# Invited Session Proposal for ICGNC 2020: *Advanced Interceptor Guidance*

Recent experience has indicated that the use of guided weapons is not straightforward, and there are many technological, economic, and political, as well as tactical issues to be considered. The emphasis on the manufacturing process, together with the development of faster, smaller, smarter, and stealthier targets have all placed greater emphasis on increased performance for less cost, with a clear upgrade path. This has resulted in the enhancement of existing equipment with better sensors and improved computation capacity, coupled with the stretching of system requirements and performance specifications. This in turn, has resulted in opportunities for the application of modern techniques to the design of advanced interceptor guidance laws that satisfy various constraints. Within this context, this invited session addresses some of the techniques, entailed in the design of the novel guidance algorithms characterizing modern missile systems.

The conventional proportional navigation guidance (PNG) law has been extensively applied to various missile systems as the terminal homing guidance law over the past several decades. The key features driving the success of the PNG are its simplicity and efficiency of implementation. The basic idea of the PNG is that it generates a guidance command to nullify the line-of-sight (LOS) rate, forcing the missile to follow the collision course. Moreover, the PNG with a specific navigation constant, $N = 3$, is known as an energy optimal homing guidance law. However, it is well known that the performance of the conventional PNG degrades drastically with the increase of target manoeuvrability. Also, the performance of the conventional PNG, when against a manoeuvring target, is far away from the optimal one. As a remedy, the augmented PNG (APNG) law was proposed by introducing a target acceleration rejection term in the PNG guidance command. Obviously, the information on target acceleration is required for the implementation of the APNG. In practice, unfortunately, it is difficult to obtain the information on target acceleration since it is uncertain in nature. A filtering algorithm can be utilized to estimate the unknown target acceleration for the implementation of the APNG. However, the APNG with estimated target acceleration cannot provide good performance in some engagement scenarios. To tackle this issue, many recent works focused on the application of modern control theories, e.g., sliding mode control, disturbance observer, H-infinity control, to enhance the robustness of a guidance law. However, this type of guidance law is usually very complicated and hence it is very complicated to analyse the physical meaning. This, in turn, hinders practical application of these guidance laws due to lack of reliability.

Another main challenge for modern missile guidance is that various constraints need to be considered. For example, constraining terminal impact angle is beneficial to increase the kill probability for anti-tank or anti-ship missiles and provide an advantageous engagement for air-to-air missiles. To enhance the survivability of the missiles against advanced close-in weapon system of battleships, the concept of salvo attack is introduced to achieve simultaneous attack among all interceptors. One typical implementation of salvo attack is the impact-time guidance, in which the missile is forced to intercept the target at the desired. Together with the increase of manoeuvrability and agility, real-world missile guidance problems will be characterized by numerous practical constraints and highly time-varying, nonlinear dynamics. Traditional guidance law design approaches that rely on approximated models with linearization, unrealistic assumptions, and an offline design fashion will be unable to handle future complexity. Future guidance framework that addresses this complexity will more focus on the computational or numerical approaches using either model-based or data-based optimizations.

This invited session therefore constitutes a snapshot of the current research and future aspects in the area of advanced missile guidance. This area is continually developing as many of the challenges have not yet been fully met and are likely to stretch into the near future.

Chairs:

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