Automated Detection of Unexploded Ordnance (UXO) Using Bespoke Unmanned Aerial Vehicles Equipped with Magnetometer Sensors and Virtual Reality Interface

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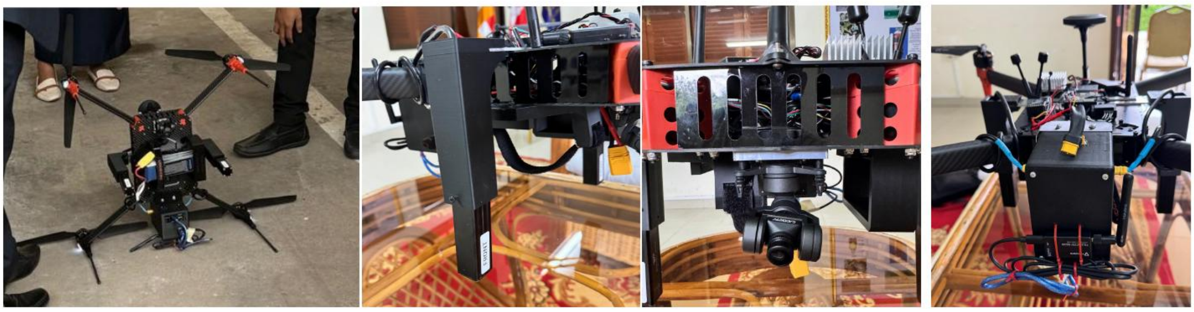

(a) The UASvrUXO (bottom view). (b) With dual magnetometers. (c) With VR camera. (d) UASvrUXO (top view).

Fig. 1: The components of the UASvrUXO from multiple views.

Abstract

The ongoing presence of unexploded ordnance (UXO) continues to impose serious humanitarian socio-economic and environmental burdens on post-conflict regions across the globe. Conventional ground-based detection methods are often slow, labour-intensive, and expose operators to substantial risk. To address these challenges, this study presents the development of a small-scale, bespoke unmanned aerial system (UAS) (Fig. 1) designed for the rapid detection of UXO using an integrated magnetometer sensor suite and a virtual reality (VR), enabled human–machine interface with intelligent automated techniques (Figs. 2 and 3). The proposed platform, the so-called UASvrUXO, combines low-altitude autonomous flight, real-time magnetic field (MF) sensing, wireless data streaming, and a human-in-the-loop (HITL) operational framework to enhance safety and operational efficiency. Extensive lab and field trials in the UK and Cambodia demonstrate the system's ability to detect magnetic disturbances associated with metallic components of subsurface UXO while enabling remote operator supervision and intervention through a VR interface. The results indicate that the proposed approach provides a safe, flexible, and cost-effective alternative to conventional UXO survey techniques, with strong potential for humanitarian demining applications.

