

Productive Programming with MATLAB®

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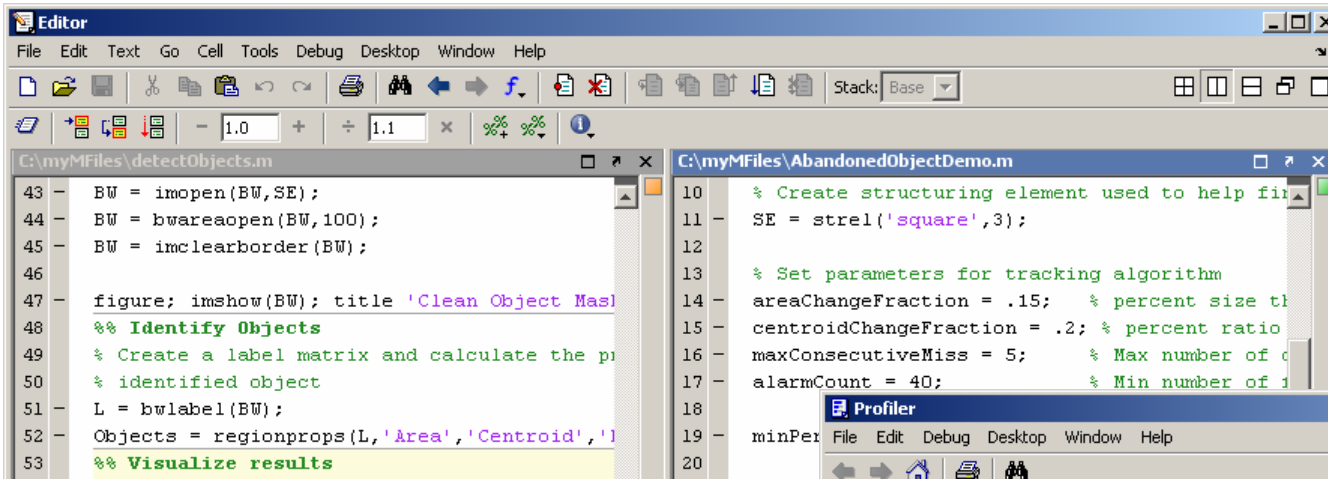
MathWorks
Aerospace and Defense Conference '07



Development Challenges

- **Developing** working algorithms
- Supporting and **maintaining** your algorithms
- **Optimizing** quality and performance

MATLAB® for Algorithm Development



```

C:\myMFiles\detectObjects.m
43 - BW = imopen(BW,SE);
44 - BW = bwareaopen(BW,100);
45 - BW = imclearborder(BW);
46
47 - figure; imshow(BW); title 'Clean Object Mas
48 %% Identify Objects
49 % Create a label matrix and calculate the p
50 % identified object
51 - L = bwlabel(BW);
52 - Objects = regionprops(L,'Area','Centroid','I
53 %% Visualize results

C:\myMFiles\AbandonedObjectDemo.m
10 % Create structuring element used to help fir
11 - SE = strel('square',3);
12
13 % Set parameters for tracking algorithm
14 - areaChangeFraction = .15; % percent size th
15 - centroidChangeFraction = .2; % percent ratio
16 - maxConsecutiveMiss = 5; % Max number of c
17 - alarmCount = 40; % Min number of 1
18
19 - minPer
20
    
```

M-Lint Code Check Report

Rerun This Report Run Report on Current Directory

Report for file [C:\lengthofline.m](#)

14 messages

- 22: The value assigned here to variable 'nohandle' might never be us
- 23: NUMEL(x) is usually faster than PROD(SIZE(x)).
- 24: 'notline' might be growing inside a loop. Consider preallocating
- 24: Use STRCMP1(str1,str2) instead of using LOWER in a call to STRCMI
- 28: NUMEL(x) is usually faster than PROD(SIZE(x)).
- 34: 'data' might be growing inside a loop. Consider preallocating for
- 34: Use dynamic fieldnames with structures instead of GETFIELD. Type
- for more information.
- 38: Use || instead of | as the OR operator in (scalar) conditional st
- 39: Use || instead of | as the OR operator in (scalar) conditional st
- 40: Use || instead of | as the OR operator in (scalar) conditional st
- 42: 'data' might be growing inside a loop. Consider preallocating for
- 43: 'dim' might be growing inside a loop. Consider preallocating for
- 45: 'dim' might be growing inside a loop. Consider preallocating for
- 49: Use of brackets [] is unnecessary. Use parentheses to group, if needed.

Profiler

Start Profiling Run this code: [AbandonedObjectDemo](#) Profile time: 42 sec

Profile Summary

Generated 04-Apr-2007 15:23:08 using cpu time.

