Development, Implementation and Evaluation of Artificial Breathing Motion on a Robot-driven Lung Phantom

The significance of navigated bronchoscopy has fastly increased since the introduction of trackable bronchoscopes with integrated electromagnetic sensors in the late 1990s.
A research group at the Department of Medical Technologies of SINTEF in Trondheim, Norway, has developed a diagnostic tool that matches the recorded position of a tool tip (e.g. bronchoscope), equipped with an electromagnetic sensor, with a 3D visualization of the lung, created from preoperative computed tomography images. For verificational and validational purposes of this technique, a lung phantom, moving like a breathing patient's lung, is desired.
Scope of this Bachelor Thesis is the development and implementation of typical breathing patterns with a provided UR5 robot arm, that moves a lung phantom. Therefore a literature review about diaphragm-induced lung movement was performed and thereby gathered information used to on the one hand derive the general lung movement progress over the breathing cycle and particularly breathing patterns to expect from patients undergoing a bronchoscopy procedure, and on the other hand to adequately simulate the diaphragm motion effects on different parts of the lung. Both features have been implemented as a program in python, the default programming language to remotely control the UR5 robot, equipped with suitable breathing patterns and a graphical user interface for parameter adjustment. The program was run on the robot and the actual movement and its repeatability was assessed.
Furthermore were the breathing patterns compared with datasets acquired from sensors placed on patients sterni during bronchoscopy procedures in the collaborating St. Olavs Hospital in Trondheim. For that the datasets were processed by means of a least square estimation for restoring the underlying breathing movement cycle and subsequently the deviations have been quantified and evaluated.