



The Surgical Navigation System with Optical Position Determination Technology and Sources of Errors

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Several causes of spatial errors in surgical navigation system have been investigated for several systems. These include identification error of the external features used for registration, geometrical distortion in the preoperative images, and tracking error of the surgical instruments. Another potentially important source of error is the patient head position detection retrospectively and concurrent with surgery. The visualization of target zone is carried out according to reference landmark points inside the center of the brain as well as an automatic algorithm for contour recognition (based on 3D segmentation and computer morphometry) was applied to edge the contour. Moreover, the optical navigation system was used to assess the accuracy of determination the position of the surgical instrument inside patient head construction using the "internal map" describing the anatomy of the brain. The major sources of errors occurring in the unit of position detection of the optical navigation system were considered. Furthermore, parts of the errors that could appear were simulated while operating the surgical navigation system. Eventually the research included the possibility of using different filters depending on natural source of noise that was also simulated and analyzed.

Keywords: Surgical Navigation System, Internal Map, Optical Detection, Errors Sources, 3D Modeling.

1. INTRODUCTION

Modern surgery depends significantly on medical equipment, which allows the quality of the surgical intervention to be raised to a level previously not achievable. Tomography technique (magnetic resonance and computed tomography) comes in the first place; this allows, besides the diagnosis of diseases, the production and construction of the "internal map" describing the anatomy of the patient organs.⁸ This enables surgeons to perform a simulation of the surgical intervention and to determine the most effective surgical approach. The evaluation of the operation process in real time should be mandatory, and the most important component here is the surgical navigation system.

2. ANALYSIS OF THE MAJOR ACHIEVEMENTS AND LITERATURE

Theme of development of surgical navigation systems for various purposes, as well as issues related to the planning of surgical interventions, devoted a significant amount of effort¹⁻⁵ to develop

an adequate 3D patient models for patient organs,⁶⁻⁸ on which intervention will be conducted, according to a computed or magnetic resonance tomography. However, it should be taken into account that the national studies describe a multiple experience and benefits of using perfect systems.^{9,10}

3. THE PURPOSE OF THE STUDY AND THE PROBLEM STATEMENT

One of the mandatory components of surgical navigation systems in real-time is the positioning detection system of the surgical instrument. Systems that are based on optical detection using three-dimensional technique have a maximum advantage when compared with ultrasonic and electromagnetic methods.¹⁷ To assess the accuracy of determining the position of the surgical instrument, and consequently, to conduct a surgical intervention with a high quality, it is necessary to determine where and in what level the main sources of error are hidden. This work can also be used for training in biomedical engineering in designing field and servicing of surgical navigation systems. Therefore, the task of the study is to determine the main sources of errors in the optical navigation surgical system. The current

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