SIPL SIGNAL & IMAGE PROCESSING LAB

Technion Israel Institute of Technology

RT Embedded Pedestrian Detection and Tracking

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Department of Electrical Engineering

Electronics

Computers

Communications

משרד הבטחון

Outline

Introduction

Suggested Algorithm

Implementation

Summary

Live Demo

Project Motivation and Domain

- High quality pedestrian detection and tracking system.
  - Fixed camera, outdoor scenes.
  - Non-deterministic environment.
  - Aid in surveillance and security tasks.

The Challenge

Complex scenarios sets several difficulties :

Other issues:

- Illumination changes.
- Moving elements.

Project Objectives

- **Establish a detection and tracking system.**
  - ***Moving*** pedestrians only.
- **Robust**
  - Lightning changes.
  - Moving scene elements (waving trees etc.)
  - More…
- **Real-Time operation.**
  - Existing solutions:
    - High computational complexity.
    - Robustness is still an issue.
- **Embedded implementation.**

Proposed Solution

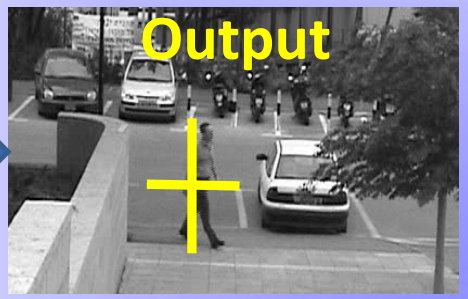
A novel background modeling algorithm

Background Modeling and Subtraction

Foreground Frame

Motion Segmentation

Target Tracking



Simple Background Model

- Moving Average (Alpha Filter)
  - Frame Averaging over time.

Fast adaption…

Slower adaptation…

  - Intermediate values also problematic.

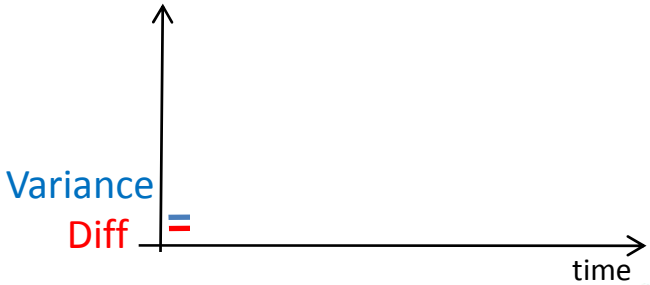
Step 1 – Background Modeling

- ***Diff*** **=** $|$ ***(Input Frame) – (Background Frame)*** $|$
- ***Temporal Variance:***
  - Constantly attempts to reach diff.
  - If ***(Diff > Variance)*** ➡ ***Variance = Variance + Const***
  - If ***(Diff < Variance)*** ➡ ***Variance = Variance – Const***
- ***Background Value:***
  - Local frame averaging over time.
  - Adaptation only when ***Variance > Diff***

