Automated ultrasound system for 4D recording of muscle movements

TLB
Technologie-Lizenz-Büro
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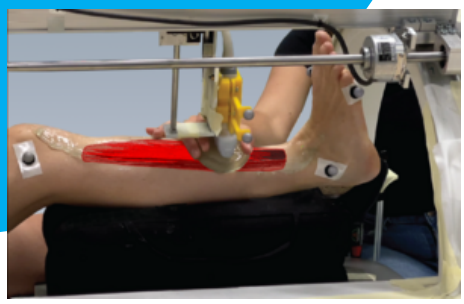
Automated ultrasound system for 4D recording of muscle movements.

- Temporally and spatially resolved in vivo 4D ultrasound recordings: Examination of complete muscle movement sequences, not just static images
- Reproducible handling (e.g. contact pressure) prevents user-induced measurement uncertainties and inaccuracies
- Mobile/portable, therefore flexible in use
- Cost-effective in terms of acquisition and operating costs
- Also suitable for patients with pacemakers



Fields of application

The new method can be used in all areas where muscle diseases and injuries need to be examined easily and reproducibly. Possible examples include

- Therapy and rehab: better diagnosis and tracking of the condition or injury and the course of treatment, e.g. for stroke patients
- Sports medicine, e.g. for the treatment of torn muscle fibers
- Trauma medicine, e.g. for the examination of trauma and injuries to the musculature
- Prosthetics, e.g. for optimal fitting of prostheses to patients
- Fitness industry, e.g. for examining muscle growth

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22/028TLB

Service
Technologie-Lizenz-Büro GmbH has been entrusted with exploiting this technology and assisting companies in obtaining licenses.

Background

Ultrasound measurements are widely used in medicine and are one of the most common imaging procedures for diagnostic purposes. They offer an excellent opportunity to visualize internal organs, tissue and muscles. Compared to other procedures, ultrasound is inexpensive, painless, low-risk and extremely flexible and mobile.

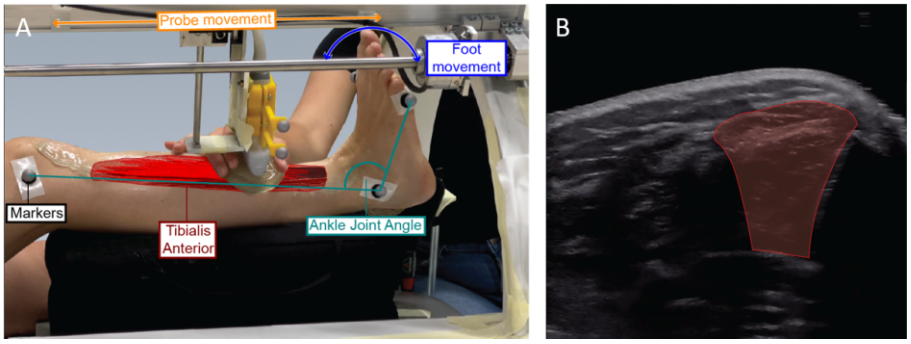
Problem

The acquisition of time-resolved 3D ultrasound images, or 4D ultrasound images, is limited by special transducers to the acquisition of very small tissue groups or organs. As these transducers cannot cover most muscles, the acquisition of such 4D ultrasound images of muscles represents a challenge in medical technology.

For the acquisition of static 3D ultrasound images of muscles, it is possible to equip a 2D transducer with position sensors and manually scan the muscles once. The accuracy and reproducibility of the measurements are particularly challenging here. These can vary greatly depending on the tissue, body part and patient to be examined. Another point that should not be underestimated is the operator himself, as he presses the ultrasound probe into the tissue to varying degrees depending on the patient and the form of the day. Accordingly, such measurements are subject to variations and measurement errors, even if the user tries to carry them out as consistently as possible.

Solution

An innovative and automatable ultrasound system for generating 3D and 4D ultrasound images has been developed at the University of Stuttgart. The new system is particularly suitable for time-resolved 3D ultrasound images and thus opens up new applications beyond purely static imaging, including for larger muscles or organs. For example, ultrasound images can be recorded during cyclical muscle movements so that the images can later be reconstructed into 4D ultrasound images with "joint angle resolution". The system includes a device with an integrated passive active mechanism to maintain the contact force, which is of crucial importance for the high image quality achieved with the system, especially during skin sweeps while measuring along the skeletal muscle. It is now possible to carry out holistic examinations and analyses of complex muscle movement sequences. The system combines various advantages, including consistent tissue deformation through the use of integrated force control and controlled movement trajectories through the use of probe motors, ensuring reliable and reproducible results. The corresponding software for the reconstruction of static and time-resolved 3D ultrasound was also developed at the University of Stuttgart.



A: dynamic, automated 3D ultrasound images of the lower leg (anterior tibial muscle) B: Ultrasound image from video sequence: cross-section of the lower leg with the anterior tibial muscle [A. Sahrmann, Institute for Modeling and Simulation of Biomechanical Systems, University of Stuttgart].

Publications and links

A. Sahrmann et al., *A System for reproducible 3D Ultrasound Measurements of Skeletal Muscle*, Transactions on Biomedical Engineering, doi: 10.1109/TBME.2024.3359854

A. Sahrmann et al., *3D Ultrasound based Determination of Skeletal Muscle Fascicle Orientation*, Biomechanics and Modeling in Mechanobiology, accepted