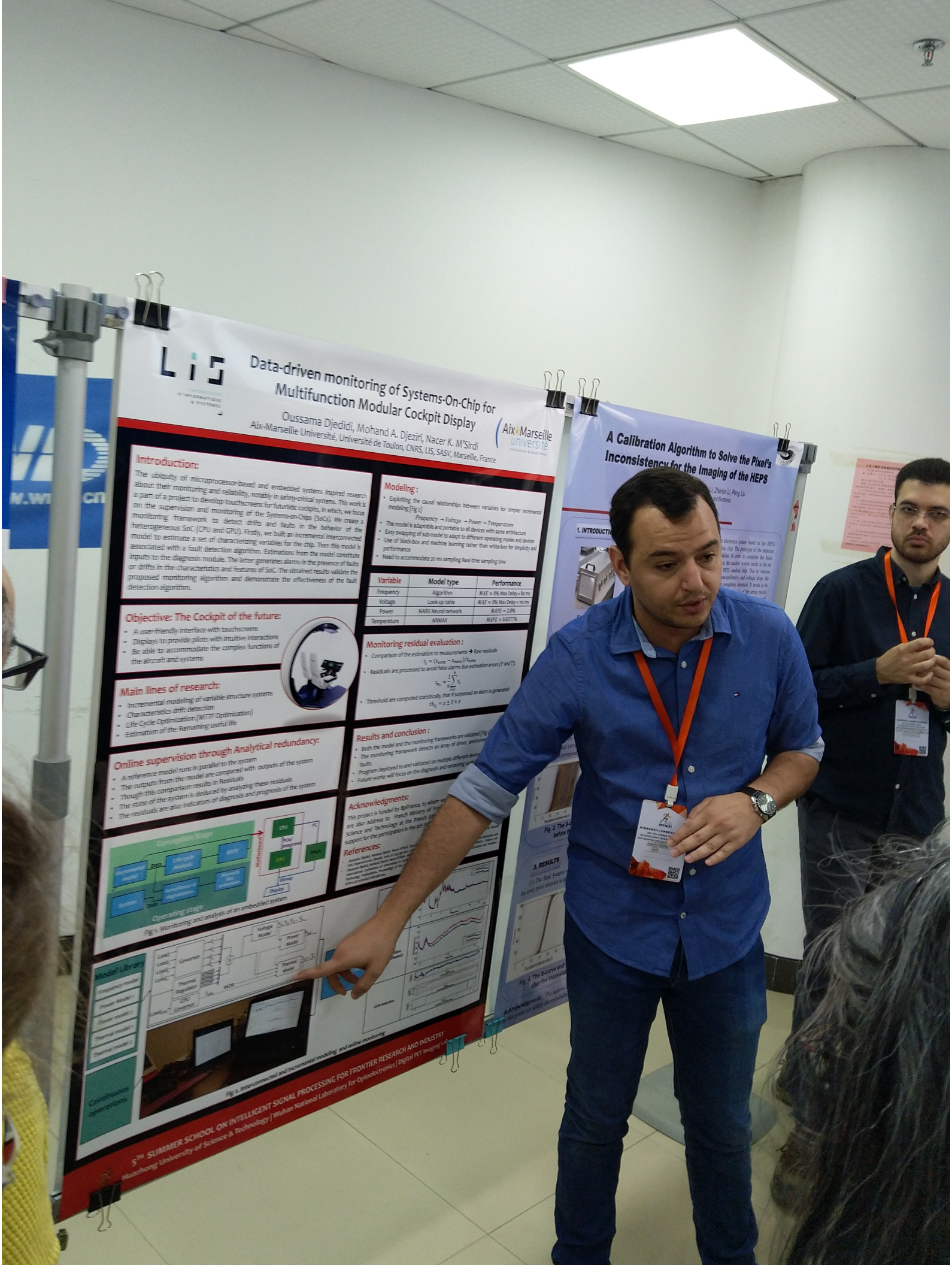
Data-driven monitoring of Systems-On-Chip for Multifunction Modular Cockpit Display
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Introduction:
The ubiquity of microprocessor-based and embedded systems inspired research about their monitoring and reliability, notably in safety-critical systems. This work is a part of a project to develop touchscreens for futuristic cockpits, in which, we focus on the supervision and monitoring of the Systems-on-Chips (SoCs). We create a monitoring framework to detect drifts and faults in the behavior of the heterogeneous SoC (CPU and GPU). Firstly, we built an incremental interconnected model to estimate a set of characterizing variables for the chip. Then this model is associated with a fault detection algorithm. Estimations from the model constitute inputs to the diagnosis module. The latter generates alarms in the presence of faults or drifts in the characteristics and features of SoC. The obtained results validate the proposed monitoring algorithm and demonstrate the effectiveness of the fault detection algorithm.
Objective: The Cockpit of the future:
A user-friendly interface with touchscreens
Displays to provide pilots with intuitive interactions
Be able to accommodate the complex functions of the aircraft and systems
Main lines of research:
Incremental modeling of variable structure systems
Characteristics drift detection
Life Cycle Optimization (MTTF Optimization)
Estimation of the Remaining useful life
Online supervision through Analytical redundancy:
A reference model runs in parallel to the system
The outputs from the model are compared with outputs of the system
Though this comparison results in Residuals
The state of the system is deduced by analyzing these residuals
The residuals are also indicators of diagnosis and prognosis of the system
Modeling :
Exploiting the causal relationships between variables for simpler incremental modeling (Fig.2)
Frequency → Voltage → Power → Temperature
The model is adaptable and portable to all devices with same architecture
Easy swapping of sub-model to adapt to different operating modes and devices
Use of black-box and machine learning rather than white-box for simplicity and performance
Need to accommodate 20 ms sampling Real-time sampling time
Variable | Model type | Performance
Frequency | Algorithm | MAE = 0% Max Delay = 8ms
Voltage | Look-up table | MAE = 0% Max Delay = 10 ms
Power | NARX Neural network | MAPE = 2.8%
Temperature | ARMAX | MAPE = 0.837%
Monitoring residual evaluation :
Comparison of the estimation to measurements → Raw residuals
Residuals are processed to avoid false alarms due estimation errors (P and T).
Threshold are computed statistically, that if surpassed an alarm is generated
Results and conclusion :
Both the model and the monitoring frameworks are validated
The monitoring framework detects an array of driver, environ
faults
Program deployed to and validated on multiple different devic
Future works will focus on the diagnosis and remaining
Acknowledgments:
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References:
Conceptive Stage
Operating stage
Fig 1. Monitoring and analysis of an embedded system
Model Library
Continuous operations
Fig 3. Interconnected and incremental modeling and online monitoring
5TH SUMMER SCHOOL ON INTELLIGENT SIGNAL PROCESSING FOR FRONTIER RESEARCH AND INDUSTRY
Huazhong University of Science & Technology | Wuhan National Laboratory for Optoelectronics | Digital PET Imaging Lab
A Calibration Algorithm to Solve the Pixel's Inconsistency for the Imaging of the HEPS
1. INTRODUCTIO
5. RESULTS
Acknowledgments