

Systems evincing delays or after-effect phenomenon, or simply time-delay systems (TDSs), emerge in a wide range of human activities and can be observed in many applications, including but not limited to engineering, economy, biology, medicine, or epidemiology. They constitute a family of processes, mechanisms, and structures that are difficult to be analyzed and their controller design can be arduous in many cases. It is mainly due to their infinite spectrum, which means that a finite number of parameters and delay values determine infinitely many system characteristic values (poles). As pole loci have a decisive impact on the system's behavior and dynamics, especially its stability, it is desirable to determine and control their positions. Moreover, the stability is fragile and be destroyed even by infinitesimal changes in delays. The system zeros may have a substantial impact on the dynamics as well.

The TBU team intends to exert the knowledge, experience, and effort of its members in studying TDS models and their control in synergy with the high-level know-how of the AGH team at advanced metaheuristic algorithms (e.g. those utilizing autonomy, so called agent-based metaheuristics) and their equipment (in particular supercomputing resources) to enhance and extend our recent research results and attempt to solve selected open problems. Namely, we want to determine delay regions in which the system is stable or to find parameters ensuring stability regardless of delay values. We also want to control positions of feedback poles and zeros, not only to ensure reaching their desired loci but also to provide other requirements. For instance, we attempt to make the control system insensitive against model uncertainties or sensor and feedback latencies, which may be applied in the networked environment nowadays. The results' analysis may provide us with general findings of the TDS model spectrum, its dependence on model parameters, the transfer function zeros' role, and further use for robust real-life engineering applications.