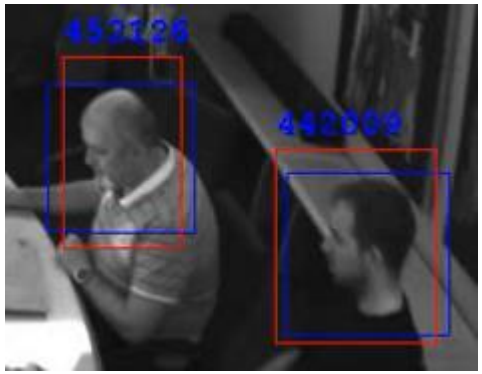
HUMAN PRESENCE DETECTION: FROM BOOSTING TO NEURAL NETWORKS

CURRENT SOLUTION

- Long running project for external customer
- Embedded camera detecting presence of people in indoor
- Mounted in approx. 2.5 m height on wall
- Our target is moving or stand still person from any side
- Many algorithms with significant computational demands
  - Motion detection
  - Online model
  - Static model



AUXILIARY ALGORITHMS

- Motion detection
  - Based on edge magnitude and angle
  - Long term detection with people like behaviour confirmation
- Online model
  - Kind of background subtraction
  - Based on HoG and Haar classifiers
  - Background online updated
  - Foreground pre-learned using boosting

MAIN ALGORITHM

- Static model
  - AdaBoost, WaldBoost, both discrete
  - Experiments with real versions of boosting, also with other classifiers (SVM, …)
  - Based on HoG and Haar (eventually MBLBP) classifiers
  - Experiments done also with more complex classifiers used as weak ones: AdaBoost, SVM,… : classifiers tree

