FAST PROTOTYPING OF EMBEDDED IMAGE PROCESSING APPLICATION ON HOMOGENOUS SYSTEM

INSTITUT PASCAL
sciences de l'ingénierie et des systèmes

A Model-driven approach for real-time road recognition on Homogeneous Network of Communicating Processors (HNCP)

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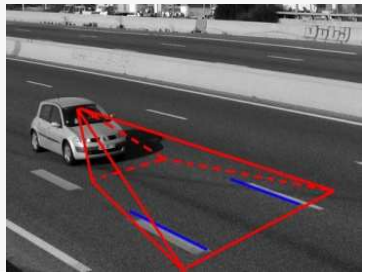


Outline

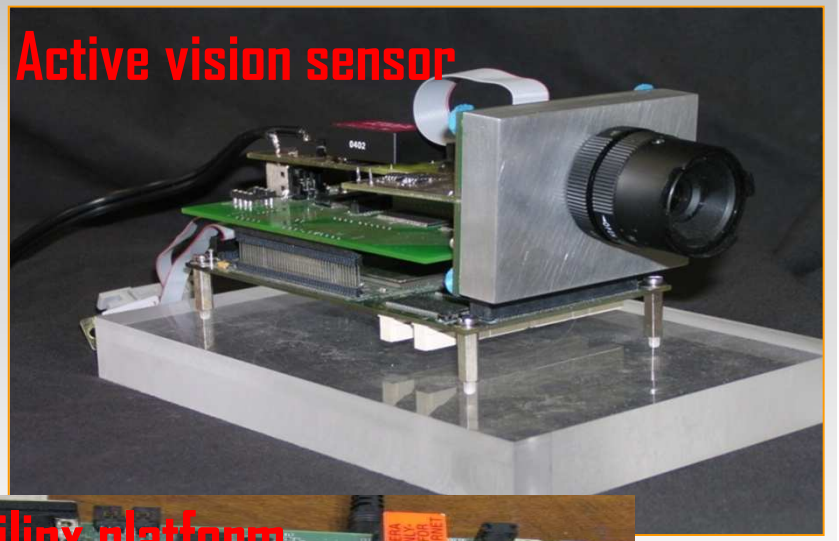
1. Context
2. Real time parallel implementation on SoPC (System on Programmable Chip)
3. Model-driven approach for real-time road recognition
4. Experiments && Conclusion

Context

General Context
embedded vision system

Embedded Vision System

- CMOS imager
- Embedded treatment
- SoC approach

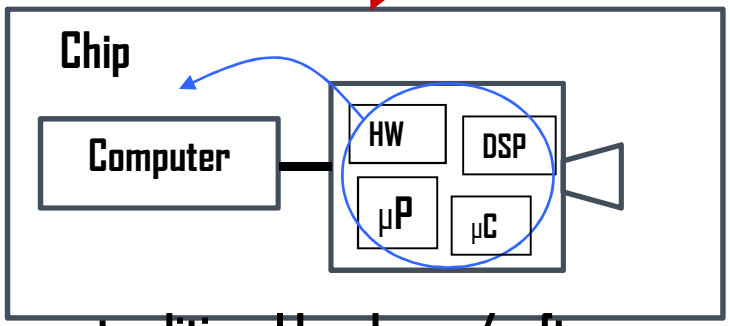


PROBLEMATIC :
INCREASING COMPLEXITY OF THE CONCEPTION OF SOC

SoC design challenges

Intelligent Camera

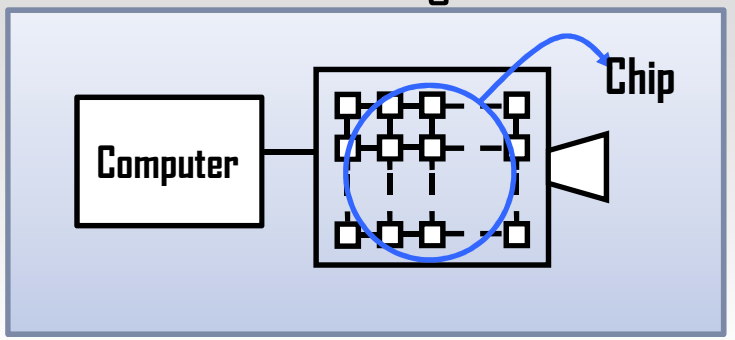
Algorithms



traditional hardware/software Codesign

LASMEA's Approach

Rapid prototyping process of Parallel algorithms



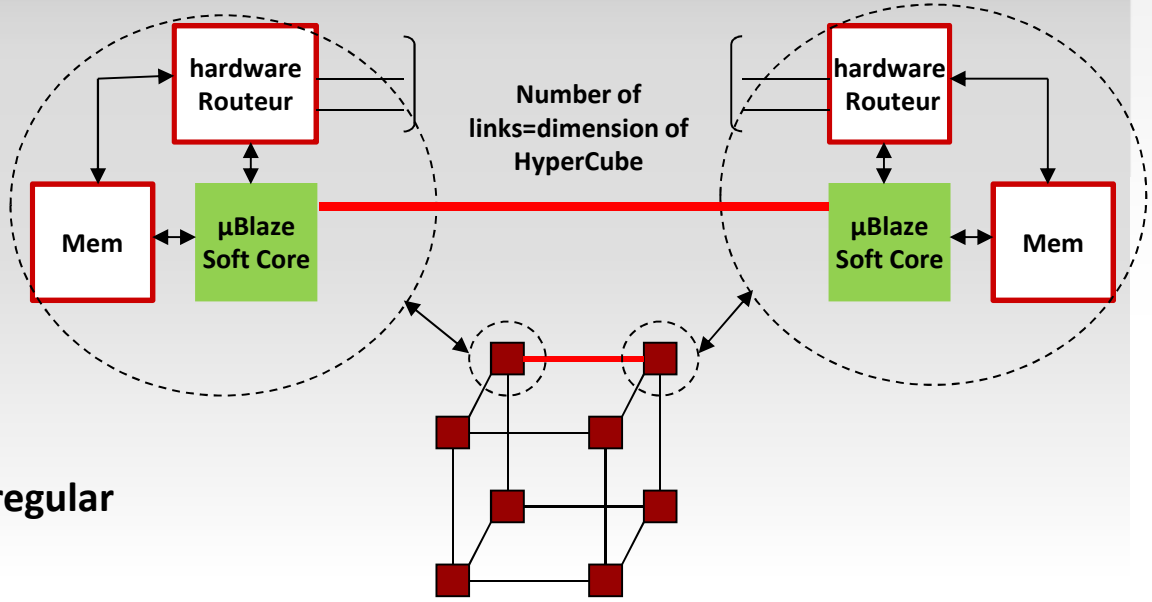
Fast Prototyping of Embedded Image Processing an Homogeneous Network of Communicating Processor (HNCP)

Real time parallel implementation on System on Programmable Chip

The HNCP Methodology

- Homogeneous Network of Communicating Processors on SoPC.

