Optimization of imaging algorithm for medicine

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Osteoporosis is the most common metabolic bone disease and there are over 200 million patients worldwide with osteoporosis. Engineering methods could allow to better identify the subjects at risk, but need automation and speed to be clinically applicable. The results of the research can improve the quality of the methods used in X-ray processing.

A method where a two-dimensional X-ray image is combined with statistical data from other patients to reconstruct its 3D anatomy was previously developed. This method allows to obtain accurate information about the patient in three-dimensions, including bone density and strength. It therefore has potential to improve clinical diagnostics.
However, the developed method is computationally heavy and therefore too slow. For commercialization and implementation into clinical diagnostics, it needs to be faster and computationally cheaper. The research conducted in this work attempts to find effective solutions which satisfy these needs. Thus, this work aimed at making a faster algorithm for image processing.

The code was first reviewed in its entirety to identify the so-called bottlenecks, that is, the parts of the code which take the longest time to run. These slow parts were then carefully analyzed and re-written optimizing for execution speed, so that the whole procedure would run faster.

The method was based on improving the most time-consuming operations in the code. For example, the improved version collects system function calls into packets instead of executing many consecutive functions.

Patients who wish to receive osteoporosis treatment can start with an X-ray image. The computer has a set of three-dimensional models of bones containing the anatomical variability of the population to match the projected 2D X-ray image available for the specific patient. Based on this information it can create a reconstruction. The digitally recreated model of bone is finally validated against the X-ray image, which is a very time-consuming process as the right 3D model needs to be found.

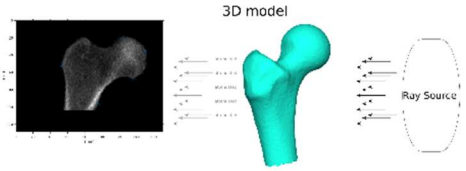

Figure: The solution attempts to estimate the parameters of the 3D bone based on statistical data and the X-ray.

The experiment shows also that the process of analysis of X-ray images performed by the computers can be engineered to run faster and create results of the same quality as with the traditional computer tomography. The run time of the computer program is reduced, and a cost-effective solution is created at no compromises.

The software will be used by solutions for creating 3D models of femoral bones. Some treatments of osteoporosis will use the improved algorithm, although not all of them.
With the method developed during this work an X-ray image is entered to the computer and the computer attempts to extract multiple pieces of information from the bone, including its density and three-dimensional shape and its appearance. This data helps to estimate facts about the disease which are helpful in the treatment.

The models generated by the algorithm can be used to estimate data needed in the treatment of osteoporosis. Using the method described by the researchers at Lund University, the important data is obtained by a modern, effective, and non-invasive method based on an X-ray and the set of similar bones belonging to different patients, compared to the classical methods like more expensive Computer Tomography.