by different coding systems could result in a more accurate algorithm able to automatically discover codification mistakes while maintaining the individualization capabilities of a larger number of codes.

To address these specific questions, the effect of different coding formats on computerized dental ranking and their hybridization, a research design was formulated. This research study was divided into two phases: (i) development of two simplified coding formats and optimized sorting algorithms; (ii) a new sorting algorithm hybridizing the two previous, and (iii) comparison of the three different approaches.

The two coding formats employed are the following:

- 7 codes: Virgin, Unerupted, Filled, Special treatment, Missing AM, Implant, Present but not observable, No information;
- 21 codes: Sound, Rotated, Displaced, Spacing, Caries, Dental wear, Filling, Tooth modification, Non information, Missing tooth, Socket, Implant, Pontic, Post, Orthodontic, Parapulpar pin, Treated, Erupting, Unerupted, Impacted, Crow.

Based on these two coding systems we have developed a sorting algorithm for each of them, and a third one hybridizing both of them.

To be able to validate the performance of the three proposed algorithms we have employed 166 AM and 166 PM dental records provided by Dr. Kahana. All these dental records correspond to real forensic cases she dealt with along her career at the National Center of Forensic Medicine (Abu Kabir) in Israel.

The three algorithms performed accurately. The worst results were achieved by the 7 codes approach with a mean ranking of 2.73, i.e. in average the positive case is within the three first solutions in the provided ranking. Percentile 75% of the ranking is 1, i.e. in 75% of the cases the positive match is in the first position of the ranking. Percentile 95%, i.e. in 95% of the cases the positive match is in the ninth position (or lower) of the ranking. Results of the other two algorithms will be provided during the conference as we are still developing further experiments.

References

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Criminalistics — from scientific findings of Mykhailo Vasylovych Saltevskyi up to artificial intelligence

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This paper will present the contribution of Mykhailo Vasylovych Saltevskyi to the development of the theory of criminalistics. The development of criminalistics from the time when outstanding scientists worked to the present is studied. The main emphasis is placed on the development and application of information technologies and artificial intelligence in criminalistics. It is emphasized that scientific criminalistic thought can be qualitatively developed by scientists who, first of all, are concerned not only with issues of theoretical developments but first of all develop the ethical foundations of science, without which modern and complex methods and technologies would not be applicable.

Keywords: criminalistics, information technologies, artificial intelligence, ethics.

Криміналістика — від М. В. Салтевського до штучного інтелекту

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У статті розглянуто внесок Михайла Васильовича Салтевського в розвиток теорії криміналістики. Досліджено розвиток криміналістики від часів, коли працював видатний вчений, до сучасності. Головний акцент зроблено на розвиток і застосування в криміналістиці інформаційних технологій та штучного інтелекту. Підкреслено, що наукову криміналістичну думку можуть якісно розвивати науковці, які, передусім, переймаються не тільки питаннями теоретичних доробок, а насамперед розвивають етичні основи науки, без яких сучасні та складні методи й технології не були б застосовні.

Ключові слова: криміналістика; інформаційні технології; штучний інтелект; етика.

The main topic that is dealt with in our work can be formulated in the form of a question: what is the scope of Mykhailo Vasylovych Saltevskyi's work and engagement in the development and promotion of criminalistics? Also, Mykhailo Vasylovych Saltevskyi's work engagement, effort, dedication and systematicity can serve as an example of how and in what way an expert researcher can contribute to the environment in which he lives and works, to his country, but also to the wider (European and world) scientific community. The scientific and professional reach of M. V. Saltevskyi could not be compared with the work of Edmond Locard (1877—1966), whom we consider the founder of forensics, and Ivan (Juan) Vučetić (1858—1925), who is associated with the first use of fingerprints in