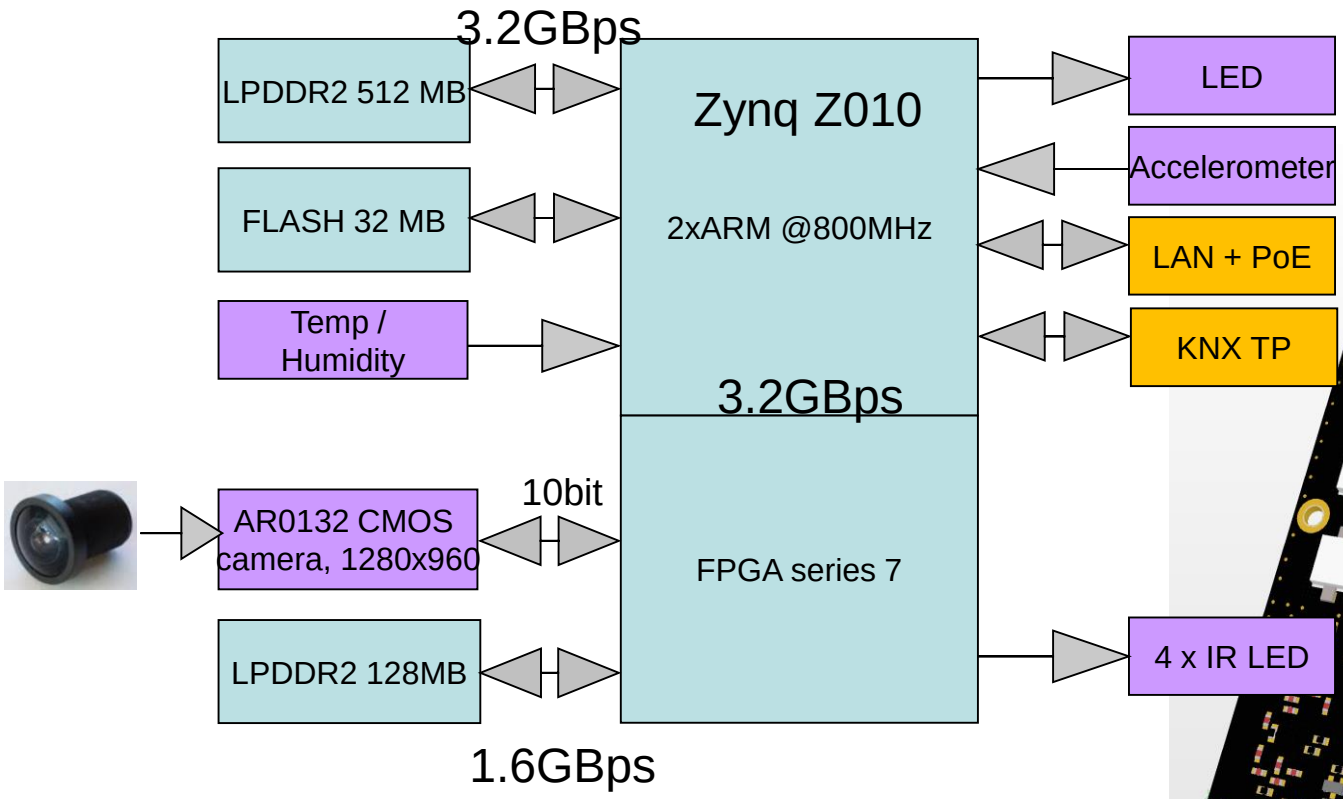
ALGORITHM LIMITS

- Wide angle + long detection range: small detection window
- Person detection from any side, also occluded
- Detection during bad light conditions
- The base part of algorithm, static model, on the edge – model growing, small results improvements
- Experiments with model dedicated to scene
  - Better results, but difficult for users
- Decision to change completely algorithm core

CURRENT HW

- Zynq Z-7010
- 1.2 Mp CMOS camera
- IR lighting
- Power consumption below 4 Watts (2.5 W without lighting)

CURRENT HW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FLASH 32 MB
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Zynq Z010
2xARM @800MHz
3.2GBps
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Accelerometer
LAN + PoE
KNX TP
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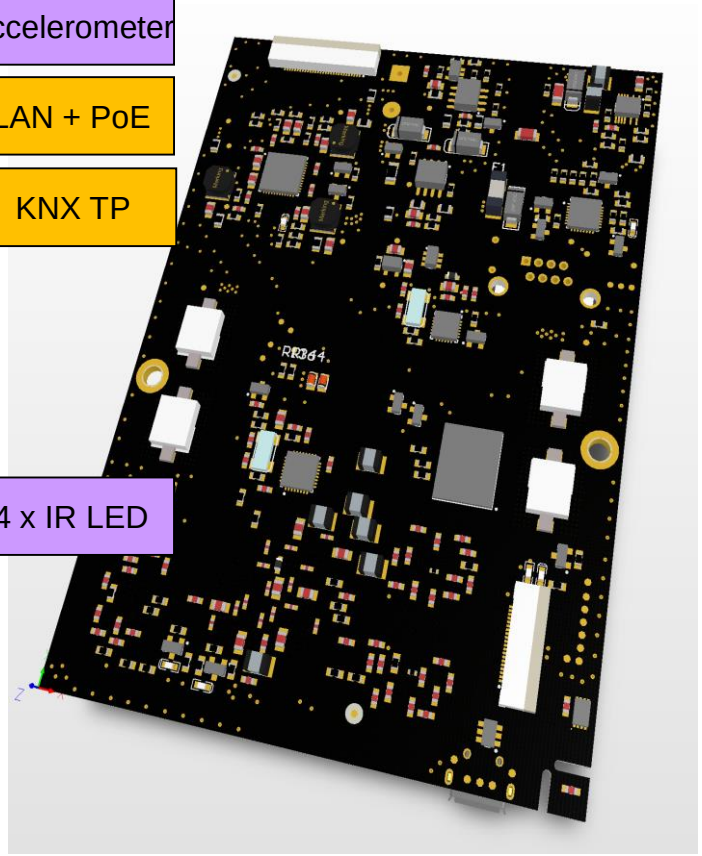
LPDDR2 128MB
FPGA series 7
4 x IR LED
1.6GBps

