



上海大学微电子中心

# Posture Recognition Based on Deep Learning

---

**Team:** *PR023*

**Member:** *Xudong Chen, Yuqi Zhou, Mengjie Li*

**Adviser:** *Prof. Zhangjin Chen*

**Microelectronics R & D Center, Shanghai University**

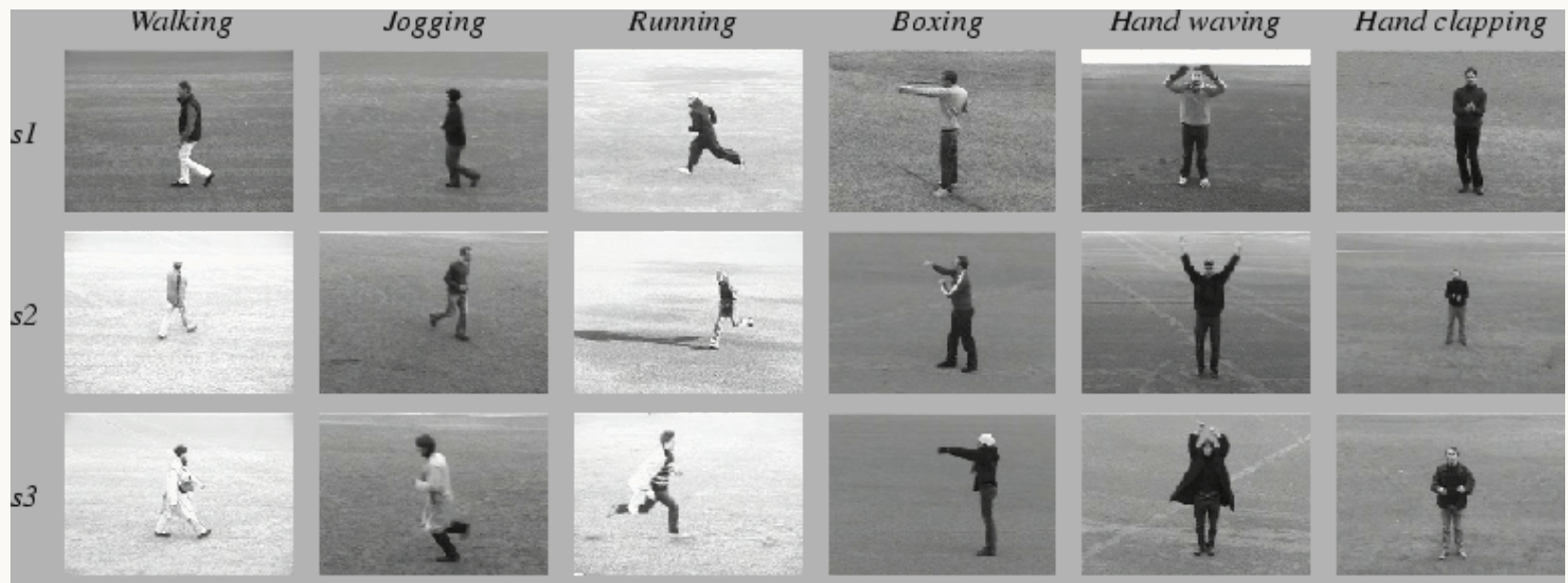
