

SIAG Control and Systems Theory (CST)

Charter Renewal

This CHARTER RENEWAL applies to the SIAM Activity Group on Control and Systems Theory. The SIAM Council and July 25, 1986 by the SIAM Board of Trustees originally formed the SIAG/CST under the aegis of SIAM on July 20, 1986. Its initial operating period began January 1, 1987 and ended December 31, 1989. Its charter has been renewed by the council and board ten times thereafter. This SIAG had 631 members including 267 students as of December 31, 2016.

According to its Rules of Procedure, the objective of the SIAG is to foster activity and interaction between mathematicians, engineers and other scientists interested in control and systems theory. The SIAG plans to encourage further development of theory and methods for the estimation and control of systems.

Within the framework of SIAM, the SIAG will conduct activities that implement its purposes.

Its purposed functions are to organize activities, including conferences, sessions at SIAM meetings, sessions at meetings of other organizations cooperating with SIAM, and publications, to (1) promote interaction between mathematicians, engineers and other scientists interested in control and systems theory, (2) keep SIAM membership up to date on developments in this area, (3) facilitate the development of control and system theory and (4) encourage its application.

The activity group awards two prizes: (1) the SIAM Activity Group on Control and Systems Theory (SIAG/CST) Prize, established in 1997, is awarded every two years to a junior researcher for outstanding research contributions, as determined by the prize committee, to mathematical control or systems theory and (2) the SIAG/CST Best SICON Paper Prize established in 2007. The prize is awarded every two years to the author(s) of the two most outstanding papers, as determined by the prize committee, published in SICON in the two calendar years before the year of the award

The SIAG has complemented SIAM's activities and supported its proposed functions. The answers to the questions below indicate how this was accomplished and what the officers propose as the future directions for the SIAG.

1. List all current officers of the activity group (including advisory board, if relevant).

- Chair: Fariba Fahroo (1/1/16 - 12/31/17)
- Vice Chair: Kirsten Morris (1/1/16 - 12/31/17)
- Program Director: Wei Kang (1/1/16 - 12/31/17)
- Secretary: Maurizio Falcone (1/1/16 - 12/31/17)

SIAG/CST Advisory Committee

- John Burns, Virginia Polytechnic Institute and State University (1/1/14 - 12/31/16)
- Michael Demetriou, Worcester Polytechnic Institute (1/1/14 - 12/31/16)
- William Levine, University of Maryland College Park (1/1/16 - 12/31/18)
- Maurice Robin, FCS Campus Paris Saclay - Digiteo (1/1/16 - 12/31/18)
- Qing Zhang, University of Georgia (1/1/2015 - 12/31/2017)

SIAG/CST Conference Steering Committee

- Catherine Bonnet, Inria
- Michael Demetriou, Worcester Polytechnic Institute
- William M. McEaney, University of California San Diego
- Bozenna Pasik-Duncan, University of Kansas
- George Yin, Wayne State University

2. How is the field covered by the activity group doing? Is it growing, is the focus shifting? What have been the significant advances over the last two years?

Even though control and systems theory may appear as an established and mature engineering field, it will always remain a field where mathematics will play a crucial role in its advancement. By its multi-disciplinary nature and by its relevance to so many applications, any emerging areas such as networked systems, biological systems, multi-agent systems, cyber-physical systems and so on present new challenges that can only be met by more rigorous mathematical research which should be of a multidisciplinary nature. For example, a growing area of research is control of large-scale systems, some with big data. Therefore, research on the computational issues, numerical control theory, and data assimilation of large-scale systems with the curse of dimensionality has become a major trend. Another rapidly growing area is management of networks and optimization, mean field games, dynamics games and applications (to economics, security, mechanics, agriculture). Stochastic control in the past has played an important role in finance, but its application to quantum control and quantum information processing has also become quite important. The emergence of data science and uncertainty quantification have made tools from stochastic control relevant to these fields and have also made stochastic algorithms numerics an essential part of stochastic control. Study of hybrid systems, systems with jumps and non-local structures have remained important areas of mathematical controls science. All these emerging areas and trends have made control and systems theory as vibrant and vital as ever and more importantly they have made the field more relevant to the other areas in applied math and computational science.

