

PROMETHEUS

Prediction and interpretation of human behaviour based on probabilistic structures and heterogeneous sensors

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The PROMETHEUS project intends to establish a link between fundamental sensing tasks and automated cognition processes that concern the understanding and short-term prediction of human behaviour as well as complex human interaction. The analysis of human behaviour in unrestricted environments, including localization and tracking of multiple people and recognition of their activities, currently constitutes a topic of intensive research in the signal processing and computer vision communities. This research is driven by different important applications, including unattended surveillance and intelligent space monitoring. The overall goal of the project is the development of principled methods to link fundamental sensing tasks using multiple modalities, and automated cognition regarding the understanding of human behaviour in complex indoor environments, at both individual and collective levels.

Despite the legitimacy of a number of privacy issues, many systems have been deployed for surveillance applications. These systems generate large amounts of data that need to be filtered out through automatic analysis, either for online detection of dangerous situations, or for offline information retrieval. PROMETHEUS will research on the characterization of atypical movements, crowd move and collective behavior interpretation, with a view to identify and respond to unusual but critical actions (e.g., violent acts, accidents, potential threat or hazard). The main objective is to provide a decision support interface to enhance the performance of human experts by overlaying machine prediction on the experts' information. Surveillance cameras are already prevalent in commercial establishments, while camera outputs are usually recorded on tapes, stored in video archives or require the constant presence of human operators. This video data, in most cases, is currently used only "after the fact" as a forensic tool, losing its primary benefit as an active real-time media. What PROMETHEUS aims for is the real-time analysis of surveillance data to alert security officers to an unlawful act in progress, an accident and atypical behavior. That is, the system will focus on security awareness in possibly congested, low light level situations.

To address a number of problems related to human behavior analysis, PROMETHEUS intends to follow two main innovative research principles:

- The use of a network of heterogeneous sensors: PROMETHEUS is going to endow internal spaces with perceptual modalities that are not only similar to human sensing capabilities (i.e., vision through cameras and hearing through microphone arrays), but also complementary and, to some degree, superior with respect to several perceptual and cognitive tasks (infrared vision, laser scanners, 3D range extraction beyond). PROMETHEUS proposes to investigate the fusion of information provided by conventional sensors (video and audio) and unconventional types (e.g., laser scanners, infrared vision, proximity indicators).
- The use of a fully probabilistic framework. The research tasks will be performed in a general Bayesian framework, which has been shown to be adaptable to the fusion of heterogeneous sources of information. In PROMETHEUS, we will rely on dynamical Bayesian networks (DBN) to model the temporal evolution of the global state, and on combinations of Sequential Monte-Carlo (SMC) and Hidden Markov Model (HMM) as practical implementations. Though DBN provide a powerful framework, applicability of this framework to complex situations is for a large part a challenging issue. Through this probabilistic setting, the project aims at bridging the gap between the low-level features that can currently be extracted from the different sensors, and the semantic level that is desirable for scene interpretation and understanding.

Prometheus is a project scheduled for duration of 36 months, and involves 7 partners from 5 countries. The consortium is composed of academic partners, research institutes and industrial companies providing highly complementary input with respect to the system set-up, evaluation, and exploitation of the results obtained. The Coordinator of the project is Swedish Defence Research Agency (FOI), which has demonstrated experience in security and surveillance systems for many years.