AIDERS

Deliverable 5.2 Technical report on algorithms' integration

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Executive Summary

The AIDERS project primarily aims to develop application-specific data analytics algorithms to harness the large volume of measurements that first responders can now collect through heterogeneous sensors (including visual, thermal and multispectral cameras, etc.). This deliverable focuses on the integration and testing of the various implemented algorithms devising the AI toolkit. The integrated algorithms enable the end-user to control multiple RPAS units through the platform easily. The collected data can be processed in the background by the AI toolkit algorithms and generate critical and timely information to the first responders.

1 Introduction

The integration of the implemented algorithms is a critical step to deliver an intuitive and solid AI toolkit that will enhance the use of RPAS by the first responder(s). The AI toolkit is responsible for processing and analyzing multi-source emergency response data and then using efficient information representation techniques and visualization tools to build an online knowledge map that delivers real-time situational awareness, to first responders that operate in the field. Moreover, the AI toolkit will enable data fusion from many heterogeneous sources, thus effectively combining information from several sensors such as visual and thermal cameras and LIDAR ranging with CBRN sensory.

Through the above functionality, the AI toolkit offers novel tools to collect and analyze emergency response data that enables incident commanders to extract knowledge about the operational conditions in the field, thus assisting them in designing evidence-based response strategies. Finally, the solutions delivered for advanced ground control data analytics and visualization can facilitate and expedite disaster response.

The integration of algorithms into an AI toolkit generates significant value to the emergency response agencies in the following departments:

- it increases human resource efficiency since AI toolkit will automate a substantial amount of manual work done for obtaining evidence-based situational awareness,
- it expands the scalability in the capacity of the RPAS unit capabilities through the support of additional sensory information,
- it improves RPAS team capabilities in communicating information, and
- it allows higher utilization of resource constraint RPAS units.

Overall, the novel AI toolkit designed and developed through the AIDERS project aims to enable first responders to achieve quick situational awareness and improve their decision-making. In this deliverable, we provide details on the integration of various implemented algorithms into an AI toolkit for emergency response situations. Section 2 describes the AI toolkit platform architecture and the various technologies used. Section 3 provides details on the implemented algorithms integration into AI toolkits and presents testing results. Finally, Section 4 concludes the deliverable.

2 AI Toolkit Platform Architecture

The AI toolkit platform is one of the main outcomes of the AIDERS project. To ensure transferability of the AI toolkit, a robust platform architecture has been designed. Specifically, the platform is composed of two parts:

- The client is a cross-platform, Electron-based application. It can be built for Windows, Mac OS X, and Linux operating systems, and with a few modifications, can be ported for web browsers. As such, end-users will be able to use it on a wide range of devices.
- The back-end stores and records all the data generated by RPAS units in operation and process them through machine-learning and/or image processing algorithms.

The back-end itself is composed of three parts:

- Greycat is the database used for geo-temporal data storage and machine-learning processing;
- MinIO is an object-oriented database used for storing other large or binary data, mainly media data: video, pictures recorded from UAVs. The data objects can then be retrieved by application instances or Greycat;
- An API powered by an ExpressJS server which is a RESTful interface for both Greycat and MinIO databases. It's the endpoint through which RPAS will upload their online-generated data and the application instances will query.