## 1

# 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, ...

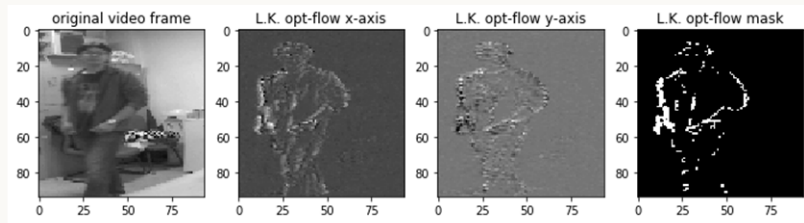


## 2

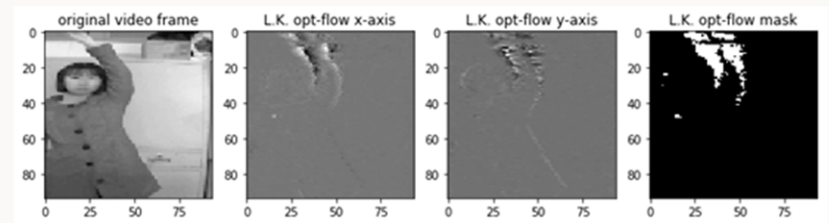
# Posture Recognition Scheme

**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

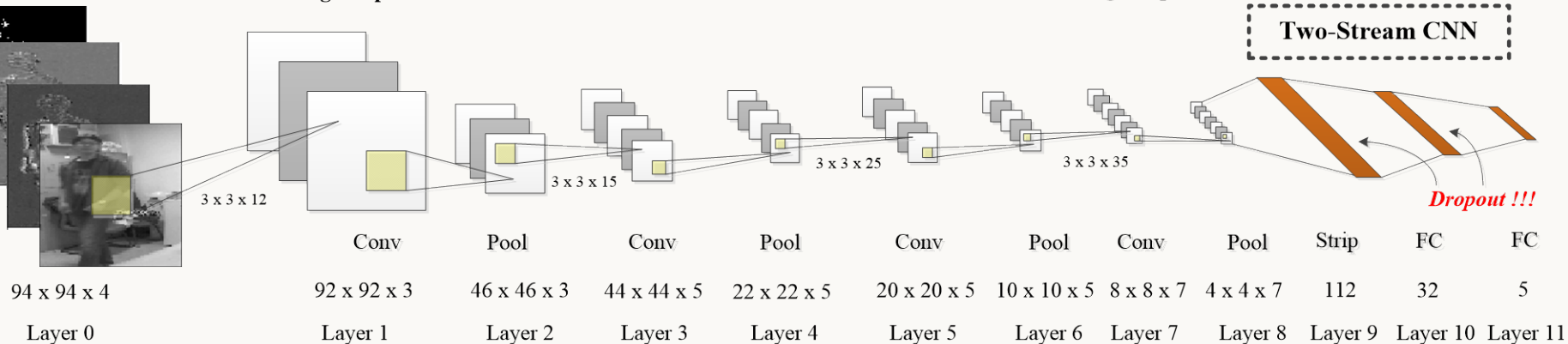
**ISA-NPU:** ADD / MULT / CONV / POOL / SIGM / TANH / ...