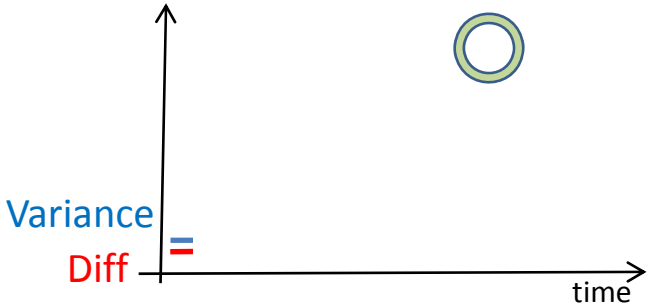
Step 1 – Background Modeling

Pixel assigned with temporal Variance

Diff =
Input – Background



Background Not Changed



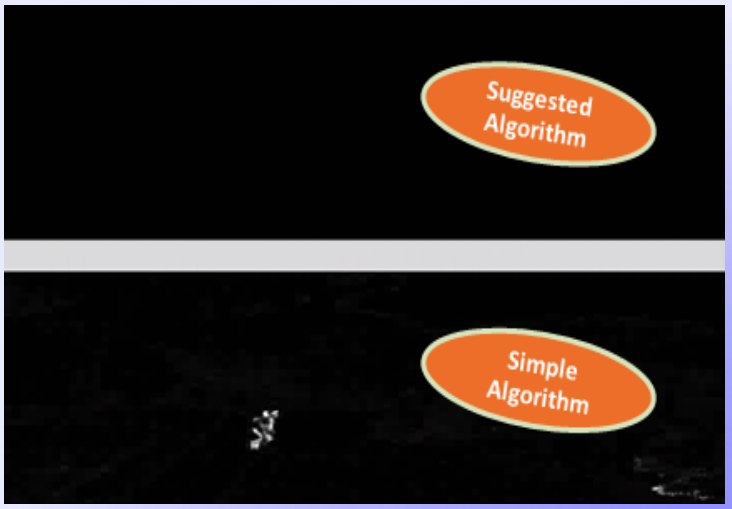
Background Adaptation Begins

$$BG_n = \alpha \cdot BG_{n-1} + (1-\alpha) \cdot INPUT_n$$

Step 2 – Background Subtraction

Foreground Frame = (Input Frame) – (Background Frame)

- Noisy regions reduces detection rate.
- Noisy regions characterized by high variance.
- High variance pixels are eliminated.



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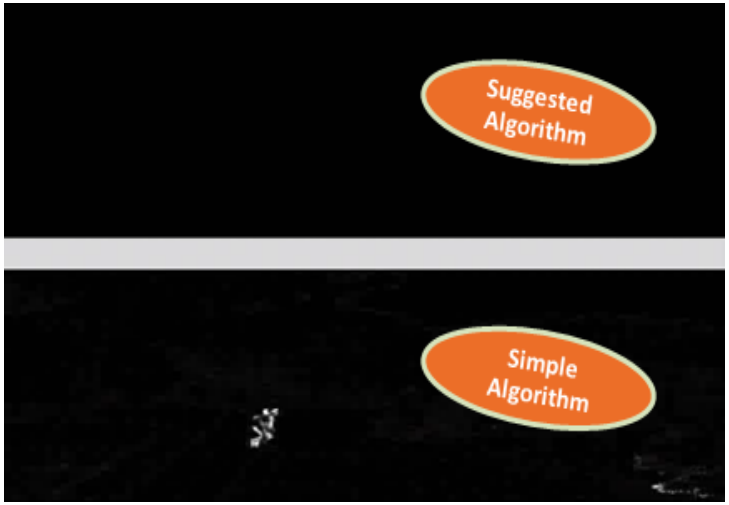


Digital Signal Processor

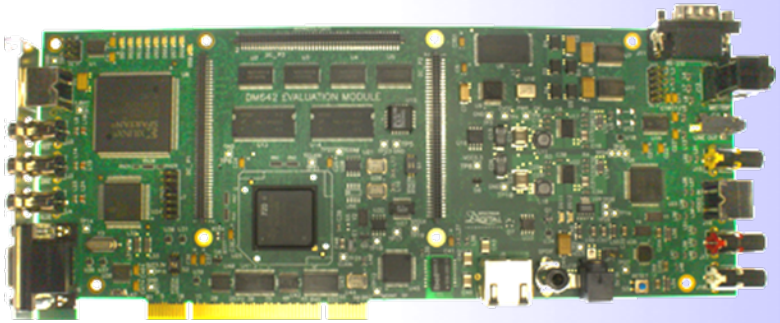
- ***A DSP is a microprocessor:***
  - Non expensive.
  - Small sized.
  - Low power consumption.

- ***Widely Used in :***
  - Audio and Video
  - Communications
  - Security systems