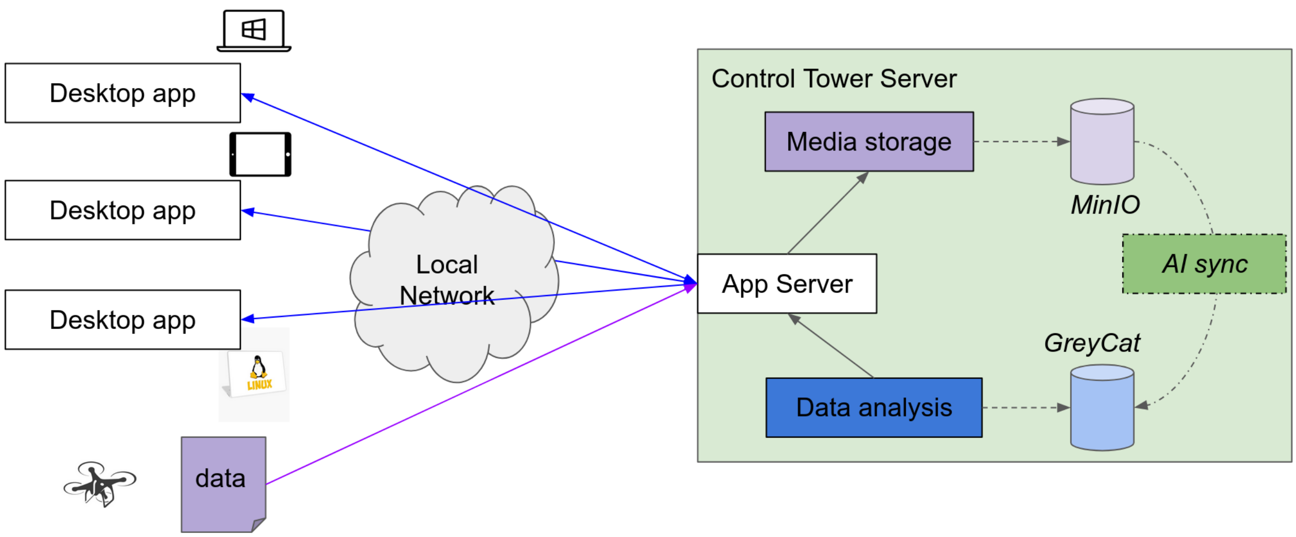

Figure 1: Platform Architecture overview.

This architecture, shown in Figure 1, allows several deployment configurations. The servers can be hosted locally on the same machine that the application is running, which is useful in restricted environments with limited Internet access. They can also be hosted on a local/remote server or in the cloud and benefit from better infrastructure.

This setup can be currently deployed only on Linux systems as Greycat doesn't run on other operating systems yet. Hence, we choose to deliver and deploy the different servers as containers using Docker compose.

Depending on the type of AI algorithms, they may either be run on the Greycat database directly, which can speed up data processing using optimized primitives for ML algorithms and faster data accesses, or run on the server with any other application. As an example, a Python implementation using OpenCV, working on the data from the Greycat database.

3 AI Toolkit Algorithms Integration and Testing

3.1. Basemap GIS layers integration

The algorithms for processing the basemap data that have been implemented to visualize various GIS layers and provide quickly various information have been integrated into the platform and tested in several scenarios to guarantee their appropriate operation. Figure 2 shows the basemap visualization algorith that selectively can highlight different GIS layers (e.g., roads, buildings, etc.) using the platform menu. Figure 3 shows the algorithm testing that, given an area radius, can calculate the number of infrastructures and find the highest elevation point. Finally, tools for measuring the area size on demand have been integrated and tested as shown in, Figure 4.

