Blockchain Integrated AI Framework for Humanitarian Demining and Carbon Emission Optimization

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***Abstract*—This paper introduces a novel proposal demonstrating decentralized storage solutions, emphasizing the potential of deep learning, specifically within the Hyperledger network for landmine detection. The objective is to establish a secure and reliable storage mechanism for landmine locations in humanitarian demining while simultaneously minimizing environmental impact to optimize carbon credits. The proposal's core involves utilizing advanced deep learning algorithms for precise landmine detection, drawing on data from diverse sources, including hyperspectral aerial images captured by unmanned aerial vehicles (UAVs). The innovative approach goes beyond conventional methods by securely transmitting the coordinates of detected landmine regions to a private blockchain network integrated with GPS technology. Beyond its immediate humanitarian impact, the integration of blockchain technology provides an innovative avenue for optimizing carbon credits. The transparent and traceable nature of the blockchain facilitates resource allocation, contributing to a reduction in the environmental footprint of demining efforts.**

***Index Terms*—Blockchain, deep learning, carbon credit, landmine detection, smart contract.**

I. Introduction

Landmines pose a grave threat to human lives and hinder post-conflict recovery efforts, contributing to prolonged humanitarian crises. The indiscriminate placement of landmines not only leads to loss of life and limb but also disrupts communities and impedes the socio-economic development of affected regions [1]. Cutting-edge technologies and the combination of artificial intelligence (AI) and deep learning (DL) algorithms have made it much easier and more accurate to find landmines [2]. However, detecting landmines in real-time, particularly when securing access to this sensitive data, poses a significant challenge [3].

To address these concerns, a novel blockchain-based concept was proposed for data management bridging blockchain technology as storage and demining records stored as NFT (Non-Fungible Token) [1]. The core focus of their work is to improve the efficiency, accessibility, and safety of humanitarian demining operations. The authors developed a system to identify the landmine using common commercial multispectral and infrared drone-based cameras [4]. In [5], the authors provide vision-based remote sensing imagery datasets obtained from a real landmine field in Croatia that incorporated an autonomous uninhabited aerial vehicle (UAV). In [6], the authors introduce a landmine location-based prediction model, combining military experience with machine-learning techniques and spatiotemporal data. This system introduced a new approach to area selection and added military-based features for context modeling and model training.

However, demining remains a major challenge. Thus, information about potential landmine regions must be spread. Landmine detection research has advanced, but blockchain is seldom used to share such vital data. The use of blockchain technology in carbon credit efforts, which represent one metric ton of averted CO2-equivalent emissions [7], may significantly contribute to sustainable development. Blockchain's transparency, security, and decentralization may improve carbon credit systems' credibility and efficiency as we work to reduce carbon emissions and promote green activities. This integrative strategy fills landmine data gaps and helps with environmental protection.

II. Proposed Methodology

This section presents an innovative architectural framework designed to create a robust incident prevention management system specifically suited for landmine threat scenarios. Central to this framework is Figure 1, providing a clear visual representation of the system's architecture and emphasizing its crucial role in proactively averting events related to landmines. Additionally, this proposed architecture addresses the critical issue of landmine-related incidents and demonstrates its potential to significantly reduce loss of life, safeguard the environment, and contribute to carbon credit initiatives.

The work aims to create an independent system that utilizes UAVs equipped with multispectral and long-wave infrared (LWIR) cameras and deep-learning algorithms to identify landmines. The system will acquire high-resolution images of locations susceptible to landmines, which will be analyzed with convolutional neural networks (CNNs). The model will undergo rigorous training using diverse datasets to enhance its performance and adaptability to various terrains and environmental situations. The process of detecting landmines and storing associated information, including GPS coordinates, will be conducted off-chain to reduce the burden on the main blockchain network. The data will be cryptographically hashed and permanently saved on the Hyperledger Fabric blockchain.

Once populated with hashed data, the blockchain ensures data integrity, transparency, and immutability. A smart contract

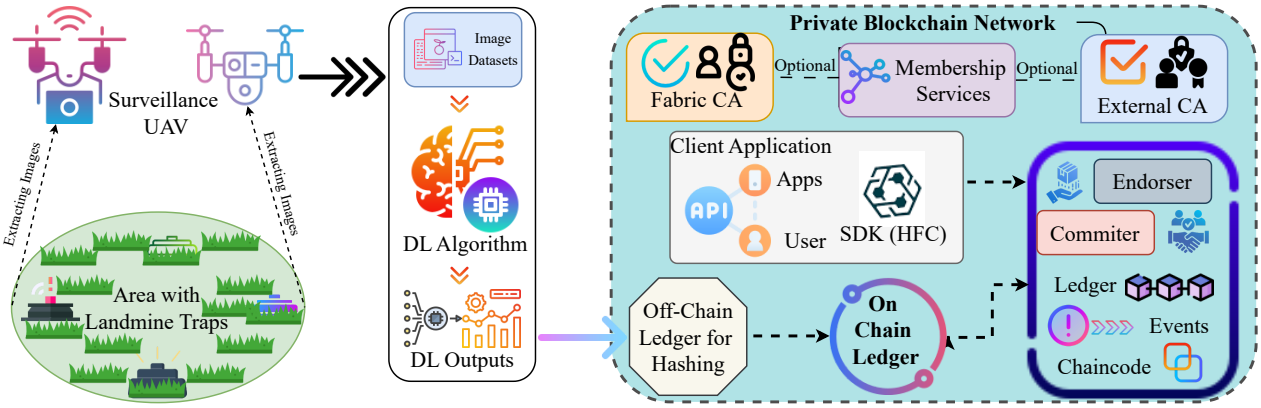

Fig. 1. Architectural design and workflow of the proposed model

is incorporated into the system, triggering automatic broadcasting of landmine detection details to participating nodes, thus facilitating the timely dissemination of crucial information. This ledger becomes instrumental in assessing the system's success through periodic analysis, revealing the number of landmines detected and the areas safeguarded. Such insights contribute to the calculation of potential carbon credits, as the system's efficacy in averting losses aligns with environmental conservation goals.

TABLE I
COMPARATIVE ANALYSIS OF EXISTING SOLUTIONS

Ref.	Approaches		Access control	Carbon Emission optimi.	Smart contract/ NFT
	AI Algorithm	Blockchain			
1	No	Not Specified	Yes	No	Yes
5	Not Specified	No	No	No	No
6	Not Specified	No	No	No	No
7	Machine Learning	No	No	No	No
Proposed Approach	Deep Learning	Private	Yes	Yes	Yes

III. Performance Evaluation

The proposed technique for landmine detection in precision humanitarian demining and carbon credit optimization is being evaluated in relation to comparable approaches discussed in the previous study. The objective of the proposed technique is to build a storage mechanism that is both secure and dependable. Table I illustrates that the focus has been on implementing the proposed concept rather than assessing the performance indicators of the existing framework.

IV. Conclusion and Future Work

This paper presents a comprehensive exploration of landmine detection and the subsequent broadcasting of affected areas, leveraging the capabilities of a private blockchain network to enhance carbon credit optimization. The proposed architectural design integrates computer vision and blockchain technologies, distinguishing itself from existing systems. While a detailed discussion of the entire process, spanning from data collection and pre-processing to the broadcast of warning alerts among network peers, requires substantial attention, this aspect will be thoroughly covered in a forthcoming article. The subsequent publication will delve into the specifics of data collection techniques and extend up to the configuration of the private blockchain network, thereby contributing to the environmental dimensions of carbon credit.

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