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Development and Research on Innovative Vocational Education Skills

SENSOR FUSION EXPERT

SFE.U3.E2

MULTI SENSOR FUSION ARCHITECTURES, DESIGN, AND IMPLEMENTATION

Introduction to Sensor Fusion

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LEARNING OBJECTIVES

The student is able to …

SFE.U3.E3.PC1	The student is able to list the functional requirements of multisensory fusion.
SFE.U3.E3.PC2	The student understands and compares the different types of architectures for sensor fusion systems.
SFE.U3.E3.PC3	The student is able to critically select the architecture that best fits a specific problem or situation.
SFE.U3.E3.PC4	The student can assemble and manage information gathering and integration from a variety of sources.
SFE.U3.E3.PC5	The student is able to design and implement a multi sensor fusion system.

Functional Requirements of a Multisensory Fusion

- Sensor Fusion combines multiple sensors to determine a more accurate result than intended.
- However, it is necessary to understand how this is done.
- Basically, a multisensory fusion is capable of integrating data sets from two or more sensors.

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Functional Requirements of a Multisensory Fusion

- When using a merge criterion, we have to take into account the diversity of the algorithms and whether merging these data results in differences for the merge effect.
- To verify the functionality of sensor fusion, three architectures must be considered.

Functional Requirements of a Multisensory Fusion

- Multisensory Fusion architectures must include several functional components to elaborate the management and control of that fusion.

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Architectures

- **Architectures can be composed of:**
  - Meta-Architecture
  - Algorithmic Architecture
  - Conceptual Architecture
  - Logical Architecture
  - Execution Architecture

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Architectures

- **Architectures can be composed of:**
  - Meta-Architecture
    - Characterize the system structure
    - Selection and organization of the system elements may be guided by aesthetics, efficiency, or other design criteria

Architectures

- Architectures can be composed of:
- <u>Algorithmic Architecture</u>
  - A specific set of information fusion and decision making methods
  - Examples:
    - Data heterogeneity
    - Registration
    - Calibration
    - Consistency
    - Information content
    - Independence
    - Time interval
    - Scale

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Architectures

- Architectures can be composed of:
  - Conceptual Architecture
    - For mapping algorithmic elements to functional structures

Architectures

- Architectures can be composed of:
  - Logical Architecture
    - Detailed canonical component types
    - The control involves both the control of action systems.
      - Within the multisensor fusion system, as well as the control of information requests and dissemination within the system, and any external control decisions and commands.

Architectures

- Architectures can be composed of:
  - <u>Execution Architecture</u>
    - Defines mapping of components to execution elements.
    - This includes internal or external methods of ensuring correctness of the code and also validation of the models.

Architectures Dimensions

- To design a Multi Sensor System there are 4 dependent design dimensions:
    - Centralized–decentralized,
    - Local–global interaction of components,
    - Modular–monolithic,
    - Heterarchical–hierarchical

Architectures Dimensions

However, there are some combinations here that multisensor architectures fit reasonably well into one of these categories, namely:

- Centralized, global interaction, and hierarchical,
- Decentralized, global interaction, and heterarchical,
- Decentralized, local interaction, and hierarchical,
- Decentralized, local interaction, and heterarchical.

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Architectures Dimensions

- **Centralized, global interaction, and hierarchical**
  - Encompass a number of system philosophies
  - One approach to this type of sensor fusion is to use artificial neural networks.
  - The user, at least in principle, does not need to understand how sensor modalities are related, nor do they model uncertainties.

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Architectures Dimensions

- **Decentralized, global interaction, and heterarchical**
  - The major example of the decentralized, global interaction meta-architecture is the blackboard system;
  - The overall architectural goals for blackboards include efficient collaboration and dynamic configuration.

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Architectures Dimensions

- **Decentralized, local interaction, and hierarchical**
  - One of the earliest proposals for this type of architecture is the real-time control system (RCS)
  - RCS is presented as a cognitive architecture for intelligent control, but essentially uses multisensor fusion to achieve complex control.
  - An early architectural approach which advocated strong programming semantics for multisensor systems is the logical sensor system (LSS).

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Implementation

- To implement a Multi-Sensor System, the following aspects must be taken into account:
    - Hardware Implementation
    - Software Implementation

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Hardware Implementation

- For the hardware implementation, the sensor(s) that best suit the purpose of what you want to measure can be selected.
- Sometimes an external controller may be needed to send commands to the sensor itself.

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Software Implementation

- For the software implementation, as a rule, three aspects should be considered:
  - Extracting sensor data
  - The sensor communication type
  - The operating system of the sensor platform

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Thank you for your attention

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The aim of the Blueprint is **to support an overall sectoral strategy and to develop concrete actions to address short and medium term skills needs.**

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