walking sample

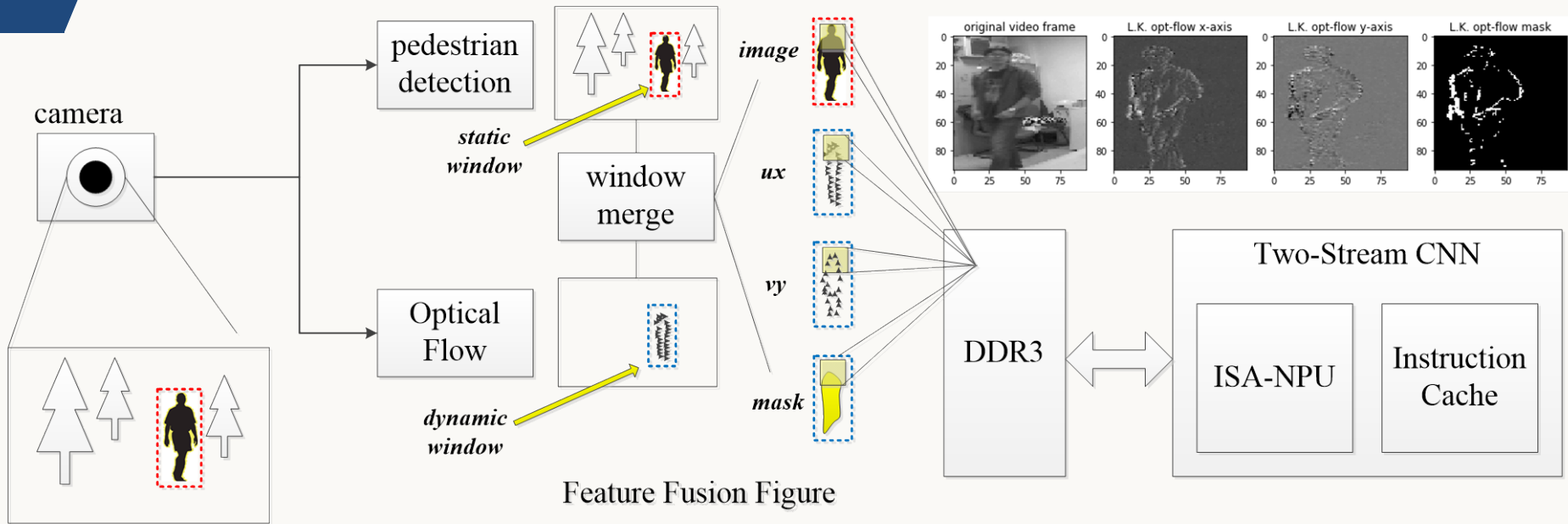


waving sample

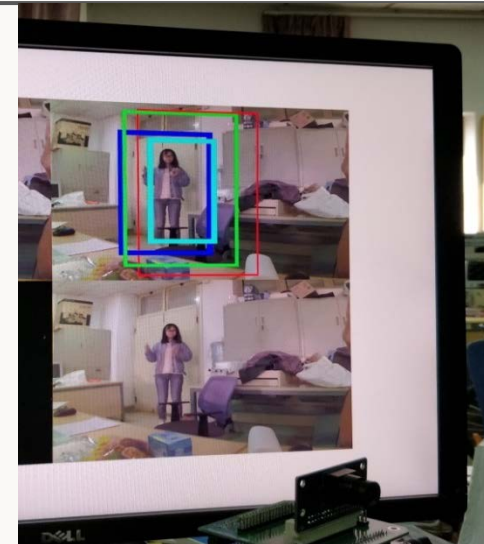
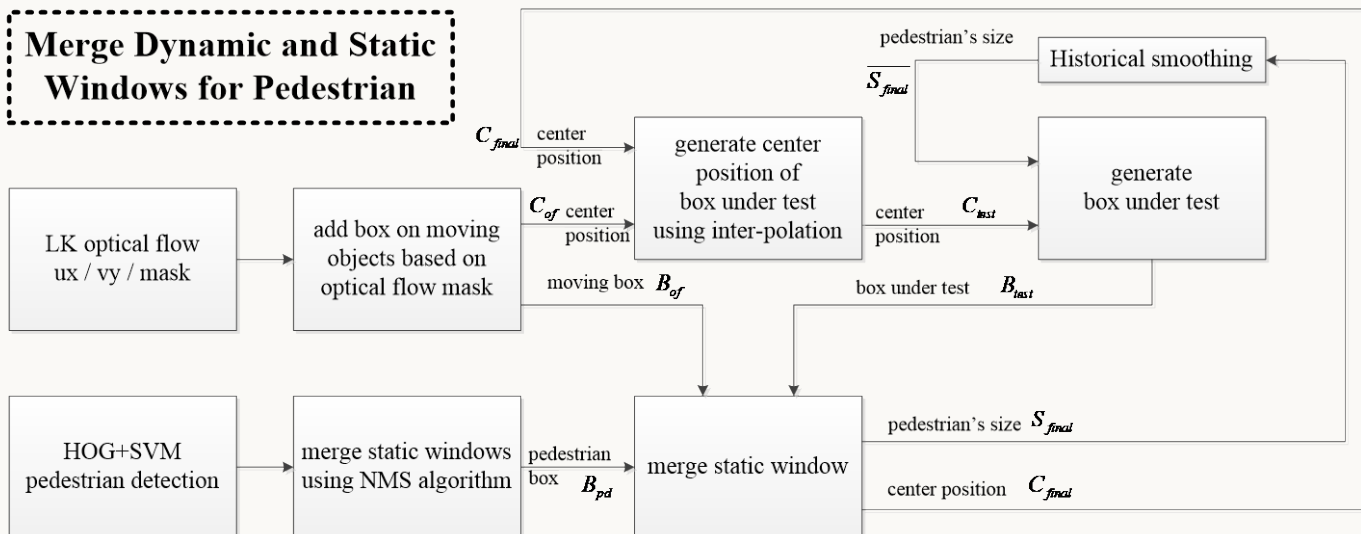


