Development of a Test Bench for Characterizing Biomaterials

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Bio-printing is an additive manufacturing technique that allows printing cell-laden biomaterials – usually hydrogel-based polymers – into 3D structures for tissue engineering. The industrial partner provides bioprinters, biomaterials, and bioprinting software for research. This work aims at developing a test bench that allows the characterization of these biomaterials.

Motivation

Bioinks are living cell-laden materials used for 3D printing of complex tissue models. These bioinks are based on polymeric hydrogel biomaterials. The bioprinting process of biomaterials has different requirements compared to standard 3D printing materials. For example, biomaterials are often deposited at body temperature and under mild conditions to maintain cells viability. To optimize the printing process, the physical behavior of these biomaterials requires investigation.

Principle

The test bench will measure the volume flow and should work according to the extrusion process, i.e., a mechanical force is applied to the plunger, which pushes the biomaterial out through a needle, similar to a syringe. The volume flow is essential for 3D printing, as it determines the individual layer thicknesses and thus the overall printing speed. Two parameters can be configured for the printing process: the plunger force and the extrusion speed. Together with the plunger diameter (given by the syringe manufacturer) they influence the volume flow. The displacement of the piston will be used to measure the volume of printed biomaterial.

Methods

For the test bench (see figure 1), the volume flow rate should be measured as a function of the force or speed of the plunger. Hence, plunger speed, plunger force, and volume flow must be measured. For the piston force, a load cell is implemented between the piston rod and the applied force. The load cell uses strain gauges and is evaluated by means of a Wheatstone bridge. The plunger speed is controlled by a spindle drive and a stepper motor. The volume flow is calculated from the displacement of the plunger and its diameter or area . A microcontroller does the control of the stepper motor and the data acquisition of the measurements.

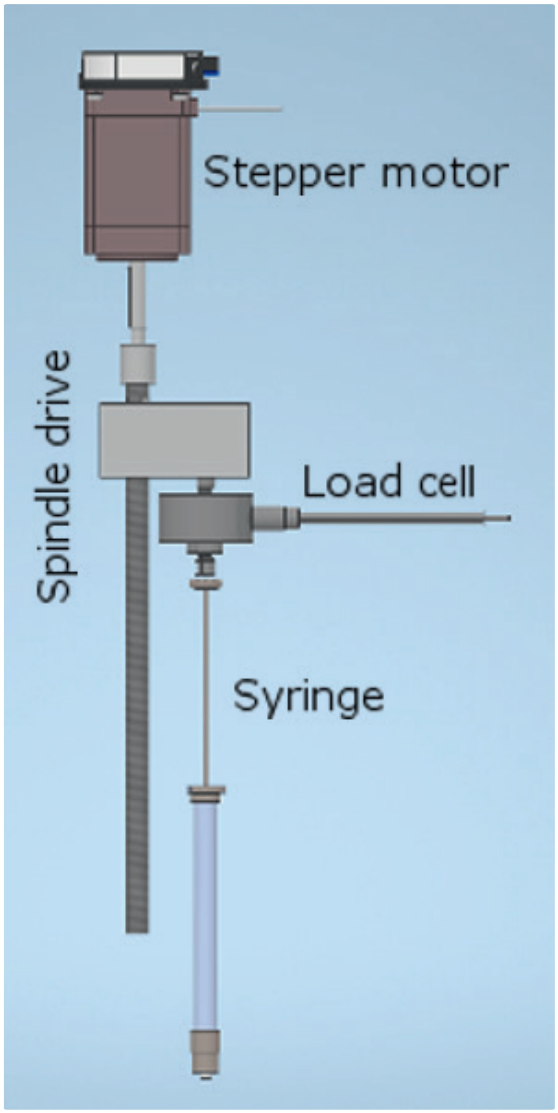

Figure 1: Principle structure of the test bench

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