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Embedded Multi-Target Tracking System

CN052

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Outline

1. Introduction
2. System Platform
3. Hardware Architecture of Multi-target Detection
4. Hardware Architecture of Multi-target Tracking
5. Experimental Results

1. Introduction

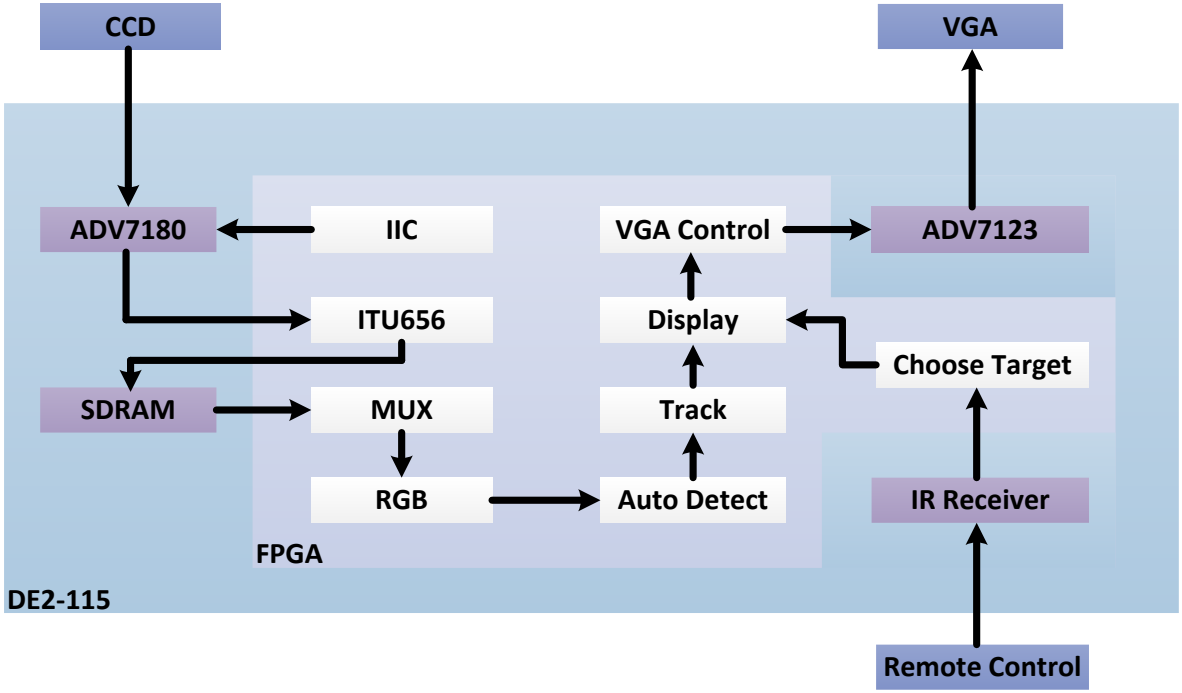
Background:

- Surveillance can detect acts of terrors, accidents, and crimes.
- Target detection and tracking are crucial steps in video surveillance.
- Traffic monitoring; Smart home; Precision Guidance; Rehabilitation.

Implementation:

- Use FPGA parallelism to accelerate image processing speed
- A combining algorithm of Frame Difference and Particle Filter
- Detect moving targets rapidly
- Track moving targets steadily; Judge tracking and lost status
- Reuse IP cores to detect and track multiple targets

2. System Platform



Input: CCD Camera

Processing: DE2-115

Output: VGA Display

DE2-115:

864×625 PAL to 800×525 VGA

Auto Detection (Frame Difference)

Tracking (Particle Filter)

