# AmiEs 2016

**International Symposium on**
**Ambient Intelligence and Embedded Systems**

# Aircraft Identification using Machine Vision

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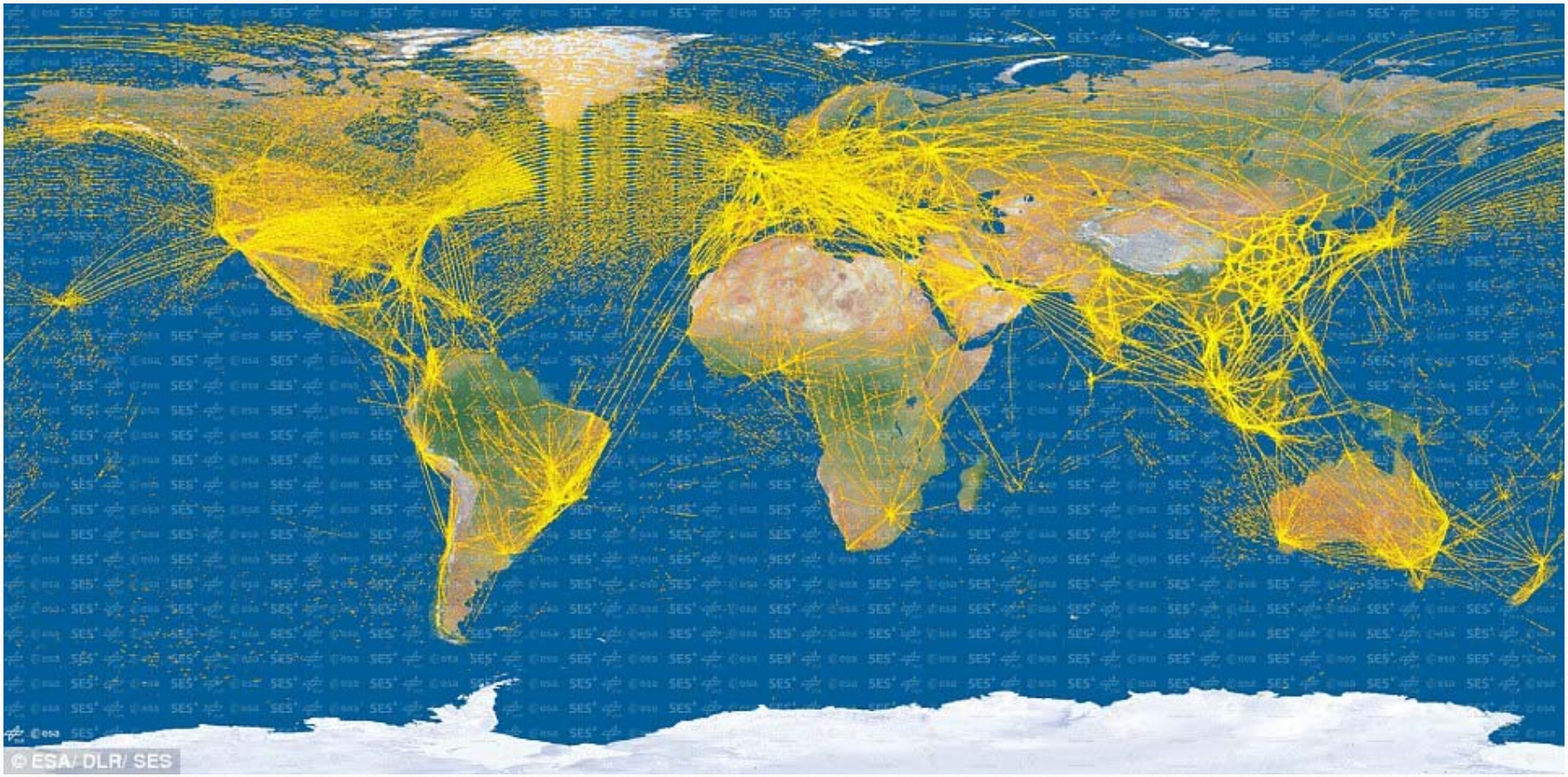
*Heraklion, Crete, Greece*

