PANEL #3

NICE
MAY 2025

Theme
Challenges of Ubiquitous Sensing Systems

NexComm 2025 & DigitalWorld 2025

PANEL #3

NICE
MAY 2025

Moderator

Prof. Dr. Lasse Berntzen, University of South-Eastern Norway, Norway

Panelists

Prof Dr. Przemyslaw Pochec, University of New Brunswick, Canada

Dr. Roger Tilley, Sandia National Laboratories, USA

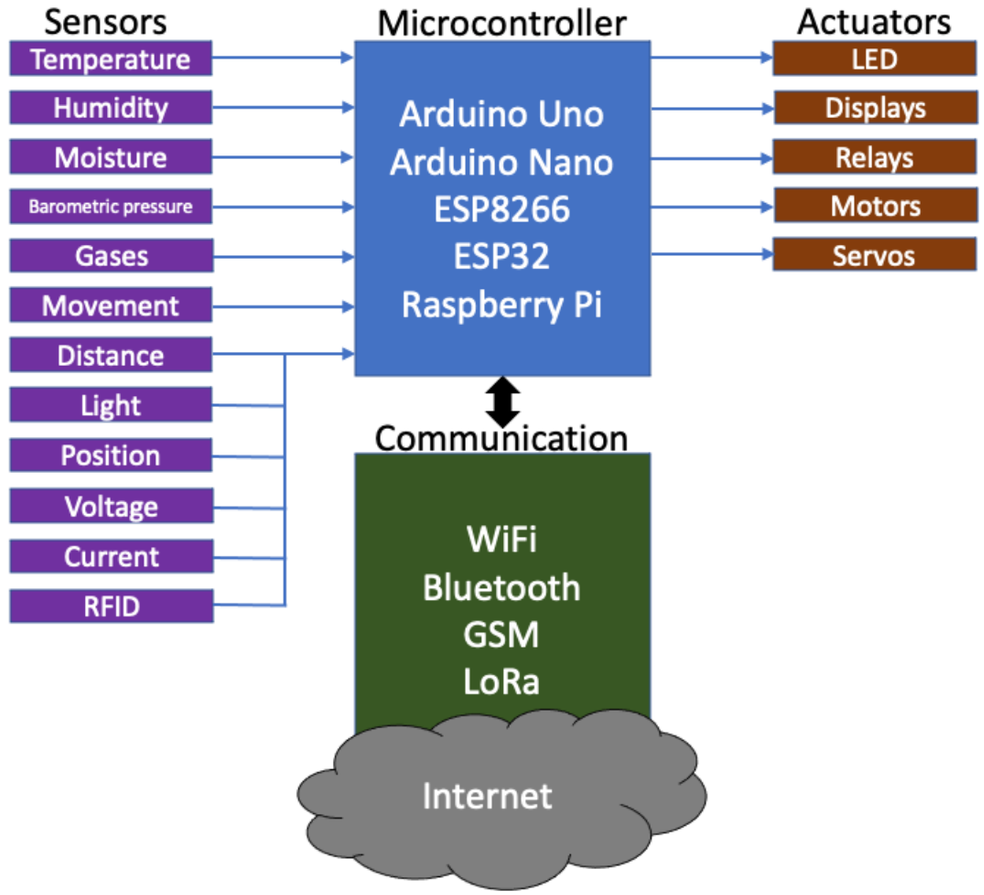
Prof Dr. Mohamed El-Darieby, Ontario Tech University, Canada

Prof. Dr. Paulo Cruvinel, Embrapa, Brazil

Moderators Opening Remark

NICE
MAY 2025

A sensing system is a configuration of sensors, communication infrastructure, and processing units designed to detect, measure, and interpret environmental or system variables (e.g., temperature, motion, pollution, location, energy use).



Lasse Berntzen
University of South-Eastern Norway

Moderators Opening Remark

NICE
MAY 2025

A ubiquitous sensing system refers to a network of sensors integrated seamlessly into the environment, continuously collecting data across space and time, often invisible to users, supporting real-time or contextual decisions.

