

Intra-abdominal type Master Device for Teleoperated Laparoscopic Surgical Assistant Robot

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Abstract— A new 5-DOFs intra-abdominal type master device to control a surgical assistant robot for teleoperated laparoscopic surgery performed by a surgeon in a sterilized area has developed. The master-follower system using the proposed master device was constructed, and the performance of the device was evaluated.

I. INTRODUCTION

With the integration of locally operated small surgical robots [1-2] in a sterile area, a surgeon can perform safe and accurate robot-assisted laparoscopic surgery. It is important to control the surgical assistant robot intuitively and accurately. We previously reported handle shaped master devices with 5-DOFs, and a unilateral master-follower control selectable connection system between a master device and LODEM which we developed as forceps robot [2]. The present study describes the newly proposed 5-DOFs intra-abdominal type master device for the master-follower control system. In addition, we report in detail the performance of the master device and the system.

II. METHODS

A 5-DOFs intra-abdominal type master device was developed as shown in Fig. 1. The pitch and yaw axes are gimbal mechanism. The insertion axis is a linear motion mechanism with two linear guides placed in parallel [3]. The roll and pitch axes are designed for free rotation and pinch operation. The dimensions of the device are 98 mm × 176 mm × 221 mm, and its math is 460 g. The motion range is more than ± 60 ° for the pitch and yaw axes, 100 mm for the insertion axis, free rotation for the roll axis, and 40 ° for the grasp axis. The mechanical backlash is 0.5 ° for the pitch axis and 1.5 ° for the yaw axis. A mobile LODEM as a follower manipulator shown in Fig. 2 is unilateral master-follower controlled by the proposed master device. The time delay including mechanical characteristics is less than 200 ms.

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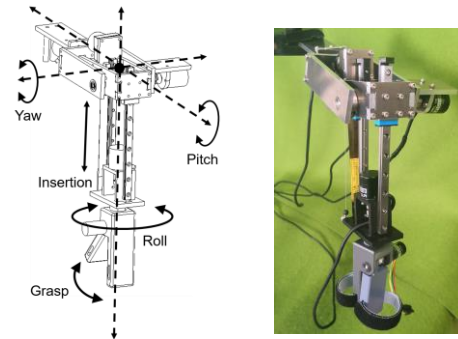


Fig.1 Prototype of the intra-abdominal type master device

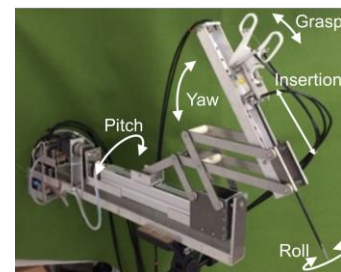


Fig.2 Forceps assistant robot mobile LODEM

The manually controlled force to evaluate the performance of the proposed master device using a force gauge (resolution: 0.01N, ZP-50N, IMADA) was measured. The force was defined as the averaged static force at the initiation of the movement in five trials.

III. RESULTS AND DISCUSSIONS

The manually controlled force of the master device was less than 0.98 N in the pitch axis, 0.88 N in the yaw axis, and 1.21 N in the insertion axis. The light operational feeling of the master device and the master-follower control were confirmed. Future works include multiple connections between master devices and follower manipulators, and applying simulated surgery.

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