

## Forum Securitatis Courses

### Sensor Data and Information Fusion for Crisis Management

#### **Description**

As a result of new challenges to our society and recent technical advances different sensor systems are becoming an increasingly common part of everyday life. Properly used, these sensor system can provide important support for crisis management. Therefore, this course aims to provide an understanding of how to use sensor data and information fusion in crisis management today and in the future. The course also provides insights into how the available information and methods can be used to improve decision support systems. The following topics are addressed: *uncertainty handling (Bayesian networks and evidence theory), target tracking and filtering, situation and threat analysis (anomaly detection, fusion based on graph models and other network models), sensor networks, the role of information fusion as decision support, and analysis of open data.*

#### **Organization**

The course is divided into two parts; an introductory part (1 ECTS credit) and a more advanced part (2 ECTS credits) focusing more on the underlying techniques used.

The introduction contains lectures on sensor data and information fusion (6 hours), and a group assignment where a crisis management scenario is analyzed and divided into parts concerning sensors, sensor data, and fusion (20 hours).

The advanced part contains additional lectures (12 hours), a project assignment (40 hours), and a workshop where a projects are presented (4 hours). In in the assignment, the students are expected to pick a technique or methodology presented in the lecture series and reflect on how it can be applied in the students' own research as well as put in the context of a relevant crisis management scenario.

#### **Examination**

**Introduction part** (1 ECTS credit): active participation in lectures and a written report on a group assignment.

**Advanced part** (2 ECTS credits): active participation in lectures, a written report on a project assignment, and a presentation of the project at the final workshop.

#### **Literature**

Selected reports and papers handed out.

#### **Target group**

All students in Forum Securitatis. The course is open to other students and participants from industry based on availability.

#### **Prerequisites**

The introductory part has no prerequisites, whereas the advanced part requires knowledge of basic mathematics.

**Course language:** English or Swedish (if all participants speak Swedish).

## Teachers

Name	Function	E-mail
Ronnie Johansson, FOI	Course organizer	<a href="mailto:ronnie.johansson@foi.se">ronnie.johansson@foi.se</a>
Gustaf Hendeby, LiU	Examiner, point of contact	<a href="mailto:hendeby@isy.liu.se">hendeby@isy.liu.se</a>
Maria Andersson, FOI	Lecturer	<a href="mailto:maria.andersson@foi.se">maria.andersson@foi.se</a>

## Schedule

	Subject	Time	Lecturer
<b>1. Introduction</b>			
1	Introduction to data and information fusion <i>What is fusion, its benefits and challenges? Example algorithms, sensors, and models.</i>	2h	Ronnie Johansson
2	Applications <i>Decision support systems and fusion, scenarios and examples, visualization.</i>	2h	Ronnie Johansson
3	Uncertainty handling (overview) <i>Reasoning with uncertainty, different types of uncertainty. Theories for uncertainty modelling (Bayesian analysis, evidence theory and fuzzy logic).</i>	2h	Ronnie Johansson
<b>2. Advanced part 1</b>			
4	Sensor data fusion <i>Sensor networks, algorithms for target tracking and navigation, general filter theory for dynamics updates of sensor networks, application examples.</i>	3h	Gustaf Hendeby
5	Anomaly detection <i>Problem description, definition of anomaly detection, examples of algorithms and applications in surveillance systems.</i>	3h	Maria Andersson
<b>3. Advanced part 2</b>			
6	Uncertainty handling with Bayesian networks <i>Introduction, probability models, most probable explanation, marginal probabilities, soft evidences, influence diagrams.</i>	2h	Ronnie Johansson
7	Complementary topics <i>Relation to data mining, other types of information fusion, decision fusion, distributed data fusion.</i>	2h	Ronnie Johansson
8	Concluding remarks <i>Summary and introduction to advanced study project.</i>	2h	Ronnie Johansson, Gustaf Hendeby, Maria Andersson
<b>4. Advanced part, workshop</b>			
9	Presentation and discussion of advanced study projects.		Ronnie Johansson, Gustaf Hendeby, Maria Andersson