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TESI DI DOTTORATO

A Data-Flow Middleware Platform for Real-Time Video Analysis

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Abstract

In this thesis we introduce a new software platform for the development of real-time video analysis applications, that has been designed to simplify the realization and the deployment of intelligent video-surveillance systems. The platform has been developed following the Plugin Design Pattern: there is an applicationindependent middleware, providing general purpose services, and a collection of dynamically loaded modules (plugins) carrying out domain-specific tasks. Each plugin de_nes a set of node types, that can be instantiated to form a processing network, according to the data-flow paradigm: the control of the execution ow is not wired in the application-specific code but is demanded to the middleware, which activates each node as soon as its inputs are available and a processor is ready. A first benefit of this architecture is its impact on the software development process: the plugins are loosely coupled components that are easier to develop and test, and easier to reuse in a different project. A second bene fit, due to the shift of the execution control to the middleware, is the performance improvement, since the middleware can automatically parallelize the processing using the available processors or cores, as well as using the same information or data for different thread of execution. In order to validate the proposed software architecture, in terms of both performance and services provided by the middleware, we have undertaken the porting to the new middleware of two novel intelligent surveillance applications, by implementing all the nodes required by the algorithms.
The first application is an intelligent video surveillance system based on people tracking algorithm.

The application uses a V single, fixed camera; on the video stream produced by the camera, background subtraction is performed (with a dynamically updated background) to detect foreground objects. These objects are tracked, and their trajectories are used to detect events of interest, like entering a forbidden area, transiting on a one-way passage in the wrong direction, abandoning objects and so on. The second application integrated is a fire detection algorithm, which combines information based on color, shape and movement in order to detect the ame. Two main novelties have been introduced: first, complementary information, respectively based on color, shape variation and motion analysis, are combined by a multi expert system. The main advantage deriving from this approach lies in the fact that the overall performance of the system significantly increases with a relatively small effort made by designer. Second, a novel descriptor based on a bag-of-words approach has been proposed for representing motion. The proposed method has been tested on a very large dataset of fire videos acquired both in real environments and from the web. The obtained results confirm a consistent reduction in the number of false positives, without paying in terms of accuracy or renouncing the possibility to run the system on embedded platforms.