IP Core Reuse

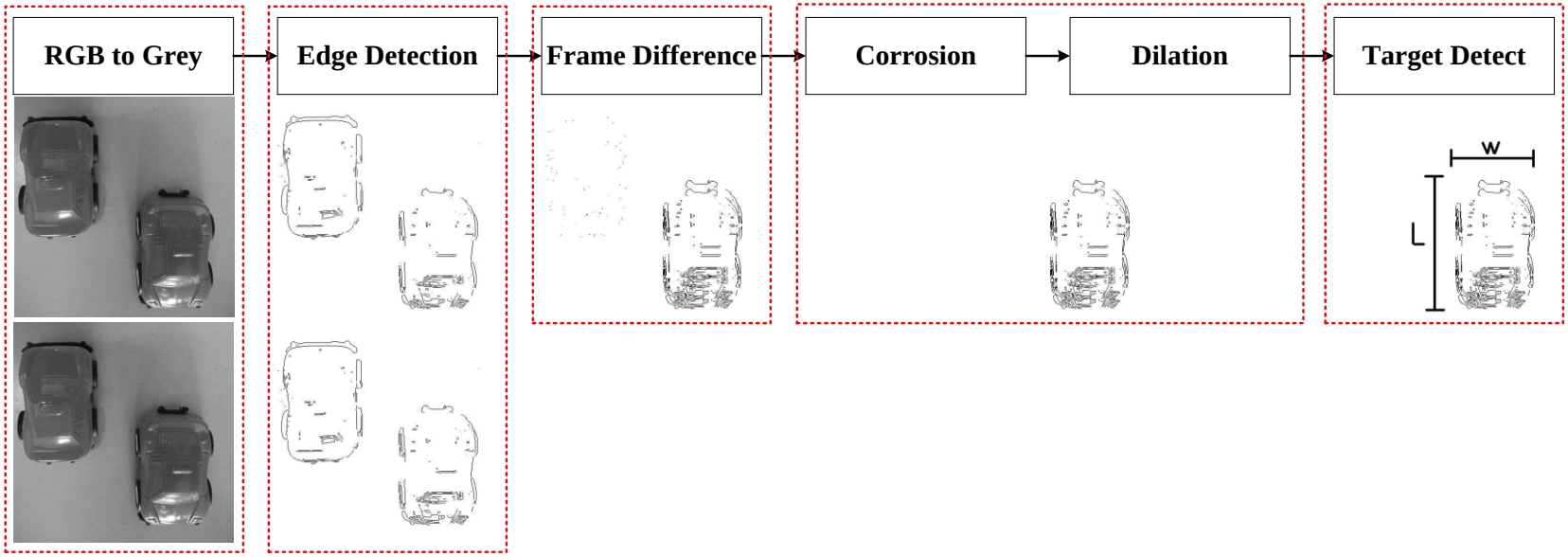
3. Hardware Architecture of Multi-target Detection