# *The problem*




*15,000 out of a total 102,000 worldwide daily flights!!!*

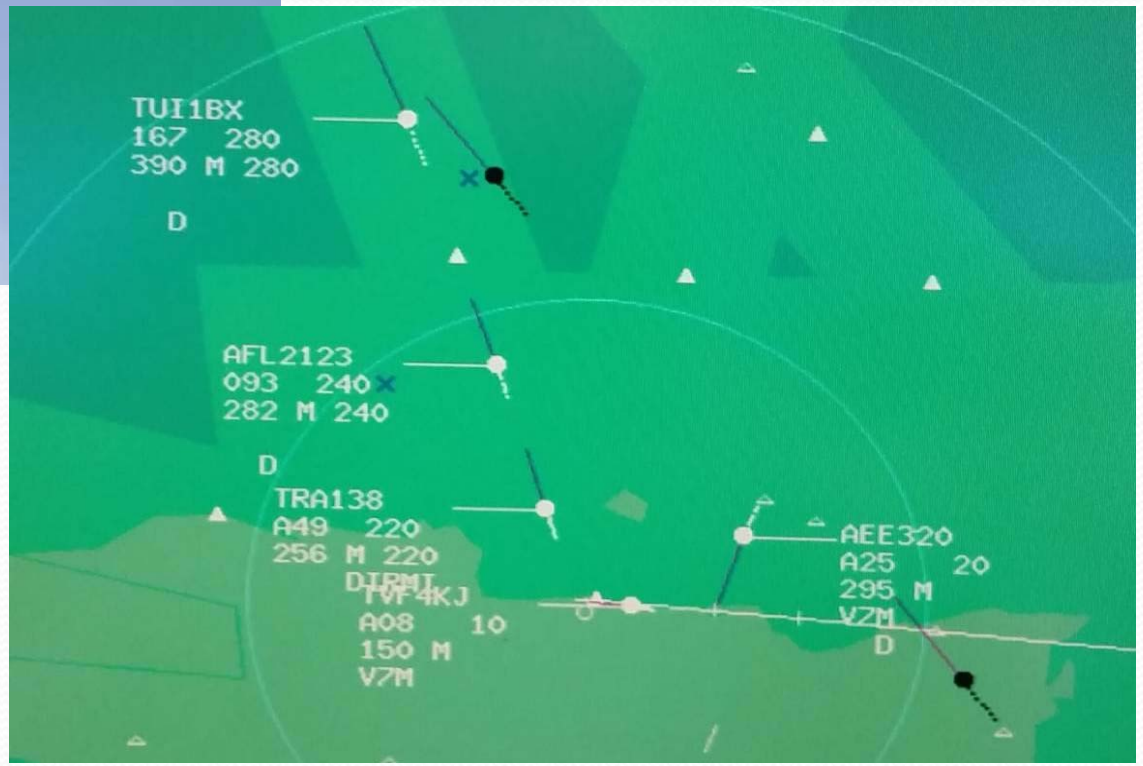
# The problem


*Aircraft congestion on the ground - demand for technical support*

**Low Cost aircraft recognition**

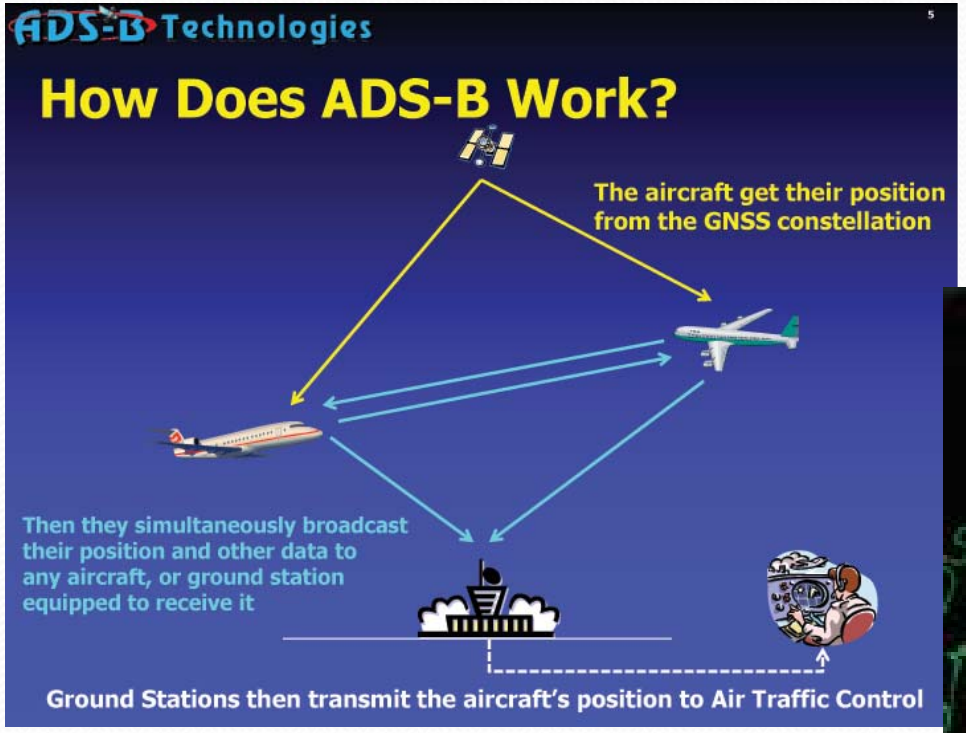
**in the airport using machine vision**

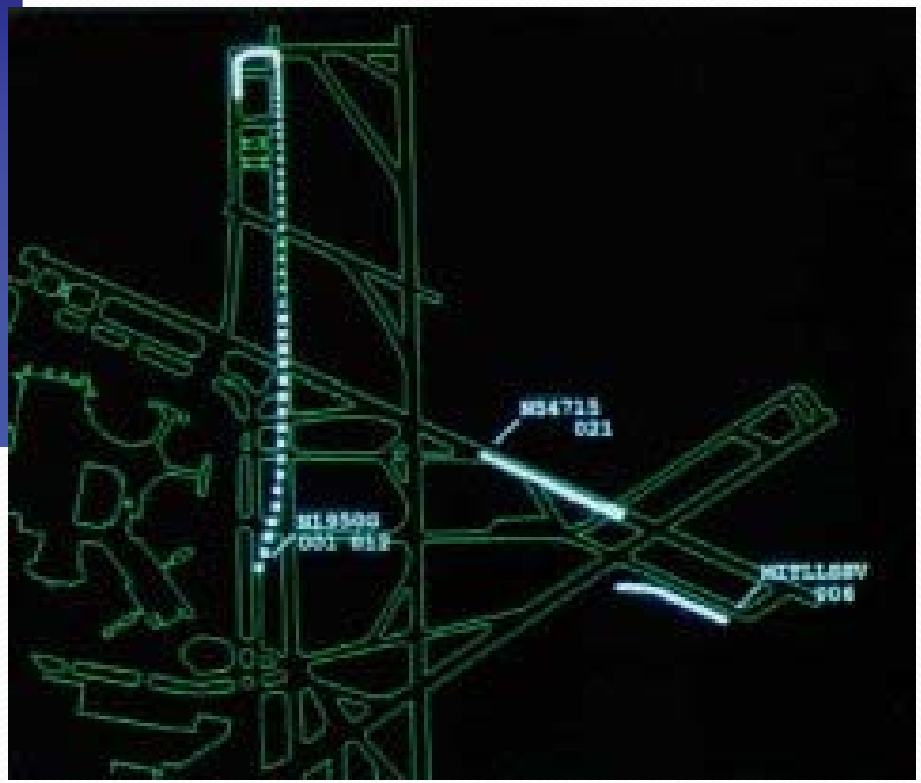
# Airport Surveillance Radar (ASR)

## Surface Movement Radar (SMR) (Schwabn and Rost 1985)


## Automatic Dependent Surveillance Broadcast (ADS-B)



| Sensor | Active | Recognition | Targets | MET conditions |
