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Modulare programmierbare Zielvorrichtung für perkutane Interventionen

Modular programmable targeting device for percutaneous interventions

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Purpose

Based on the experiences with the fully automated 7DOF robot system „B-Rob I" ([1], [2]), a new design should address topics related to clinical practice and cost/benefit ratio. The major aims for the new prototype „B-Rob II" are:
+) Modular setup for a broad variety of clinical applications
+) Acceptable cost/benefit ratio for the entire system
+) Integration to (already) available devices for interventional radiology
+) Easy integration to the clinical workflow
+) „Plug&Play" philosophy

Materials and Methods

The kinematic concept for the planned 2DOF position/angulation module is based on the parallelogram mechanism already realized for „B-Rob I", where orientation of the needle is defined via relative motion of two parallel carbon „fingers" connected to each other by means of spherical joints. Following the general idea of modularity, different configurations should be possible in order to allow 2DOF needle angulation, 2DOF positioning and combination of these two functionalities. For each DOF the already proven driving system consisting of a motor/planetary gear combination + anti-backlash gear stage + anti-backlash ball-screw system is being used. Linear movement is supported by a pair of high-precision monorail guides with two carriages for each rail. The described setup allows a positioning resolution of about 5Âµm respectively an angulation resolution of about 1/100 degree.

Results

The developed targeting device consists of one or two 2DOF (degree-of-freedom) positioning modules in different configurations.
For (gross) positioning of the needle guide the targeting device is mounted onto one or two passive 7DOF holding arm(s) developed by „Medical Intelligence". The integrated design allows high dexterity regardless of the small footprint of the module (100mm x 150mm x 30mm) which further enables use of the system inside the CT gantry without major restrictions.
Planning of the intervention is on basis of CT-imaging data sets acquired immediately before an intervention. Spatial relation between imaging space and targeting device is either established by using of an optical tracker system or via robot registration based on a CT data set. After graphically selection of the target point and manually pre-positioning of the device, correct needle angulation will be set automatically by the system. During the intervention, the robot kinematics holds the needle guide in a defined position/orientation to the patient's body - needle insertion will be performed manually by the physician.

Conclusions

Based on the experiences made with the robot prototype „B-Rob I", a considerable re-design was performed in order to combine the high reliability and accuracy demonstrated by „B-Rob I" with a modular, cost efficient approach. The resulting system „B-Rob II" is easy-to-use and does not interfere to the clinical work-flow. System accuracy and clinical relevance currently is being tested in a series of in vitro tests.

References

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