Embedded Implementation

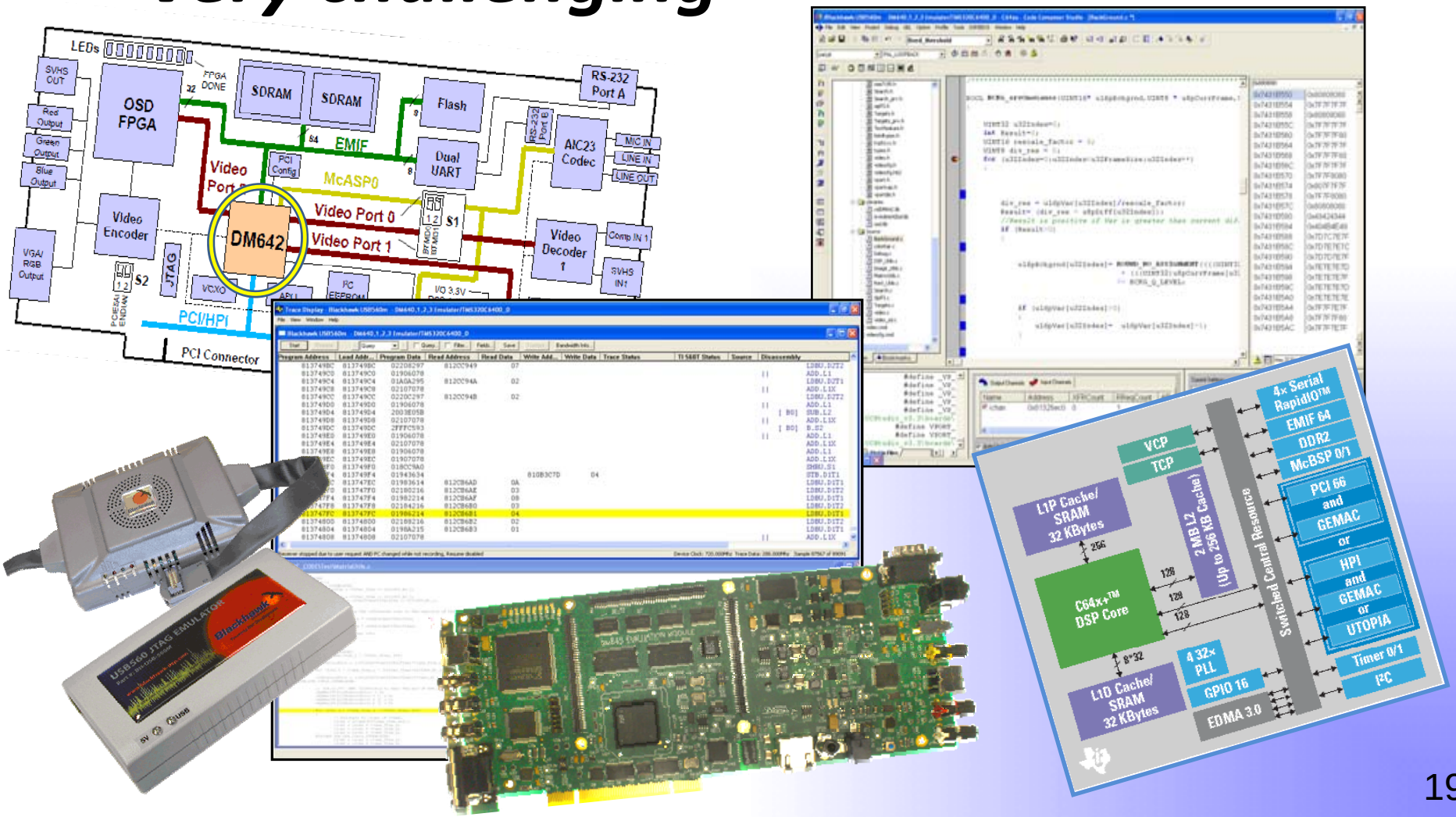
- ***Embedded development is complicated:***
  - Small “on chip”, fast memory.
  - Fixed-Point arithmetic.

  - Complex specific development environment.

