Real-time Video Alignment and Change Detection For Vehicle Mounted IED Early Warning System

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Abstract.

Improvised Explosive Devices (IED) became one of the main threats of the military troops in operation. Designed to cause death or injury by using explosives alone or in combination with other materials, they become more difficult to detect. The use scenarios of IED are extremely varied. They are typically buried in the middle of the road or hidden on the side of the road [1].

In this context, the European Defence Agency (EDA) has just lunched a research and technology programme to improve IED detection in “Route Clearance Operations”. This research programme consists of the development of three multi-sensor technology demonstrators. Each demonstrators will focus on a specific phase in IED detection and route clearance: Detection of IED indicators for Early Warning, Stand-off detection of IED components and Confirmation and Identification.

The work we present is one of a part of the first demonstrator project " Detection of IED indicators for Early Warning ", where the purpose is to detect the IEDs or the indicators of IED at a certain distance from an UGV (Unnamed Ground Vehicle) equipped with a multi-sensor system (Visible optical camera, LWIR and SWIR camera). The images of the cameras are compared to historical images that were recorded during an earlier drive at the same location. By looking for suspicious changes between the live and reference images, possible threats from IED can be detected.

Thus, this work is to develop a method allowing real-time detection of changes [2] in two video sequences recorded at separate times. However, one of the main task in this change detection algorithm is the two video sequences alignment step. It consist to temporally and spatially align the frames such that change detection can be performed on the aligned images [3]. The output of this process is a new two video sequences in which the frames consist of a pair of registered images.

The algorithm is divided in two parts: The video frames synchronization (temporally matched) and the fine registration step (spatially aligned). The synchronization part is done by measuring the amount of similarity between the I_{obs} frame in the observed video sequence and some frame candidates [I_{r0},I_{r1},...] in the reference sequence. The reference frame with the highest score corresponds to the best match with the observed frame. Giving these two closest frames, the last step is the fine registration (spatially) process in order to obtain good alignment needed by the change detection algorithm.

The use of CUDA parallel architecture help to achieve speedup for the algorithm and thus to realize the real-time video alignment and change detection. The environment of development was the Jetson TX1 Developer Kit including module with NVIDIA Maxwell GPU, ARM 64-bit CPUs, 4 GB LPDDR4, 16 GB eMMC and a pre-flashed Linux environment.

References

[1] M. Cathcart, A. Thomas, T. Harrell and S. Lane, “Final Report: Army Advanced Concept Workshop on Disturbed Soil Characterization and Exploitation”, Georgia Tech Research Institute, 2008
[2] D.W. J. M. van de Wouw, K. van Rens, H. van Lint, E.G.T. Jaspers and P.H.N. de With, "Real-time change detection for countering improvised explosive devices”, Proc. SPIE 9026, Video Surveillance and Transportation Imaging Applications, March 5, 2014
[3] F. Diego, D. Ponsa, J. Serrat and A. M. Lopez, "Video Alignment for Change Detection," in IEEE Transactions on Image Processing, vol. 20, no. 7, pp. 1858-1869, July 2011.