Design Concept Development and Evaluation for a Novel non-invasive Bladder Emptying Device

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Introduction

Urinary retention is a condition where patients are not able to void the bladder correctly. It is differentiated into acute urinary retention (AUR), which suddenly prevents the voiding, or chronic urinary retention (CUR) which prevents the complete voiding of the bladder and a residual volume of urine remains in the bladder. This condition appears more frequently in older men. A possible treatment method is catheterization. The Urogenital Engineering (UGE) group of the ARTORG Center for Biomedical Engineering is currently looking into the feasibility of an alternative treatment method using the impedance pumping principle to help void the bladder. Impedance pumping is a valveless pumping principle which uses the impedance mismatch to generate a net flow.

Materials and Methods

For the experiments, a new setup is created to be able to produce reproducible data with the ability to have a changeable and easily adaptable system. The new setup is built from aluminium profiles, a rail to define the actuator's position, a space to place the model and one or two reservoirs. Currently, the setup can be changed into three different configurations.

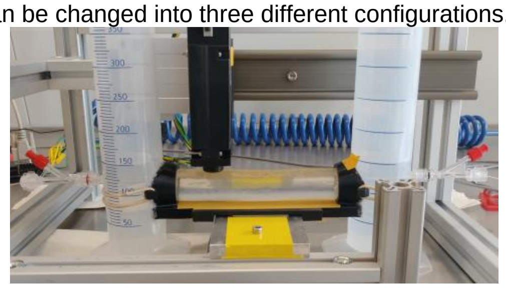

Fig. 1: Setup in the second configuration. The experiment performed is for the evaluation of the computational model.

Multiple experiments are performed to evaluate wave speed velocity, dampening, performance, and evaluation of a developed computational model, reflection or the influence different stimulators and compression can have on the created pressure waves. The actuator compresses the urethra model and therefore introduces pressure waves travelling in the fluid. The wave curves are measured with pressure catheters and then analyzed.

Results

The results obtained for the wave velocity showed a mean velocity of 3.47m/s with a standard deviation of 0.2. This is similar to the results obtained in a previous thesis. The results for the computational model showed the same trend as predicted by the simulation. The influence of the compression applied was visible in the response of the recorded amplitude of the pressure wave. The compressed area by the stimulator showed also a relation between the size and measured amplitude. It was not possible to identify a wave reflection coefficient for the model and experiment performed.

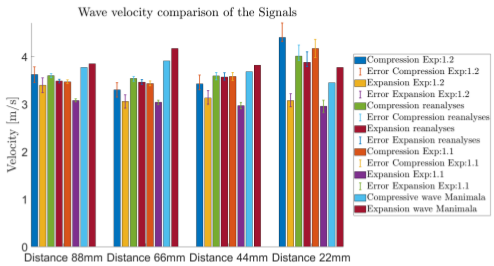

Fig. 2: Evaluated wave velocity from different experiments to validate the newly created setup.

Discussion

For the computational model, it was possible to see a change in flow direction only by changing the applied frequency. However, no attenuation is yet implemented in the simulation. This is indicated by smaller height measurements during the validation. However, some results showed a similar behaviour as described in the literature. For further flow measurements of the system, the found results can be implemented to see the influences on the performance.

References

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