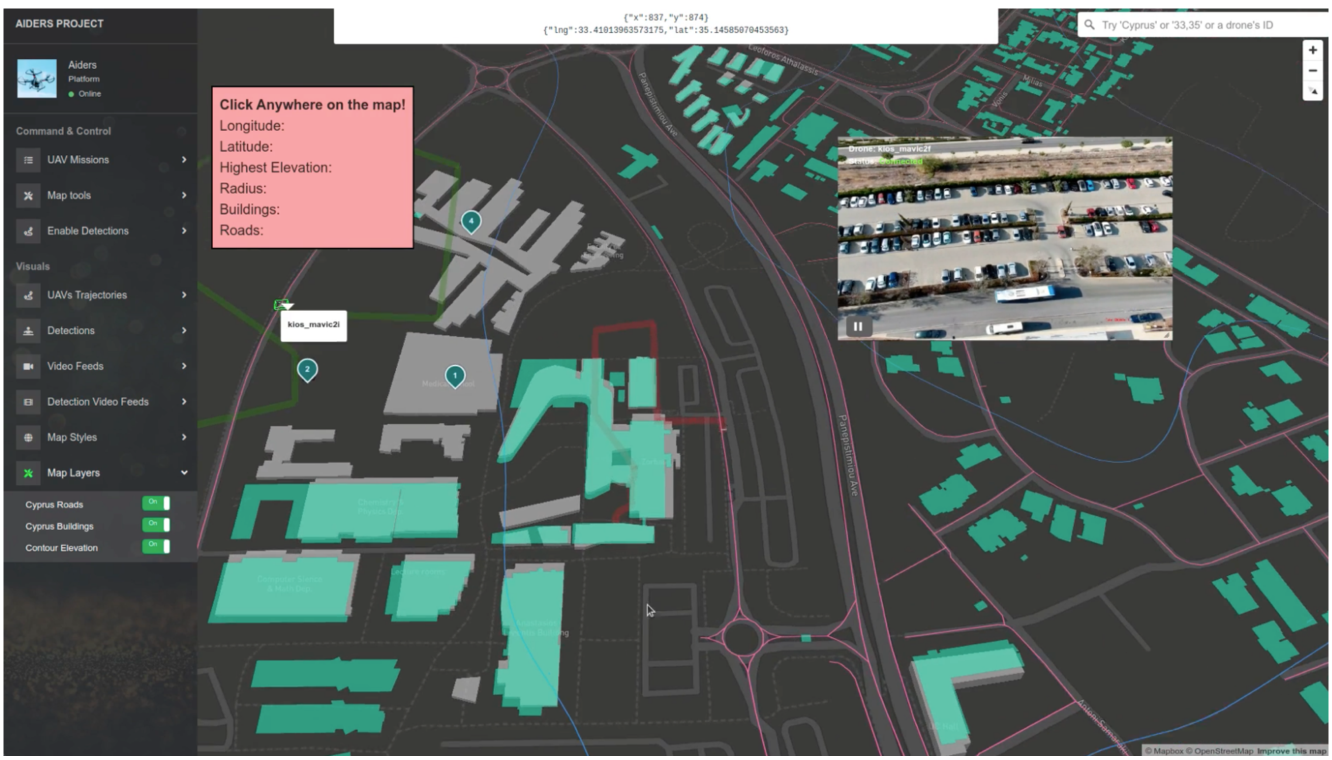

Figure 2: GIS layer visualization algorithm testing.