Examples:

- Smart cities
- Smart energy
- Smart parking

Lasse Berntzen
University of South-Eastern Norway

Panelist Position

NICE
MAY 2025

Przemyslaw Pochec
Faculty of Computer Science
University of New Brunswick
Canada

- **UBIQUITOUS SENSING SYSTEMS (+ applications)**
  - **Ubiquitous**
    prevalence, energy efficiency, cost efficiency
  - **Sensing**
    direct measure, indirect measure
  - **Systems**
    collection, (pre)processing, aggregation, transmission, storage, presentation
  - **+ Applications**
    domain specific, inferential

Panelist Position

NICE
MAY 2025

Przemyslaw Pochec
Faculty of Computer Science
University of New Brunswick
Canada

- **CHALLENGES**
  - **Reported in literature (according to Grok):**
    privacy, security, energy efficiency, interoperability
  - **Cost:**
    manufacturing, maintenance (incl. power), disposal
  - **Volume of data:**
    (pre)processing, storage, transmission (my own work: *mobile medium*)
  - **Processing (aka “applications”)**
    inference, planning, recommendations, conscious thinking …
  - **… and most of all: <u>Social Acceptability</u> and regulatory approval !**

Panelist Position

NICE
MAY 2025

Roger Tilley
Sandia National Laboratories

- **Challenges of Ubiquitous Sensing Systems**
  - **Data Interoperability**
    - Being able to make use of devices made by different manufacturers with non-standard communication protocols
    - How is the data retrieved? Does it need to be retrieved from a cloud system?
    - Are some Sensing Systems AI Monitored? If So, How do we integrate them?
  - **Data Collection Problem –**
    - Data too sparse in time and space to provide for better information content for modeling critical phenomena.
    - Data is too regular in frequency and the content does not cover adequately critical events.
    - Communication in harsh environments

Panelist Position

NICE
MAY 2025

Roger Tilley
Sandia National Laboratories

- **Challenges of Ubiquitous Sensing Systems**
  - **Data Quality and Processing–**
    - **Is there a Need to process data in real time?**
    - **Noisy data can be difficult to analyze and interpret.**
    - **Non-Uniform Sample sizes can hamper analysis and decision making.**
    - **There may be a need to develop adaptive sampling techniques to increase the quality of collected data.**
  - **Sensor Design and Deployment –**
    - **For the desired collection area, is it covered adequately?**
    - **Planning for sensor system use can be challenging (complicated) based on the types of systems intended for use.**
    - **How does one integrate the sensors in the system?**
    - **Are the Systems designed for scalability (up or down)?**
    - **Cost and energy consumption must be considered.**
    - **Reliability and durability in harsh environments must also be considered.**

Panelist Position

NICE
MAY 2025

Mohamed El-darieby
Ontario Tech University, Canada

- More Challenges

- Human Sensor Data
- Security Vulnerabilities & Privacy Concerns
- Ethical Governance

- Cross-Jurisdictional Laws:(e.g., GDPR)
- Regulatory and Compliance Issues
- Standardization Gaps