- The generic architecture model chosen is the type MIMDDM.



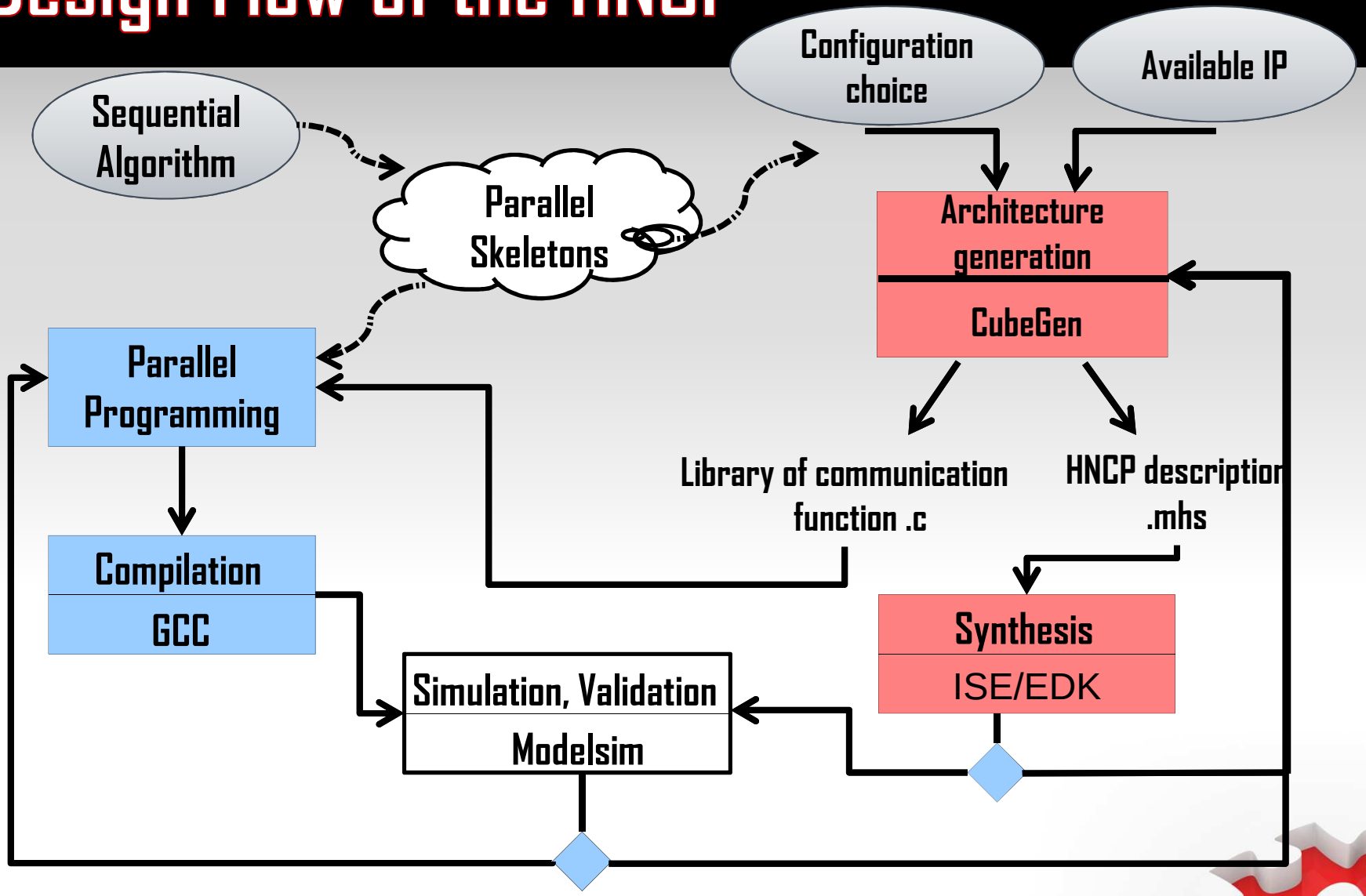
- The static topology choice is the hypercube.

- This parametrizable architecture is regular and homogeneous.

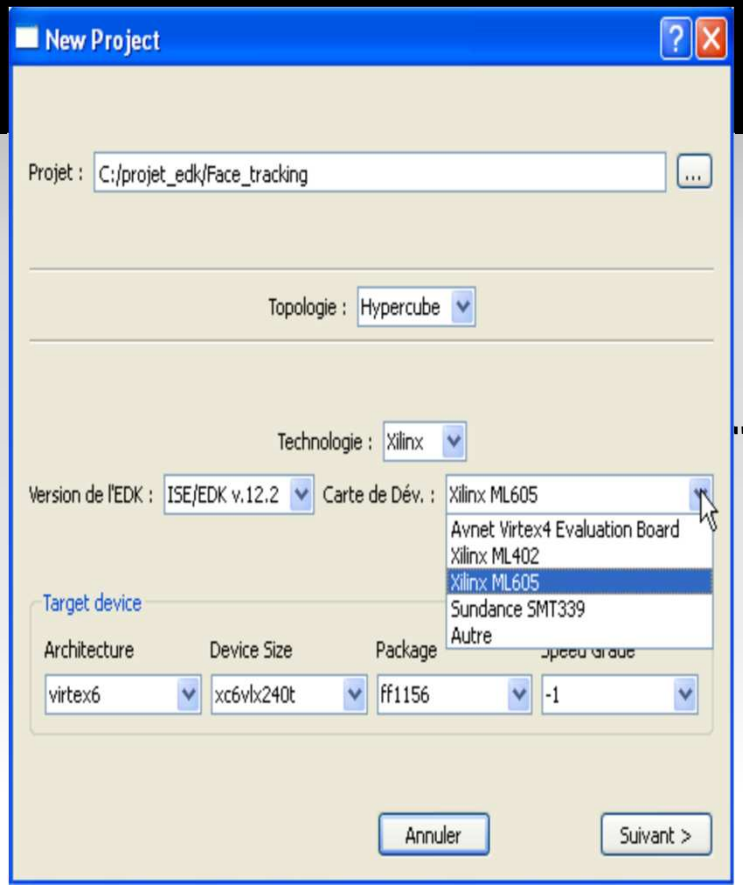
- Direct point to point links and the other using a hardware router.