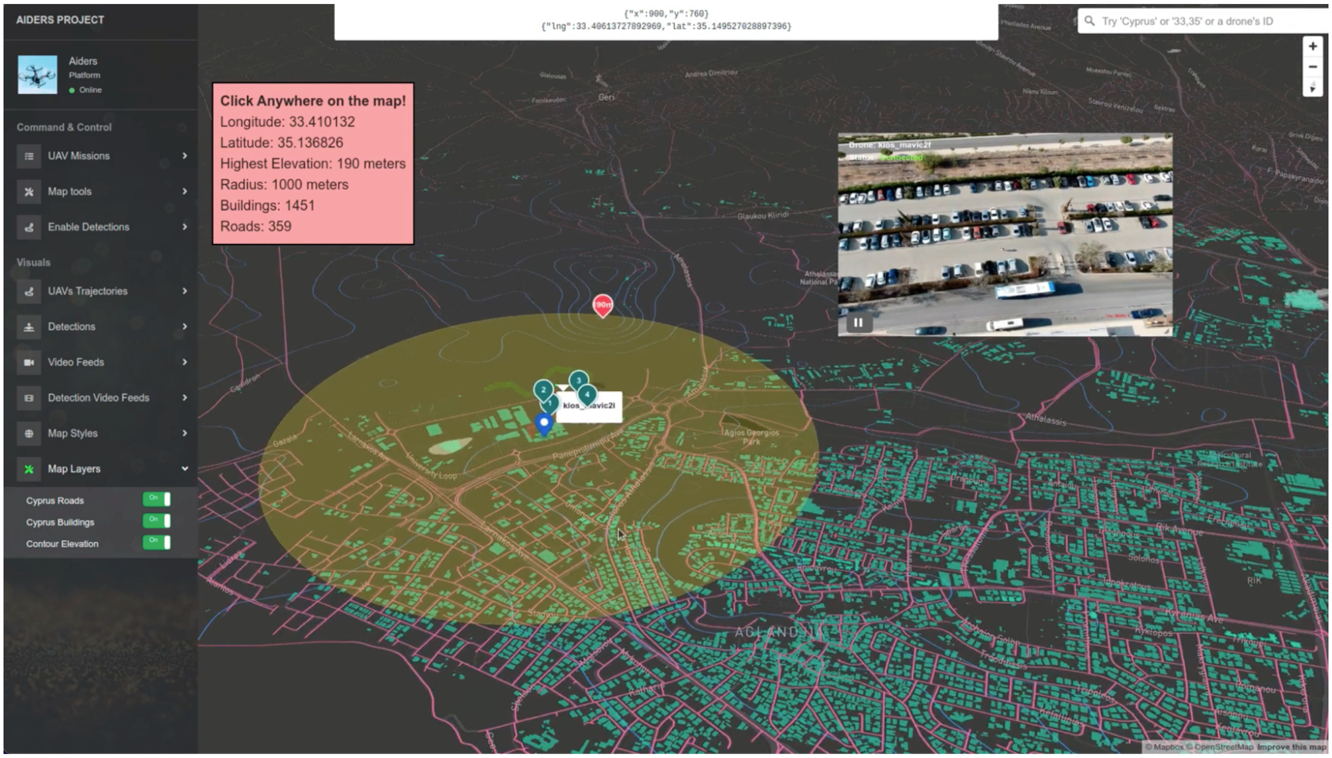

Figure 3: Algorithm for infrastructure identification in a selected radius.

Figure 4: Area measurement tools integration.

3.2. Real-time object detection

The implemented computer vision and machine learning (ML) algorithms have been integrated into the platform to identify objects of interest in real-time using images and video captured by multiple RPAS units. The integrated object detection algorithms have been tested in various toy scenarios. Figure 5 shows the results of real-time object detection from data captured by RPAS cameras. Furthermore, Figure 6 shows the real-time mapping and labeling of the detected objects in the basemap, providing spatial situational awareness to the end-user.

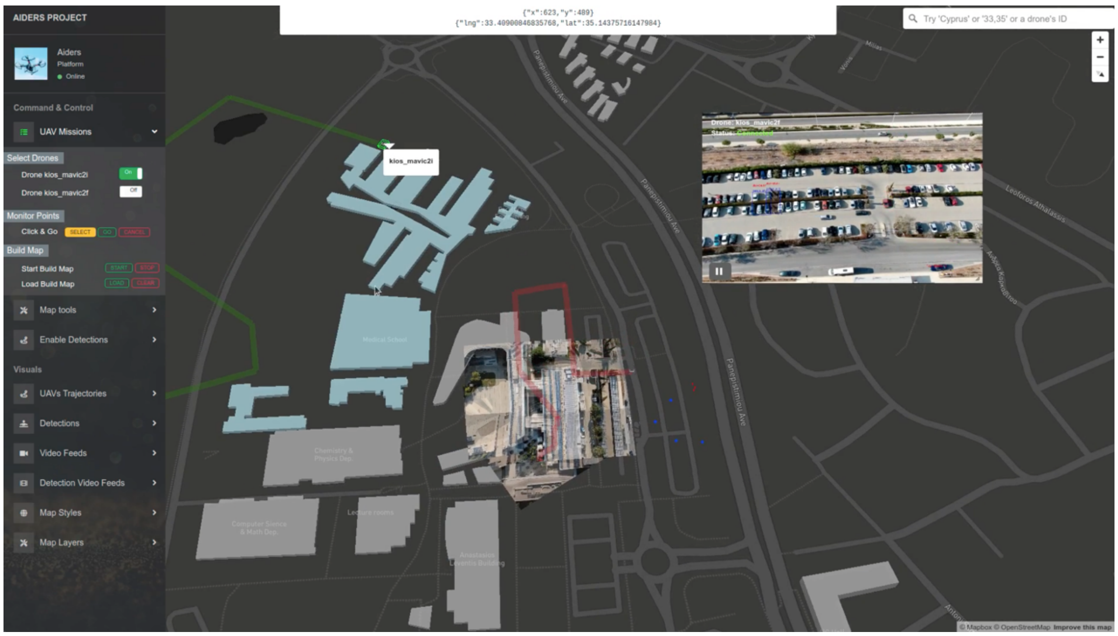

Figure 5: Real time object detection testing using video captured by RPAS units.

