Mobile Fog AI for Internet of BattleField Things (IoBT)

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Abstract
New mechanisms provide soldiers automation capabilities that include interactive, mobile, fast, scalable, secured, powerful computational communication in contested environments such as battle fields. Internet of BattleField Things (IoBT) is a technology that develops integrated Internet of Things (IoT) solutions for the war of the future. The IoBT connects soldiers with smart technology in armour, radios, weapons, munitions, other objects such as health sensors, GPS, and various IoT devices. These “things”, objects, or constrained devices can communicate with each other or across existing network infrastructure such as the Internet or network meshes. They most of the time come with limited capacity in terms of memory storage, computational power and energy. IoT, networking (Device Communication (D2D), Peer to Peer Communication (P2P)), machine intelligence, multimodal sensing and fusion are some areas involved in developing interdisciplinary IoBT networks. Our aim is to equip soldiers with AI powered IoBT devices. Existing D2D/P2P/LPWAN based IoBT technology focuses on edge computing devices which are very limited, being slow, insecure, and lack sufficient scalability. We present a novel concept, i.e., Mobile Fog AI for IoBT to overcome existing IoBT limitations.

Introduction
AI-offering IoT devices, e.g., camera/microphones are carried by soldiers. These devices are heavy, not least due to their need of many batteries. Therefore, we propose the novel Mobile Fog AI concept, moving supportive AI to vehicles/robots. Battle space involves heterogeneous activities in a multitude of spheres, namely space, ground, air, sea, and the cyber areas. Figure 1 illustrates an evacuation mission, where soldiers are burdened with different heavy devices and batteries including IoT in complex operations in (Anadolu Agency 2021). Figure 2 is a standard IoBT platform where soldiers are equipped with different isolated devices, vehicles, wearable, weapons, tanks, drones, helicopters in (Kott, Swami, and West 2016). Figures 3 and 4 illustrate standard fog computing with edge and IoT devices, see https://www.africanwomenintech.com/fog-computing/ and (Hungud and Arunachalam 2020). In Figure 5 is our novel mobile IoBT platform with the cloud computational setting in the left; and on the right we show the more advanced fog computational setting in an IoBT platform — a fog layer is found in-between the IoBT devices and the cloud computational layer. The vehicles and robots are mobile —- they support our proposed innovative Mobile Fog AI Layer.

Internet of BattleField Things and Mobility
Internet of BattleField Things (IoBT) aims to connect battlefield entities such as soldiers with wearables, weapons, tanks, drones, helicopters. IoBT is a network of military things that collects data from the battlefield and send this data to the IoBT command centre for processing (Joshi, Thakar, and Patel 2023). Communication is a novel mobility feature, but mobility is also related to sustainable growth, change goals. Mobility is an important tool in military activities, as well as in many other critical situations. In IoT-based communication model, the things collect information using sensors; inter-connect the “things”; and process the data flow to and from “things”, e.g., cloud computing. Current IoBT is missing sustainable features (Kang et al. 2020; Feng et al. 2020). Therefore, an extension for the Internet of BattleField things with the Mobile Fog AI is shown in Figure 5. The Fog AI network sustaining D2D/P2P/LPWAN applications is shown in Figure 6.

IoBT Fog Layer
Fog computing is a decentralized computing infrastructure that places storage and processing components at sufficiently powerful devices found at the edge of the cloud where data sources, application users, and sensors need it (Bononi et al. 2012). The Fog layer adds an intermediary between cloud and the edge device layer, allowing for more complex computations than edge computing. It also improves security and privacy by keeping information local to the users, and increases scalability by increasing computing powers and resources.

Novel Mobile Fog AI Layer
Typically, soldiers use multiple IoT devices such as health sensor, GPS, camera, microphone, etc. These IoT devices
are too weak to handle complex AI tasks such as those based on Deep Learning (DL) processes. This would be easier if the data from these devices is sent to military vehicles or robots, e.g., mobile platforms to perform the AI tasks with sufficient energy and compute power for the faced requirements. The results can then be sent back to the evaluators of the global battlefield performance analysis, to soldiers, and to the cloud data centres. The mobile Fog AI is an innovative approach composed of a Mobile Fog layer specialized for AI tasks that extends the D2D/P2P network exploiting Fog computing as a service supporting AI functions. For this, the Fog AI uses Edge computing/AI mainly to simplify data, since the D2D is assumed to handle only small amounts of data (Bellavista et al. 2019).

In the process of developing the Mobile Fog AI, we design and test architectures and APIs for providing AI services such as the communication with the human, classification, decision making, coordination, and medical advise.

Mobile Fog AI IoBT Work in Progress

We reviewed existing IoBT devices and networks, including D2D/P2P/LPWAN; and explored the opportunities to integrate new platforms, e.g., a mobile Fog node with an embedded system, e.g., NVIDIA Jetson. An application of our novel Mobile Fog AI for IoBT is shown in Figure 6. Essential devices that soldiers require are being classified and integrated into the IoBT network. A Fog computing framework with AI capabilities is developed, based on NVIDIA Jetson. It enables to build and evaluate DL networks: (a) Train the DL network on a high performance GPU based computational device (b) carry on the DL computation using the embedded system such as NVIDIA Jetson. The entire Mobile Fog AI for the IoBT framework is planned to undergo tests with the solders in real world scenarios. The Mobile Fog AI for IoBT is an interactive modular framework in the ongoing multimodal communication in complex environments.

Conclusion

Current IoBT computations are neither available on the cloud nor in data centre nor on the devices. A goal is that the AI is to take care of the soldiers. This goal is not yet available, because the available energy and computation power cannot handle the battlefield problems. Therefore, a Mobile Fog AI based IoBT evolves to assist soldiers. Our aim of the digital transformation is to minimize the human exposure on the battlefield and provide the soldiers with the AI-powered IoBT devices that they are currently lacking during critical tasks such as the military missions or tactical and operational activities.
References


