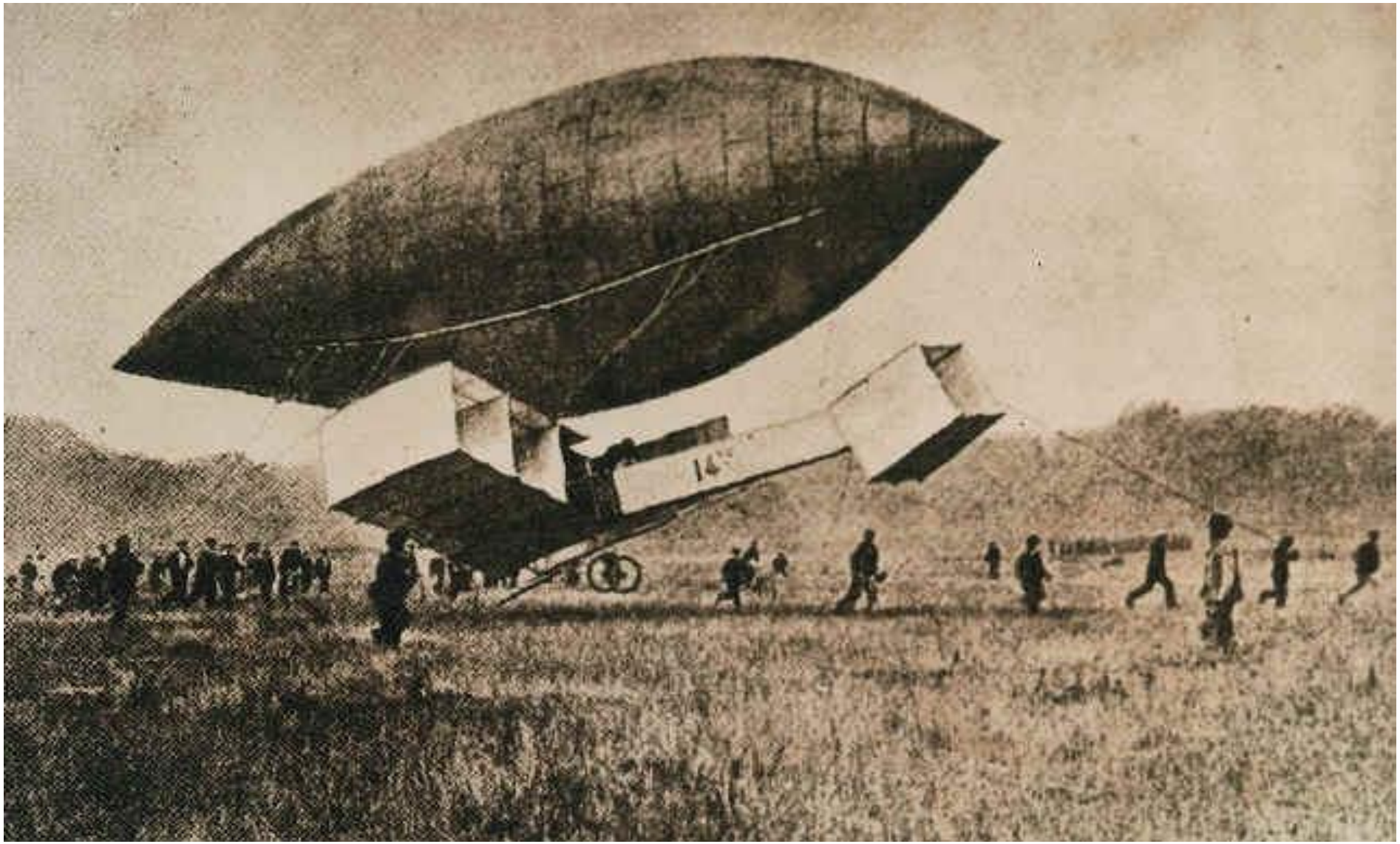
14 bis

Using Image Processing and Pattern Recognition in Images From Head-Up Display

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Topics

- Introduction
- HUD Overview
- Challenges
- Tool Development
- Tool Evaluation
- Summary
- Acknowledge

Introduction

- Images frames have been always used as information source for the Flight Test Campaigns (FTC).
- During the flight tests, the images displayed on the Head-Up Display (HUD) could be stored for later analysis.
- HUD images present aircraft data provided by its avionics system.
- For a simplified Flight Test Instrumentation (FTI), in which data accuracy is not a big issue, HUD images could become the primary information source.
- However, in this case, data analysis is executed manually, frame by frame, for information extraction.