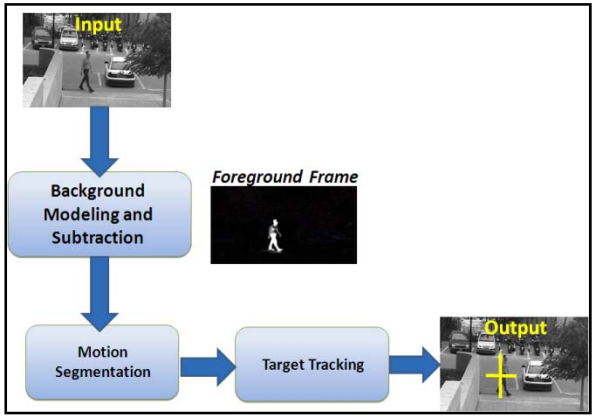


Embedded Implementation

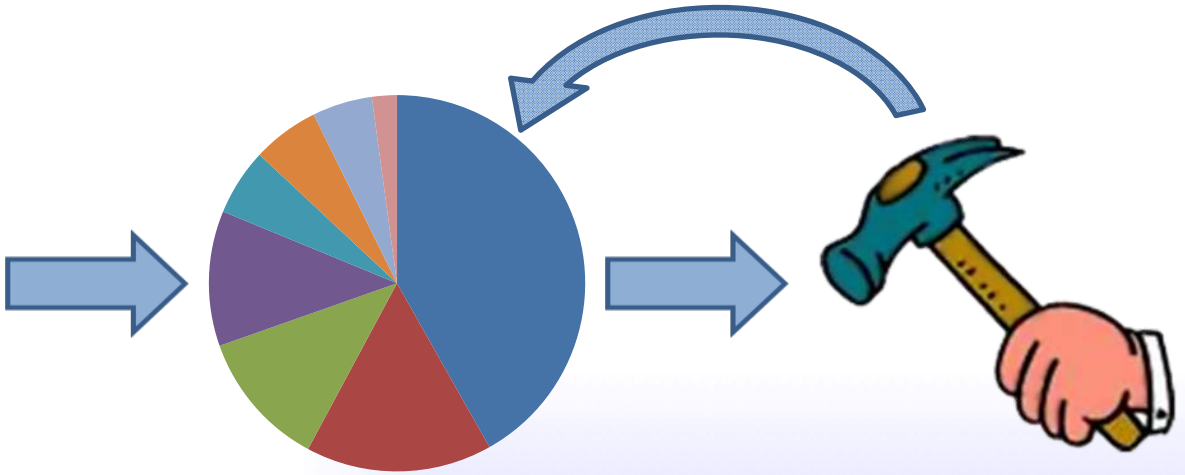
- ***Very challenging***



Performance Tuning



Algorithm



Time Consumption Mapping

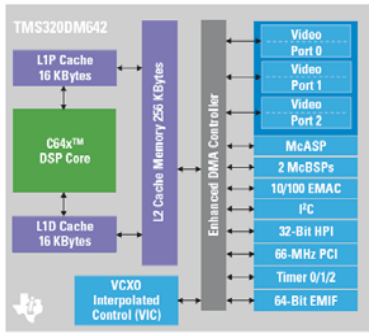
Enhancements

System works in real time

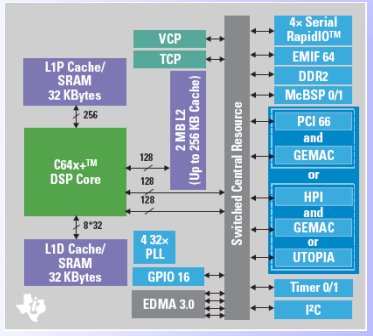
Performance Comparison

- ***Two DSP platforms from Texas Instruments:***
  - *DM642 – very common.*
  - *C6455 – new, much more powerful.*
  - **System implemented on both platforms.**