## 4

# The Flow of Posture Recognition



## Merge Dynamic and Static Windows for Pedestrian



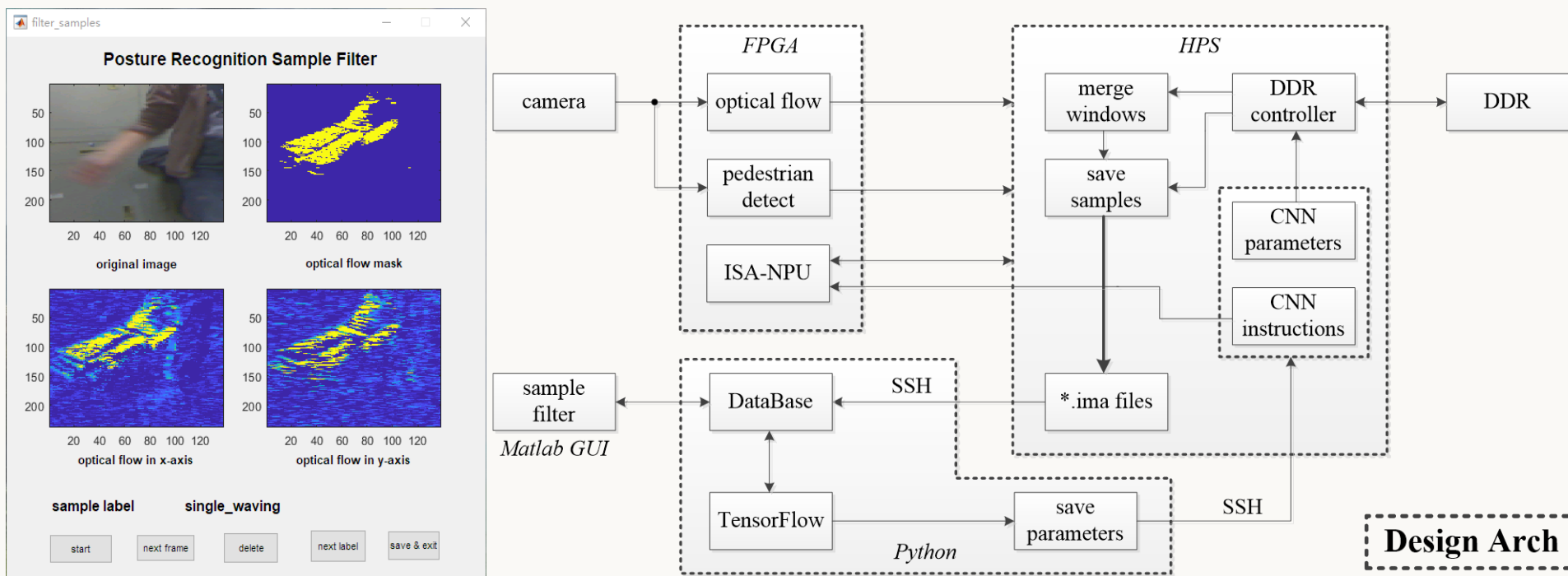
## 5

# 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



上海大学微电子中心

# Thanks for Your Attention

---

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

**Name** Xudong Chen, Yuqi Zhou, Mengjie Li

**Email** [chenxudong0318@gmail.com](mailto:chenxudong0318@gmail.com)

**Team** PR023



*innovatefpga*



*GitHub*





## 6

# Hardware Architecture

