



上海大学微电子中心

# Posture Recognition Based on Deep Learning

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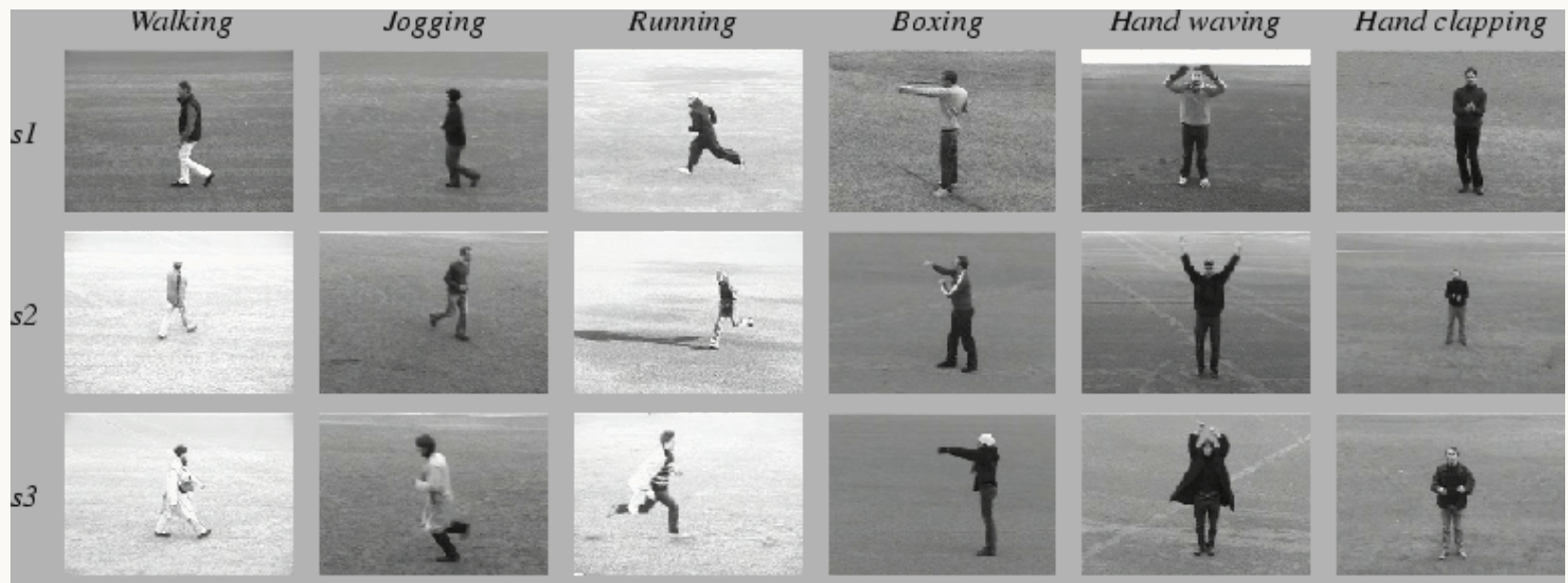
## 1

# Posture Recognition Based on Vision

**Pedestrian Detection:** find where the person is

**Posture Recognition:** recognize what posture it is

**Applications:** somatic games, abnormal behavior detection, ...

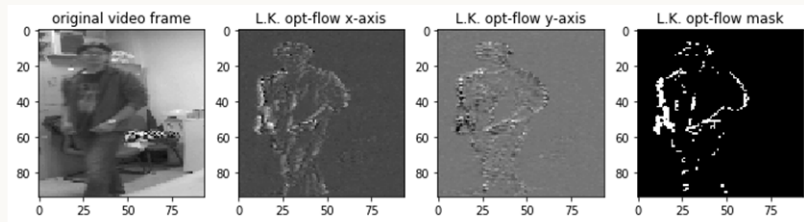


## 2

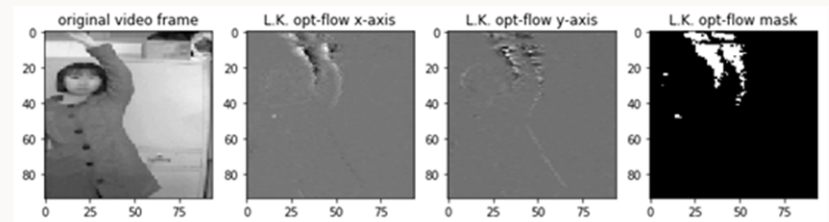
# Posture Recognition Scheme

**Two-Stream Convolution:** compute optical flow in the video stream, and use video and optical flow as the input channels of CNN to recognize the posture