Function Name	Calls	Total Time	Self Time*	Total Time Plot (dark band = self time)
AbandonedObjectDemo	1	41.675 s	0.832 s	
findObjects	200	28.060 s	5.377 s	
imclearborder	200	12.417 s	0.284 s	
makeDisplay	200	8.238 s	1.725 s	
imreconstruct	200	7.933 s	0.020 s	
images\private\imreconstructmex (MEX-function)	200	7.852 s	7.852 s	

Demonstration:

Abandoned Object Detection

- Description
 - Detect abandoned objects on a train platform
- Approach
 - Use video surveillance to capture the scene
 - Develop an algorithm to:
 - Identify objects on platform
 - Track the objects over successive video frames
 - Determine which objects are abandoned

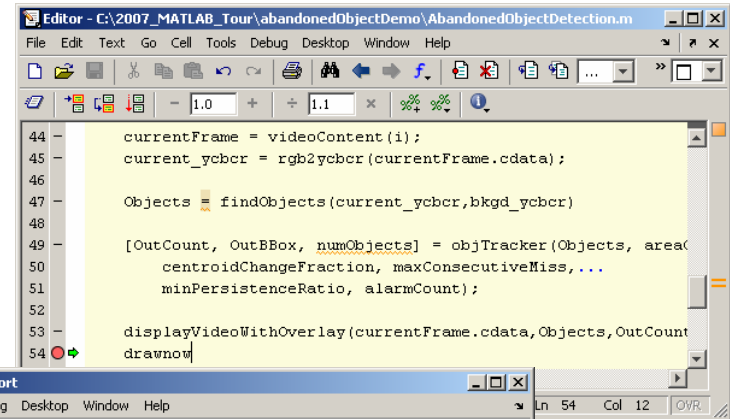


Demonstration Summary

- **Developing** working algorithms
 - MATLAB® desktop environment
 - Editor / debugger
 - Directory reports

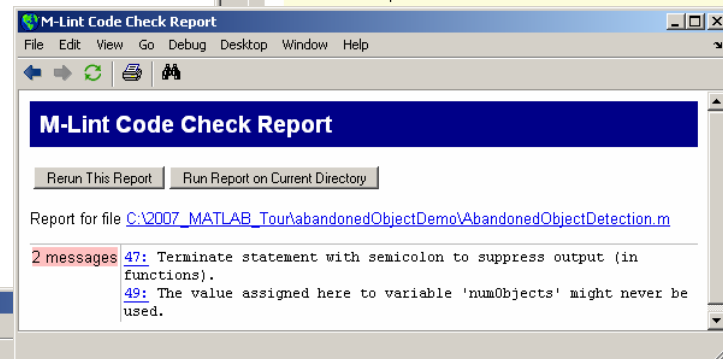
- Supporting and **maintaining** your algorithms
 - M-Lint

- **Optimizing** quality and performance
 - Profiler



```

44 -   currentFrame = videoContent(1);
45 -   current_ycbcr = rgb2ycbcr(currentFrame.cdata);
46 -
47 -   Objects = findObjects(current_ycbcr,bkgd_ycbcr)
48 -
49 -   [OutCount, OutBBox, numObjects] = objTracker(Objects, area(
50 -   centroidChangeFraction, maxConsecutiveMiss,...
51 -   minPersistenceRatio, alarmCount);
52 -
53 -   displayVideoWithOverlay(currentFrame.cdata,Objects,OutCount
54 -   drawnow
  
```



M-Lint Code Check Report

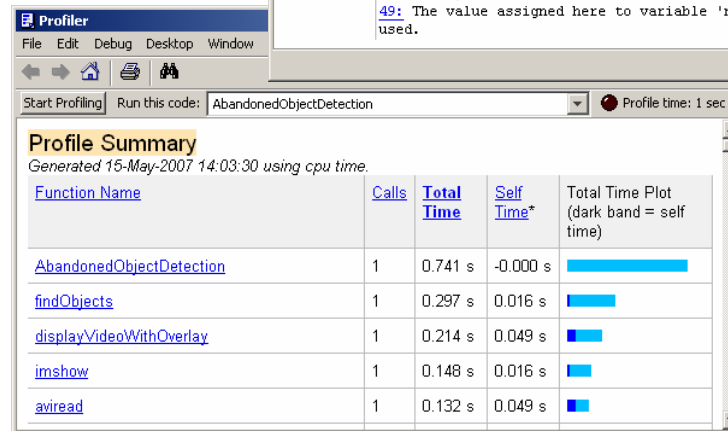
Rerun This Report Run Report on Current Directory

Report for file C:\2007_MATLAB_Tour\abandonedObjectDemo\AbandonedObjectDetection.m

2 messages

47: Terminate statement with semicolon to suppress output (in functions).

49: The value assigned here to variable 'numObjects' might never be used.



Start Profiling Run this code: AbandonedObjectDetection Profile time: 1 sec

Profile Summary
Generated 15-May-2007 14:03:30 using cpu time.