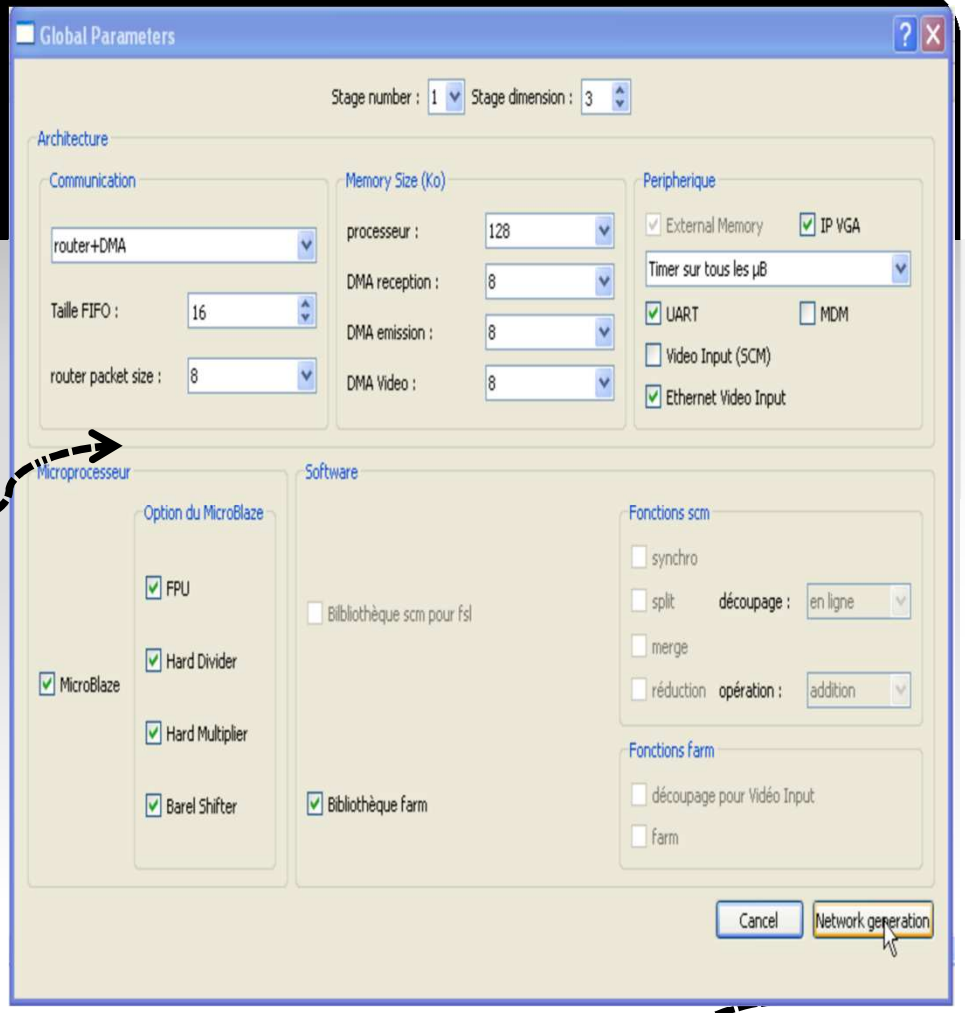
- Parametrization of the HNCP via the CubeGen Framework (dimension, communication ,Size of memory, Configurations of softcore…).

