Pressure-based control in a pipette tip of an automatic pipetting system

About aspirating liquids of different viscosities

Graduate

Nikola Jovanovic

Initial Situation:

Electronic pipettes enable precise dispensing and transport of liquids in the microliter range. In biological research, they are used to induce specific reactions between two liquids. In electronic pipettes from industry partner INTEGRA Biosciences AG, the aspiration speed is manually preset according to liquid classes.

Consistent dispensing therefore requires that always the same speed is selected for each class. However, a problem becomes apparent if this speed is set too high and is not adapted to the dynamic behaviour of the liquid. In the case of highly viscous liquids, inertia occurs, which prevents them from flowing immediately into the tip if the aspiration velocity is too high. During the time required to overcome this inertia, there is no liquid suction. Instead, there is an expansion of the air column and an increasing negative pressure in the tip. Although no liquid is flowing in, the pipette continues to control the aspiration process based on the predefined velocity, resulting in inaccurate dispensing.

Approach:

The industry partner's pipette requires adjustments to hardware and firmware to achieve the desired goal.

Suitable controller parameters are required to implement pressure control in the firmware. For this purpose, the maximum suction velocity and the associated pressure were determined experimentally for various reference fluids. It was determined up to which point the liquids follow the suction velocity without causing excessive decompression of the air column in the pipette. The suction process is controlled based on these findings to keep the pressure constant in the tip.

The basis for determining the controller parameters is a system analysis and a simulation of the controlled system. In addition, the fluid to be aspirated is assigned to a fluid class based on its viscosity. Deviations between simulation and reality were corrected by further tests with the identified parameters.

Result:

This bachelor thesis shows how a pressure-based control in an electronic pipette eliminates the need for manual speed adjustment. For highly viscous liquids, the aspiration speed can be reduced, so that the pressure in the pipette does not drop and remains constant. This ensures precise dispensing.

D-One electronic pipette from the industry partner
Integra Biosciences AG

Pressure-based control eliminates the need for manual adjustment of the suction speed
Integra Biosciences AG

Dipping of a tip into the liquid before a suction process
Integra Biosciences AG

Advisor
Prof. Dr. Rainer Pickhardt

Co-Examiner
Prof. Adrian Weitnauer

Subject Area
Electronics and Control Engineering

Project Partner
INTEGRA Biosciences AG, 7205 Zizers, Graubünden