Edge Detection: Sobel Operator; Protect the performance from light

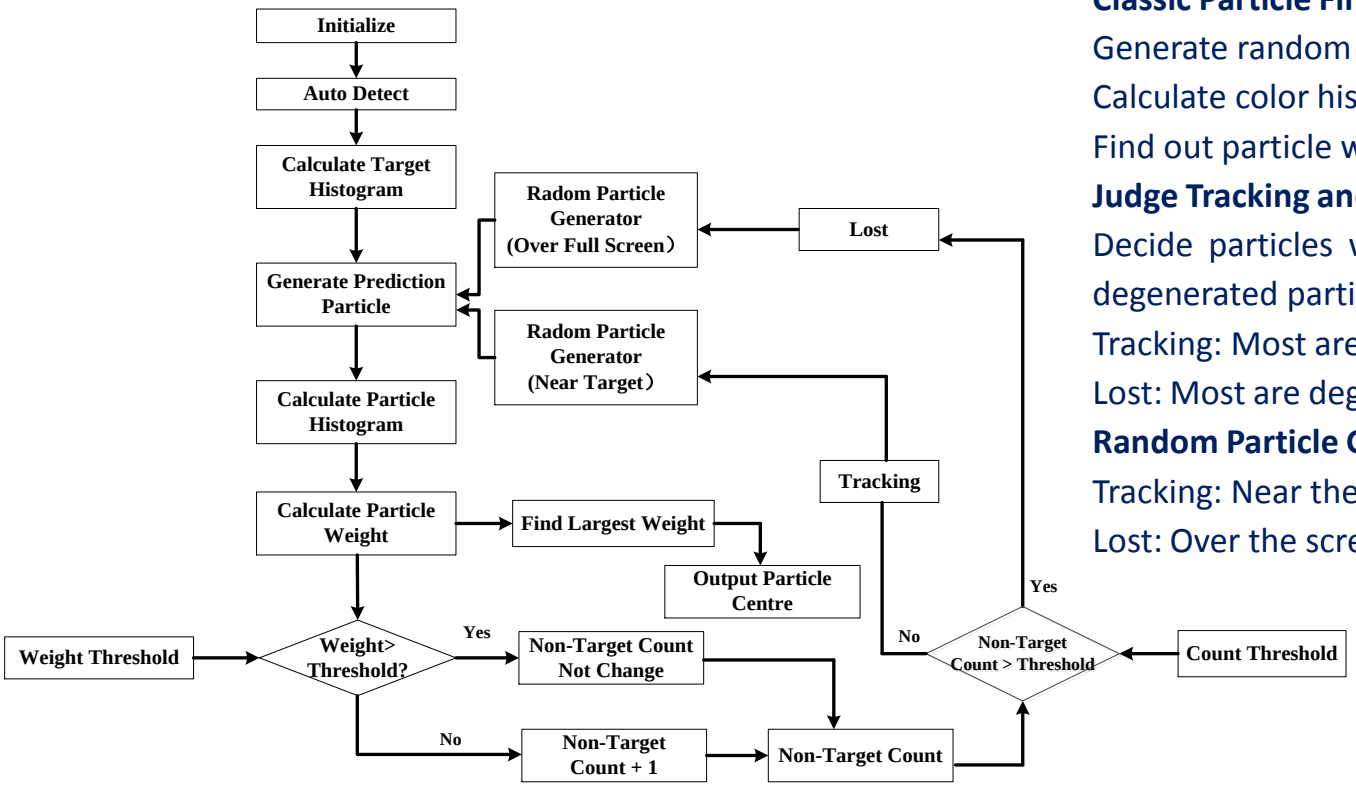
Frame Difference: Subtract corresponding pixels between two adjacent frames; To save memory resources, operate frame difference just at the surrounding of the screen

Corrosion: Remove the noises in the result of Frame Difference

Dilation: Enhance the connectivity of detected moving target



4. Hardware Architecture of Multi-target Tracking



Classic Particle Filter:

Generate random prediction particles;

Calculate color histogram of target and particles;

Find out particle with largest weight as target;

Judge Tracking and Lost Status:

Decide particles with extremely low weight as degenerated particles;

Tracking: Most are qualified particles;

Lost: Most are degenerated particles;

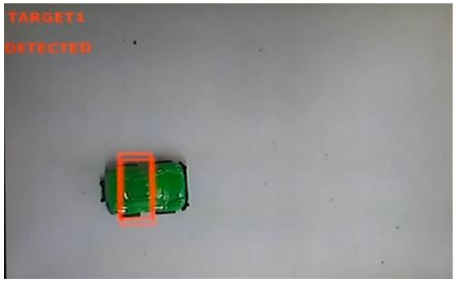
Random Particle Generation:

Tracking: Near the Target;

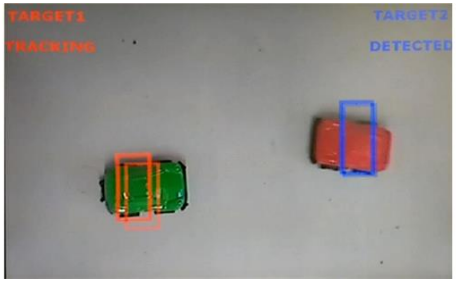
Lost: Over the screen;

