POLITECHNIKA ŚLĄSKA
WYDZIAŁ INŻYNIERII BIOMEDYCZNEJ

ROZPRAWA DOKTORSKA

Redukcja błędu dopasowania czasowo-przestrzennego punktu docelowego do przedoperacyjnego modelu pacjenta w małoinwazyjnych zabiegach jamy brzusznej

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The abstract of the PhD thesis

„Registration error reduction of spatial-temporal adjustment of the target to the preoperative patient model in minimally invasive abdominal surgery”

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In the doctoral thesis entitled: Registration error reduction of spatial-temporal adjustment of the target to the preoperative patient model in minimally invasive abdominal surgery, the focus was on the problem of estimating the location of the lesion during the procedure and methods of reducing the target registration error.
When formulating the subject and scope of work on the basis of the literature review, the following specific objectives were proposed and implemented, which are considered as the original contribution to the work:

- Adaptation of the approach of registration circuits to the problem of minimizing the time space adjustment error of the target point to the preoperative patient model in minimally invasive abdominal surgery.
- Development of a method of finding a breathing phase allowing the introduction of a surgical tool into the abdominal cavity ensuring reduction of target point adaptation error to the pre-operational patient model.
- Selection and testing of the possibility of using swarm optimization algorithms in order to choose the abdominal deformity model parameters used to estimate the location of the target point.
- Comparative analysis of the correlation of the multiplicative error measure in the 3rd order registration circuit and marker matching error with the error of the target point alignment.

These objectives were implemented in the conducted research. Adaptation of the approach of registration circuits to the problem of minimization of time-spatial adjustment of the target point to the pre-operative patient model in minimally invasive abdominal surgery together with the development of the method of finding the breathing phase, selection of the swarm algorithm and results obtained in the study confirmed the rightness of the thesis:
The use of 3rd order registration circuits allows reducing the time-space adjustment error of the target point to the pre-operative patient model in minimally invasive abdominal surgery.
Analysis was performed on the 21 collection of computed tomography of the abdominal cavity with the position of the markers. The research was performed to divide the input data into 5 breathing phase groups: group corresponding to minimum of Fiducial Registration Error in breathing cycle (minimum FRE), Assessing Quality Using Image Registration Circuits (AQUIRC), inspiration, exhaust, whole breathing cycle. The obtained TRE values for AQUIRC, exhaust, whole breathing cycle, and inspiration

breath groups for the best RIGID-EBSDE-AQUIRC method are: 3.47 mm, 3.771 mm, 3.839 mm, 4.01 mm.

In addition, the research hypothesis put forward in the literature regarding the comparative analysis of the correlation of the multiplicative error measure in the 3rd order registration circuits and the marker matching error (FRE) with the target point matching error (TRE) was verified on clinical data. Based on the obtained results, the hypothesis based solely on simulation cannot be confirmed that the multiplicative measure of registration error in 3rd order recording circuits is not better correlated with the TRE error than the FRE measure.