A MINIATURE PROPORTIONAL VALVE FOR A TACTILE DISPLAY

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Abstract

In minimally invasive surgery, tactile feedback is lacking. A tactile display, consisting of a matrix of micro-actuators, represents tactile sensations on the fingertip. Miniaturising powerful, dynamic and accurate actuators with a sufficient stroke and bandwidth is a considerable challenge. The use of pneumatics is promising due to the potential for high power density. This paper discusses a proof of concept for taxels driven by pressurised air. The tactile display becomes very simple and light. The challenge moves to the design of a miniaturised proportional pneumatic valve.

Keyword(s): medical/clinical engineering

1 Introduction

Minimally invasive surgery (MIS) continues to grow in importance and to gradually change and improve the medical practice. This technique comes with great advantages, but requires an increased dexterity and concentration on the part of the surgeon. To solve those problems, robots were introduced that mimic the movements of the surgeons, allowing them to focus solely on the medical procedure. A configuration with a ‘master’ robot, controlled by the surgeon, and a ‘slave’ robot, following the movements of the master, can achieve this goal (Fig. 1).

One of the remaining problems with robot assisted minimally invasive surgery is the absence of haptic feedback. Currently, there is only visual feedback from the patient to the surgeon. Haptic feedback consists of kinaesthetic feedback, which relates to muscle force and spatial perception registered in our muscles and joints, and tactile feedback, which is a pressure distribution registered in our skin. The absence of this distributed pressure leads to a disproportion between pressure sensitivity, orientation detection and spatial perception [1]. In conventional operations, the surgeon often uses his fingers to palpate tissue and underlying structures. This palpation is necessary to determine for example the location and thickness of arteries and to localise tumours or nerves [2].

2 Tactile feedback system

To restore the tactile information channel, a tactile feedback system was developed. Such a feedback system consists of two main parts. A tactile sensor to register the tactile information inside the patient [3], and a tactile display, to reflect the tactile information to the skin of the surgeon. Tactile display design is discussed in [4].

The display has 8x4 taxels (tactile pixels) with a stroke of up to 3 mm which can exert a force of 0.5 N. The total display weighs only 6 g and can easily be mounted on any mobile platform. A miniaturised valve is developed to control each taxel individually.

References


