Abstract: Contour-based Bone Axis Detection for X-ray-guided Surgery on the Knee

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The anatomical axis of long bones is an important reference line for guiding fracture reduction and assisting in the correct placement of guide pins, screws, and implants in orthopedics and trauma surgery. While planning such axes can be easily done on pre-operative static data, doing so consistently on live images during surgery is inherently more complex due to motion and a limited field of view. In addition, non-sterile interaction with a planning software is unwanted. To circumvent these limitations, we propose a simple and clinically motivated image-guided approach for detection of the anatomical axis of long bones on 2D X-ray images. We translate the established two-line/two-circle manual method to a learning based extraction of anatomical features and subsequent geometric construction. A multi-task neural network first predicts a bone segmentation mask as well as region of interest (ROI) encodings of the relevant shaft sections of the bone. A segmentation contour is then computed using a logical XOR operation with a morphologically eroded version of the segmentation mask. Lastly, the relevant sections of this contour are extracted by evaluating the predicted ROIs and are subsequently used as auxiliary lines to derive the anatomical axis with the 2-line/2-circle method. The approach is evaluated for the femur and tibia in the knee joint and achieves a median angulation error of 0.19° and 0.33° respectively. An inter-rater study with three trauma surgery experts confirms reliability of the method and recommends further clinical application [1].

References

1. Kordon F, Maier A, Swartman B, et al. Contour-based bone axis detection for X-ray guided surgery on the knee. Proc MICCAI. 2020; p. 671–680.

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