|---|---|---|---|---|
| SMR | No | No | All | All |
| DGPS | Yes | Yes | Equipped | All |
| MS | Yes | Yes | Equipped | All |
| Camera | No | No | All | Clear |

- **SMR -> Surface Movement Radar**
- **DGPS -> Differential GPS via digital data link**
- **MS -> Multilateration systems**

## *Pros*

- Zero radiation
- Low cost
- Video availability
- High rate data refresh

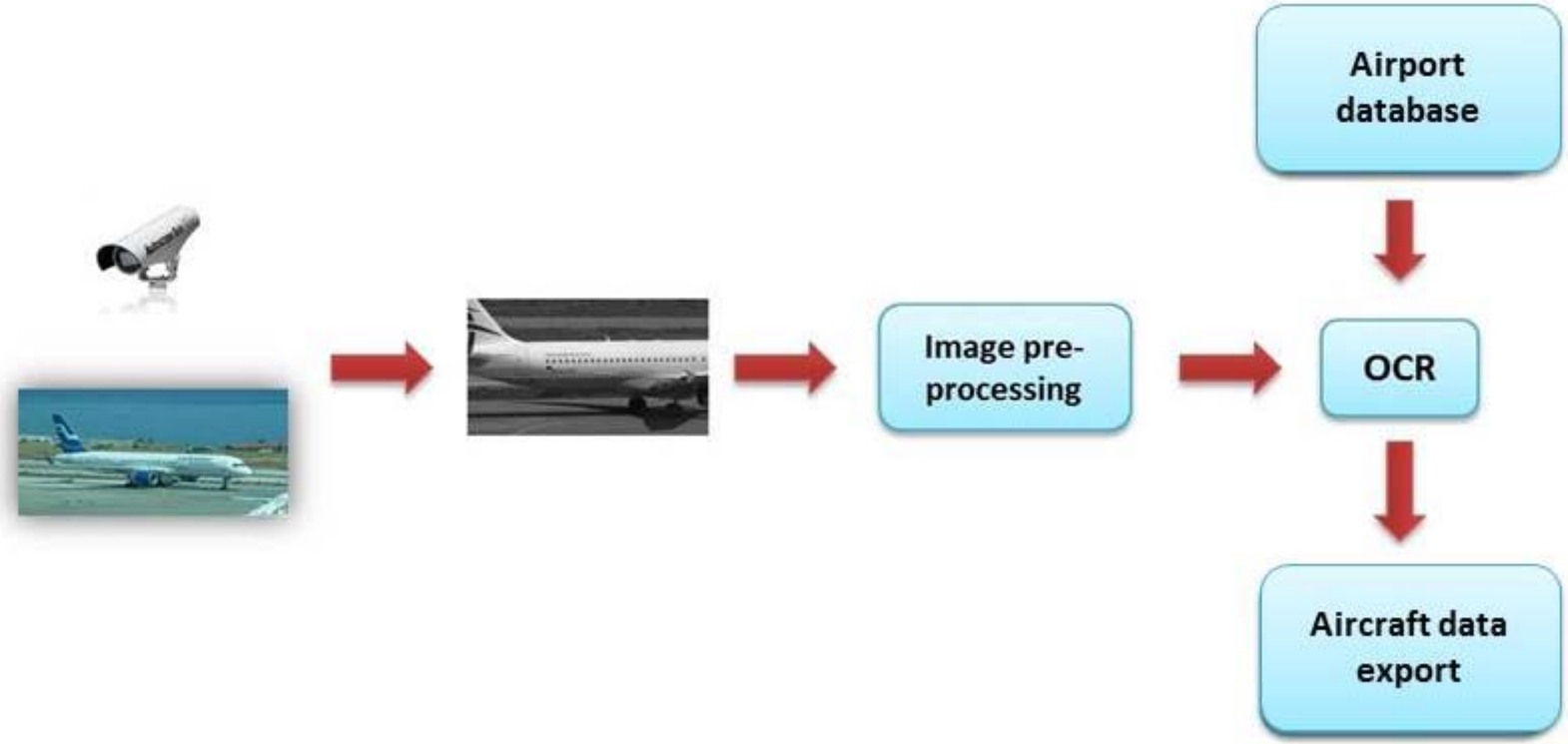
# Aircraft registration number

The **aircraft registration number** or tail number is an alphanumerical sequence that is unique for every aircraft flying worldwide.