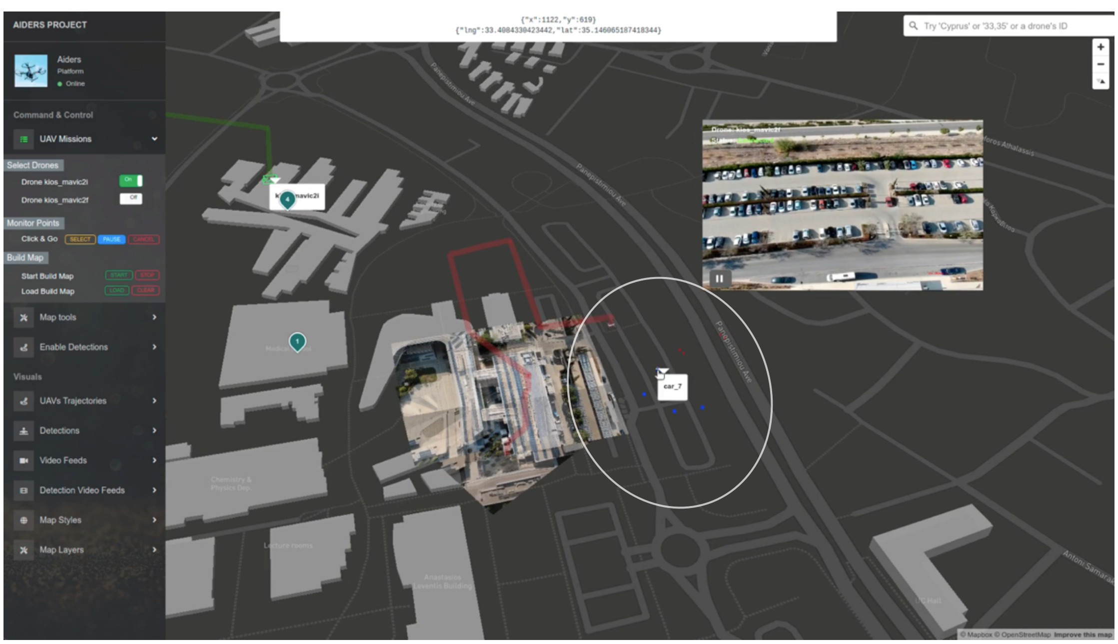

Figure 6: Real-time mapping and labelling of detected object.

3.3. Path-planning for data collection

The implemented RPAS path-planning algorithms have been integrated into the platform and extensively tested. Figure 7 shows the result of a testing scenario. The user, through the platform, can effortlessly pinpoint the locations that multiple RPAS units need to visit. Then the mission can start, and the collected data are shown in real-time to the basemap.