3. How is the activity group doing? Is it remaining vibrant? Is the size of the SIAG stable or increasing? How is the SIAG keeping up with the changes in the field? How are the broader interests of SIAM reflected in the activities of the SIAG?

The CST activity group is vibrant and its membership is expanding by including more research from other fields such as computational math, optimization, life sciences and network science. The membership number reached its height in 2011, and then for three years it declined. The good news is it has been in a steady rise since 2014. Submissions to the CT meetings have been increasing with the CT15 topping the previous meetings. This year's meeting, CT17, which is co-located with the SIAM AN17 meeting, is in conflict with the IFAC World Congress meeting, which attracts most of the European and the more mathematical community, who also form the bulk of the CT meeting participants. Still there are 249 submissions to the CT17 meeting, which is quite impressive given the time conflict. It shows the community is quite active and the multidisciplinary research collaboration with other fields is keeping the activity group relevant.

4. Please list conferences/workshops the activity group has sponsored or co-sponsored over the past three years, and give a brief (one sentence or phrase) indication of the success or problems with each.

The SIAG/CST organizes the biennial conferences SIAM Control on Control and Its Applications (CT). CT13 was held in San Diego, California in 2013. The CT15 conference in July of 2015 was in Paris, France. The CT17 meeting will be in Pittsburgh concurrently with the SIAM Annual meeting, in July 2017. The CT conferences have been doing well and the number of participants and submissions are increasing. It has been difficult to obtain attendance numbers when CT conferences are co-located with the SIAM AN meetings. The CT15 meeting in Paris was one of the most successful CT meetings in terms of both participation and number of submissions. The enthusiastic response was due to its desirable location for both the US and the European participants. This year's CT conference, co-located with the AN meeting happens to coincide with the IFAC World Congress, and there have been significant challenges with attracting the researchers in the CST community who also interact closely with the IFAC community to attend the SIAM CT meeting. Due to the hard work of the SIAG/CST officers and members, the number of submissions to the 2017 meeting is around 250, which is quite respectable given the unfortunate overlap of two major conferences in control theory.

It should be noted that the decision to publish conference proceedings starting with CT13, has contributed a great deal to a larger participation to the CT meetings. For reference, the list of conferences may be found at: <http://www.siam.org/meetings/ct###/>.

5. Please indicate the number of minisymposia directly organized by the activity group at the last two SIAM annual meetings. When did the SIAG last organize a track at an annual meeting or meet jointly with the SIAM Annual Meeting?

The CT conferences that have met jointly with the SIAM Annual Meeting are CT05, CT09 and CT13. Participation of the CST activity group in the last two annual SIAM meetings have been minimal due to the overlap of the SIAM AN meeting dates with other major Controls meetings in the same time-period. In 2016, the SIAM AN meeting coincided with the Mathematical Theory of Networks and Systems (MTNS) meeting in Minneapolis which capped the year of controls at IMA. Most of the CST activity group members actively participate in MTNS meetings, which are important international meetings in the general area of mathematical systems theory. As the Chair of activity group, I understood the choice of the members to attend the MTNS meeting over the SIAM annual meeting and I empathized with their frustration with constant overlap of SIAM annual meetings with other Controls meetings.

6. Please indicate other activities sponsored by the activity group, to include newsletters, prizes and web sites. Have each of these been active and successful?

The first few activities below are from the previous report as they are continuing successfully, and additional ones are added to include the activities in 2016-2017.