Introduction

- **Main disadvantage**: In approximately one hour of flight test about 36,000 frames are generated using standard-definition television format (i.e. 704 x 480 pixels of resolution x 30 frames/s).
- Therefore data extraction becomes complex, time consuming and prone to failures.

Introduction

- **Solution**: IPEV developed an image processing application with pattern recognition to extract information from different positions on the images of the HUD.

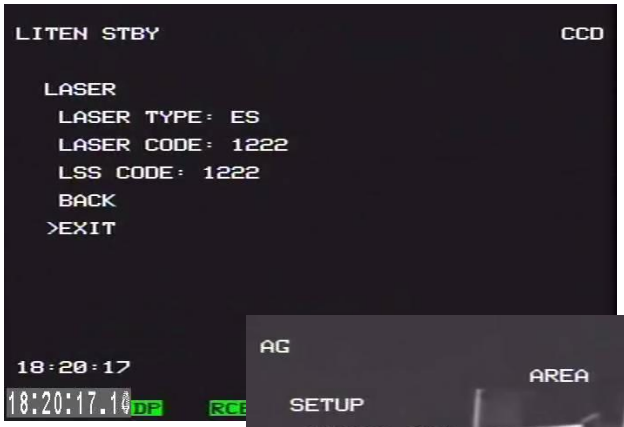
view

ain important semantic

tude, elevation, azimuth,

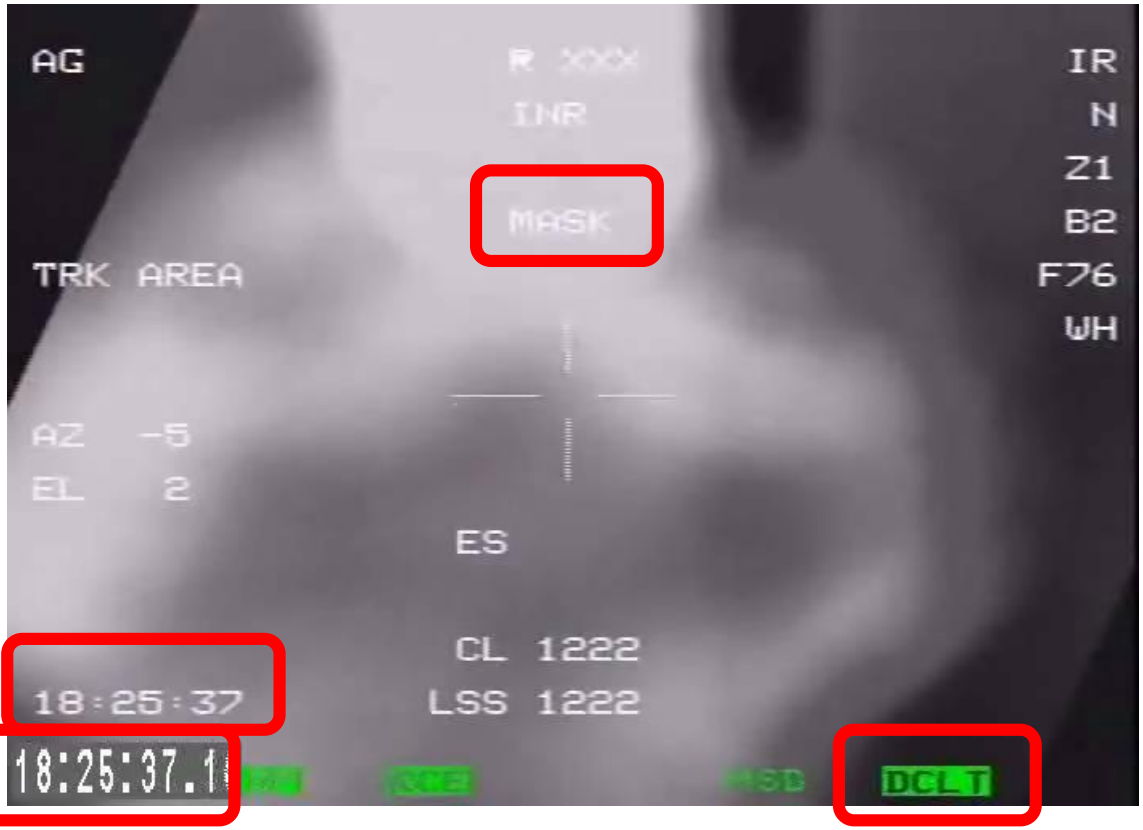
Challenges

- The scenarios could change very rapidly which can result in significant change of lighting



Challenges

- The images have different formats of texts position.