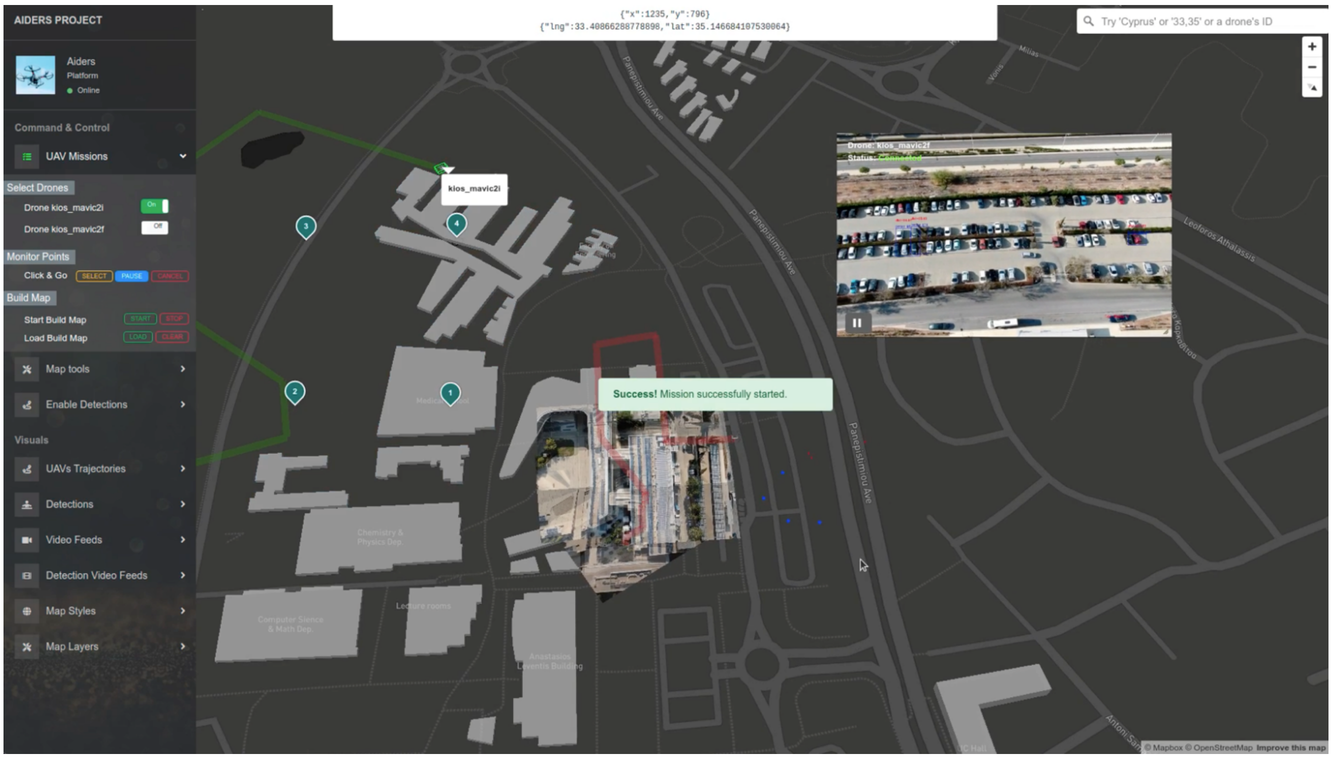

Figure 7: Path planning commands are sent to RPAS units through the platform for data collection missions.

3.4. Fire analysis algorithms integration

Several algorithms that have been implemented to address the fire response scenario have been integrated into the platform. Specifically, the algorithms for burned area mapping have been integrated and tested, as shown in Figure 8. The user utilizing the platform can easily guide RPAS units with multispectral sensors into the burned area and collect data. Then the algorithms for multispectral processing, classification, and clustering can map the burned area (e.g., generate polygons) in real-time and derive information for the burned area size, affected infrastructures, etc. Also, the algorithms for predicting and visualizing the fire spread have been integrated into the platform as well. Figure 9 shows the necessary user input, while