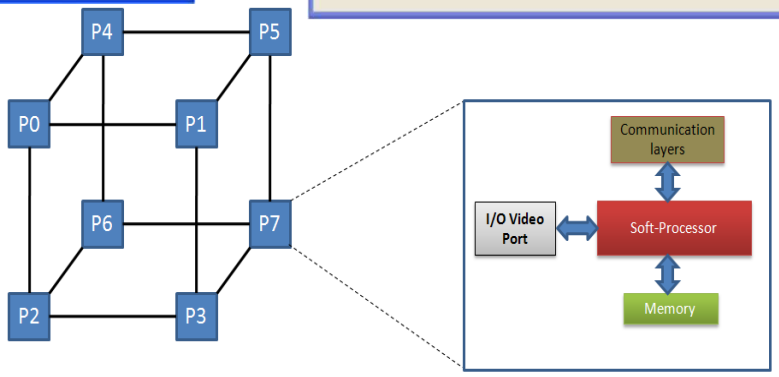
Design Flow of the HNCP



CubeGen Interface

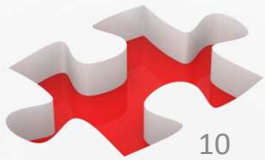




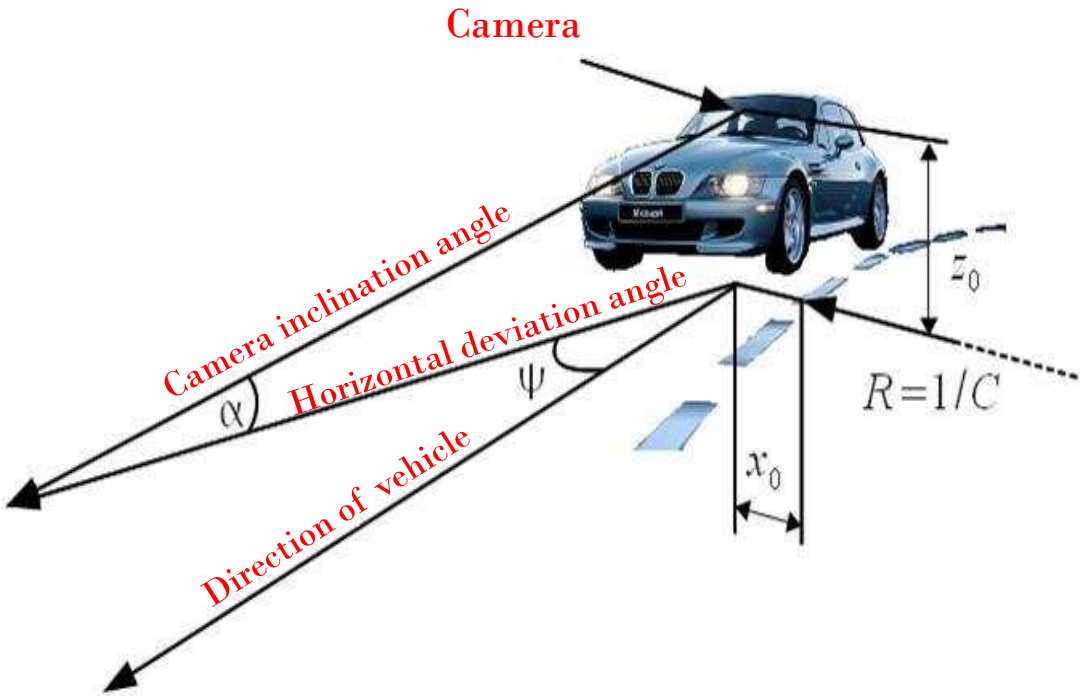


Details of node

Model-driven approach for real-time road recognition



road recognition approach



The steps contained in our proposed recognition process are :

- **Learning phase**
- **Recognition phase.**

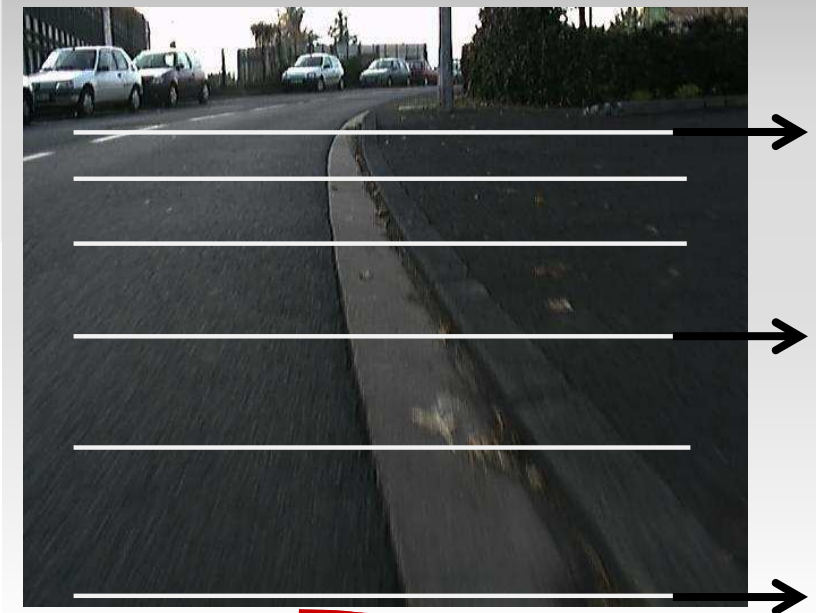
road recognition approach

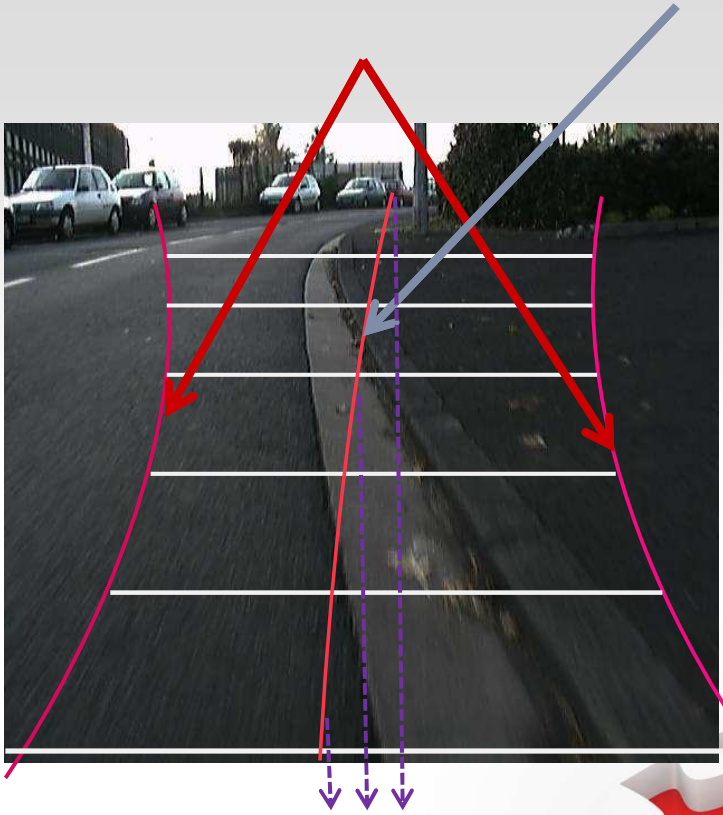
This method is based on recursive recognition driven by a probabilistic model of the road edges in the image.