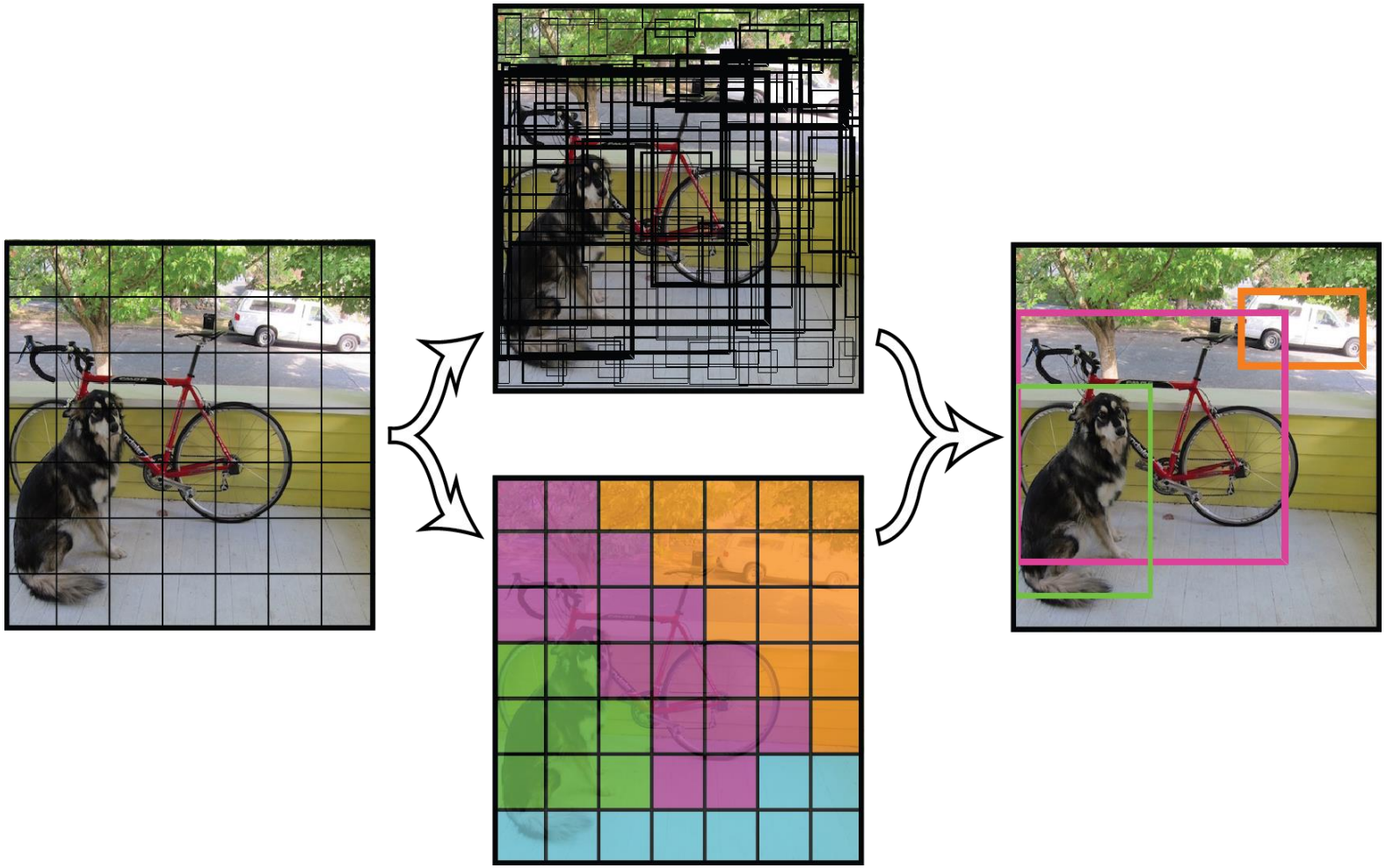


CURRENT HW

NEURAL NETWORKS

- Single shot architecture (no location proposals, object detection in one forward pass)
- Single-class detector
- Network based on Yolo detector (by Joseph Redmon) currently gives us best results
- 22 convolutional layers, approx. 50M parameters
- Input image 480x480px
- We were able to quantize parameters to 9 bits in dynamic fixed point format with no or acceptable loss in accuracy