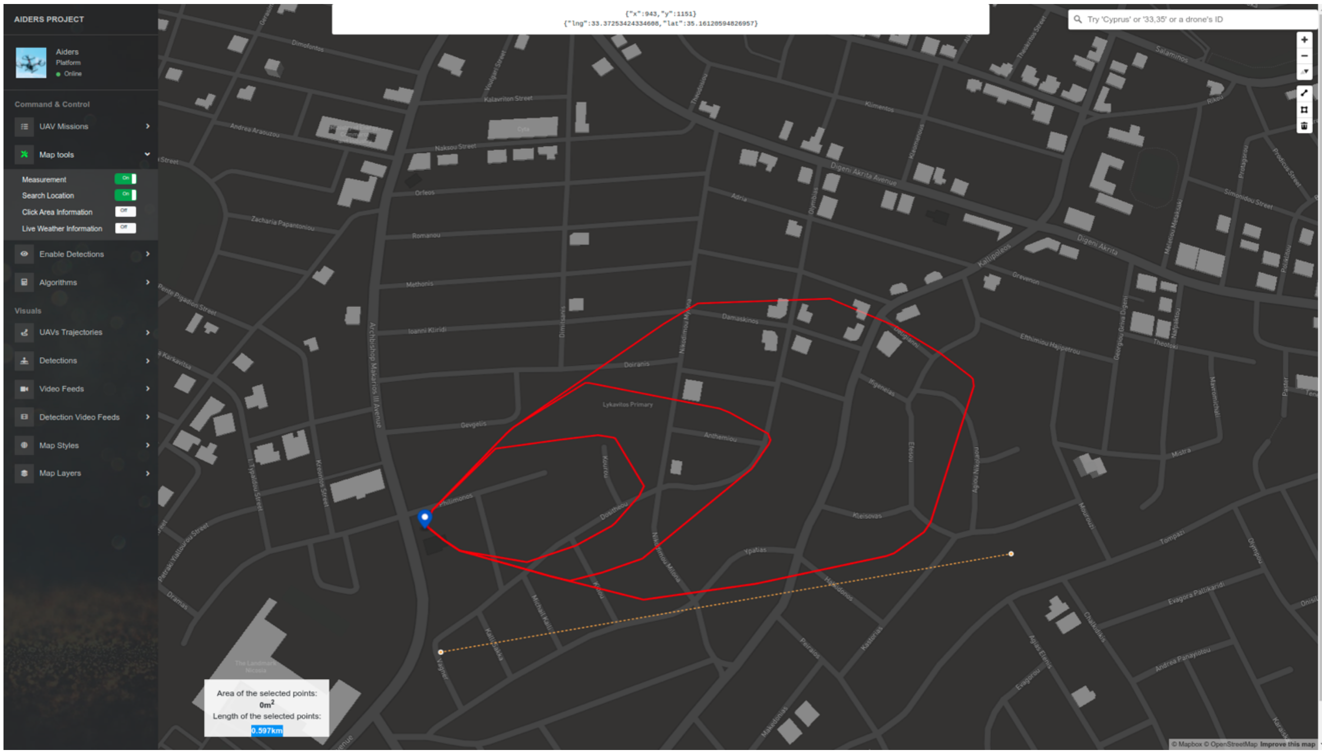

Figure 10 shows the visualization of the fire spread through the platform.

Figure 8: Burned area mapping.

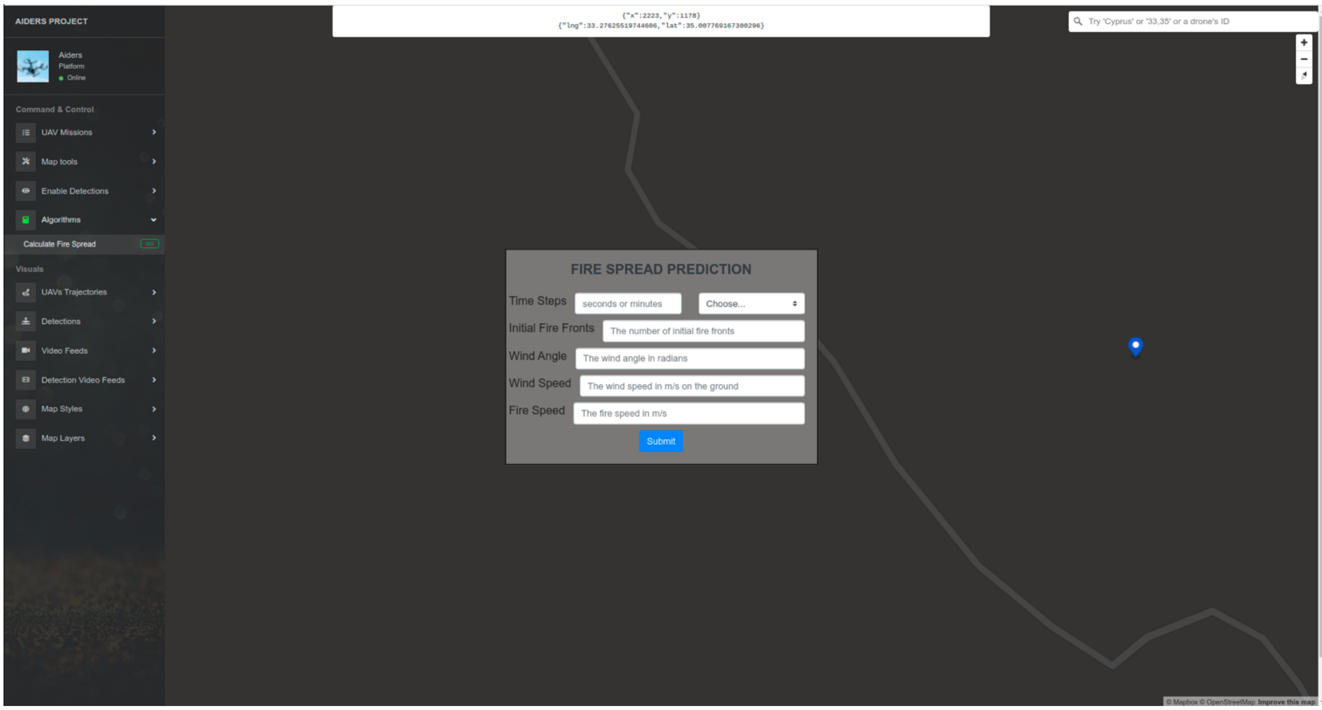

Figure 9: User input for fire spread prediction.