# Aircraft registration number


**Registration numbers in various aircrafts**

# Basic idea




*Video Recording and analyzing procedure*

# Description

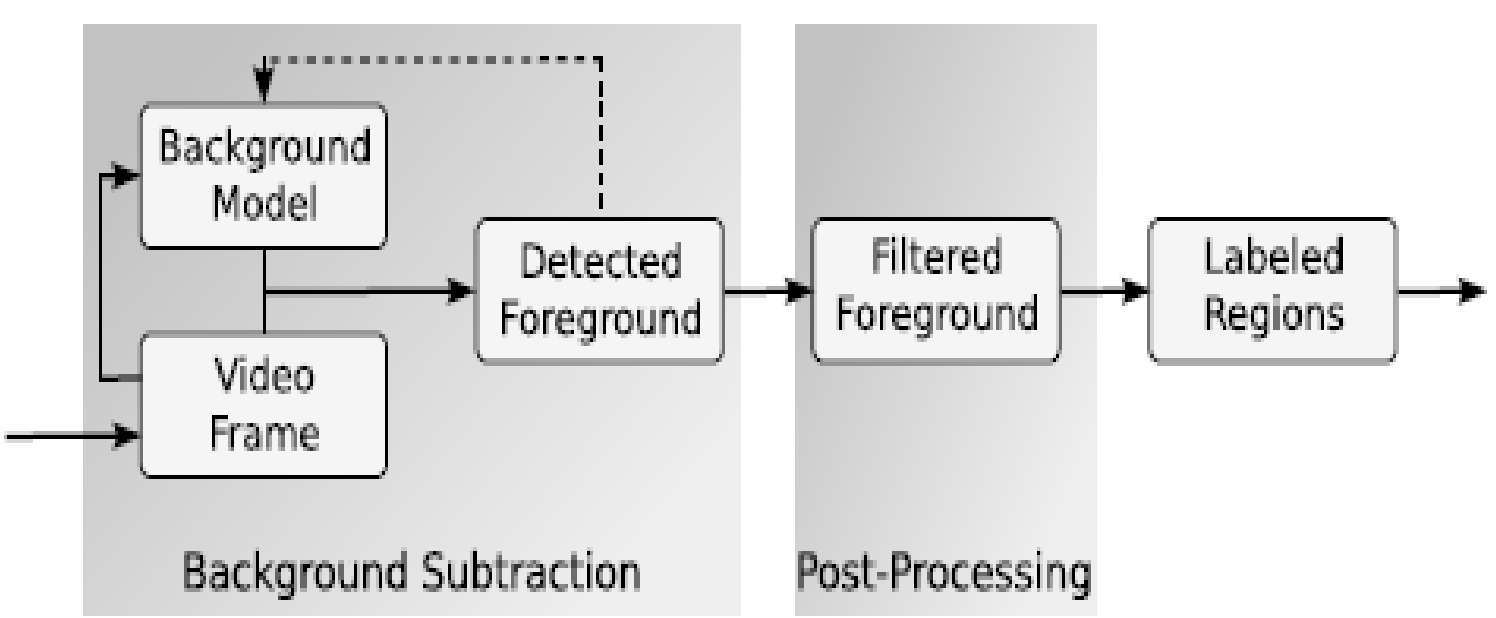
- Record and display aircraft movements in the aircraft moving area of an airport.
- Faster information delivery to everyone involved.
- Monitoring of aircrafts enlisted in 'blacklists'.
- Monitoring of aircrafts landed unauthorized eg when airports are closed
- Detection of aircraft suspected of any irregularities, such as "emitting noise above permissible limits."
- Detection of aircrafts involved in runway incursion incidents.

# Optical Character Recognition

**“ocr.m” – MATLAB 2014b +**

- Text in pictures
- Text in Regions of interest (ROI)
- Words bounding boxes and confidence percentage