- **The model used is based on image data and camera parameters.**
- **Our statistical model is composed of n image parameters.**
- **This model is represented by a vector and its covariance matrix :**

$$X_d = \begin{pmatrix} u_{1l} \\ \cdot \\ \cdot \\ \cdot \\ u_{nl} \end{pmatrix} \text{ and } \quad C_{X_d} = \begin{pmatrix} {\sigma_{1l}}^2 & \cdot & \cdot \\ \vdots & \ddots & \cdot \\ \cdot & \cdot & {\sigma_{1n}}^2 \end{pmatrix}$$

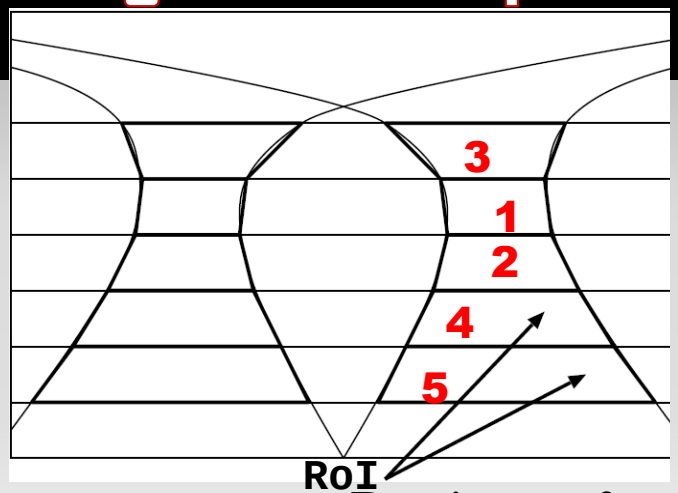
Learning step

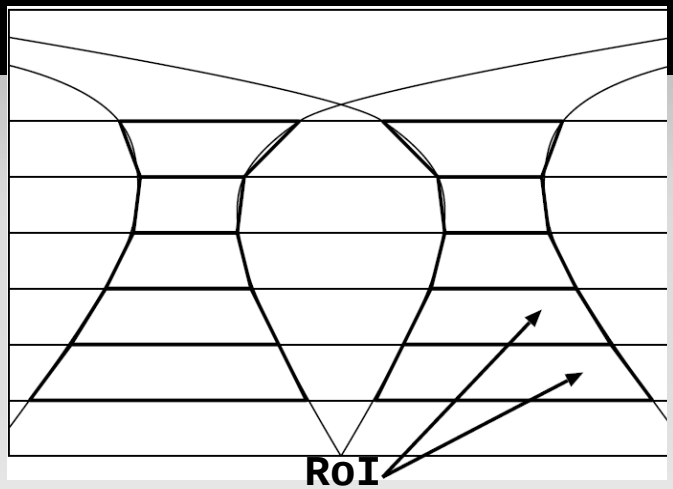


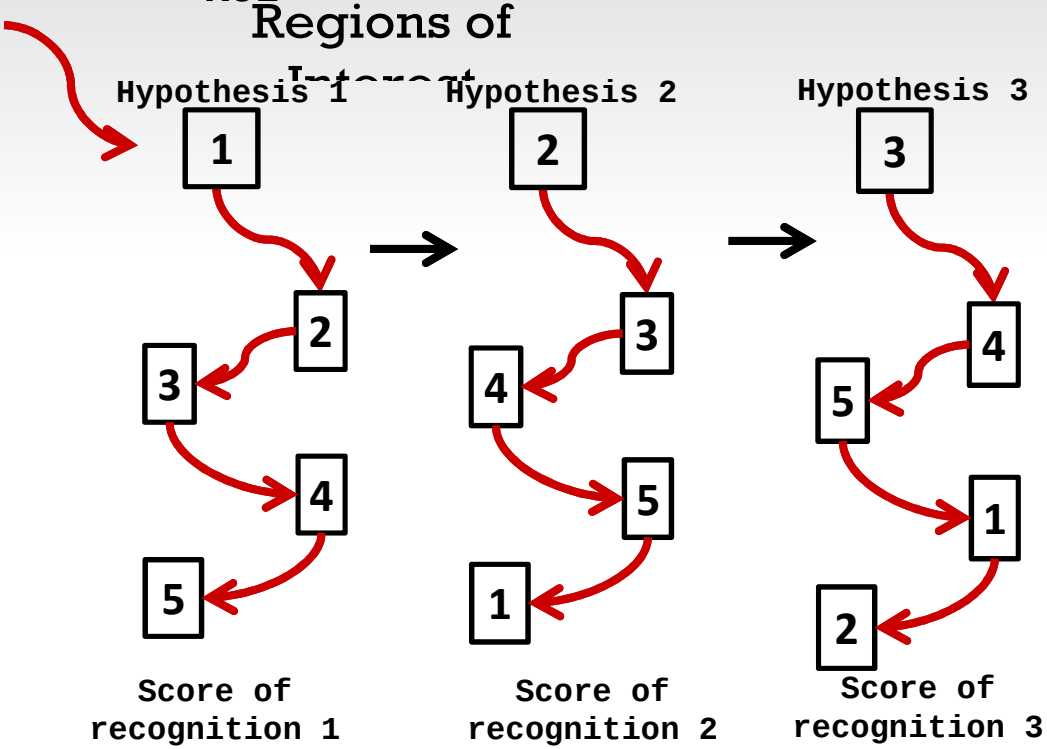


$$X_d = \begin{pmatrix} u_{1l} \\ \cdot \\ \cdot \\ \cdot \\ u_{nl} \end{pmatrix} = \mathrm{g}(V_i,\ X_0, \omega, \alpha, C, \mathrm{L})$$

