TOPOLOGICAL STRUCTURE OF CONTINUOUS-TIME TIME-INVARIANT CONTROLLABLE LINEAR SWITCHED SYSTEMS

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Many systems encountered in engineering applications exhibit switching among subsystems, which depends on various physical phenomena. Each system of the above type can be modeled as a switched control system which is a hybrid dynamical system consisting of a family of subsystems and a rule that describes how the subsystems switch among them. Such switched systems are called supervisory-based switched control systems. Switched control systems deserve investigation for both theoretical and practical reasons since switching based control strategies can result in algorithms that offer significant performance improvements over traditional linear control.

A fundamental requirement for the design of feedback control systems is the knowledge of structural properties of the plant under consideration. These properties are closely related to the generic properties such as controllability. The knowledge on topological structure of controllable and observable linear systems was utilized to clarify certain issues pertaining to the structural properties of such systems. Similarly, the investigation of the topological structure of switched systems consisting of continuous-time time-invariant linear subsystems will hopefully help to answer certain issues related to structural properties of such control systems. This work is mainly aimed at laying the groundwork of identifying the topological structure of the class of supervisory-based controllable switched systems consisting of continuous-time time-invariant linear subsystems.

In the process of identification of the topological structure of continuous-time controllable linear systems evolving in n-dimensional space, it was shown that the Lie group $GL(n,R)$ acts freely on such systems. This fact was eventually used to establish the canonical forms of such systems. Similarly, in this effort, it is established that the Lie group $GL(n,R)$ acts freely on the controllable switched systems consisting of continuous-time time-invariant linear subsystems evolving in R^n. It is argued that the topological structure of controllable switched systems consisting of continuous-time time-invariant subsystems may fail to be a manifold. However, it turns out to be an algebraic variety.

Thus, a theoretical stratification process should be employed to decompose it into a union of finite number of disjoint connected smooth submanifolds by recursively extracting portions of the aforementioned semi analytic set. This makes the identification of the topological structure of supervisory-based controllable switched control systems consisting of continuous-time time-invariant linear subsystems extremely tedious. This difficulty can be bypassed by focusing the attention to the topological properties of the aforementioned algebraic variety.