

INTRA-OPERATIVE REASONING & SITUATION AWARENESS ALGORITHM FOR KIDNEY TUMOR CRYOABLATION BY ROBOT

Nguyen Ho Quoc Phuong¹, Ole Jakob Elle^{1,2}, Dilla Handini¹, Kim Mathiassen¹

¹The Intervention Centre, Oslo University Hospital, Oslo, Norway

²Department of Informatics, University of Oslo, Oslo, Norway

Introduction: Intra-operative reasoning & situation awareness is an important part of intelligent robotic surgery which allows robot to be able to perform automatic operation. One of the basic operations for this early stage of medical automation is kidney tumor cryoablation. In which, robot inserts a needle towards the tumor on kidney and then destroys it by extremely-low temperature. During the operation, risky situations are predicted.

Methods: One cryoablation operation can be divided into many phases namely initialization, heading to the skin, penetrating the skin, heading to the target, doing cryoablation, getting out of the ice-ball and retracting. Each phase has its specific strategies of sensing, reasoning and control. There are many sources of information involve to the decision making algorithm: from model, CT scan images, robot kinematics and force sensors, vision and ultrasound scan images.

The reasoning and situation awareness algorithm includes two modules, one helps find the phase-end events, the other keep tracking and predicting risky situations. Due to the uncertainty and sensors noise, two probabilistic methods are applied. Bayesian networks are used to detect the phase-end event based on many sources of information. On the other hand, Particle Filter is employed to track and predict the position of the needle tip and then determine if it fails to hit the target, hits the forbidden area or it is broken.

Results: Given phase-end event detections are simulated based on Bayes Net Toolbox which makes use the training data from phantoms. A Particle Filter designed to track and predict risky situations of "needle fails to hit the target" and "needle touches forbidden area" are simulated based on Robotics toolbox

on Matlab. The algorithm then will be verified by real system and performed on phantoms before the further process on living organ.