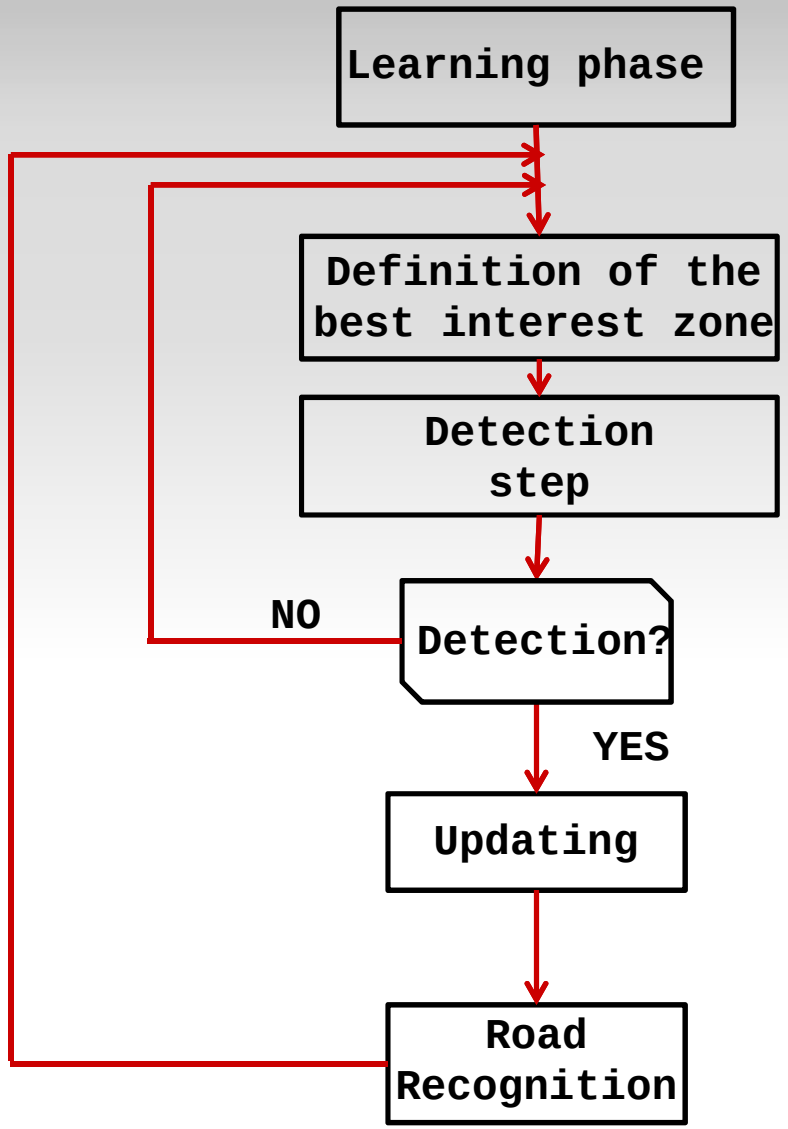
Recognition step



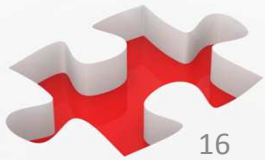




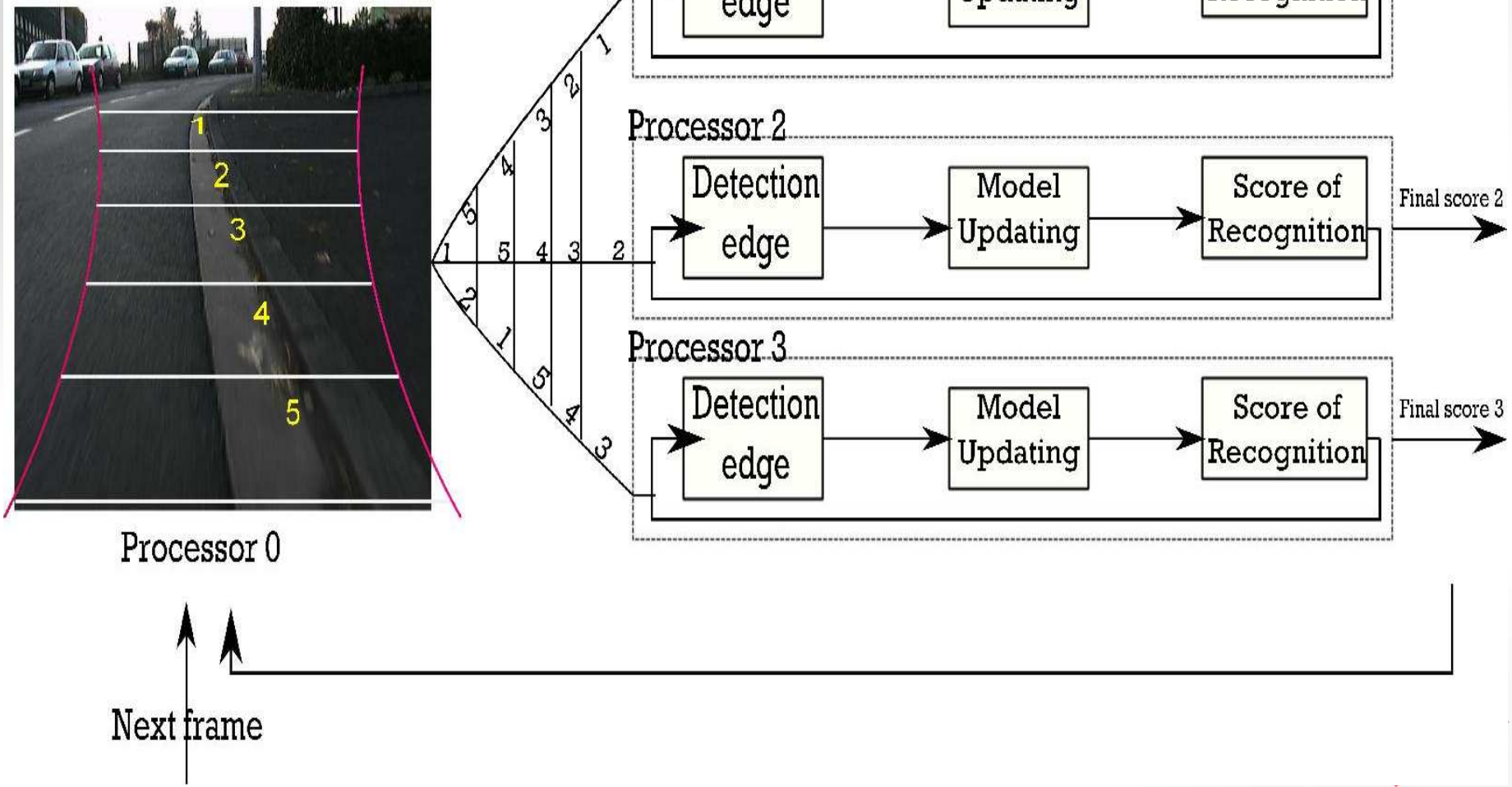
Organization chart of the recognition step



