

Report on the outcomes of a Short-Term Scientific Mission¹

Action number: CA18232

Grantee name: Julian Hölz

Details of the STSM

Title: Modelling of networks of nonlinear control systems via the Koopman and Perron-Frobenius operator

Start and end date: 11/06/2023 to 22/06/2023

Description of the work carried out during the STSM

Description of the activities carried out during the STSM. Any deviations from the initial working plan shall also be described in this section.

The purpose of this meeting was to initiate a collaboration with Alexandre Mauroy and his students, and to exchange ideas on how to mathematically model a general class of nonlinear dynamics with Koopman and Perron-Frobenius operators. We focused in particular on nonlinear dynamics that is either observed or controlled by an input. Of particular interest was the duality the controlled/observed nonlinear system, the observed/controlled Koopman system and the controlled/observed Perron-Frobenius seem to exhibit, as it resembles the duality of linear controlled/observed systems in finite dimensions. We have found the contravariance to be the cause of this.

During my stay we have discussed different approaches to model how outputs are incorporated in a linear Koopman formulation for observed systems and found that our approaches are of similar nature. Further, we talked about the possibility of proving the existence of a linear Lundberg observer for the observed Perron-Frobenius system.

Description of the STSM main achievements and planned follow-up activities

Description and assessment of whether the STSM achieved its planned goals and expected outcomes, including specific contribution to Action objective and deliverables, or publications resulting from the STSM. Agreed plans for future follow-up collaborations shall also be described in this section.

We planed on further investigating the existence of the linear Lunberg observer and proposed to look into the dual problem, namely to find a feedback to the controlled Perron-Frobenius system that will

¹ This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the GH for payment of the Grant.

control the nonlinear system to a given point. A particular interesting question, we could identify, is whether the feedback of the Perron-Frobenius system can be chosen such that the perturbed semigroup is again a Perron-Frobenius system (structure preserving feedback).

In the next few months our main goal is to make some of the intuition gained in our discussions rigorous and work out the functional analytic details in which we study the linear models. We suspect that an article for submission on this issue might be ready within the next year.