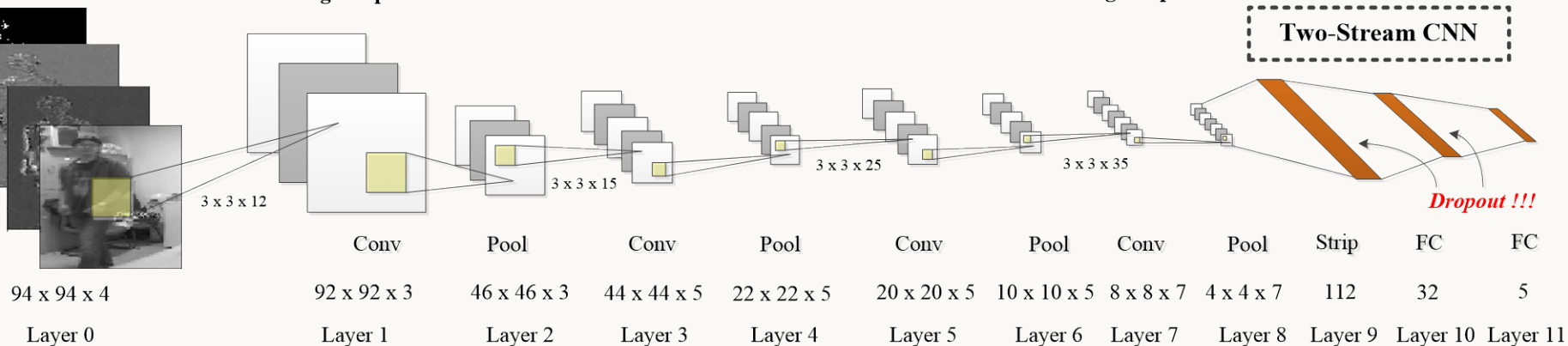
**ISA-NPU:** ADD / MULT / CONV / POOL / SIGM / TANH / ...