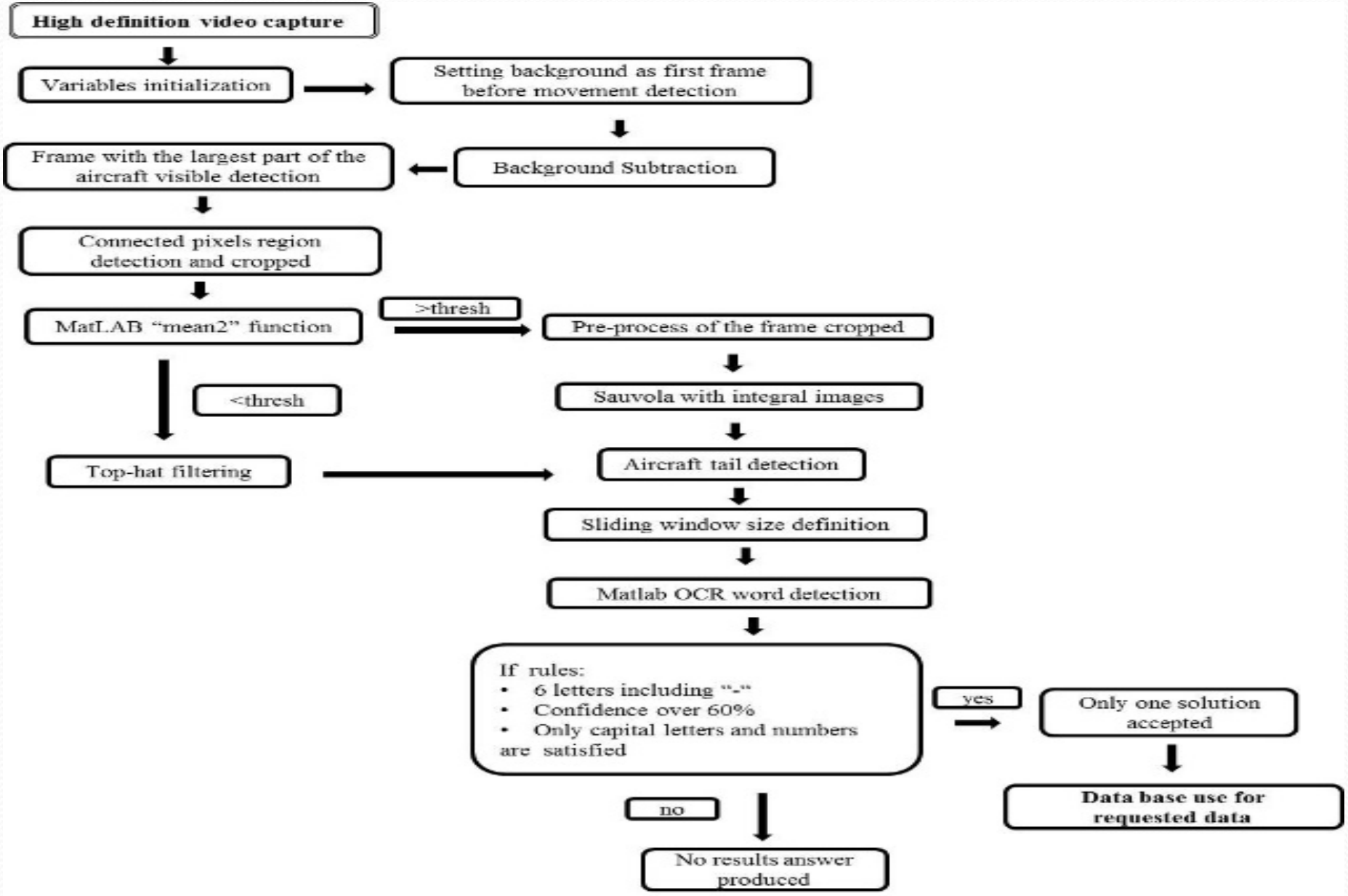
# Background subtraction




*Background subtraction with post processing for surveillance applications*

# Algorithm description



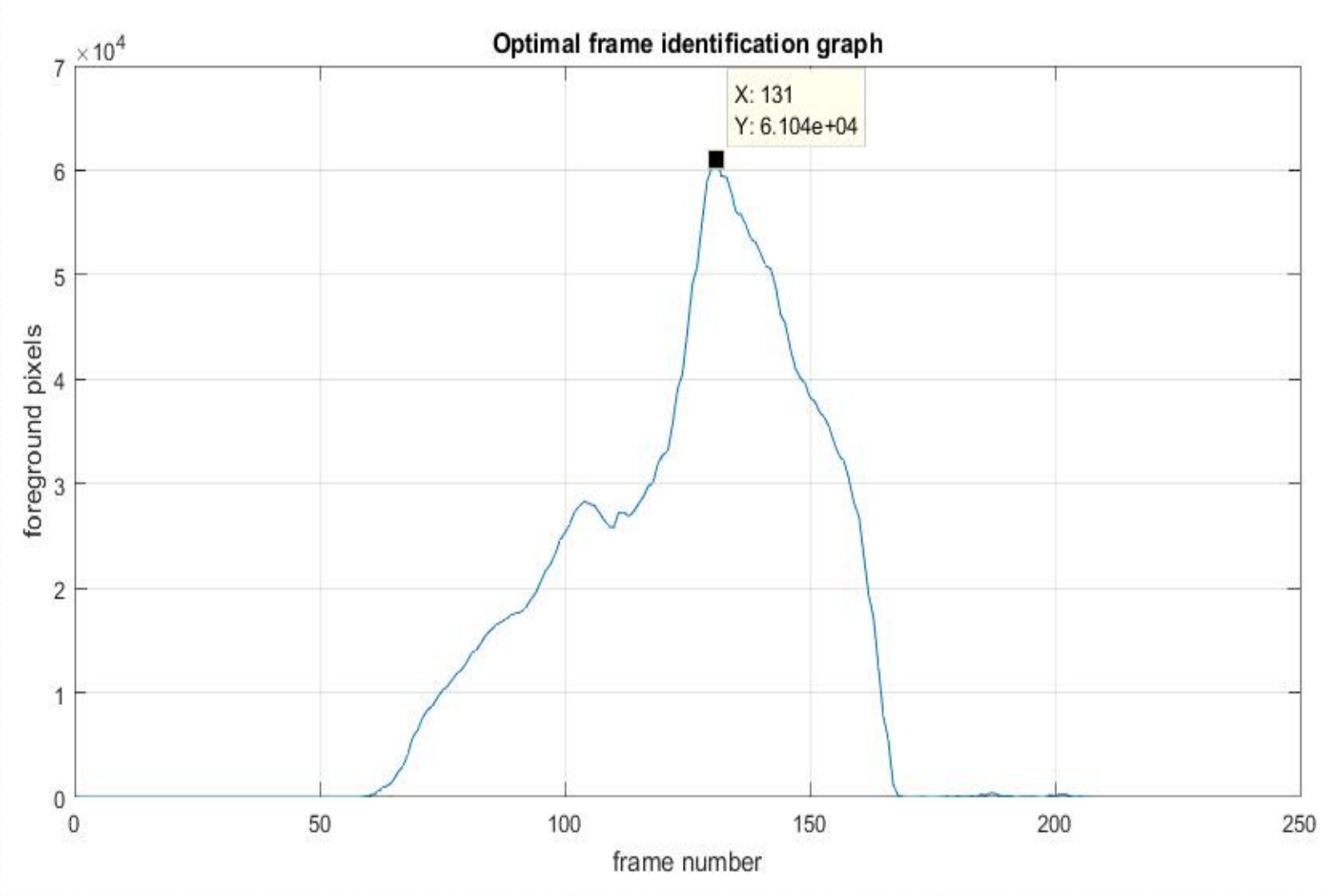


