Project Title: Development of a Brain Surgery Simulator using Haptic Devises	
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1. Background of research

Important areas that control life functions such as language function and motor function are tightly packed in a human brain, and hence high-skilled operation is needed in a brain surgery in order to remove the entire lesion without injuring the surrounding area. Therefore, development of a brain surgery simulator has been expected for surgery training and preoperative planning. However, only few brain surgery simulators have so far been developed, which can display reaction forces and haptic sense.

2. Research objectives

In this study, a brain surgery simulator will be developed using virtual reality techniques, which can simulate fundamental operations in a brain surgery such as dissection, removal of lesion, and suture. Using the brain surgery simulator, an operator will be able to perform a medical operation on a brain model in an virtual environment, with manipulating surgical tools attached to haptic devices and seeing computer graphics model displayed on a monitor. Force generated by contacts between the surgical tool models and brain model is computed in real-time, and is displayed to a human operator through haptic devices.

3. Research characteristics (incl. originality and creativity)

Due to the recent progresses in information technology, visual guidance systems in surgery have showed rapid progress, and contributed to safety in brain surgery. Important point of this study is that the brain surgery simulator will display force and haptic sense as well as the visual information, which will contribute to drastic improvement of the reality during a surgery simulation. The brain surgery simulator can be used as a good training tool for medical doctors to improve their surgical skills for safe operations.

4. Anticipated effects and future applications of research

The brain surgery simulator can easily reproduce rare or difficult cases in the virtual environment. It will be very useful even for a veteran doctor if he/she can simulate surgery for the rare or difficult cases before a real surgery. Therefore, the simulator contributes to improving surgical skills of medical doctors. Furthermore, medical doctors can perform preoperative planning using the simulator such as planning of craniotomy, sequence of operation and plan for emergency action. It is expected that the preoperative planning using the simulator contributes to drastic improvement of safety in a brain surgery.

Development of a Brain Surgery Simulator using Haptic Devises

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Breakthrough so far in brain surgery
NeuroNavigator: A computer-assisted technology that localizes lesion area in real-time during a surgery, based upon previously taken CT and/or MRI data.

Breakthrough from now
Prediction of response to operation = surgery simulator
Training to improve surgical skills
Preoperative trial
Preoperative planning

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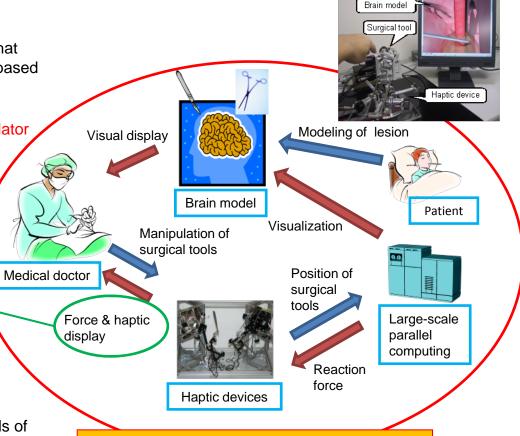
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Brain model
Surgical tool
Haptic device

Visual display
Modeling of lesion
Brain model
Patient
Manipulation of surgical tools
Visualization
Medical doctor
Position of surgical tools
Force & haptic display
Large-scale parallel computing
Reaction force
Haptic devices

Concept of the brain surgery simulator