Small UAS Detect and Avoid Requirements Necessary for Limited Beyond Visual Line of Sight (BVLOS) Operations

Architecture Delineation

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1 Architecture Delineation

The comparison of DAA approaches is enabled by delineation of different architectures. These have been divided according to the following characteristics.

1.1 DAA Sensor on/off Board

SWaP imposes the most severe constraint on utilization of sUAS DAA systems. Thus, this is the top-tier characteristic that is used to delineate different DAA approaches for sUAS. This not only matches how most people think about such systems, it provides a natural division for both many of the hazards that may be encountered with such systems and with other characteristics of such systems (technical performance, limitations, communication requirements, cost, etc.).

1.2 Degree of Autonomy

The next level of delineation for sUAS DAA systems is the degree of autonomy. Herein, the word autonomy is used in the general sense of "acting independently", wherein the sUAS has a DAA system and utilizes that information to take action without input from a human. In fact, in such a system, a human is not able to intervene in either the DAA system or in the utilization of that information to avoid intruders.

Autonomous systems represent one far end of the spectrum with regards to this characteristic. On the other end of this spectrum is Human In The Loop (HITL). In such a DAA system, the pilot plays a critical role in avoiding intruders. However, the exact degree of human involvement varies. This can be illustrated using Fig. yy. In such a system, minimal pilot involvement occurs when the pilot is responsible only for the Execute Maneuver step. Additional pilot involvement occurs when the pilot is responsible for the last two or three steps. The greatest amount of pilot involvement occurs when the pilot is responsible for all four steps. While it may seem to be counterintuitive that the pilot may be responsible for the Detect step in a BVLOS DAA system, one can conceive of such a system. For instance, EO data could be transmitted to a display that a pilot uses to identify intruders. While such an approach is not likely, it is possible and, thus, is included herein.

Within HITL systems, function allocation can be further subdivided. For instance, within the Evaluation step, cues (e.g., visual or aural) can be provided to alert the pilot of potential conflicts. In such a case, the pilot is alleviated, at least partially, of having to identify potential conflicts. Moreover, the system may provide recommended resolutions. Again, this, at least partially, reduces the responsibility to evaluate the best course of action, although in such a system the pilot may reject the recommended resolutions.

In a Human Over the Loop (HOTL) system, human intervention is possible. Otherwise, such a system is autonomous. Such a system may or may not provide cues to illicit human intervention (visual, aural, etc.). In such a system, the human plays the role of a manager rather than of an active participant, but can take on an active participant role if needed.

1.3 Active/Passive Sensor

The final delineation level is whether a sensor is active or passive. An active sensor produces a signal that interacts with objects that enables their detection (e.g., radar). A passive sensor does not produce a signal, but rather utilizes signatures produced by objects, to detect them (e.g., passive acoustic sensor).

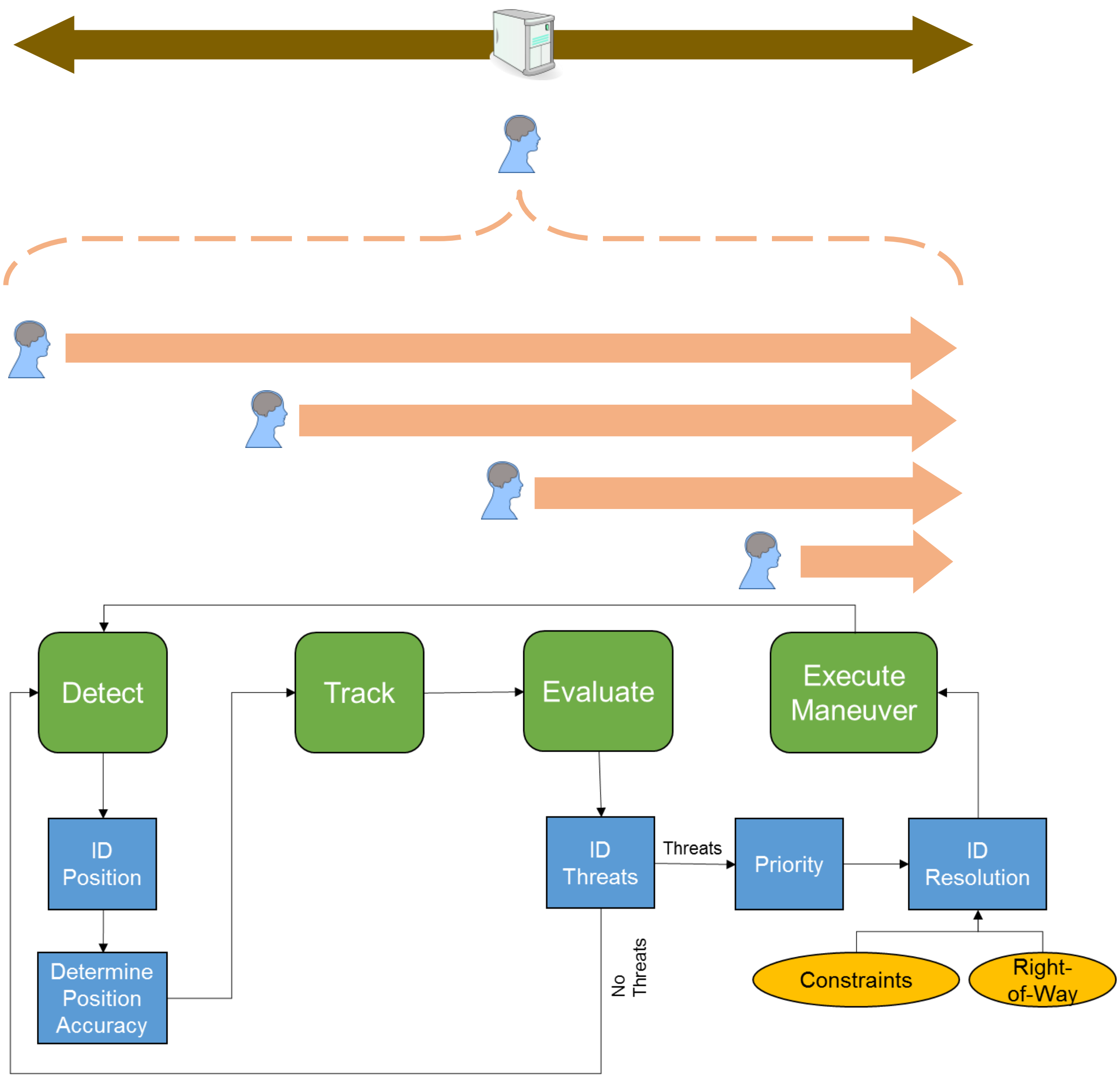

Figure yy. Illustration of architectural impacts on human involvement in the system. The flow chart represents the DAA encounter timeline. The brown arrow represents an autonomous system, the orange curly bracket represents a HOTL system, and the orange arrows represent HITL systems.

Bibliography

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