- Starting from 2014, the CST SIAG has been publishing a monthly newsletter and the distribution is through emails, which appears to be an effective channel for rapid communications.
- Thanks to the diligent work of the liaison person of the SIAG/CST to the SIAM News, this SIAG has contributed a number of articles to the SIAM News recently, which improved SIAG/CST's visibility. The plan is to submit an article regarding the CT17 meeting, as well as others on specific themes of quantum control, and mean-field control to SIAM News in the next few months.
- SIAM has been a member of the American Automatic Control Council (AACC). We have been organizing several invited sessions (equivalent to the SIAM minisymposia) at the American Control Conference (ACC) and the IEEE Conference on Decision and Control (CDC) every year. One of the most active subgroups has been the control of distributed parameter systems, which has been also collaborating with a new IFAC meeting in the area. The subgroup of networked systems has also participated in many IFAC and IEEE workshops.
- The two major SIAG/CST prizes, the SIAM Activity Group on Control and Systems Theory (SIAG/CST) Prize and the SIAG/CST Best SICON Paper Prize, have been instrumental in identifying and honoring the work of the rising young researchers in the field, as well as excellent scholarship of the mathematical researchers in controls. The broader impact of the work of these awardees is enhanced by their semi-plenary presentations during the CT conferences. Recipients of the awards can be found in <https://www.siam.org/prizes/sponsored/siagcst.php> and <https://www.siam.org/prizes/sponsored/bestsicon.php>, respectively.

- In 2016, the year in Control Theory and its Applications was held at the IMA and the organizers were all members of the SIAG/CST including myself as the SIAG chair. Even though the activities were not officially sponsored by any society, the workshops were all organized and attended by many of the SIAG members. Several of the themes of the workshops such as control at large scales, quantum control, networks dynamics, and computational methods for control of infinite dimensional systems are the main themes supported at the recent CT meetings.

7. What activities are planned and proposed for the next period of the charter? Please describe scheduled and suggested future activities in detail.

The success of CT15 in Paris both in terms of number of participants (464) and submissions (437) which were the highest in the CT conference history attested to the international nature of the CST community. This meeting was the first CT meeting to be held outside the US. Growing the SIAG/CST community internationally has become an important task of the SIAG and the goal is to increase this growth with Asia, which represent the fastest growing scientific community in controls. There are 24 submission from China alone to CT17. This number should be increased for the future conferences and should include more contributions from countries such as Japan, Singapore, Korea, India, and Vietnam. The plan is to increase international participation both at the leadership positions for the SIAG/CST and at the CT meetings. The choice of location for the next CT meetings is an important factor in future plans for attracting more international participation. There are also plans to increase student membership. One idea is to sponsor or organize summer schools on control theory and its applications.

8. How can SIAM help the activity group achieve its goals?

It will be crucially important if the SIAG can have much longer planning horizon for its biennial conferences. Since the other conferences in Controls announce their dates and venue at least two years in advance, we need to find ways to coordinate the dates for the future CT meetings with these conferences. The CST community is multidisciplinary and is active in multiple societies, and there is always competition for time and attention from all these conferences. The recent effort of SIAM to collect data regarding dates and venues of relevant controls meeting to avoid time conflict with other major conferences is important. The information should be integrated into the system for future conference planning.

9. How can the activity group help SIAM in its general role of promoting applied mathematics and computational science?

Control and systems theory by its nature is inter-disciplinary and has always spanned fields such as optimization, dynamical systems, and stochastic analysis. In recent years, numerical control theory and approximation methods for control of large distributed systems are playing an important role in the field so computational science and numerical controls algorithms have become more essential for transition of theoretical results to practical controls engineering. This

transition has made applied math and computational science more relevant in new areas of engineering practice. SIAG/CST provides a bridge to link applied mathematics and control engineering. Meanwhile, control engineering continuously demands new developments in fundamental mathematical control theory. This further promotes the development in applied and computational science.

This SIAG requests that the SIAM Council and Board of Trustees renew its charter for a two-year operating period beginning Jan. 1, 2018 and ending December 31, 2019.

Fariba Fahroo, SIAG CHAIR

May 29, 2017