Universidade Federal de Minas Gerais
Escola de Engenharia
Curso de Graduação em Engenharia de Controle e Automação

EHDA closed loop control system based on real time non-visual spray mode classification

Relatório de Atividades 4
Projeto Final de Curso

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1 Summary

Electrohydrodynamic Atomization (EHDA), also known as Electrospray (ES), is a way to disintegrate a liquid into droplets by exposing it to a strong electric field. EHDA surveys have contributed as an important tool for the development of water technology (thermal desalination and metal recovery), material sciences (nanofibers and nano spheres fabrication, metal recovery, selective membranes, and batteries), and biomedical application (droplet encapsulation). Besides that, the project is merged with the Energy Transition strategy and Innovation Agenda Agriculture, Water, and Food, Key Enabling Technologies (KETs). Although, there are EHDA applications in industry, stabilizing the cone-jet spray mode is done empirically and based on mean current measurements.

The electric current flowing transported by the spray reveals characteristic shapes for different spray modes. Those shapes cannot simply be summarized by its mean value. In figure one we can see an example of cone-jet mode electrospray.

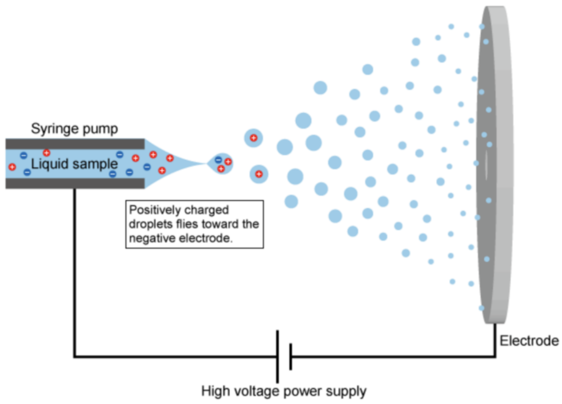

Figure 1: EHDA

Signal processing techniques can allow a non-visual classification of the spray mode based on the electric current shape. The spray process imposes noise and random sequences on the measured signal making its classification not a trivial task.

Industrial applications demand automated stabilization of a spray mode. This can be achieved by a closed-loop control system. Figure 2 shows the control model implemented in this project.

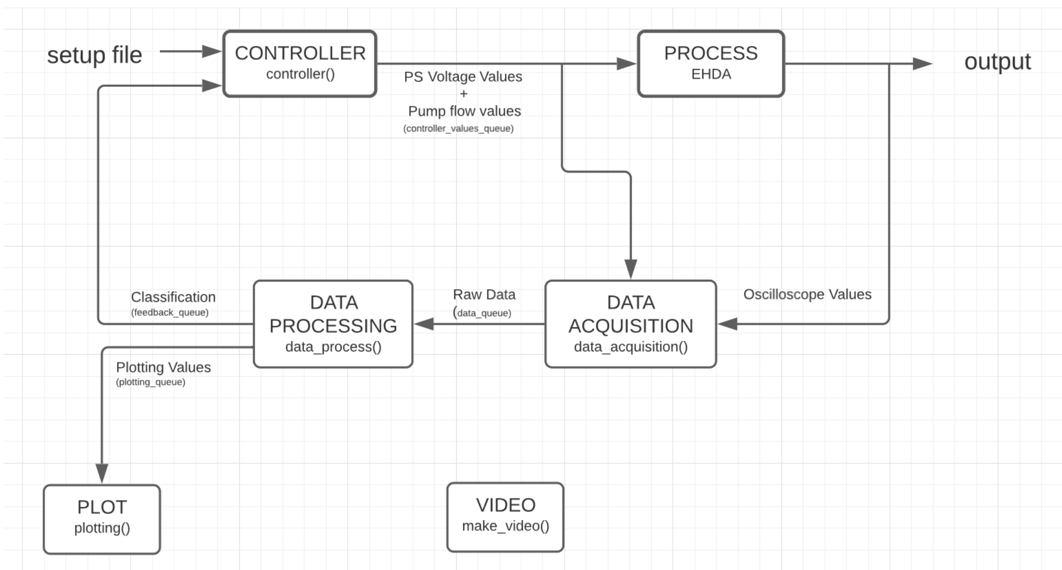

Figure 2: Control model implemented in software

The setup used for this project can be seen in the Figure 3 and 4. To run the experiment automatically it is used a computational processing machine to integrate the peripherals and run their routines, system sensors such as the oscilloscope and the high speed camera and also the system actuators which is represented by the high voltage power supply and the syringe pump.