walking sample

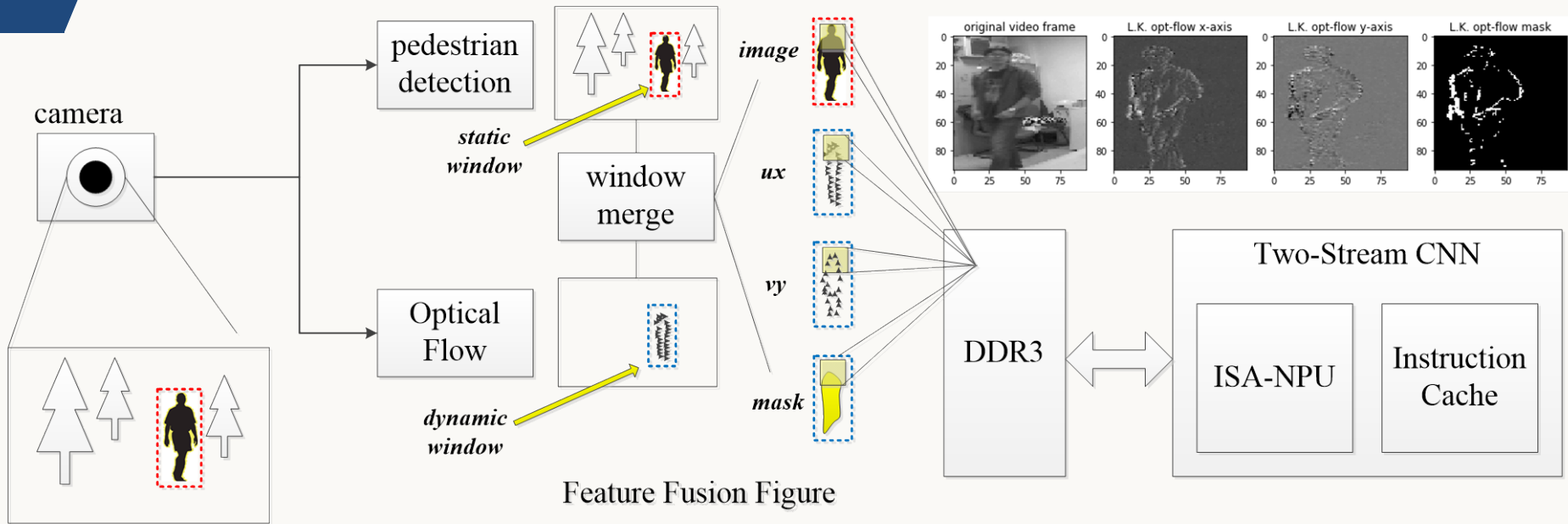


waving sample

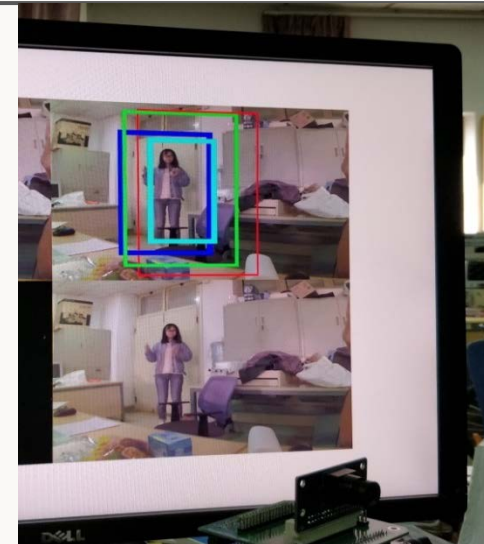
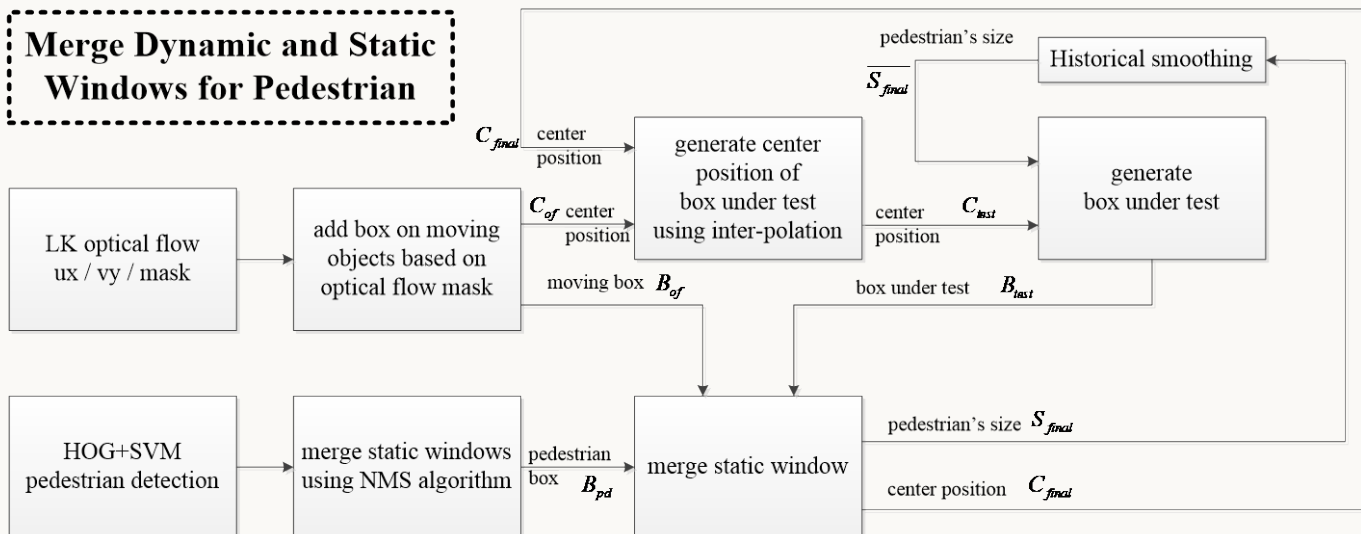


