

Intelligent camera automatically detects roadside bombs

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Credit: Eindhoven University of Technology

Roadside bombs are sneaky and effective killers. They are easy to manufacture and hide, making it the weapon of choice for insurgents and terrorists across the world. Finding and disabling these lethal devices is very difficult. Electrical engineer Dennis van de Wouw of Eindhoven University of Technology (TU/e) has, in close collaboration with industry and experts of the Netherlands Ministry of Defence, developed a real-time early-warning system. When mounted on a military vehicle, it can automatically detect the presence of those bombs by registering suspicious changes in the environment. He will defend his PHD thesis on December 11th at TU/e.

Roadside bombs, or so-called Improvised Explosive Devices (IED), are a serious threat to both troops and civilians in conflict zones. They are easily fabricated using common house-hold items, and, with instructions widely available online, their construction no longer requires [military training](#). Due to their high impact (over 66% of coalition casualties in the war in Afghanistan are a result of IEDs), ease of construction and relative undetectability, they have become the favorite weapon for insurgents and terrorists in conflict zones across the world.

In order to reduce casualties during military transports, frequent surveillance of the high-risk routes is required. One effective method of surveillance is ground-based patrols, who localize potential threats by searching for suspicious patterns in the environment. This is a very demanding task, because humans have difficulties with concentrating on a task for a longer time in an unknown environment. Therefore, an urgent need emerges for a system that can assist military personnel in finding potential threats during driving.

Any size, shape or color

Dennis van de Wouw and his project partners developed a [real-time early-warning system](#) for IEDs that is mounted on a vehicle. This system

is able to automatically detect unknown objects and suspicious changes in the environment. Automated detection of such unknown objects is very difficult using conventional detection techniques, as it is simply not known what the IED looks like. It could have any size, shape and color.

Instead, they started from the assumption that placing an IED causes subtle changes to the environment, such as digging tracks or newly appeared objects, like triggers used by insurgents or terrorists to detonate the IED. Therefore, Van de Wouw equipped a military vehicle with an intelligent video system that is able to automatically find suspicious changes in the environment while driving. This system consists of a [stereo camera](#) (a camera with two lenses that generates 3-D-images), a GPS positioning system and an image analysis platform.

The system automatically records the environment and compares it to images recorded previously, for instance during an earlier clearance operation (see example above). All changes are then analyzed by the system. Only those changes that indicate the possible presence of an IED are presented to the military operator through an interactive Graphical User Interface. "This enables a military operator to take appropriate actions, such as stopping in time for further inspection of the potential threat, or to avoid it altogether," says Van de Wouw.

Challenge

His main challenge was designing a system that was able to compare accurately historical and live images of the environment. This is not trivial: the viewpoint of the recordings may differ, as well as the weather conditions and time of day, creating confusing changes in perspective and lighting. Using stereo cameras, advanced 3-D modelling and automated image analysis, Van de Wouw was able to create a robust system that is able to successfully detect suspicious changes in the environment. Moreover, he conducted first exploratory experiments with

Artificial Intelligence, which show promising detection capabilities even under severe lighting conditions.

The developed system has been successfully demonstrated to the Dutch Ministry of Defense, showing its detection capabilities on a military terrain. There, it was able to detect all 'unknown' test objects and changes with at least medium contrast. The Ministry is therefore very happy with the work of Van de Wouw and his partners, especially with the speed at which the new system processes the warning signals.

"The threat warning has to come in time, so that the [military vehicle](#) can stop at a safe distance from the roadside bomb. This puts a great strain on the time-management for the parallel processing. So far all the results look very promising," says Silvester de Bruin, innovation advisor at the Ministry.

According to Van de Wouw, the new early-warning system is one of the few functional change detection systems for countering IEDs, capable of finding small suspicious changes in the [environment](#) in real time. He is now working for ViNotion, a spin-off of the Video Coding and Architectures research group at TU/e, where he is further developing this technology in close collaboration with the Ministry of Defence.

More information: Change detection system design using stereo vision for countering Improvised Explosive Device.

pure.tue.nl/ws/portalfiles/portal/57/20191211_Wouw.pdf

Provided by Eindhoven University of Technology

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