

Mathematics for Industry Network STSM

Summary of the Scientific Mission

The short term scientific mission took place between Sunday 24th and Saturday 30th of January 2016 in France. The visit was hosted by Dr. Alban Quadrat who works as a senior researcher at Inria (National Institute for computer science and applied mathematics) Lille - Nord Europe, Non-A Project. The main venue of the visit was a local research centre at Lille, and representatives of Sagem-SD were met in Paris.

The main aim of the visit was to complete our joint journal article on the theory of robust regulation based on fractional representation approach that has been developed in collaboration by me and A. Quadrat, and to further develop the results. In addition, a meeting with people in industry and a presentation were planned to promote the results.

In the beginning of the one week visit we reviewed our old results for single-input single-output (SISO) systems and considered what there remains to be achieved. We got some new ideas related to the structure of stabilizing controllers, but they were not directly related to robust regulation. We decided to finalize our current research article first, and then see how they may be extended to multi-input multi-output (MIMO) systems.

On Wednesday I gave a talk on robust regulation at Inria Lille - Nord Europe. The talk presented a new formulation on the famous internal model principle, which states a necessary and sufficient condition for a controller to be robustly regulating. The audience consisted of local researchers and students, and the discussion and questions afterwards showed that the topic is of interest.

During Wednesday and Thursday we gave the finishing touch to the research article. We also discussed the opportunities of module theoretical approach in control theory. Applying it to robust regulation seems to be a very prominent approach and is likely to provide good insight into the problem when generalizing the results to the MIMO case. On Thursday I had the opportunity to participate in a talk given by visiting professor Arie Levant (Tel Aviv University) on black box control¹.

On Friday I traveled to Inria Saclay Ile-de-France research centre in the Paris region, where I met Arnaud Quadrat working for Sagem-DS and his and Alban Quadrat's doctoral student Guillaume Rance. Sagem-DS is a big high-tech company that holds European and even world leadership positions in optronics, avionics, electronics and critical software for both civil and military markets. Applications related to a scanner forming string beam system and to a helicopter mounted camera were discussed. Due to scheduling problems the meeting with Arnaud Quadrat was unfortunately short (about an hour), but it was seen that the theoretical results on robust regulation can be used in the applications considered. After the meeting we continued to work with Guillaume Rance on the ring beam system and formulated the class of all robustly regulating controllers for it.

The scientific mission was successful. Its main outcomes were a paper ready to be submitted, and general directions on the future collaboration with Dr. Alban Quadrat. Our mutual interest is to understand the robust regulation theory in terms of module theory which is a natural mathematical language to treat the problem. Mathematics were promoted by giving a presentation and having a meeting with people in industry, thus achieving the goal of Mi-Net eCost action.

¹<http://www.inria.fr/centre/lille/agenda/colloquium-polaris-arie-levant-black-box-control-in-theory-and-applications>