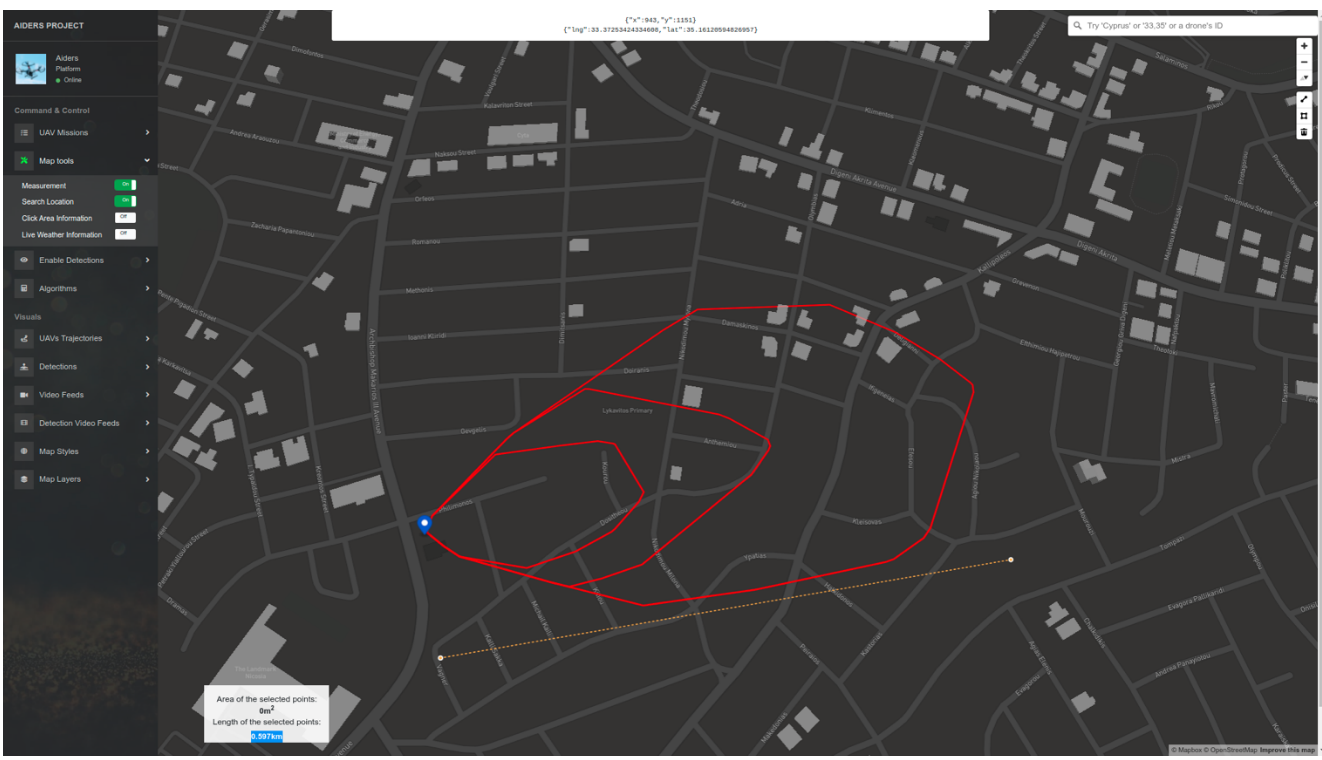

Figure 10: Fire spread prediction visualization through the platform.

4 Conclusion

In this deliverable, we provide details on integrating various implemented algorithms into an AI toolkit for emergency response situations. Initially, the AI toolkit platform architecture and the various technologies employed, such as Greycat and MinIO, are presented. Then we described the integration of implemented algorithms for basemap visualization and processing, real-time object detection, path-planning and data collection, and fire analysis into the AI toolkit. Moreover, we presented results from several tests that helped us improve the AI toolkit and ensure its correct operation.