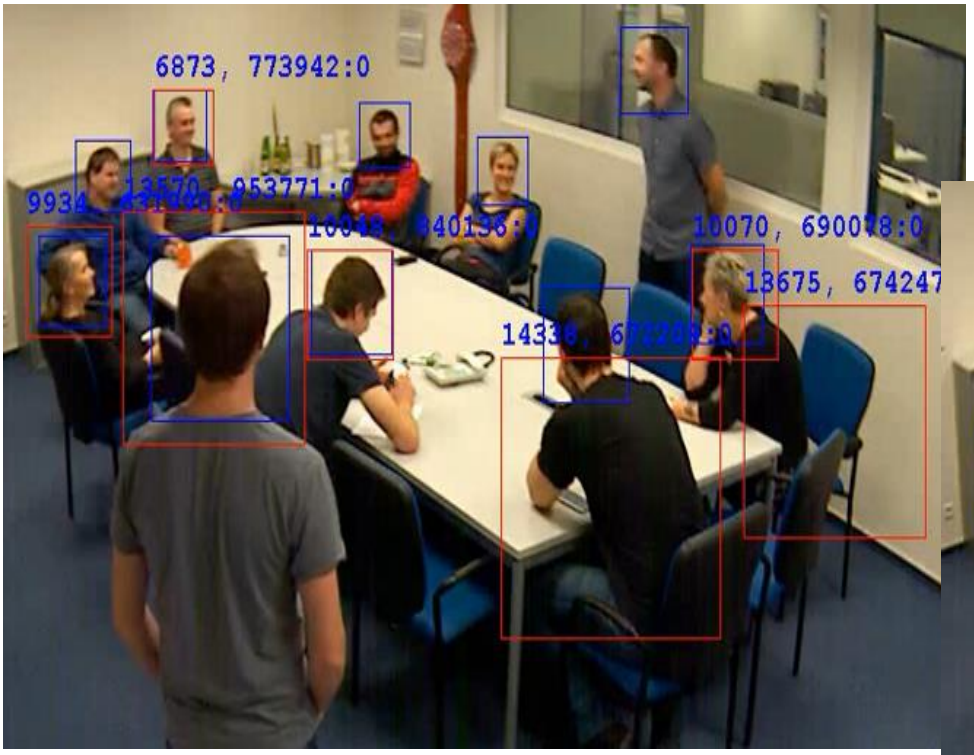
YOLO



FPGA IMPLEMENTATION

- First design for CNN implemented
- Consist of two computational units
- „Pseudo assembly code“ used to describe CNN layers
- Speed up in progress
- Expected speed is 1 FPS without other optimizations
- Motion detection part of implementation

OLD VS. NEW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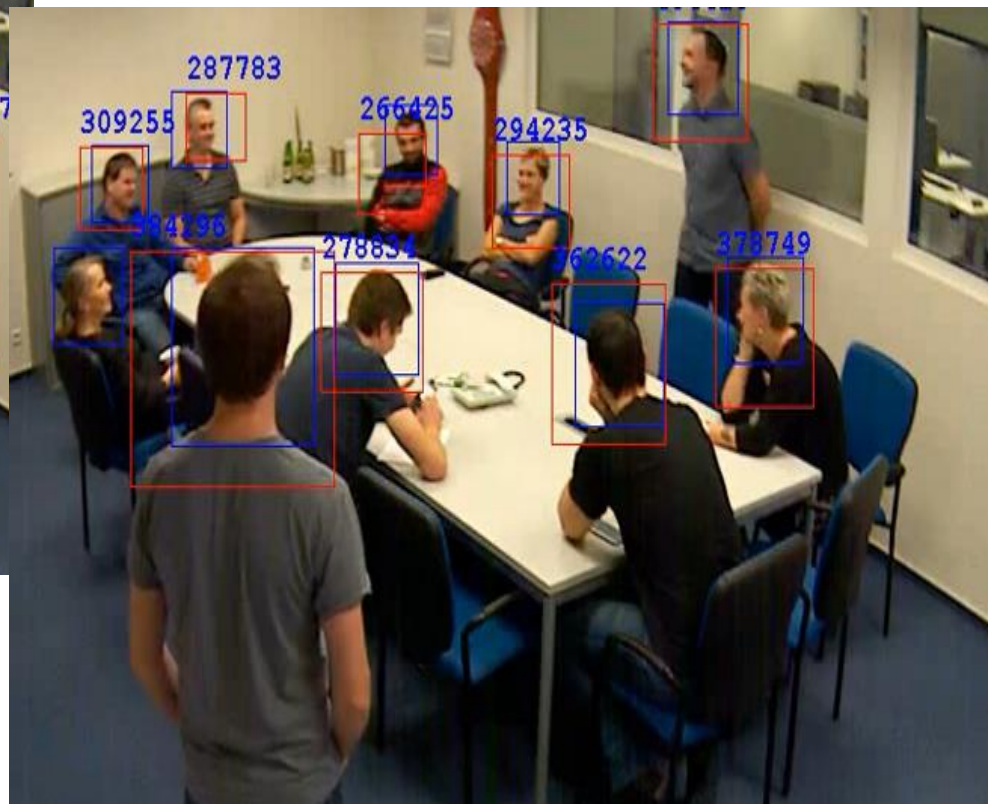
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NEXT STEPS

- Learn better models
- Re-learn quantized models
- Higher quantization