Information and Control

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The theme of the lecture is the similarities between control and communication. These fields have the same roots. Remember that Wiener's book on Cybernetics had the subtitle "Control and Communication in the Animal and the Machine." Two of the portal figures Bode and Shannon developed their ideas in the same environment. Concepts, mathematical tools, and techniques are also quite similar even if the applications are very different. Another similarity is that the IEEE Information Theory Society and the IEEE Control Systems Society are the strongholds for theory within the IEEE. Although the fields started from the same base, they have over time separated in an unfortunate manner.

Finding fundamental limitations is a central issue in all engineering sciences. This has been very prominent in information theory inspired by Shannon's seminal work. Basic results on limitations in control were developed by Bode. They have, however, not had the impact they deserve. Some consequences of Bode's work will be discussed in the lecture.

The main theme of the lecture is to discuss how to associate a value with information in the context of control. Stochastic control theory is a natural framework. By starting with a cost function that gives the value of control it is possible to give answers to many questions, such as: What is the value of introducing extra sensors? What is the value of obtaining sensors with less noise or more accuracy? Quite a lot of research have been devoted to these questions over the years. The mathematical setting is either linear systems with Gaussian disturbances or controlled Markov processes with discrete states.

Another interesting issue is the question: How much information about a system do we need in order to control it? This question has not been much discussed in the literature on control. Some preliminary results will be presented.

The lecture concludes with a discussion of some differences between control and communication. Two issues are time delays and computational requirements.

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