EDGE AI ENABLED UAVS WITH MINIMAL COMMUNICATION

Problem, need, relevance in Defence

In hostile environments, building situational awareness is usually conducted through multiple disparate sensors in order to maximise the correct identification of items or targets of interest. This can be done through the agency of drones which can do the sensing as well as much of the data processing and data fusion onboard. While a network of drones could offer a wealth information to the user to gain tactical advantage they also limited by size, weight and power (SWaP) constraints.

Simultaneously, it is important to protect high value assets from being detected.

In these hostile environments, the risk of detection escalates with increased duration and frequency of communication. Consequently, when drones are deployed to increase situational awareness, they should be enabled to conduct sensing, onboard processing, limited drone-to-drone communication and restricted but high-quality communication to the protected user.

While conventional distributed learning methods employed in Edge-AI have shown promise in overall learning performance without raw data being transferred to central servers, they tend to increase the frequency of communications due to the iterative nature of distributed or decentralised learning. It is also important to assume that the adversaries in the hostile environment have equal or higher capability in the field.

The key objective of this project is for the user to assess the acquisition of critical ISR information using secure and fast communication with low latency, without compromising the user's location, since staying undetected is crucial for mission success.

To this end, a multiple drone system needs to be considered equipped with heterogeneous sensors, hence a variety of information.

However, not all this collected information may be critical or time-sensitive. Hence information prioritisation and selection could be considered. In addition, the roles of all the drones need not be similar. Task allocation between drones can be considered to ensure optimisation of data processing resources as well as reducing communication between drones and data links back to the user. The purpose of the drone network is to capture ISR data from the surrounding hostile environment and transmit key tactical information to the user (central server) whose location information is sensitive.

Research questions

How can we enable Edge-AI in a swarm of drones operating in a hostile, communication-constrained environment with the objective of providing key tactical information to the user in a safe and secure manner while minimising the risk of exposure of the user? Ensuring minimal communication is a key requirement in the exposure-threatened environment to minimize chances of the user being detected or data compromised. Allied to this is assuring that data transmissions are optimised to ensure that only the most vital or time-sensitive data that is crucial to mission success is transferred securely through the limited communication links available.

Expected outcomes

An assessment and analysis of Edge-AI solutions that enable drone teaming to deal with data processing and data optimisation activities, coupled with minimal inter-drone and drone-to-user communications is expected. The quality and importance of the transmitted data and the amount of data will need to be optimised in order to operate within a constrained communication architecture.