An approach to a new fluoroscopic X-ray image to a CT-like atlas registration algorithm of long bone fracture sites

ARTICLE *in* MINIMALLY INVASIVE THERAPY & ALLIED TECHNOLOGIES · AUGUST 2010

Impact Factor: 1.18

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18. An approach to a new fluoroscopic X-ray image to a CT-like atlas registration algorithm of long bone fracture sites (O)

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Background: Registration of intraoperative fluoroscopic X-ray images to preoperative CT images has already been used to provide virtual models of the patient anatomy during surgery. However, most registration algorithms work with images of intact bones. Our algorithm works with images of fractured bones, providing a virtual model of the fracture site without the need of a CT scan, reducing the cost for the hospital and the amount of radiation exposure for both the patient and the surgeon. Purpose: We aim to develop a 2D/3D registration algorithm of X-ray images to an anatomical atlas obtained from CT scans. The algorithm has been extended to images of clean bone fractures. Finally, the results provided by the registration algorithm have been compared with those from a CT scan. Method: A sample of 10 patients was taken in order to obtain the femoral shape with a CT scan. A reference anatomical atlas was built from this sample. A mathematical model of the bone was built using points of interest (POI) to identify anatomical landmarks. These landmarks allowed us to parametrize its shape. The registration algorithm works in two phases. First, at least two X-ray images are taken of the fracture site from different angles. The 2D bone shape is extracted and reconstructed to get the original non-fractured bone. Next, the surgeon marks the POIs that were used to build the atlas in each of the images. The algorithm builds the 3D model of the bone, and applies the fractures to the model to recompose a virtual model of the fracture site. The obtained results were compared with a reference CT image of the fracture in order to validate our algorithm. Results: Several bone phantoms representative of common fractures were used to compare the results of the algorithm with CT images. The mean surface error was measured using a Hausdorff metric. Preliminary tests show that the registration error lies within acceptable bounds. Conclusion: Early results show that our algorithm can be useful as the first step towards a robotic assistant for bone fracture reduction based in virtual modeling. The algorithm allows obtaining a virtual model of the fracture site with a lesser amount of radiation, both for the patient and the surgeon.

19. An automated dynamic phantom to produce a figure of merit for the image quality of medical ultrasound imaging systems (O)

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Background: The limitations of quality assurance of medical ultrasound imaging systems are well recognised. These include repeatability, difficulty in quantifying results, and the time involved. This is important as the use of these systems for diagnosis and treatment management is increasing. A sub-optimal system could lead to multiple missed or misdiagnoses. Materials and methods: To address this problem, novel phantoms have been developed that can aid repeatability and produce quantitative parameters, including a phantom developed in Edinburgh, UK, that produces a single figure of merit, the 'resolution integral'. However, this still requires time-consuming manual scanning. To overcome this limitation, a dynamic phantom has been developed. The dynamic phantom is based on imaging of filamentary targets positionable in a tank of tissue-mimicking liquid under the computer control. The images produced by the system are captured and analysed to assess if the targets are resolved. The control program is incorporated in a feedback loop in National Instrument's LabView for completely automated beam profiling and resolution integral calculation. The method requires only a few minutes set up time before running autonomously and producing easily interpreted results. Results: Results were repeatable and consistent when compared with those produced using the Edinburgh phantom, and from qualitative assessments and clinical experience. Calculation of resolution integrals successfully differentiated high quality scanners from lower quality or obsolete systems. Conclusions: The dynamic phantom offers a low cost method to assess ultrasound imaging systems quantitatively for purchasing decisions, delivery acceptance and on-going quality assessment. With minimal further work, the dynamic phantom could be developed to test systems more rigorously and set bench marks prior to equipment introduction. It could then form a quantifiable reference at production, acceptance or to validate future transducer performance.