5. Experimental Results

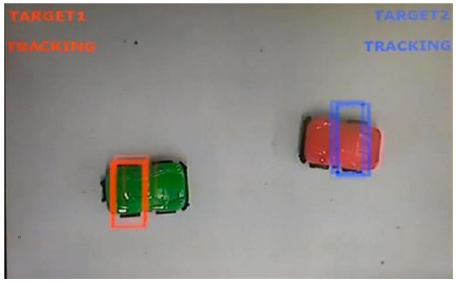
Multi-target Auto Detection



(a) Target1 Detected

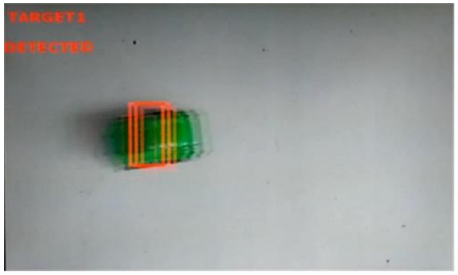


(b) Target1 Tracking Target2 Detected

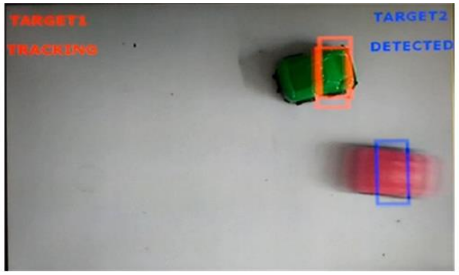


(c) Target1 Tracking Target2 Tracking

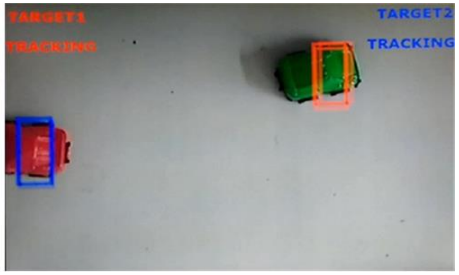
Multi-target Auto Detection With Shadows