Challenges

- Transitions between images produced by the HUD generate blurring areas.

Tool Development

The Tool has five main steps:

Step 1.

The video produced by HUD is converted to JPEG images;

Step 2.

The template for each character is loaded from the database;

Tool Development

Step 2. Partial database.

Partial database of templates for each character

Tool Development

Step 3.

The HUD images are loaded in the application;

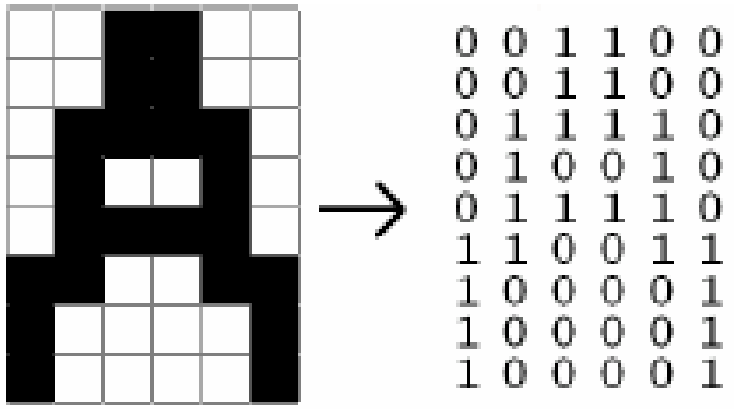
Step 4.

Each image is processed;

Tool Development

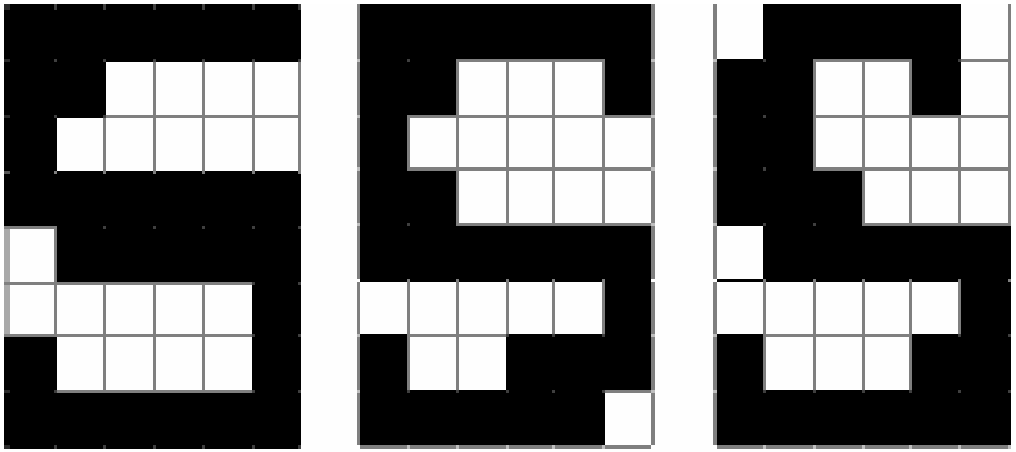
Step 4. Images are processed by using the following steps:

- Binarization;
  - Each image is an array with values ranging between zero and one
  - The template used for each character has 24 x 42 pixels



Example of character ‘A’ represented by matrix format.

Tool Development



Examples of character "***S***" in different images

- We applied a learning process based on context. For example, the character "***S***" should not be identified in areas which may appear only numbers.

Tool Development

Step 4. Images are processed using the following steps:

- Adjustments are applied to the image;
- Extraction of the preset positions of the image;
- Extraction of images that represent the characters in each preset position ;
- Applying the correlation algorithm;
- The results are stored in an array structured with all the image information.

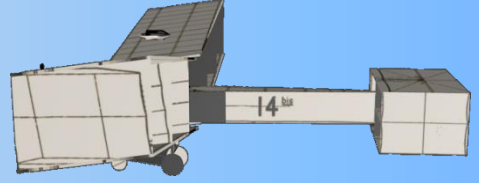
Tool Development

Step 5.

