DEFRA
DEFENCE-RELATED RESEARCH ACTION

DEFENSIE
LA DÉFENSE

Defence-related Research Action - DEFRA

ACRONYM: GUIDED

Title: Goggles-based User Interface for Detection of Explosive Devices

Duration of the project: 1/12/2024 - 01/03/2028

Budget: 1.947.036 €

of which RHID contribution: 1.799.556 €

Key words: Explosive Ordnance Disposal, robotics, 3D reconstruction, 3D visualization, SLAM, Neural networks

PROJECT DESCRIPTION

In the field of Explosive Ordnance Disposal (EOD), (demining) robots are used to safely dismantle suspicious objects. These robots are navigated remotely (either wirelessly or wired) by a human operator who controls the robot actuators based on a 2D video stream from a camera on the robot. DOVO operators currently struggle with the non-intuitive user interface of such systems, which lacks situational awareness. The operation process is difficult and therefore requires continuous training for experts.

In this project we aim to assist EOD operators by creating an augmented 3D reconstruction of the scene, providing useful context and 3D awareness during robot operation. The aim is to create a TRL5 multi-spectral sensor demonstrator that can be mounted on a DOVO EOD robot. We will develop advanced image processing software that can provide a real-time 3D overview of the scene. This will allow the operator to more easily control the robot from a third-person or bird's-eye view (BEV), rather than relying on a single 2D camera view. By presenting an overview of the surrounding scene in head-mounted displays or VR goggles, the operator can more easily take in all the information and operate the robot in a more intuitive way. Information from multispectral cameras can provide the operator with interesting indicators that could be critical to the successful disposal of improvised explosive devices (IEDs). One of the challenges is that an operator can only monitor a limited number of spectra at the same time. Switching between different views can consume valuable time during operations and distract the operator, with potentially serious consequences. To reduce the associated cognitive load on the operator, we will use AI to locate regions in specific spectra that contain useful information that is not obvious from the visible spectrum. Within the VR interface, a user-friendly interface will combine the information from the predicted regions of interest and present it visually when the operator's attention is required.

In view of the above, the general objectives of this project are threefold: (1) Improve situational awareness for operators and commanders through multi-sensor, vision-based 3D reconstruction. (2) Detect salient regions in the multispectral spectrum to improve detection and identification of hidden threats using state-of-the-art AI techniques. (3) Reduce the cognitive load on EOD operators and enable faster, more informed decision-making through intelligent visualisation.

Our research strategy is agile and fully end-user driven: we will start by defining the DOVO requirements and operational validation scenarios. The implementation will start with off-the-shelf hardware and proceed to the integration of the various sensors and processing devices into the existing used EOD robots. We will then complement this by developing the software tools and technologies needed to create augmented 3D awareness. Throughout the project we will maintain constant communication with the end users, using an iterative development methodology and holding regular interim design review meetings. The technologies include: (1) Advanced multimodal SLAM for accurate localisation of the robot in challenging environments; (2) State-of-the-art real-time NeRFs for photorealistic scene visualisation, enabling the creation of virtual 3rd person views beyond the reach of the robot's sensors; (3) Image-based Salient region prediction in different spectral bands to identify regions of interest to the operator; (4) Intelligent Virtual Reality to reduce the cognitive load on the operator.

By embracing these technologies, the field of EOD has the potential to significantly advance since they enhance the user-friendliness and safety in the interaction between robots and operators and reduce the cognitive load of the operators. By relying heavily on feedback from experts at DOVO, we aim to maximise the impact and usability of the research results for potential end-users within the Belgian Defence. By providing a TRL5 demonstrator, we will introduce state-of-the-art innovations and new technologies within the reach of the Defence, while demonstrating real process improvements in a military context.

The results of the project will be published in targeted conferences and journals in the relevant field of robotics, machine vision and artificial intelligence. The results will also be exploited by the industrial partner, as it aligns closely with their current activities in Visual SLAM systems for mobile robots and sensor visualisation software for operators of robotic applications.

CONTACT INFORMATION

Coordinator
Marc Proesmans
Trace vzw
marc.proesmans@trace.vision

Partners
Dominick Vanthienen
Intermodalics BV
dominick.vanthienen@intermodalics.eu

Geert De Cubber
Royal Military Academy
geert.de.cubber@mil.be

LINK(S)