## 4

# The Flow of Posture Recognition



## Merge Dynamic and Static Windows for Pedestrian



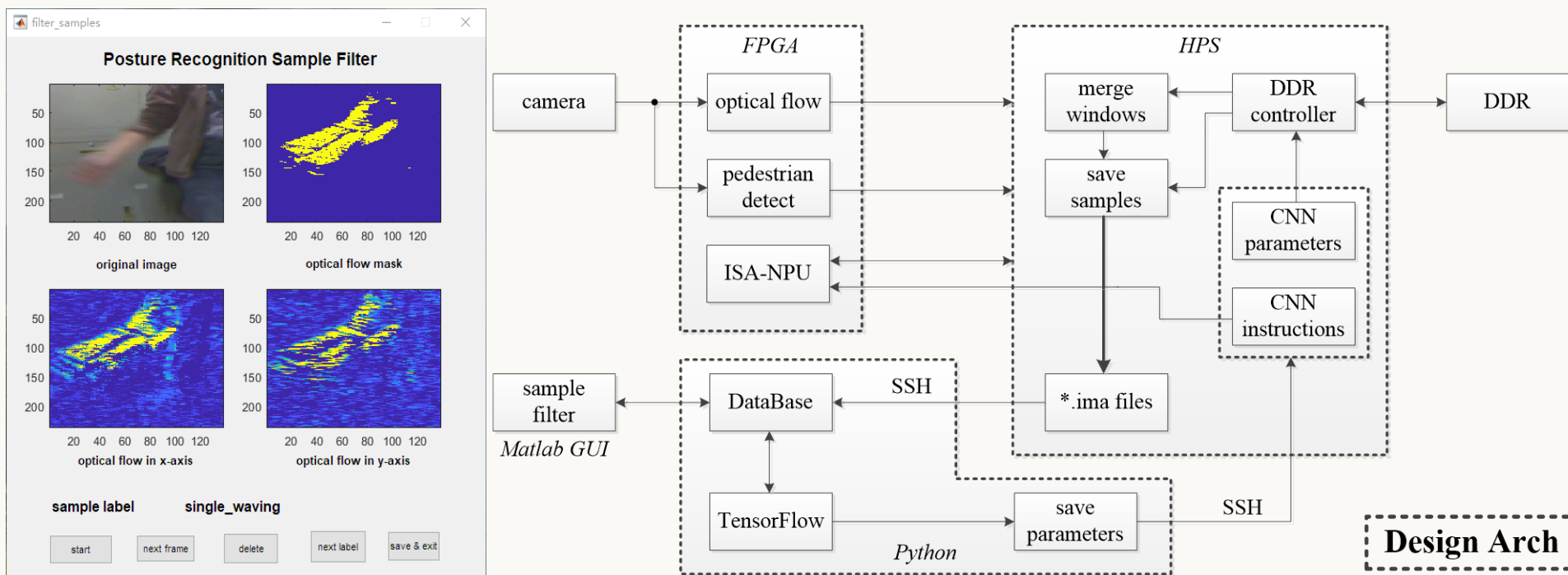
## 5

# Framework of the System

**Co-process of software and hardware on DE10-Nano**

**FPGA:** optical flow, static detection, ISA-NPU, memory scheduler, video output; **HPS:** add box, NPU command;

**Matlab:** filter samples; **Python:** train the CNN model



# Performance of the System

## The resource usage of the total hardware system

Item	ALMs	Memory Bits	DSPs
Utility	37,933 ( 91 % )	2,513,876 ( 44 % )	106 ( 95 % )

## The theoretic limit of performance of modules

Performance		LK Optical Flow	HOG + SVM	ISA-NPU
Speed	Fmax	118.68 MHz	76.8 MHz	79.6 MHz
	Period	800 x 600	800 x 600	814,177
	FPS	247	160	97.7
Area	ALMs	7,799	14,105	3,530
	Memory Bits	188,202	1,167,512	73,984
	DSPs	41	16	43

## The experimental performance of hardware and software modules

Performance		LK Optical Flow	HOG + SVM	ISA-NPU
Speed	Fmax	35 MHz	35 MHz	66.67 MHz
	Period	800 x 600	800 x 600	814,177
	FPS	20	20	3.84
Performance		Dynamic Window	Static Window	Merge Window
Time		70.2 ms	11 us	8 us

## Conclusion and Outlook

*We propose a posture recognition system that:*

1. process optical flow, static pedestrian detection **very fast**, actually it is pipeline processing;
2. **flexible for different CNN models**, if the model changes, only parameters and NPU instructions should be re-generated;
3. recognize four postures with **high precision**: standing, squatting, waving and walking;

*We can improve the system later in these aspects:*

1. **more postures** can be recognized once the CNN model grows;
2. **high performance** can be achieved if bandwidth of DDR increases