- Deployment Challenges
- Scalability
- Resource Constraints

- Data

Panelist Position

NICE
MAY 2025

Mohamed El-darieby
Ontario Tech University, Canada

- Enrichment / Interpretation

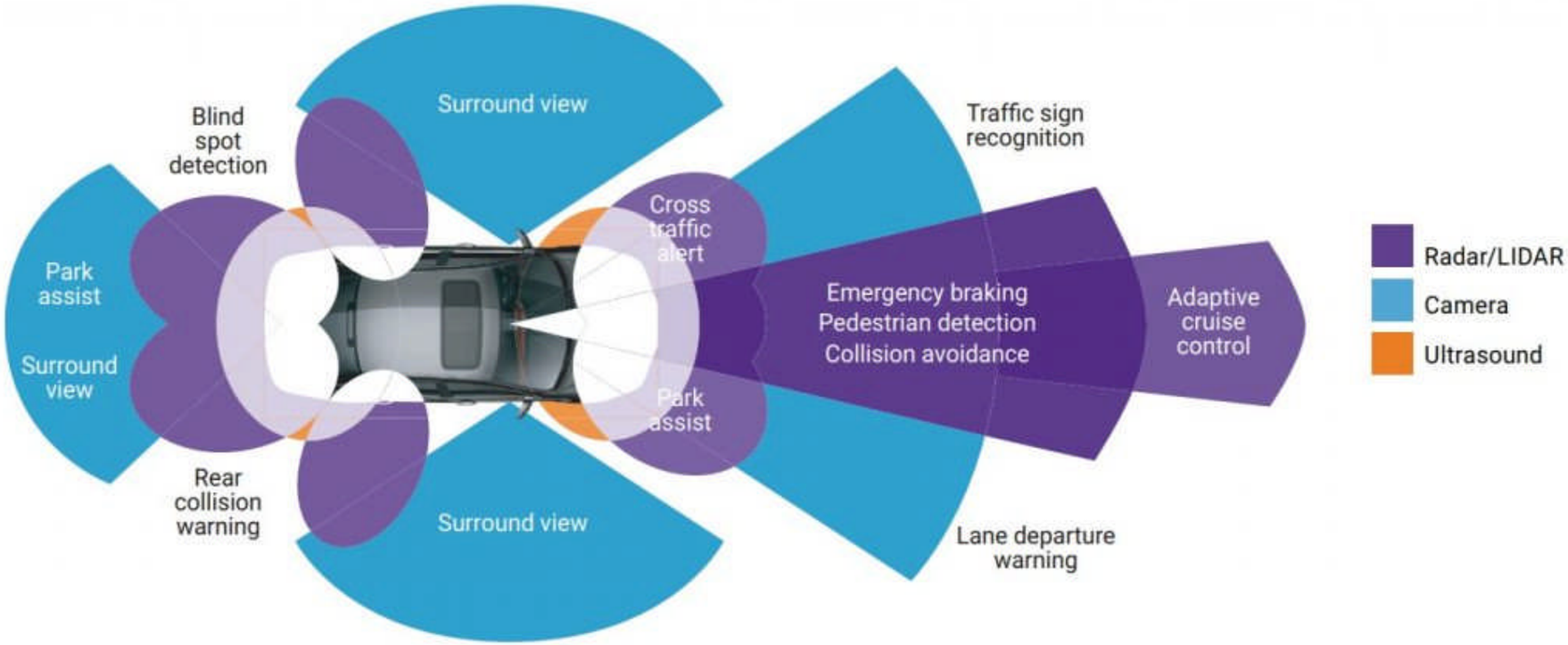
- Contextual
  - Sensor Fusion
  - Better modeling of environment

- Semantics
  - Vocabulary augmentation
  - Ontological
  - Knowledge Graphs

- Explainability

Panelist Position

NICE
MAY 2025



Mohamed El-darieby
Ontario Tech University, Canada

https://www.researchgate.net/figure/Sensors-in-Vehicle-collision-avoidance-system_fig2_358821552

Sensor Data Fusion: Spatial-Temporal Attentive

Panelist Position

NICE
MAY 2025

AI

- can mimic creativity
- Can solve problem
- Explainability
- Symbol Grounding Problem
  - AI manipulates symbols (e.g., words, pixels) without connecting them to real-world referents.

- AI "knows" by identifying correlations in data
  - a complex function
  - computational entities
- not through
  - understanding
  - reasoning.

- Illusion of Agency
- emergent properties** of optimization, not true agency.
- no consciousness, desires, or self-awareness