(a) Target1 Detected

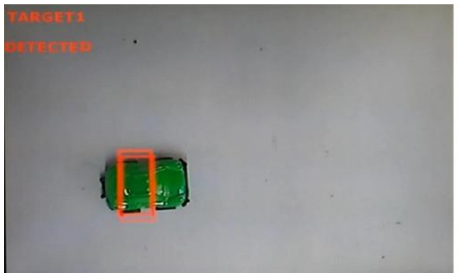


(b) Target1 Tracking Target2 Detected

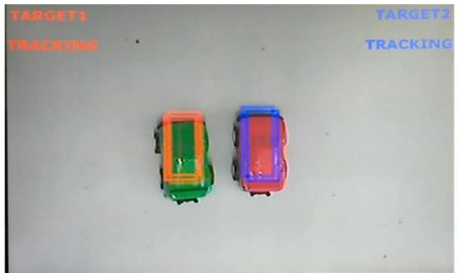


(c) Target1 Tracking Target2 Tracking

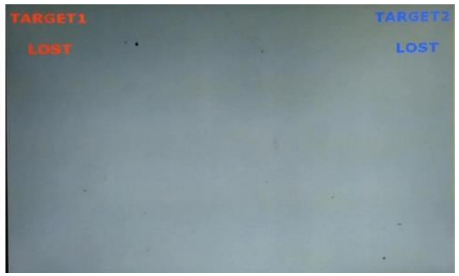
Multi-car tracking



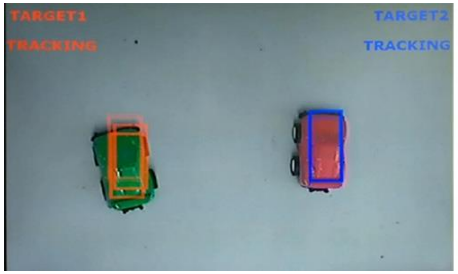
(a) Target1 Detected



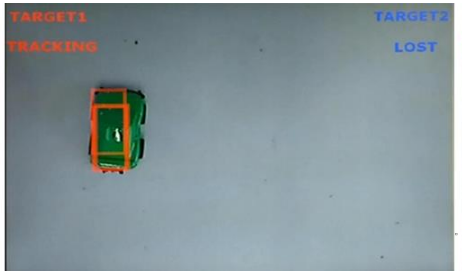
(b) Target1 Tracking Target2 Tracking



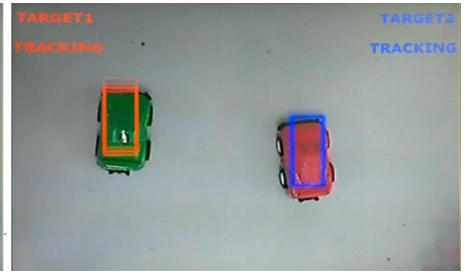
(c) Target1 Lost Target2 Lost



(d) Target1 Tracking Target2 Tracking

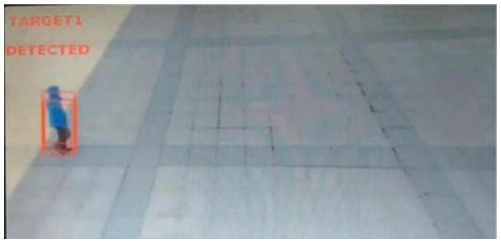


(e) Target1 Tracking Target2 Lost

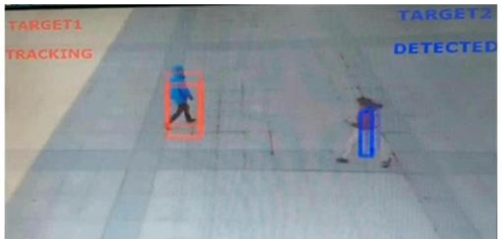


(f) Target1 Tracking Target2 Tracking

Multi-person tracking

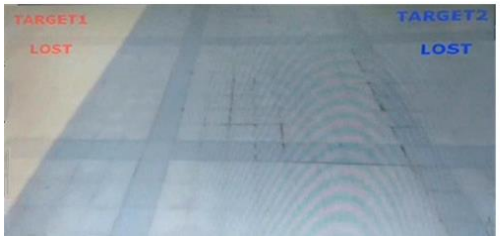


(a) Target1 Detected



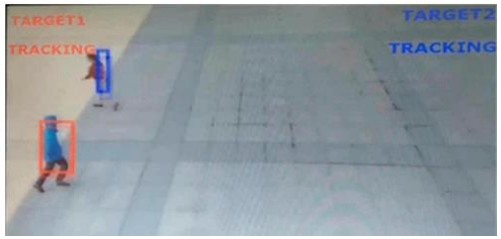
(b) Target1 Tracking Target2 Detected

(c) Target1 Tracking Target2 Tracking



(d) Target1 Lost Target2 Lost

(e) Target1 Lost Target2 Tracking



(f) Target1 Tracking Target2 Tracking

System Power Dissipation

Total Thermal Power Dissipation	549.73 mW
Core Dynamic Thermal Power Dissipation	234.45 mW
Core Static Thermal Power Dissipation	108.67 mW
I/O Thermal Power Dissipation	206.61 mW

IP Core Power Dissipation

Power Dissipation	**Frame Difference**	**Particle Filter**
Thermal Power by Hierarchy	5.99 mW	80.12 mW
Block Thermal Dynamic Power	1.36 mW	38.78 mW
Routing Thermal Dynamic Power	4.63 mW	41.34 mW

System Resource Consumption

Resource	**Usage/Total (percentage)**
Total Logic Elements	78,511 / 114,480 (69 %)
Total Combinational Functions	71,026 / 114,480 (62 %)
Dedicated Logic Registers	24,315 / 114,480 (21 %)
Total Pins	443 / 529 (84 %)
Total Memory Bits	2,820,382 / 3,981,312 (71 %)
Embedded Multiplier 9-bit elements	110 / 532 (21 %)
Total PLLs	1 / 4 (25 %)

IP Core Resource Consumption

Resource	**System**	**Frame Difference**	**Particle Filter**
LC Combinational	71,026	1,068 (1.5%)	31,376 (44.2%)
LC Registers	24,315	400 (1.6%)	9,366 (38.6%)
Memory Bits	2,820,382	1,002,936 (35.6%)	351,975 (12.5%)

Thanks !

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