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# TUTORIAL

## SURVEILLANCE ANGELS

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**Abstract:** The use of sensor networks has been proposed for military surveillance and environmental monitoring applications. Those systems are composed of a heterogeneous set of sensors to observe the environment. In centralised systems the observed data will be conveyed to the control room to process the data. Human operators are supposed to give a semantic interpretation of the observed data. They are searching for suspicious or unwanted behaviour. The increase of surveillance sensors in the military domain requires a huge amount of human operators which is far beyond available resources. Automated systems are needed to give a context sensitive semantic interpretation of the observed kinematic data.

As a proof of concept two automatic surveillance projects will be discussed in this paper. The first project is about a centralised system based on the AIS-Automated Identification System which will be used to monitor ship movements automatically. The second project is about a decentralised system composed of a network of cameras installed at a military area.

There is a need for a surveillance system along the coast of Europe. There is an increase of illegal drugs transport from the open sea, intrusion of boat refugees, illegal fishing, pollution of the sea by illegal chemical and oil pollution by ships. An automated sensor system is needed to detect illegal intruders and suspicious ship movements. Vessels fitted with AIS transceivers and transponders can be tracked by AIS base stations located along coast lines or, when out of range of terrestrial networks, through a growing number of satellites that are fitted with special AIS receivers. AIS data include a unique identifier of a vessel and kinematic data such as its position, course and speed. The proposed system enables identification, and tracking of vessels and to detect unwanted or illegal behaviour of ship movements. If ships violate traffic rules, enter forbidden areas or approach a critical infrastructure an alert will be generated automatically in the control room. Human operators start an emergency procedure.

The second project is about a network of cameras installed at a military area. The area is monitored by multiple cameras with non-overlapping field of views monitored by human operators. We developed an automated surveillance system. At the entrance gate the identity of visitors will be checked by a face recognition system. In case of intruders, unwanted behaviour, trouble makers the emotional state of the visitor will be assessed by an analysis of facial expressions using the

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Active Appearance model. If unwanted behaviour is detected an alert is send the control room.

Also license place of cars will be recognized using a system based on Neocognitron Neural Networks. Moving objects as persons and vehicles will be detected, localized and tracked. Kinematic parameters are extracted and a semantic interpretation of their behaviour is automatically generated using a rule based system and Bayesian networks. Cars violating the traffic rules or passing speed limits or entering forbidden areas or stopping/parking at forbidden places will be detected. A prototype of a system has been developed which is able to monitor the area 24 hours a day, 7 days a week.

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## 1. Intelligent surveillance

In his inaugural lecture in 2010 Professor Rothkrantz introduced the concept of a guardian angel. An angel is an animation of software agents. An agent is able to perceive its environments, to reason about context and observations and to take appropriate actions and finally is able to evaluate the impact of its actions. The goal of a personalised guardian angel is to care of the safety of guarded person. Every human observer has a digital counterpart, taking care of its wellbeing and taking care of the communication with other parts of the system. In case of threat or dangerous situations the guardian angel has to take actions to protect the guarded person. A surveillance angel is another member of the community of angels. The main task is to monitor an environment and to detect unusual events. An angel is like agents an autonomous object communicating with other angels in its virtual angel world.

The last three years our research was focused on surveillance angels. The concept surveillance angels in a military context can best be illustrated with drones, such as a ScanEagle [1] (see Fig 1). A drone is an unmanned aerial vehicle (UAV), equipped with high definition cameras and able to survey large areas from the air. A drone can be considered as a flying camera system or as a flying angel. A drone can be launched from the ground or from a ship by human operators, and is navigated by human operators in the control room. Actions as launching a missile from a drone will be initiated by human operators. Video recordings are transmitted from the drones to the ground station and the semantic interpretation of these recordings in the given context is again done by human operators. So a drone is under control of human operators and many operators are needed.

Human operators in the control rooms are supposed to survey video data 24/7 and to give a semantic interpretation of the observed data. In case of suspicious or unwanted behaviour they start an alert procedure.

Nowadays many military researchers are involved in projects to design autonomous drones. Such an intelligent drone is modelled as an agent and should be able to monitor the environment, to detect and track objects and to reason about their behaviour and to choose appropriate actions. Such a drone should also be