Editorial

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In June 2016, the second IFAC Workshop on Control of Systems Governed by Partial Differential Equations was held in Bertinoro, Italy. As plenary speakers, Bao-Zhu Guo, Marius Tucsnak, Stefan Volkwein, and Enrique Zuazua were invited to write papers. In the regular program, there were two sessions devoted to backstepping. Due to the activity in this field, we also included a paper on it in this special section.

This special section includes 5 papers highlighting different research fields within the area of infinite-dimensional or distributed parameter systems. All papers contain a historic, or background, section motivating the origin of the control problem. From there it can be seen that some problems and methods have been research topic since the start of infinite-dimensional systems theory.

In the contribution of Scott Hansen and Marius Tucsnak, Russell's principle is applied. Roughly speaking, Russell's principle states that (exponential) stabilisability implies (exact) controllability. A natural question is whether or not the controllability property is conserved under approximation. This is shown to hold for two cases, namely for approximation of the boundary control operator and for approximation of the partial differential equation. Typical examples include vibrating systems. Vibrating systems also constitute the class of examples studied by Enrique Zuazua. For conservative systems, he shows that if the control horizon is very large, then for most of the time the optimal control of the finite horizon approximately equals the optimal control of the infinite horizon. This is known as the turnpike property. The Saint-Vernant or shallow water equation is another well-known example of a conservative system. Control via backstepping of these equations, which is important for open-channel management, is investigated in the contribution of Mamadou Diagne, Shu-Xia Tang, Ababacar Diagne, and Miroslav Krstic. Since backstepping provides a state feedback, these techniques can be difficult to implement. To overcome this, an observer design is constructed based on the measurement at one end of the channel.

Proper orthogonal decompositions (POD) constitute a commonly employed approximation technique. Stefan Banholzer, Dennis Beermann and Stefan Volkwein use this technique to solve the multi-critical optimisation problem of energy-efficient heating, ventilation and air-conditioning of a building. Hence a control is sought, which minimizes more than one cost functional. Since this is in general not possible, a Pareto optimal control is constructed, meaning that there exists no control that lowers all cost.

Disturbance rejection has been a control goal since the beginning of system theory. Honyingping Feng and Bao-Zhu Guo discuss a recent approach to this. They demonstrate the theoretical basis behind the concept of active disturbance rejection control and apply it to wave and beam equations.

As is clear from these brief descriptions, the problems faced within the field of distributed parameter systems are very diverse but, at the same time from both the applications and mathematical perspectives, very exiting. We hope these papers foster continued research and growth in the field of distributed or infinite-dimensional control theory.