At the end of the process, it's possible to view the results of the array.

frame: ''
top: ''
left: ''
middle: ''
trk: ''
cardinal point: ''
menu: ''
altitude: ''
feet: ''
azimuth: ''
elevation: ''
coordinate south: ''
coordinate west: ''
hour: ''
radius: ''

Example of array structured

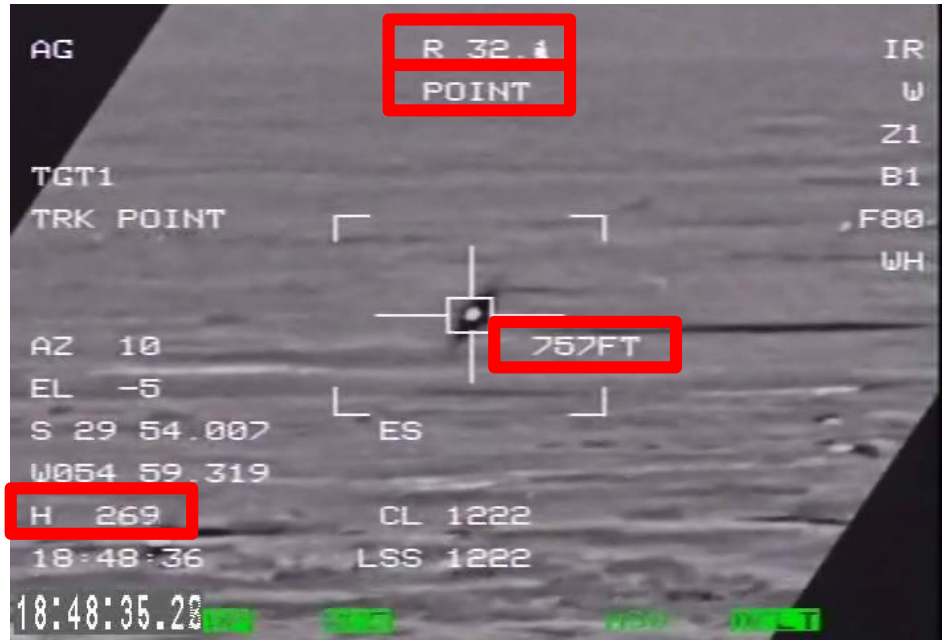


Tool Evaluation

- MatLab® environment
- Intel®Pentium IV Core™ 2 Duo CPU T5800 2.00 GHz notebook, 4 Gb RAM and Microsoft Windows 7 Professional.
- HUD images produced by EMBRAER A1 (i.e. AM-X) aircraft, during the Brazilian Flight Test Course (CEV) carried out by the 2012 class students.
- The application was evaluated with more than 1,000 frames and more than 40,000 characters in the frames.

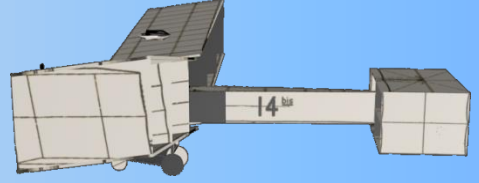
Tool Evaluation

- Example of results of the array.




```
frame: '36996.jpg'
top: 'point'
left: 'ag'
middle: ''
trk: 'trkpoint'
cardinal point: 'w'
menu: ''
altitude: '269'
feet: '757'
azimuth: '10'
elevation: '-5'
coordinate south: '29.54.007'
coordinate west: '054.59.319'
hour: '18:48:36'
radius: '32.1'
```

Image processed by the application. On the left is the original image and on the right is the array structured after the processing

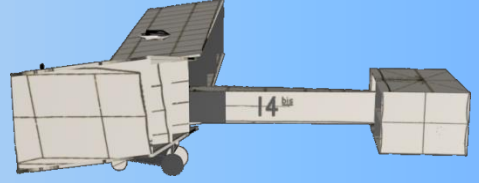


Summary

- Usage of image processing and pattern recognition in images from HUD produces results that can increase flight tests efficiency.
- This paper proposed an automatic recognition system for text image recognition, based on an specific correlation algorithm.
- The application allows reduction of processing time in post-mission operations for data extraction from HUD images

Summary

- The next steps are:
  - Different strategies for pattern recognition (e.g. Neural networks) should be evaluated;
  - It is possible to use parallel processing techniques to improve image processing efficiency; and
  - Different setup schemes for post processing to improve the accuracy index should be experimented



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