# Optimal frame

Aircraft Tail in frame 131 Sum of values of pixels 43339306

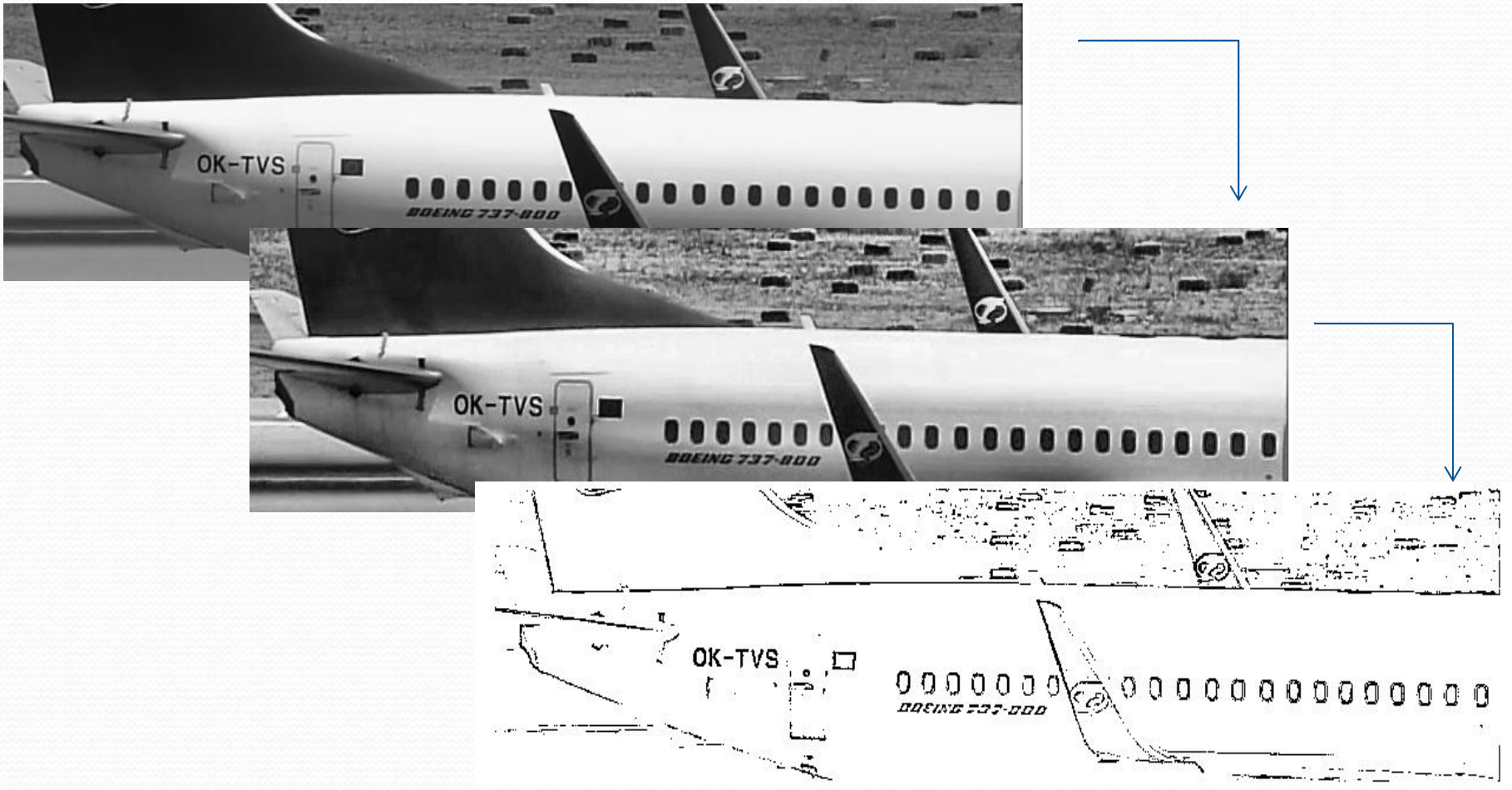
Aircraft Tail in frame 131 Number of pixels "on" 83266
Frame Coverage Percentage 20.3127 %

