EmberEye: A Technical Proposal for an Alert Service to Prevent Wildfires

Nordlys Rakett

Abstract— **In this paper, the NASA Space Apps Challenge team Nordlys Rakett proposes an alert service infrastructure that predicts wildfires using deep learning models and alerts the concerned institutions. The main goal of the proposed service is to make an adaptable service so that the predictions can be sent and spread throughout the whole globe, including developing countries with low access to Internet and other technology resource. Also, the project is proposed to be Open Source so that all scientific community can help improve the prediction results.**

I. INTRODUCTION

Due to climate change and the observed ascending trend of temperatures in our planet, the probability of the start of wildfires in hot and dry biomes steadily on the rise. Consequently, the impact of these natural caused disasters is notably higher, including loss of biodiversity, poor air quality, increased soil erosion, greenhouse gas emissions among many others. Presently, it remains a challenge not solely to forecast the start of wildfires, but also to effectively disseminate such prognostications worldwide, giving each nation and institution an opportunity to prevent such disaster to take place.

Our nowadays challenge is to find an efficient way to forecast fire data with enough anticipation to create alerts and send them anywhere so that the corresponding forces can take action before the disaster occurs.

The proposed solution is an Open Source, low cost infrastructure that benefits of the already existent models and publicly available data to generate fire forecasts alerts and send them to the affected regions. Also, the service's communication protocol is totally flexible, so that any network can be used, making it possible to reach wireless regions and extending the scope of the project.

II. LITERATURE REVIEW

The viability and reliability of our proposal relies on the accuracy and effectiveness of the predictive AI models at its core. After studying the current state in this field, we conclude that there already exists many prediction models that can predict fires not only via NASA's satellite data, but also using sensor-based monitoring and the local historical of a location. Some examples are [1], that collects minimal and maximal temperature, average humidity, solar radiation, average wind speed and cumulative precipitation level (sensor based input data). Implementing a SVM that generates an index risk of fire, the prediction obtained by this algorithm reaches the 96% of accuracy. Following the same approach, but now including historical data in a specific location (India), [2] compares a linear SVM and a parallel SVM model, achieving 94% accuracy and 100% accuracy respectively. Furthermore, another model [3] nourished not only by sensor data but also from satellite data has demonstrated to be able to make accurate predictions ($\tilde{9}2\%$) using a long-term and short-term time series network (LSTNet) model. Lastly, [4] has proved to be able to predict fires with an accuracy of 98.32% using satellite data and in-situ weather stations.

Concerning how to approach a solution to reach developing countries and nations with less Internet infrastructure, telecommunications in Africa have experienced significant growth in the last decade and have become a key driver for economic and social development for the African society. However, they still face considerable challenges that they will improve through significant changes expected on the horizon.

Much remains to be improved, especially regarding digitalization in Africa. Despite some advancements, infrastructure, connectivity, and access to technology continue to lag behind in the region. The expansion of mobile networks and Internet access in urban areas is an important point, but there is still much work to be done. Between 2010 and 2021, the Internet penetration rate in the region only grew from 9.6% to 33% [5], indicating that progress has been slow and significant efforts are required to close the technology gap. However, telephone network services such as SMS, 2G, 3G and 4G can be considered, and even 5G in the future. Let us take as an example Sub-Saharan Africa. Although the percentage of smartphone connections in this region was 49% in 2021, the 82% of the population had access to SIM connections in that same year [6].

This is crucial information, having into account that climate change has severely impacted the African country, especially the Sub-Saharan region. According to official data [7], in 2021, satellites could observe an increase of 80% in the burnt surface in Africa. More precisely, this increase and fires affects Sub-Saharan regions as seen in 1

III. TECHNICAL PROPOSAL

The technical proposal is composed by four key components:

- The publicly available data, acting as an entry for the forecast process.
- The dedicated server launching the fire forecast AI trained model, generating a prediction with the necessary resources to provide an alert with enough anticipation.
- The government agency client of the service, receiving alerts with information that can help them avoid the

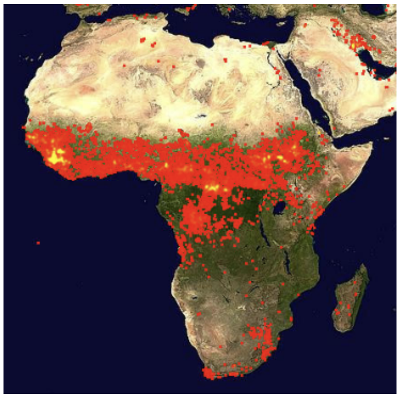

Fig. 1. Global Fire Map (NASA EarthData) [8]

inception of a wildfire
- The civil's client of the service, a web application with a map-view of all the generated fire alerts and the real-time detected fires.