$$SpeedUp = \frac{DM642\ Execution\ Time}{C6455\ Execution\ Time} = 2.08$$

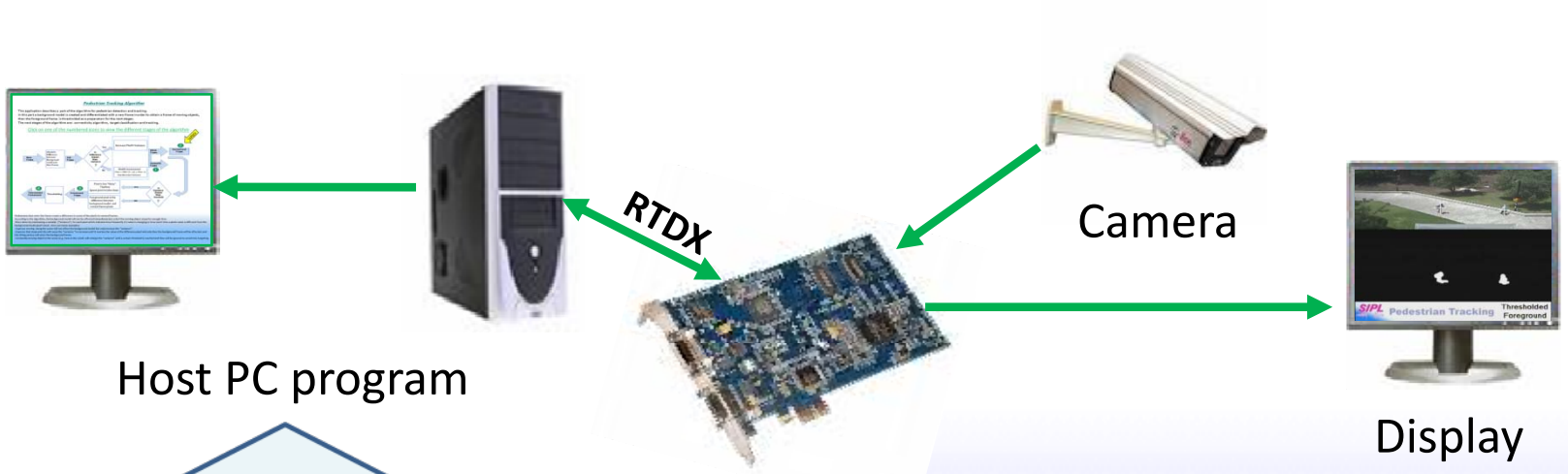


DM642 DSP



C6455 DSP

Pedestrian Tracking System



User Interface:

allows the user to choose and view different algorithm stages.

A Complete Hardware & Software Integrated System

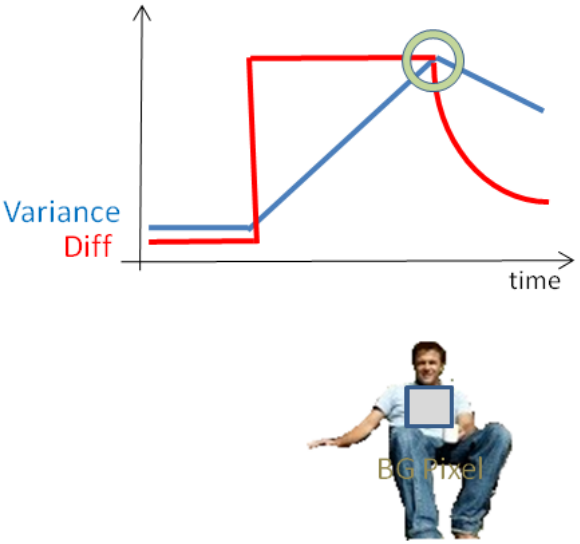
SIPL

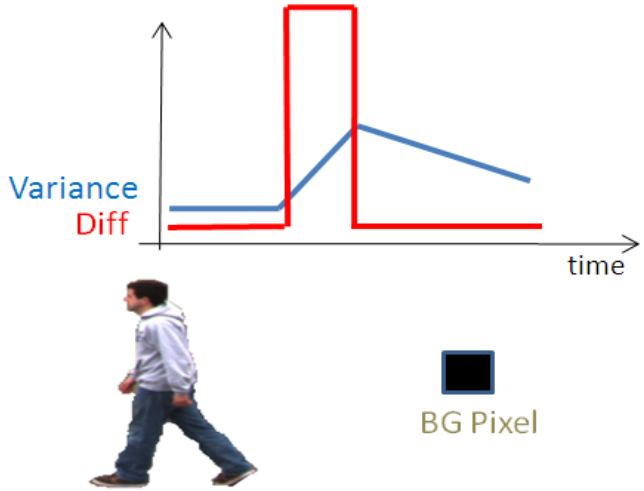
Pedestrian Tracking

Thresholded
Foreground

Conclusions

- Novel background modeling
  - Real time.
  - Robust.
  - Embedded oriented.





Conclusions

- Prototype system development:
  - Efficient and accurate.
  - Real time on DM642 and on C6455.
  - Works 24/7 in SIPL.
- Infrastructure for future developments.