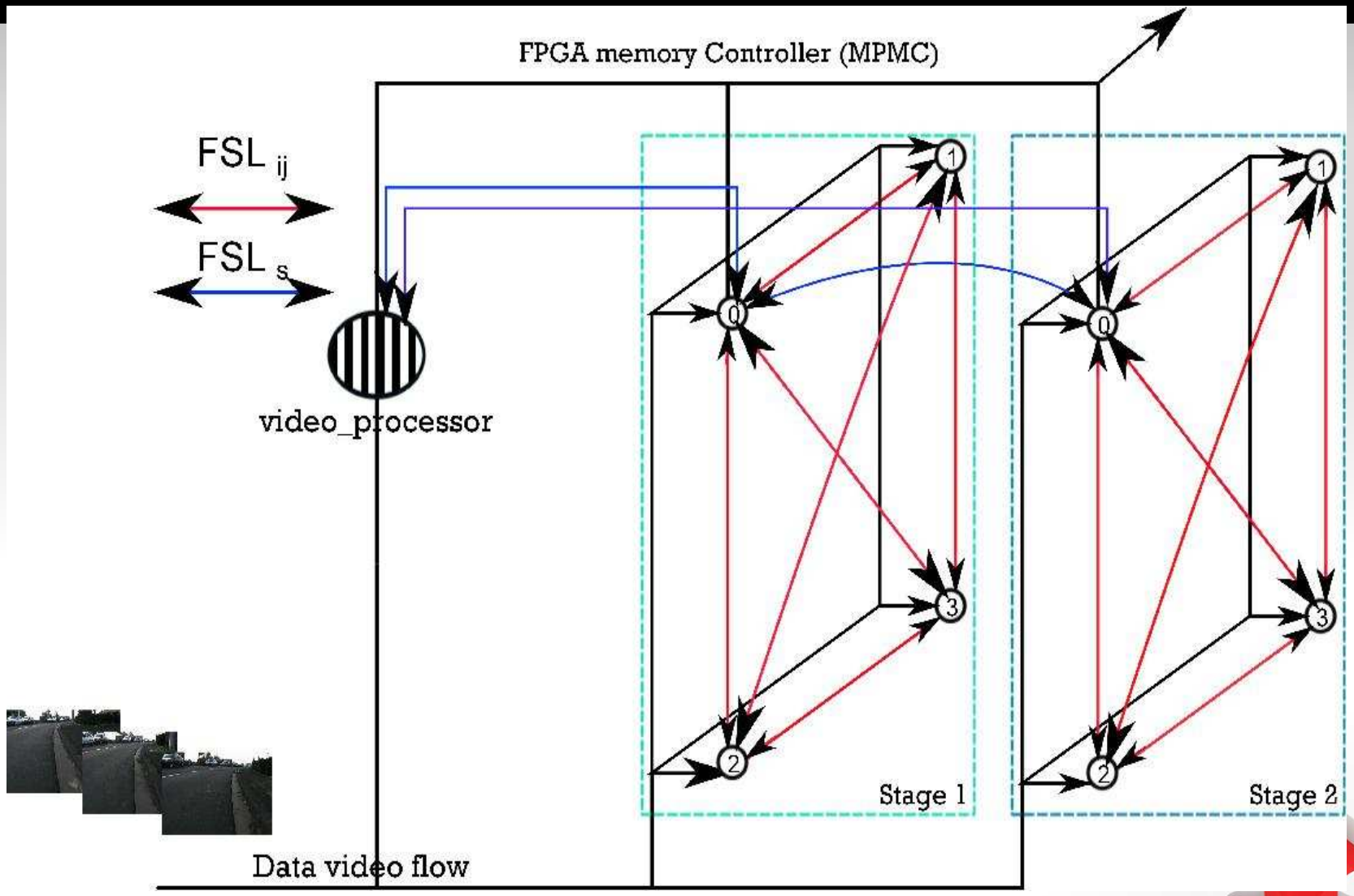
Parallel implementation of recognition algorithm



