Emergency Medicine Assistive Robot Technology for Non-invasive Bleeding Search
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Abstract—This talk first provides a concept design of emergency medicine assistive robot technology allowing injured patients to take a tele-diagnosis for FAST. Also, blood flow measurement algorithms under non-periodic displacement of an artery by controlling an ultrasound (US) probe are presented.

I. TELE-OPERATED FAST DIAGNOSIS ASSISTIVE RT

First we present a portable and attachable tele-echography robot system: FASTele. Focused assessment with sonography for trauma (FAST) is important for patients who have shock by internal bleeding. However, the patient has little time, and transportation to a hospital may take too long. A system which enable FAST more quickly is required. Therefore, we aim to develop a tele-echography (FAST) robot system that can be used by a paramedic easily for shock patient in ambulance or at injury scene. To develop the system, portability and usability (for paramedic) are significant issues. We developed a tele-echography robot system which has 4-DOF. The robot is attached to each roughly FAST areas of patient body (body-based set up) and remotely fine-tuned by a specialist in a hospital. The robot can control the posture of probe by curvature rails. The mechanism that maintains passively the contact force between the probe and patient’s body surface by using springs enables the robot small and lightweight. Feasibility experiments of FAST are reported.

II. INVASIVE BLOOD FLOW MEASUREMENT ALGORITHM

Next, blood flow measurement algorithms under non-periodic displacement of an artery by controlling an ultrasound (US) probe are proposed. Detecting the position and velocity of a bleeding source is required as the first step in treating internal bleeding in emergency medicine. However, the current methods for detecting a bleeding source involve an invasive approach and cannot quantitatively estimate the velocity of bleeding. Therefore, current emergency medical care requires an alternative system to address these problems. In this study, we aim to develop a blood flow measurement system for detecting a bleeding source by using a non-invasive modality, such as a US imaging device. Some problems related to the measurement error still need to be addressed before we can create this system. In particular, the blood flow measurement error in the abdominal area is typically large because the displacement of the artery is too large and non-periodic to adequately control the probe. As the first step in solving these problems, we focused on the displacement of the artery towards the out-of-plane state of a US image and developed measurement algorithms to control the probe under the displacement based on respiratory information.

Fig.1 FASTele allowing injured patients to take tele-diagnosis for FAST

Fig.2 Vessel following algorithm for blood flow measurement

We conducted cross-sectional area and flow rate measurement experiments using an ultrasound phantom containing an artery model and a manipulator equipped with a US probe (BASIS-I). The results represent the first experimental validation of the proposed algorithms.

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