Mohamed El-darieby
Ontario Tech University, Canada

Panelist Position

NICE
MAY 2025

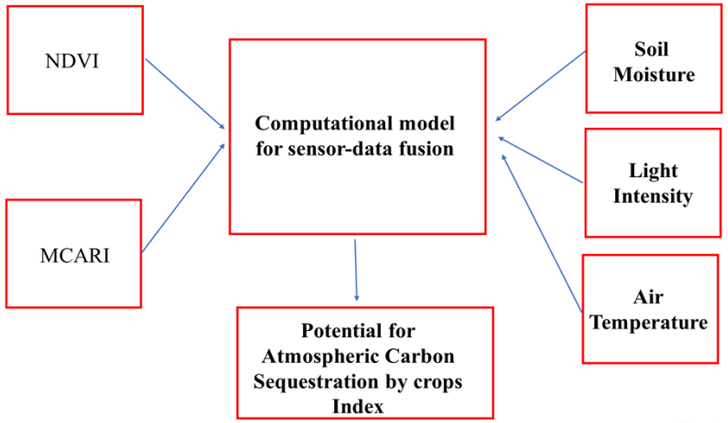
UBIQUITOUS COMPUTING AND SENSING SYSTEMS IN AGRICULTURE

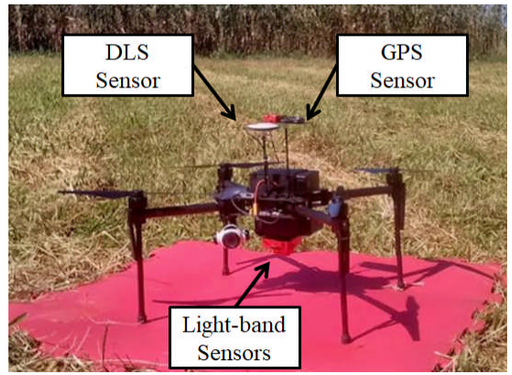
- ✓ **Ubiquitous sensing systems involve a network of sensors distributed throughout an environment to collect real-time data and information.**
- ✓ **Pervasive computing, also known as ubiquitous computing, is the concept of embedding computing capabilities into everyday objects, making them accessible from anywhere and anytime.**
- ✓ **Systems are designed to be low-power, readily, available and accessible, enabling the integration of intelligence and connectivity.**

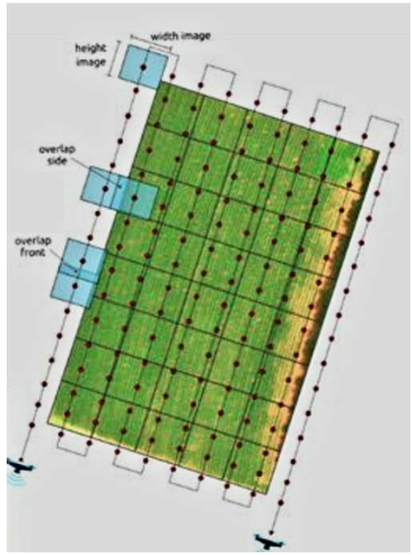
Paulo E. Cruvinel
Embrapa Instrumentation
Federal University of São Carlos (UFSCar)
Brazil
paulo.cruvinel@embrapa.br

Panelist Position

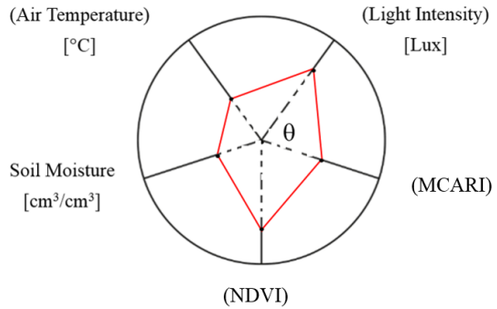
NICE
MAY 2025

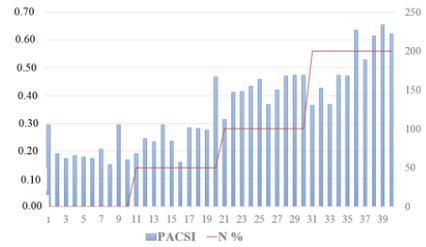






$$PACSI \triangleq g\left(\begin{matrix}Light\ Intensity, Air\ Temperature,\\ Soil\ Moisture, NDVI, MCARI\end{matrix}\right)$$





Source: Cruvinel & Colnago, 2025

Paulo E. Cruvinel
Embrapa Instrumentation
Federal University of São Carlos (UFSCar)
Brazil
paulo.cruvinel@embrapa.br

Moderators Closing Remarks

NICE
MAY 2025

Challenges

- Sensor quality and reliability
- Need for calibration
- Example: MQ2 gas sensor
- Software can handle sensors with range problems

Lasse Berntzen
University of South-Eastern Norway

THE STAGE IS YOURS