# Optimal frame graph



# boundingBox -> adapthisteq -> Sauvola





# Possible results

Command Window

```
Possible Registrations and Confidence Percentages
index: 127, conf: 0.77303, words: OK-TII
index: 143, conf: 0.83222, words: OK-TVS
index: 158, conf: 0.81872, words: OK-TVS
```

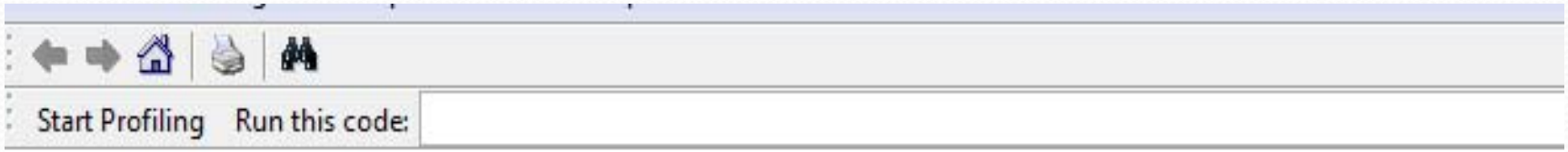
Command Window

```
Possible Registrations and Confidence Percentages
index: 127, conf: 0.77303, words: OK-TII
index: 143, conf: 0.83222, words: OK-TVS
index: 158, conf: 0.81872, words: OK-TVS
Aircraft Registration and Origin: OK-TVS
    'Czech Republic'

fx >>
```

```
Aircraft Registration and Origin: SK-DVD
WARNING: There is a problem with the OCR of the Aircraft Regitration,
         so the origin country of the aircraft is not available
>>
```

# Matlab time results




## Profile Summary

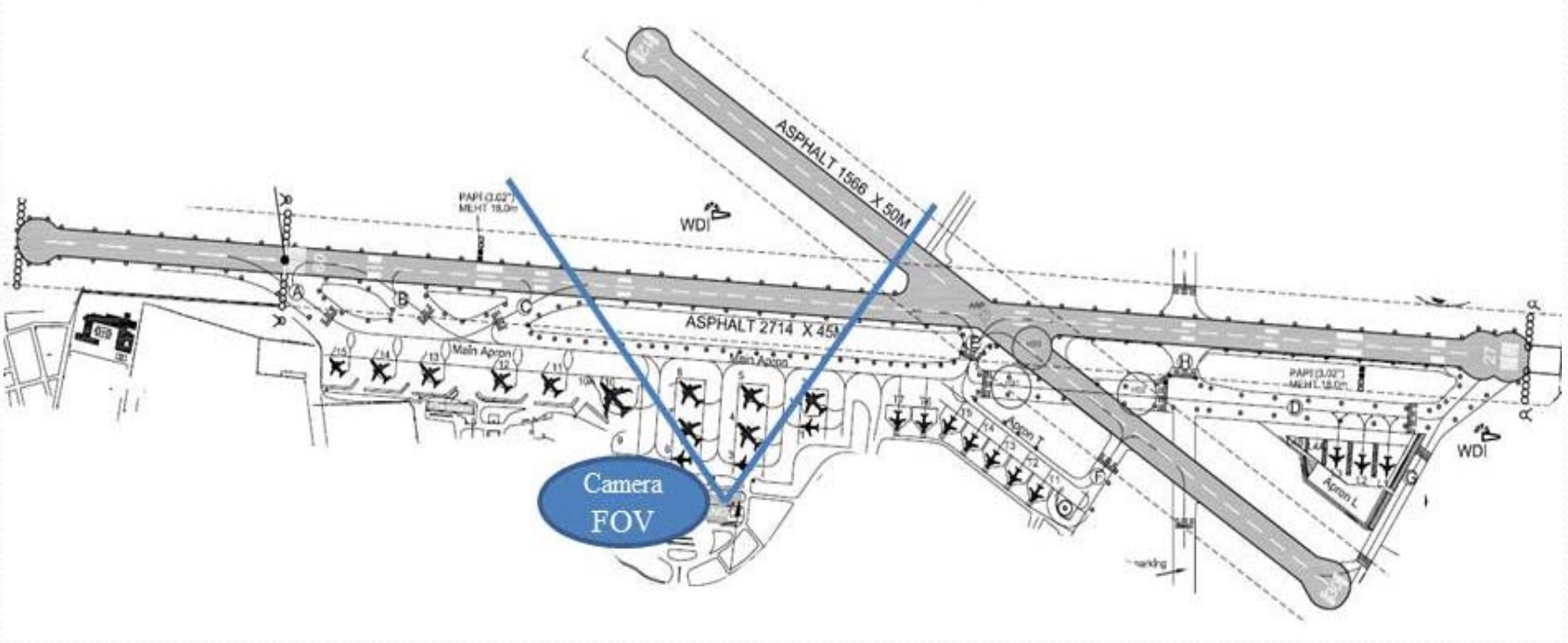
*Generated 03-Jun-2015 22:47:25 using cpu time.*

