

Multi-robot AI based Explosive Detection

Demonstration



Grant Agreement PADR-FDDT-EMERGING-03-2019 884866 - AIDED,



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I. Objectives

AIDED Background

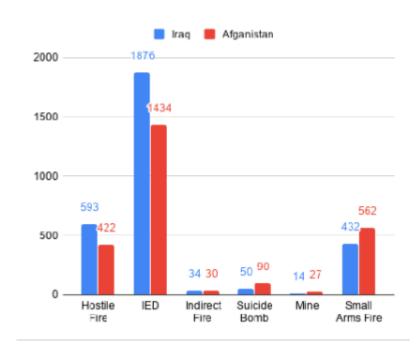
In modern warfare operations, consistently **50% of all soldier deaths** in action are directly related to **IED**s (Improvised **E**xplosive **D**evice).

- Afghanistan 2872 NATO troops were killed in action in total. 1434 of those were killed by IEDs.
- In Iraq, 3801 soldiers were killed in action and 1876 of those were killed by IEDs.

The AIDED Project 2021-2023

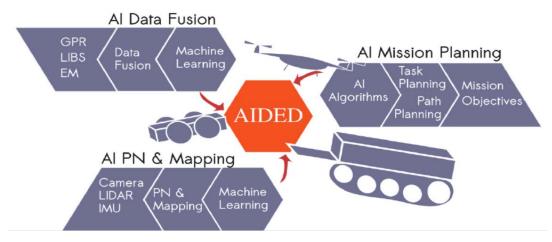


source: icasualties.org

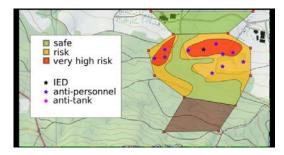


I. Objectives

- Al-enabled heterogeneous robotic fleet
- Advanced ML based IED/UxO detection
- Automated mission planning capabilities
- Sent out in advance to detect and classify IED/UxOs in the terrain
- Keeping the human soldiers out of harm's way
- Humanitarian applications demining



origin minefield destination



Technical Objective

l. Objectives

Robots & Sensors







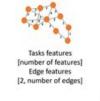


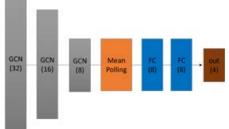
II. Why AI-ML for demining ?

II. Why AI-Machine Learning for C-IED and demining?



Adaptative to non-conventional IED's







Sensor fusion $\rightarrow \begin{cases} \text{Increased detection probability} \\ \text{Reduced false positive rate} \end{cases}$



Automated **multi-agent** tasks & path planning - coordination & cooperation

Robustness in localization & mapping in case of jamming and loss of communications



Optimal use of available resources

II. Cooperative Intelligence among Robots



Multi-agent systems are :

- Share mission objectives
- More efficient area coverage
- Cooperative behaviour
- Optimize the capacities of each agent

Added value to AIDED

- Decrease the time of area coverage
- Reduce the false detection by sensor fusion
- Challenge the state of art for localisation and mapping

II. Locations for data gathering & testing

Integration





III. Demonstration Outcomes

III. State of play

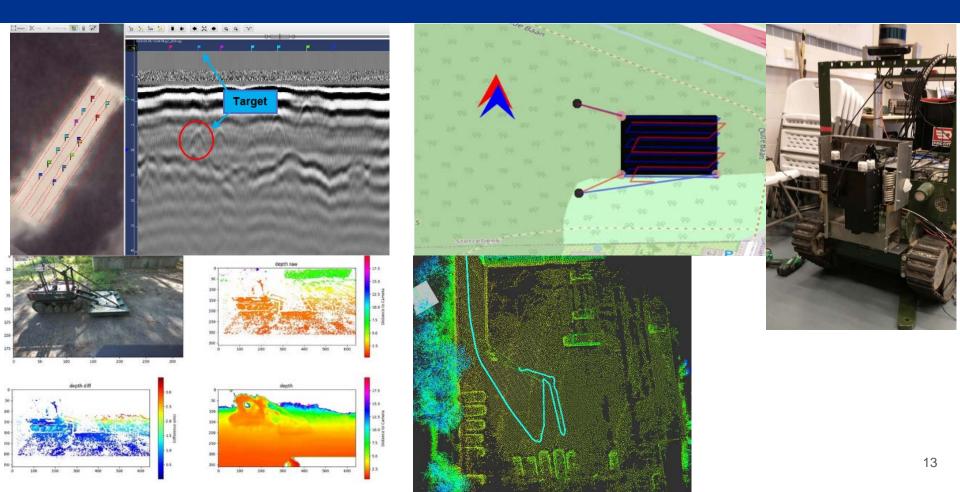
DOVO Collaboration

DOVO:

- Provide **test fields** and facilities to collect data to **train AI** and **test** the **robots**
- Develop **mock-up** EOD's / IED's
- Fabricated by **experts**
- Chemicals Extremely low concentrations of TNT or TATP (to be confirmed)
- Soil conditions where the measurement is taken (humid, dry, clay, sandy, hot, cold)



III. Results (Unclassified)



III. State of play

Outcomes of the project

Achievements

- Sensor integration on the robots
- Large labelled data sets acquired
- Navigation tests conducted with mission planning
- ROS Architecture implemented on the different robots
- Control centre and communications
- Deployed and test trained Neural Networks for detection
- Multi-agent planning
- Cooperative Navigation
- Trial campaign realized with DOVO



IV.Conclusion

IV. Conclusion

Objectives Review:

- AI-ML can generalize detection methods for sensors, terrains and data fusion
- Multi-robot system to clear area faster and more effective
- Application of AI to demining field of study
- Al based:
 - IED detection by sensor fusion
 - Navigation
 - Multi Robot Mission Planning



Challenges

- Data labelling complex and time consuming
- Classical technique was robust to external noise than trained NN (Ex. GPR on drone)
- Featureless terrain (Grass) classical navigation worked slightly better
- AI-ML does not solve everything!

IV. AIDEDex Follow up – EDF Challenge







*Lightnovo

Fraunhofer

• Project Duration: 48M

- Budget: ~5M Eur
- Partners: 6
- Start date: 12/2023
- Funding Scheme: Lump Sum EDF HTDP 03-2022
- Inspired from DARPA challenges



Competition Organised in Sweden

• HitDOC

Competition with projects:

- CONVOY
- DeterMine
- TICHE





Thank you



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https://aidedpadr.eu/

The Project

The AIDED project will develop Artificial Intelligence (AI) tools for the detection of explosive devices. AIDED will use a set of state of the art Artificial Intelligence algorithms able to identify unconventional (IEDs) and conventional (buried mines) explosive devices, and autonomously plan offline and run-time missions plans.

Al-Machine Learning techniques such as deep learning will be designed & trained using simulated & outdoor data sets for the detection of Explosive Ordnance using heterogeneous sensor data. AIDED will also develop an Albased Centralized & decentralized mission planning system to coordinate a swarm of small and medium heterogeneous robots (land and aerial) that are

Project videos

