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Description of the funded research project

2nd Call for H.F.R.I. Research Projects to Support Post-Doctoral Researchers

Title of the research project: **Reconstructing a human skeleton: Sorting human skeletal elements from mass disasters**

Principal Investigator: **Dr. Maria-Eleni Chovalopoulou**

Research Member: **Dr. Andreas Bertsatos**

Reader-friendly title: **RecHumS**

Scientific Area: **Life Sciences**

Institution and Country: **National and Kapodistrian University of Athens, Greece**

"Spanish Civil War - Mass grave - Estépar, Burgos" by Mario Modesto Mata is licensed under GFDL/CC-BY-SA

Host Institution: **National and Kapodistrian University of Athens**

Members of research team:
Maria-Eleni and Andreas

Budget: **179,820 €**

Duration: **36 months**

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Research Project Synopsis

The “**RecHumS**” project will address the key issue of sorting commingled human remains, by amalgamating state-of-the-art techniques in three dimensional geometric morphometrics and machine learning. The deposition of multiple bodies in mass graves has been common practice worldwide after warfare or as part of natural disasters. In Cyprus the events that took place in 1963-64 and 1974 have resulted in an unspecified number of individuals having been buried in mass graves, of which over 2000 Greek and Turkish Cypriots are still missing. Commingling, the mixing of the skeletal elements of different individuals, is a grave issue in such contexts. A major limitation of current methods for sorting the remains of different individuals is that they do not effectively take into account the three-dimensional bone morphology. The “**RecHumS**” project will focus on matching the main elements of the lower and the upper skeleton (os coxae, femora, tibiae and humeri, ulnae respectively), which are the elements that provide basic biological profile information (age, sex and stature). The “**RecHumS**” project will have major implications in forensic anthropology as it will facilitate the identification of unknown subjects. Furthermore, a highly accurate surface analysis method for matching adjoining bone surfaces, as well as for matching the superior and the inferior long bone epiphyses can be of great value to prosthetic implant manufacturers.

Project originality

Despite numerous proposed methods, commingling remains a pressing issue. During excavation, the reassociation of mixed skeletons is partially possible based on the spatial distribution of the skeletal elements and taphonomic evidence. However, if the excavation takes place in the absence of an anthropologist, reassociation of the human remains in the lab is even more problematic. Histological and DNA analyses can be used for sorting commingled skeletons; however, the human skeleton has 206 bones and every one of them would have to be analyzed, rendering such approaches impractical in terms of time, cost and material destruction. Morphological reassociation of the elements that constitute a human skeleton is the most commonly adopted method. Osteometry is the main approach adopted as a means of quantifying morphological parameters. A major limitation of osteometric sorting methods is that they require a good preservation of the human skeleton. Another important limitation of these methods is that their effectiveness is hindered when applied on cases outside their reference sample.

New methods that could quantify the intrinsic morphology of the skeletal elements of the lower and the upper limbs could hold great potential in sorting skeletal remains given that technologies, such as CT and 3D surface scanners, are increasingly being used in the field of forensic anthropology. Furthermore, the computational geometric feature extraction of the bones' intrinsic morphology constitutes an analogy to visual observation methods that provide the most effective sorting method to date, whereas machine learning techniques, which have already proven their advantages in other fields such as computer vision and speech recognition, are incorporated to relax the requirements of highly trained professionals and the related reliability/repeatability limitations. **The "RecHumS" project aims at filling this gap in currently available methods for sorting commingled human remains.**

Expected results & Research Project Impact

The innovation and originality of the “RecHumS” project lie in a) the newly produced open access methodology for reassociating commingled human skeletal remains, which is anticipated to have important applications in forensic anthropology; b) the first-ever combination of geometric morphometric techniques with machine learning approaches in the study of human skeletal variation to address a particularly pressing interdisciplinary topic. The effective pair-wise and element-wise sorting of the lower and the upper skeleton among different individuals will have major implications in forensic anthropology as it will allow for individual biological profiling (age, sex, stature, habitual activity) of skeletal assemblages from commingled burials of mass disaster victims. Therefore, this project will make a significant contribution by developing new methodological tools that will become readily available to the international research community but also to forensic practitioners working along with law enforcement agencies worldwide.

Additionally to its applications in forensic anthropology, the methodology developed by the “Reconstructing a human skeleton” project is anticipated to have implications in bioarchaeology by allowing a more accurate assessment of the palaeodemographic profile of past populations. Furthermore, a highly accurate surface analysis method for matching adjoining bone surfaces, as well as for matching the superior and the inferior long bone epiphyses can be of great value to prosthetic implant manufacturers.

The importance of this funding

The “RecHumS” project will greatly enhance Dr. Chovalopoulou’s career plan by developing her skills in research leadership, proposal preparation, project supervision and budget management, which will greatly influence her career prospects as a principal investigator in academia.

The materialization of the “RecHumS” project will allow Mr. Bertsatos to widen his knowledge in geometric analysis and machine learning techniques, while expanding his research in osteometric applications in diverse contexts of forensic anthropology.

The “RecHumS” project will also allow the participation of a postgraduate trainee/student as a member of the project’s research team. The specialized training in skeletal digital documentation will bring the trainee to the forefront of methodological developments in the field of large-scale anthropological data collection and 3D skeletal modeling and provide him/her with a significant advantage in the job market.

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