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Grid Computing for Biomechanical Markers Extraction

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Overview

Visual evaluation of an object (in images) in biomechanical and orthopedic processes is a usual method of contemporary medical diagnostics. In some cases visual diagnostics is relatively simple (for example, in case of non-complicated bone fracture) and does not require complex medical methods and calculations. However such cases are rare, and also mere visual inspection is not sufficient. The diagnosis require more complicated measurements, as well as extraction of biomechanical parameters of an object. However this is a time-consuming process also prone to mistakes. The article presents computer vision algorithms, developed and implemented to improve diagnosis and increase the reliability of medical decisions. Algorithms, set in grid environment, are capable to accelerate and unify the diagnosis, leaving to a physician mainly a function of interpretation (assessment of medical condition), selection of an appropriate treatment method and evaluation of its efficiency.

Impact

The approach researched in this article influences medical procedures to: a) specify more in a more precise way set of recognisable objects and calculate/separate biomechanical parameters, b) examine the adaptability of the developed methods for diagnostics of other body areas which is based on the analysis of bone structures visible in x-ray images, c) examine the adaptability of the developed methods for diagnostics of other areas which is based on the visual analysis of objects in 3D images.

Description of the work

Different dysfunctions of an acetabulofemoral joint result in pain and/or motility restrictions. Such dysfunction may be congenital, caused by trauma or joint operation conditions (such as long-term joint strain exceeding joint stress limits), natural wear on joints or may be a result of other pathologies. Modern medicine can help all patients suffering from these types of joint dysfunctions, however, treatment resources are not sufficient. Establishment of pathological diagnosis in the pelvic area (such as dysplasia, arthrosis, dislocation or fracture) and selection of treatment methods relies on a number of methods based on calculations of biomechanical parameters of objects under analysis. These parameters can be conveyed in geometrical expressions: points, distances among objects, positions of objects to each other and angle formations. In general, the diagnostic process involves the following steps: a) pain diagnostics, b) anamnesis, c) patient examination (temperature, visual changes, palpation, pace, stand, movement extent), d) radiology test and extraction of biomechanical parameters, e) additional diagnostic methods (computed tomography, radioisotope bone scan, ultrasound testing, magnetic resonance imaging, arthroscopy). This article presents a number of computationally-based methods for extracting biomechanical parameters, intensively using computer vision approach. Such parameters are used in primary diagnostics, certain calculations are made when observing

the course of treatment, while other methods are employed only in exceptional cases when standard methods fail to provide enough information. Grid platform provides “on demand” computational resources, as well as suitable services for such computing procedures.

Conclusions

While extracting biomechanical markers by various computational procedures a number of methods have to be applied when analysing radiographs. The most easily recognizable objects are femurs. When searching for clearly visible pelvic arches a set of additional thresholds for parameters due to peculiarities of the equation describing pelvic arches and the radiograph itself are done on the basis of data about detected femoral ridges. After defining the parameters pelvic bones are successfully detected. Various sequences of calculations and parameters of detected objects allow involve more sophisticated diagnostic methods, involve drug selection and shorten diagnostic procedures. This also opens more broader suggestions for further explorations. These computational procedures are obviously suitable to implement in cloud computing or virtualization environment.

Primary authors: Prof. JUOZAPAVICIUS, Algimantas (VU); Mr MARKAUSKAS, Ramunas (Vilnius University)

Presenter: Mr MARKAUSKAS, Ramunas (Vilnius University)

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