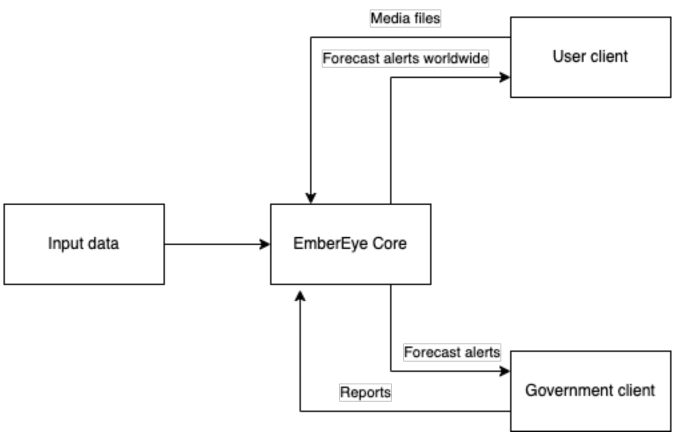

Fig. 2. EmberEye Key Components Scheme

From the telecommunications point of view, the team already knows that this way of communication is viable and already exists in a similar format. The communication model that we propose can be compared to the EGNOS service which, from satellite-based information, is able to predict outages in the SBAS service.

A. Input Data

The fundamental underpinning of our proposed solution lies in the diverse and comprehensive input data component. This element integrates various sources of data to fuel the predictive capabilities of the system. The four primary sources of information are as follows:

1) **Publicly Available Satellite Data**: the system retrieves and normalizes publicly available satellite data to gain crucial insights into environmental conditions. Satellite imagery provides information on temperature fluctuations, vegetation health, terrain characteristics and fire data. With this information, it is possible to identify potential hot spots and conditions conducive to wildfire ignition.
2) **Open Source Community Contributions**: An integral facet of this proposal is its commitment to collaboration and knowledge sharing. To enhance the precision of our AI predictive models, we incorporate an Open Source Database. This repository allows communities, researchers and concerned individuals to contribute relevant data, thus enriching the system's ability to assess risk factors. By fostering open data sharing, EmberEye ensures that the collective expertise of global stakeholders is collected for this common and global goal.
3) **Government Reports**: The third source of the data is the receipt of official reports from government agencies. These reports provide authoritative and up-to-date information on wildfires that have recently occurred. They provide vital details such as the cause of the fire, primary ignition points, environmental impact assessments, and more.
4) **Civilian User Inputs**: Finally, the project takes into account the voluntary engagement of civilians with internet access in wildfire detection and prevention. To facilitate this, the system is opened to receive multimedia files from any user. These submissions are meticulously analyzed and filtered to extract valid and valuable insights. Such contributions empower the predictive model to gather additional information about potential wildfire incidents, including location, smoke patterns, and possible ignition sources.

B. EmberEye Core

At the core of the project lies the "EmberEye Core", a powerful AI engine trained to harness the vast wealth of input data. This AI model serves as the predictive model that fuels our system's capacity to anticipate wildfire events with precision and relevance. The EmberEye Core is designed to generate actionable insights for wildfire prevention, benefiting both civilian users and governmental agencies. Essentially, this component fusions and analysis all its data sources, nourishes the AI model with the result of the analysis, generates alerts and disseminates them. Despite being executed in a dedicated server with the required resources to give a satisfying performance, the model used is proposed to be Open Source, so that anyone from any field can propose innovative and improving changes to the code. Then, instead of letting reviewers accept improving pull requests, Nardlys Rakett proposes to do an annual contest. In this contest, a predictive model will be selected from among the community contestants, encouraging researches and scientists to propose new models to innovate and make part of this project.