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# Thanks for Your Attention

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**GitHub** [https://github.com/cxdzyq1110/posture\\_recognition\\_CNN](https://github.com/cxdzyq1110/posture_recognition_CNN)

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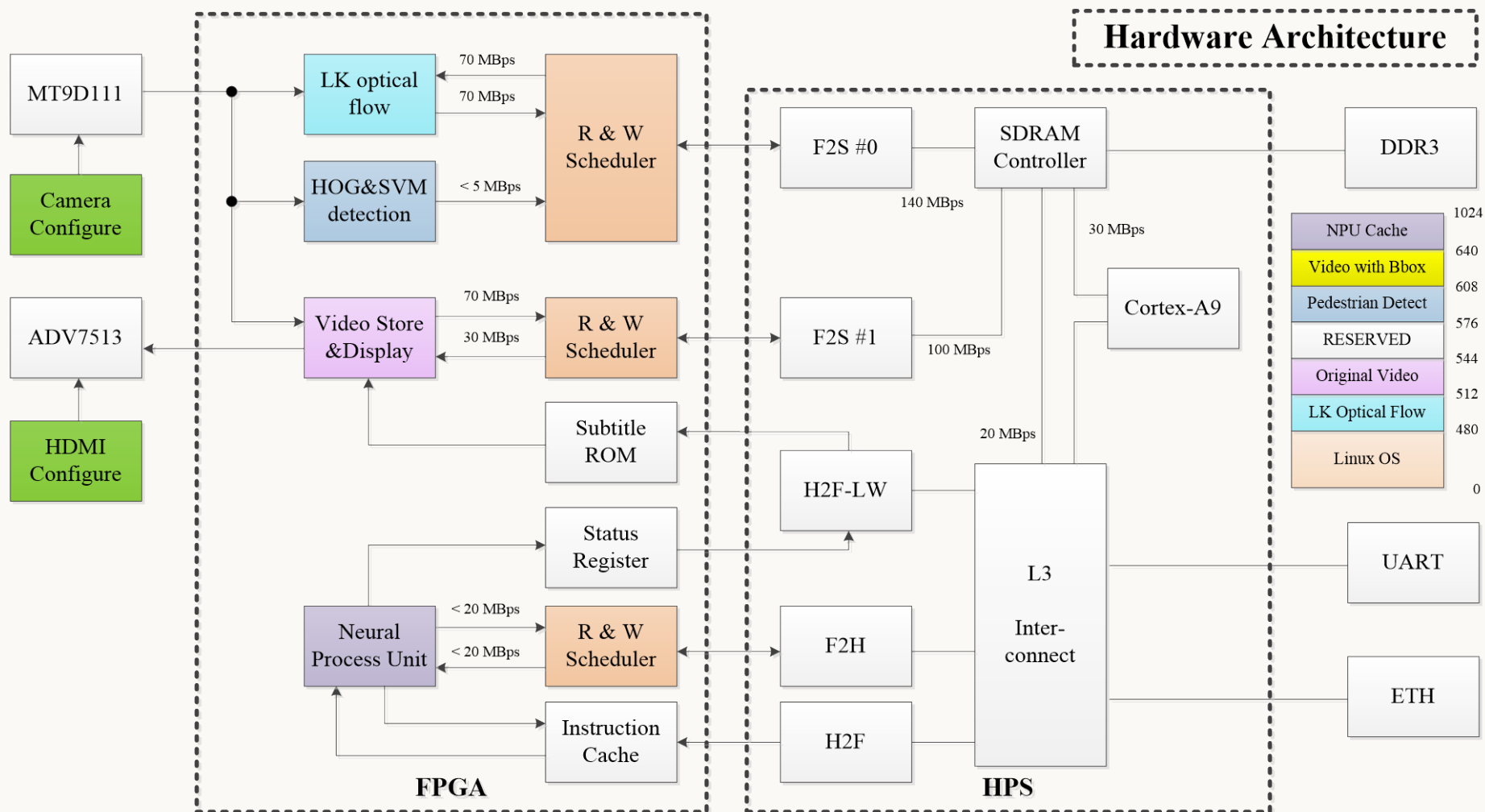






## 6

# Hardware Architecture



## 7

# Software Architecture

## *Different Mode:*

1. **running mode:** merge windows and recognize
2. **sampling mode:** merge windows and sample
3. **testcnn mode:** use training set to test CNN