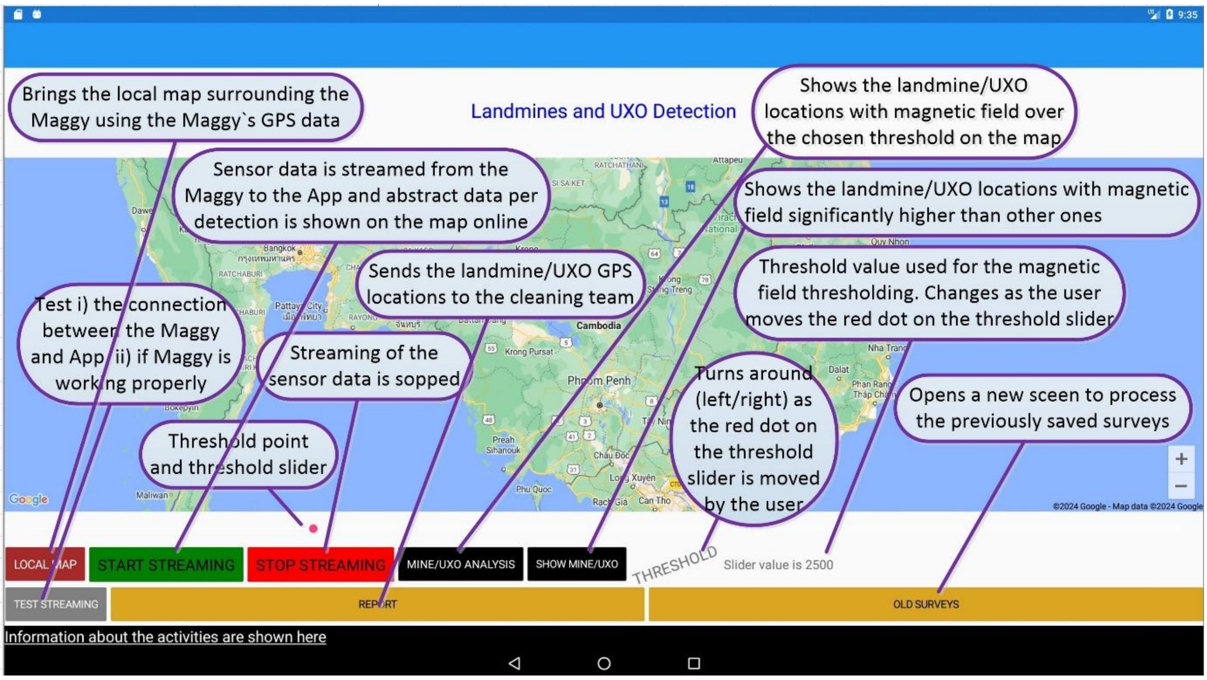

Fig. 2: Main interface of the Android tablet/smartphone application and its functions.

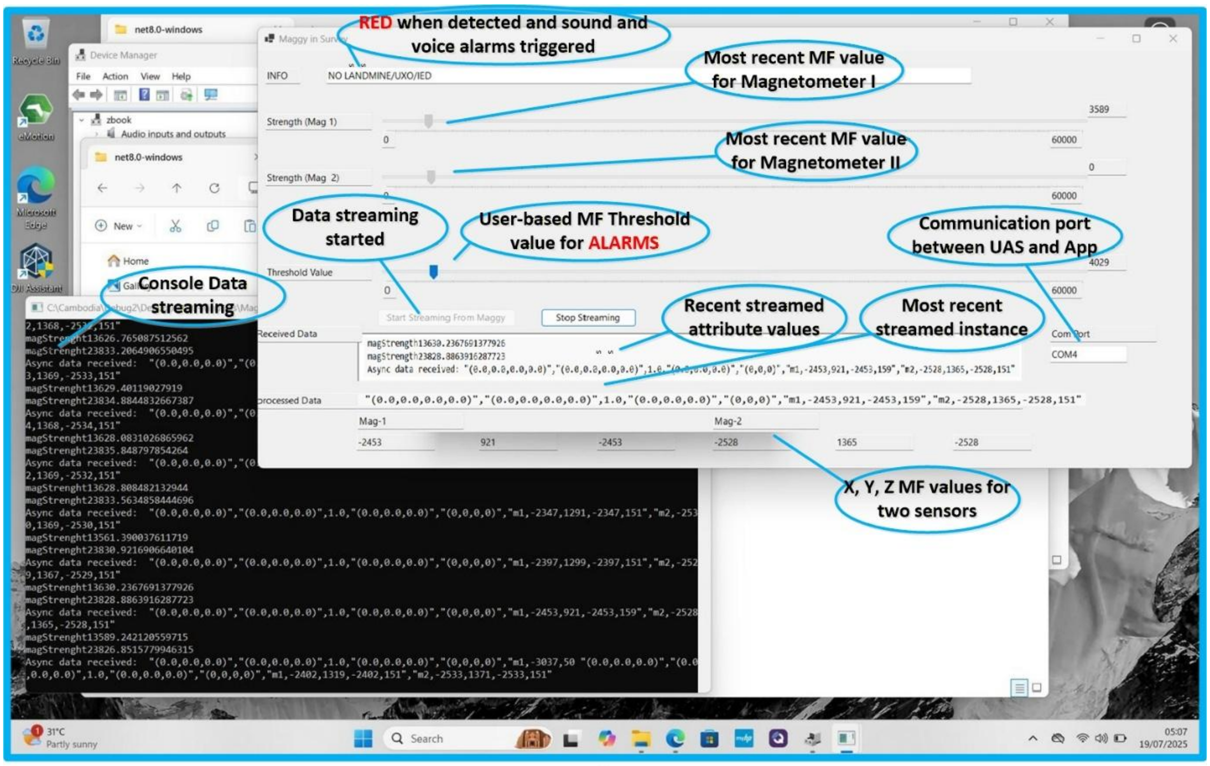

Fig. 3: Main interface of the Windows application and its basic functions.

Index Terms— Unexploded Ordnance (UXO), Improvised Explosive Devices (IED), landmines, Unmanned Aerial Systems (UAS), Virtual Reality (VR), magnetometers, airborne demining.

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