| Function Name | Calls | **Total Time** | Self Time* | Total Time Plot (dark band = self time) |
|---|---|---|---|---|
| testocrWork7 | 1 | 61.384 s | 9.401 s | |
| apron5bbox | 1 | 29.033 s | 2.022 s | |
| imshow | 672 | 24.787 s | 13.915 s | |
| ocr | 255 | 14.960 s | 0.045 s | |
| ocr>tesseract | 255 | 14.270 s | 13.985 s | |

# Algorithm cases



# Camera Field of view in Iraklion Airport



# Results



| video (mp4) | sliding window size (pixels) | | total time (sec) | ims (sec) | OCR (sec) | conf (%) | reg result | correct reg | succ (%) | country result | correct country | succ (yes/no) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | cols | rows | | | | | | | | | | |
| AEE_2 | 60 | 30 | 95 | 32 | 45 | 73.56 | SX-DST | SX-DGT | 83,33 | Greece | Greece | yes |
| TFL_1 | 110 | 40 | 187 | 26 | 45 | 84,00 | PH-HZG | PH-HZG | 100,00 | The Nederlands | The Nederlands | yes |
| TVS_4 | 90 | 30 | 139 | 24 | 32 | 79,00 | OK-TSJ | OK-TSJ | 100,00 | Czech Republic | Czech Republic | yes |
| TVS_4 | 90 | 50 | 336 | 68 | 101 | 84,00 | OK-TSJ | OK-TSJ | 100,00 | Czech Republic | Czech Republic | yes |
| AFL_2 | - | - | 30 | 9,5 | 0,3 | 73,00 | VP-BUS | VP-BOS | 83,33 | Bermuda | Bermuda | yes |
| AEE_9 | 100 | 40 | 111 | 21 | 25 | 75,00 | SX-DVV | SX-DVV | 100,00 | Greece | Greece | yes |
| AEE_19 | 100 | 40 | 238 | 30 | 57 | 81,00 | SX-DGI | SX-DGI | 100,00 | Greece | Greece | yes |
| BIE_1 | 90 | 40 | 208 | 28 | 51 | 75,00 | F-GVAP | F-GVAP | 100,00 | France | France | yes |
| BIE_2 | 200 | 100 | 57 | 16 | 2,8 | 81,00 | F-GVAD | F-GVAO | 83,33 | France | France | yes |
| ALS_1 | 100 | 50 | 119 | 25 | 37 | 87,00 | EC-LNC | EC-LNC | 100,00 | Spain | Spain | yes |
| BER_22 | 150 | 70 | 77 | 18 | 18 | 82,50 | D-ABFZ | D-ABFZ | 100,00 | Germany | Germany | yes |
| BIE_8 | 150 | 70 | 55 | 11 | 16 | 76,00 | F-HCOA | F-HCOA | 100,00 | France | France | yes |
| CFG_8 | 150 | 70 | 42 | 11 | 7 | 75,00 | D-AICL | D-AICL | 100,00 | Germany | Germany | yes |
| FPO_6 | 150 | 50 | 71 | 15 | 22 | 80,00 | F-GZTC | F-GZTC | 100,00 | France | France | yes |
| LLC_5 | 150 | 50 | 47 | 12 | 7,6 | 75,00 | SP-HAF | SP-HAF | 100,00 | Poland | Poland | yes |
| LLC_7 | 100 | 40 | 112 | 25 | 30 | 72,00 | SP-HAG | SP-HAG | 100,00 | Poland | Poland | yes |
| LLC_8 | 100 | 40 | 100 | 21 | 30 | 74,00 | SP-HAD | SP-HAD | 100,00 | Poland | Poland | yes |
| MAV_3 | 150 | 50 | 58 | 12 | 18 | 83,00 | SX-MAR | SX-MAR | 100,00 | Greece | Greece | yes |
| SEH_1 | 150 | 50 | 36 | 8 | 5 | 83,00 | SX-LDS | SX-LOS | 83,33 | Greece | Greece | yes |
| SWG_2 | 150 | 50 | 82 | 15 | 24 | 88,00 | OK-TVV | OK-TVV | 100,00 | Czech Republic | Czech Republic | yes |

**Average Success: 91% - Average Confidence: =77%**

# Effectiveness

To examine the effectiveness of the algorithm, high definition video of the actual movements of Nikos Kazantzakis airport of Iraklion was recorded. The time period was from May to August 2015.

The recording was made from the site of the airport control tower (Figure 14).

Table 1 presents the results of the algorithm. The Average Success of the algorithm was 91%.

## Conclusion and future work

- Use of a fixed position video recording system specialized for monitoring moving objects.
- Combination with airport collaborative decision making systems to confirm registration numbers and optimize results.
- Implementation of camera networks in an airport to achieve full area, real time registration scanning and consequently produce a low cost airport surface movement ground control system (SMGCS).
- Use as part of a hybrid radar – camera surface surveillance system for optimum result

*Thank you…!*