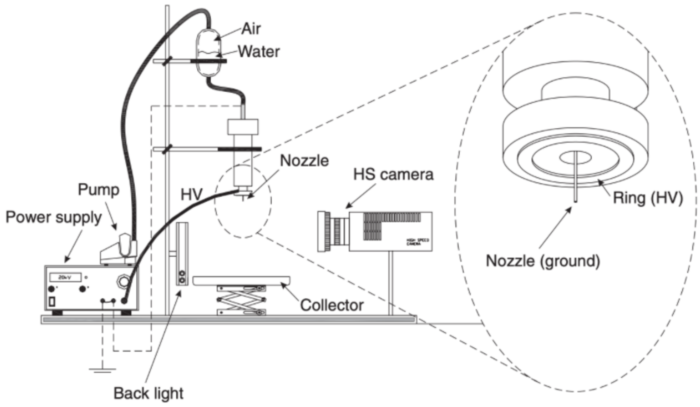

Figure 3: System Diagram

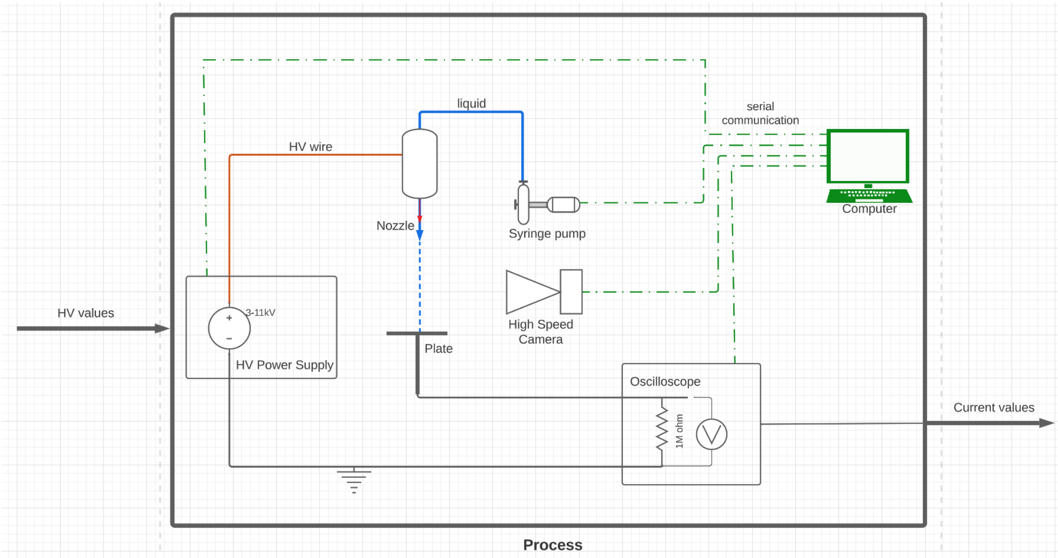

Figure 4: System Automation Diagram

Automated classification of the spray mode is a crucial part of a control system same as the development of an appropriate control algorithm. Signal processing implementations of previous projects of the NHL Stenden Water Technology group are showing good classification results. Further research is necessary to improve the classification accuracy and research and implementation of a suitable classification algorithm. Because of that, this work is being done by the Water Technology Group at NHL Stenden University of Applied Sciences and in combination with Dutch companies to match analysis possibilities with knowledge and infrastructure availability.

2 Metodology and Results

The following subsections are about the work done in this 3rd part of the project.

2.1 Save experiment in real time

2.1 Raspberry pi

2.1 Correctly Join threads and qeues

3 Conclusion

The integration with the pump machine in the automatic system brings a new dimension of possibilities in this project. The goal at the moment is to improve the algorithm in order to be capable of scanning the stable region of cone jet mode in the Voltage X Flowrate map. After that define the middle point in the stability island to set as a setpoint to our control system. The control system will be capable of rejecting noises and disturbance in the system in order to keep always in the stable cone jet spraying mode.

For further goals we have:

- Save the experiment data in a file while running the experiment. This will prevent lost of data if the program crashes and also not overflowing the program memory.
- Install and run the experiments in a raspberry pi portable computer running Linux.
- Study about the fourier transform peaks and how it can be used in the classification and in the mapping.
- Improve the classification and routine performance.
- Optimize the controller.

Until the moment the project has been shown good results. The map routine, the control routine and the classification are already implemented and working. Now its more about improvements to get better accuracy in results.