

SCOVIS

Self-Configurable Cognitive Video Supervision

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Abstract

SCOVIS will significantly improve the versatility and the performance of the current monitoring systems for security purposes and workflow control in critical infrastructures. The resulting technology will enable the easy installation of intelligent supervision systems, which has not been possible so far, due to the prohibitively high manual effort and the inability to model complex visual processes. A medical equipment industry has been selected for the evaluation of the SCOVIS research tools under a real world environment. SCOVIS supports the automatic detection of a) behaviours, b) workflow violation and c) localization of salient moving or static objects in scenes, monitoring by multiple cameras (static or active). The project investigates weakly supervised learning algorithms and self-adaptation strategies for analysis of visually observable workflows and behaviours. The goal of these algorithms is to use a relatively small number of labelled data, almost at the initial stage of the algorithm, while in the following, unlabelled data are exploited. Camera network coordination is also supported so that complex behaviours can be identified as combination of spatio-temporal object relations in multiple scenes. SCOVIS supports self-configuration (system is able to automatically calculate the camera spatial relations) and adaptation (the models are automatically enriched through time via online data acquisition and unsupervised learning strategies). User's interaction is also foreseen for improving the behaviour detection through relevance feedback mechanisms. This way, the user evaluates the system performance and then the rules used by the system are automatically updated (without imposing any additional knowledge from the user about the system operation) so that in the following responses better decisions are accomplished. The proposed research will be performed with absolute respect to privacy and personal data of monitored individuals.

Concept and Objectives

SCOVIS aims at automatically detecting behaviours and learning visually observable procedures and workflows, especially in manufacturing and public infrastructure environments. Large scale regions will be exploited in a real world environment of medical equipment construction.

SCOVIS research advocates a synergistic approach that combines largely unsupervised learning and model evolution in a bootstrapping process; it involves, on the one hand, continuous learning from visual content in order to populate and enrich models and, on the other hand, the direct use of these models to enhance the robustness of the extraction system. This is achieved through the use of weakly supervised learning algorithms and self-adaptation strategies as well as active camera network coordination.

The main measurable objective of the project is to significantly improve the performance and applicability of current monitoring systems. Towards that objective, SCOVIS will develop a framework for adaptable, largely unsupervised extraction of objects and behaviour, through a network of cooperating active cameras, which will be realized as an open architecture. Furthermore, SCOVIS aims to initiate a new research activity that will converge object learning using low level object descriptors and procedure learning with adaptation mechanisms and active camera network coordination. This way, we can achieve consistent monitoring so as to identify behaviours in large areas with higher tracking quality. Complex camera networks using sensors with overlapping and disjoint fields of view would require calculation of a large number of sensor parameters to enable consistent monitoring of objects moving across their fields of view. Approaches that would enable automated camera registration would be desirable. Additionally, focus-of-attention mechanisms based on biological models will assist the extraction process and will guide the active cameras. A

disambiguation process will be integrated to reduce errors. At the same time, the user will be able to provide high-level feedback and guide the modelling process.

Throughout the project, the SCOVIS research programme and resulting technology will be informed by, and then evaluated, against realistic scenarios in the manufacturing industry and protection of critical public infrastructure. In particular, we will evaluate the results in the specific case of monitoring the manufacture of medical equipment which provides an exemplar test case in the industry domain. To ensure the broadest possible applicability of the SCOVIS results, we have the support of a governmental security advisory body that will provide requirements and scenarios for the use of SCOVIS to help protect critical national infrastructure.

The expected outcome of the project comprises the following:

- a. *A methodology for largely unsupervised learning of salient objects, implemented as an open architecture.* This methodology will coordinate the various tools that will use the extracted data to adapt the models. The interfaces for the various types of tools will be specified, thus it will be completely open to the replacement of the tools with new ones in the future.
- b. *A methodology and an open architecture for large-scale camera networks.* It will define the methods for automatically setting up, operating and maintaining networks of active or static cameras with overlapping or disjoint views. It will constitute the basis for building scalable monitoring systems.
- c. *A toolkit for weakly supervised learning and object detection.* The toolkit will include tools for detection and learning of moving or static objects using a library of generic features and attention models.
- d. *A toolkit for behaviour analysis.* This will include tools for workflow learning and recognition for single or multiple agents. It will also include tools for workflow disambiguation.
- e. *A toolkit for adaptation mechanisms.* It will include tools for model adaptation (object or behaviour) using either automatic mechanisms or user feedback.
- f. *A toolkit for camera network coordination.* It will include tools for consistent monitoring using cameras with overlapping or disjoint field of view, and for controlling an active camera.
- g. *A testbed* which will integrate all above toolkits and will demonstrate the benefits of the proposed synergies.

A major target of the project is to initiate a new research activity towards the automation of observable workflow modelling through adaptation and camera coordination. SCOVIS will pursue the aim of achieving truly versatile and precise workflow modelling and will promote and disseminate its core proposal for the combination of the above tasks.