Application parallelization



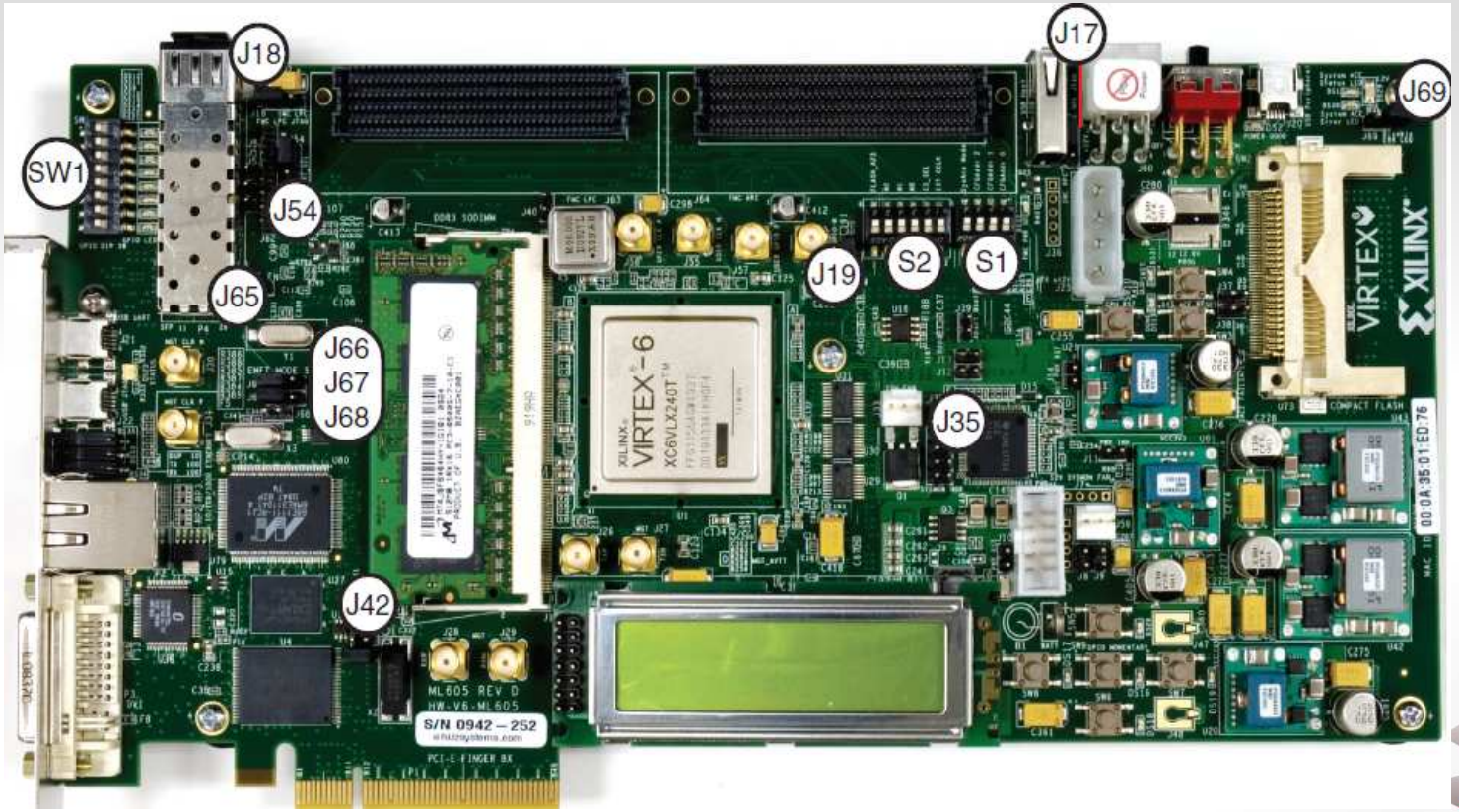
Parallel architecture



Experiments & Conclusion

Experiments implementation

Road recognition Demo

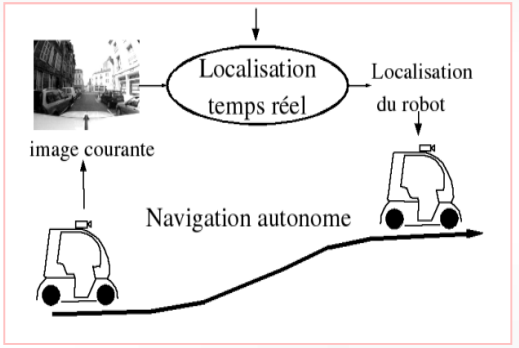


Conclusion

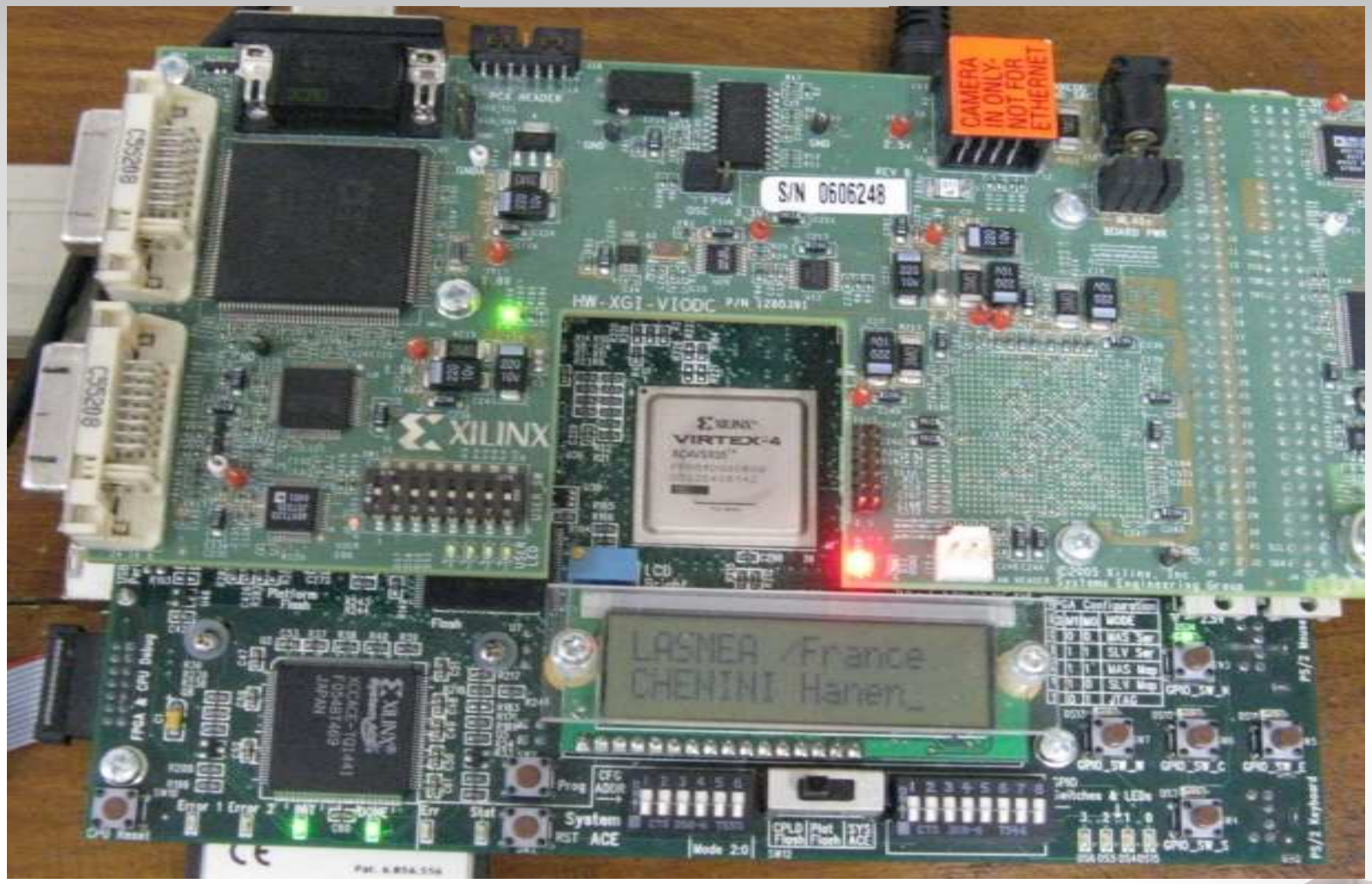
- **Some research of Institut Pascal groups focus their work in development of autonomous robot navigation.**

- **As a consequence, we propose :**

  - **Multi-processors approach for embedded systems.**
  - **HNCP methodology that allows to quickly prototypes different flavors of a given application**
  - **Prototypes designed in a very short time frame.**
  - **Prototypes validated by simulation and on board (FPGA, up to ~50 processors up to now)**



Thank you !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