C. Government's client of the service

In the proposed infrastructure, the Government's client of the server is fundamental in the dissemination of alerts in any region. This part of the system addresses the dynamic and diverse needs of governmental bodies tasked with responding to wildfires. On one hand, this project is designed to provide governmental clients with the flexibility to customize their alert preferences and mobilize response teams according to their unique requirements, without imposing rigid protocols. On the other hand, one of the system's distinctive features is the ability to customize alert management based on regional or organizational boundaries. Governmental clients can specify the geographical regions for which they wish to receive wildfire alerts. This flexibility empowers governments to efficiently allocate resources and respond promptly to wildfire threats in specific areas, whether urban, rural or remote. This allows, for example, that a Sub-Sahara government, having one or more computers with Internet Access, receive the alerts via REST API whilst informing the response teams via SMS, a technology that could be used in that concrete region. Also, the service encourages active participation from these clients by allowing them to contribute to the system's knowledge base. Governmental agencies have the capability to report on confirmed wildfire incidents within their justifications. These reports provide authoritative and verifiable data that enriches the Input Data component. The information includes critical details such as the cause of the fire, the main ignition points, environmental impact assessments, and resources deployed. By fostering this collaborative reporting mechanism, EmberEye continuously enhances its predictive accuracy and ensures that its alerts are based on real-world observations. Above all, this proposal places the power of response in the hands of governmental clients. The system does not dictate any approach but rather empowers governments to mobilize the relevant agencies and services according to their established protocols. This adaptability ensures that responses are aligned with the specific needs and resources of each region. From firefighting teams and law enforcement to emergency services and, if necessary, military units, EmberEye serves as a tool for coordinated and agile wildfire response. By accommodating diverse communication methods, customized alert settings and user-initiated reporting, the project ensures that even the most disadvantaged communities have access to critical wildfire information and that governments can respond effectively to protect lives, property and the environment.

D. *User's client of the service*

Drawing from the same data sources as the governmental client, the User application displays all the notifications generated by EmberEye Core in a map, with both prediction and real-time information. Specifically, the application is proposed to be web-based and mobile-based. Each wildfire event or potential hot spot is marked with precise location indicators, ensuring that users are well-informed about the proximity and status of nearby fires. Additionally, as mentioned previously, users of the application are encouraged to actively participate in the wildfire detection and reporting. The User application allows individuals to voluntarily capture and submit photographs and videos of ongong or extinguished fires. These multimedia submissions are meticulously analyzed by EmberEye Core, providing additional insights into the scope and intensity of wildfire events. Incorporating the User Application into the project enhances situational awareness among civilian populations. Users gain a real-time understanding of wildfire dynamics, enabling them to adapt to evolving conditions. This heightened awareness contributes to safer evacuation plans, resource allocation and community resilience in the event of a wildfire incident.

IV. CONCLUSIONS

Analysis, prevention and action, that is how our powerful and accessible open-source tool for fire prevention worldwide through real-time satellite information works. Supported by artificial intelligence models that predicts wildfires and enhances the accuracy of historical data, allowing for better planning in preventive measures and greater precision in anticipating areas at risk.

Furthermore, our tool provides a comprehensive communication system capable of interconnecting stakeholders (population, institutions, authorities...) to obtain an informed, precise and effective response with the sole and clear goal of preserving the environment.

REFERENCES

[1] George Emil Sakr, Imad H. Elhajj, Geroge Mitri, Uche Wejinya, "Artifial intelligence for forest fire prediction", July 2010.
[2] Kajol R Singh, K.P. Neethu, K Madhurekaa, A Harita, Pushpa Mohan, "Parallel SVM model for forest fire prediction", 10 August 2021.
[3] Xufeng Lin, Zhongyuan Li, Wenking Chen, Xueying Sun and Demin Gao, "Forest Fire Prediction Based on Long and Short-Term Time-Series Network", 10 April 2023.
[4] Younes Oulad Sayad, Hajar Mousannif, Hassan Al Moatassime, "Predictive modeling of wildfires: A new dataset and machine learning approach".
[5] Dipo, "Status of internet access and connectivity in Africa", 2022.
[6] GSMA, "The Mobile Economy Sub-Saharan Africa", 2022.
[7] Ismael Muñoz Linares, "La superfície quemada en África es un 80% mayor de lo que se estimaba", 26 March 2021.
[8] Climate Signals, "Global Fire Map", 2022