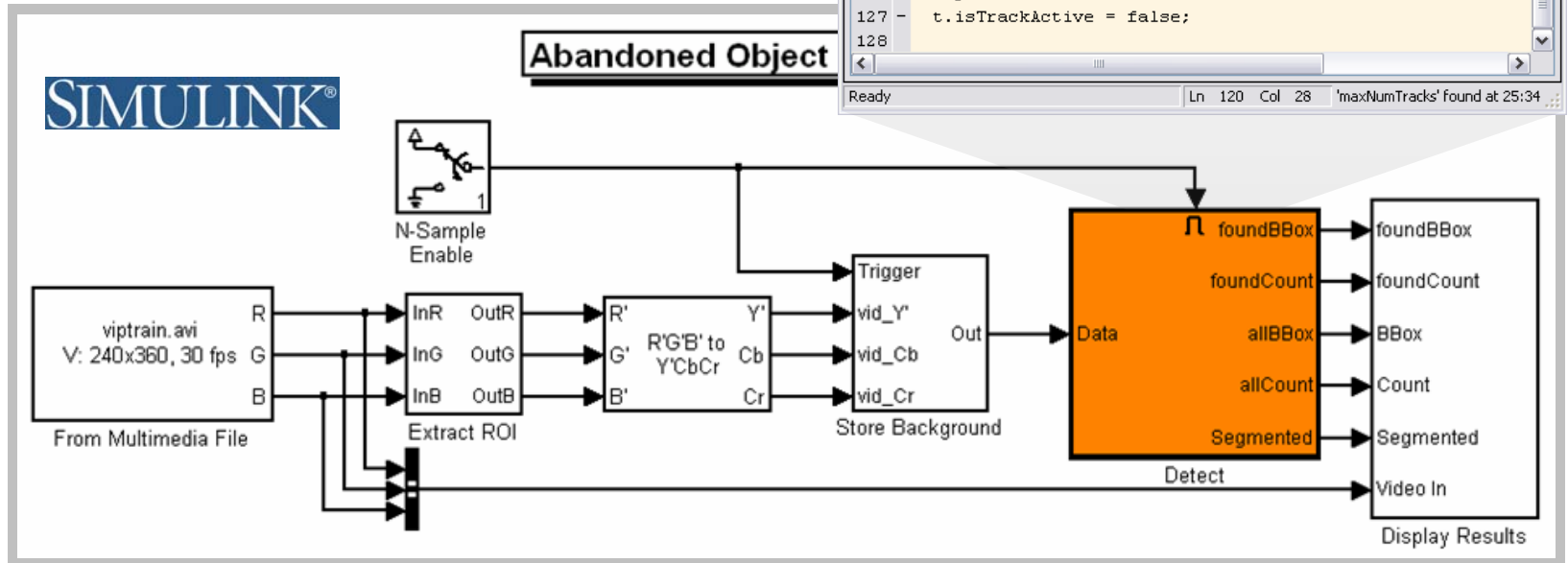
Function Name	Calls	Total Time	Self Time*	Total Time Plot (dark band = self time)
AbandonedObjectDetection	1	0.741 s	-0.000 s	
findObjects	1	0.297 s	0.016 s	
displayVideoWithOverlay	1	0.214 s	0.049 s	
imshow	1	0.148 s	0.016 s	
aviread	1	0.132 s	0.049 s	

Merging Algorithm Development and Embedded System Design

- MATLAB
 - Fixed Point Toolbox
 - Embedded MATLAB
- Simulink® family of products
 - Automatic code generation
 - Hardware in the loop testing

```

Embedded MATLAB Editor - Block: vipabandonedobj/Detect/Abandon...
File Edit Text Debug Tools Window Help
[Icons]
112 -     if track(i).hitCount >= alarmCount
113 -         OutCount = OutCount + 1;
114 -         OutBBox(:, OutCount) = track(i).bbox;
115 -     end
116 - end
117
118 - function t = empty_track
119
120 -     t.area          = int32(0);
121 -     t.centroid      = int32([0; 0]);
122 -     t.bbox          = int32([0;0;0;0]);
123 -     t.age           = int32(0);
124 -     t.hitCount      = int32(0);
125 -     t.missCount     = int32(0);
126 -     t.justHit       = false;
127 -     t.isTrackActive = false;
128
Ready                               Ln 120 Col 28 'maxNumTracks' found at 25:34
    
```



Broadcom Develops Low-Cost Semiconductor Product with MathWorks Tools

The Challenge

To develop a low-cost semiconductor product based on 3G standards that handset manufacturers could combine with chips based on 2G standards

The Solution

Use MathWorks tools to develop algorithms and model the chip subsystems

The Results

- Chip saves manufacturers millions of dollars
- Models reused for production release
- Development time cut in half



SPINNERchip add-on WCDMA baseband processor

“MATLAB® is an ideal environment for developing and understanding our algorithms. Simulink® integrates well with MATLAB and lets us produce a design that looks very similar to what we end up with ultimately in hardware.”

**Francis Swarts,
Broadcom**

Questions?

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