“Feature Selective Validation”
A new approach for new Engineers

D. Di Febo, F. de Paulis, A. Orlandi
UAq EMC Laboratory, University of L’Aquila, L’Aquila Italy

European IBIS Summit
Naples, May 11, 2011
What is FSV?

The Feature Selective Validation technique has been proposed by

Prof. Alistair Duffy

De Montfort University, Physical Layer Laboratory, Leicester, UK
What is FSV?

• The UAq EMC Laboratory, in cooperation with DMU Physical Layer Laboratory, has developed an automatic tool to compare datasets.

• The FSV tool can compare 1D and 2D datasets.

• FSV uses the same approach for all data → this makes standard each comparison.
Why Do We Need FSV?

What do you think about these two files?

They are:
- EQUAL?
- SIMILAR?
- DIFFERENT?
- VERY DIFFERENT?
- VERY SIMILAR?

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Why Do We Need FSV?

And these?

They are:
- EQUAL?
- SIMILAR?
- DIFFERENT?
- VERY DIFFERENT?
- VERY SIMILAR?

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Old Approaches to Compare

Comparison

Now can YOU classify these two files?

EQUAL, SIMILAR, DIFFERENT

And YOUR NEIGHBOURS?
FSV Method

Input DATA 1

FFT and filtering process

DC LOW HIGH

Computation figure of merit

TREND

Input DATA 2

FFT and filtering process

DC LOW HIGH

FEATURE
ADM Computation

Point-by-Point

\[ ADM (n) = \left| \frac{\alpha}{\beta} \right| + \left| \frac{\chi}{\delta} \right| \exp \left\{ \frac{\chi}{\delta} \right\} \]

From the ‘trend’ data

\[ \alpha = \left( |Lo_1(n)| - |Lo_2(n)| \right) \]

Calculate:

\[ \chi = \left( |DC_1(n)| - |DC_2(n)| \right) \]

From the ‘offset’ data

\[ \beta = \frac{1}{N} \sum_{i=1}^{N} \left( (|Lo_1(i)| + |Lo_2(i)|) \right) \]

\[ \delta = \frac{1}{N} \sum_{i=1}^{N} \left( (|DC_1(i)| + |DC_2(i)|) \right) \]

Point-by-point

Once only

n is the nth data point

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FSV: Feature

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FDM Computation

Feature Different Measure (FDM)

\[ FDM( f ) = 2\left( |FDM_1( f )| + |FDM_2( f )| + |FDM_3( f )| \right) \]

\[ FDM_1( f ) = \frac{|Lo_1'( f )| - |Lo_2'( f )|}{2 \sum_{i=1}^{N} \left( |Lo_1'( i )| + |Lo_2'( i )| \right)} \]

\[ FDM_2( f ) = \frac{|Hi_1'( f )| - |Hi_2'( f )|}{6 \sum_{i=1}^{N} \left( |Hi_1'( i )| + |Hi_2'( i )| \right)} \]

\[ FDM_3( f ) = \frac{|Hi_1''( f )| - |Hi_2''( f )|}{7.2 \sum_{i=1}^{N} \left( |Hi_1''( i )| + |Hi_2''( i )| \right)} \]
Global Different Measure (GDM)

\[ GDM(f) = \sqrt{ADM(f)^2 + FDM(f)^2} \]
From ADMi to ADMc: Histogram

How many points of the ADMi fall into each category?

Same algorithm applies for FDM and GDM

<table>
<thead>
<tr>
<th>FSV value (quantitative)</th>
<th>FSV interpretation (qualitative)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 0.1</td>
<td>Excellent</td>
</tr>
<tr>
<td>Between 0.1 and 0.2</td>
<td>Very good</td>
</tr>
<tr>
<td>Between 0.2 and 0.4</td>
<td>Good</td>
</tr>
<tr>
<td>Between 0.4 and 0.8</td>
<td>Fair</td>
</tr>
<tr>
<td>Between 0.8 and 1.6</td>
<td>Poor</td>
</tr>
<tr>
<td>Greater than 1.6</td>
<td>Very poor</td>
</tr>
</tbody>
</table>

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Grade & Spread Chart

- Grade: number of categories starting from ‘Excellent’ to contain 85% of the total confidence data.
- Spread: number of categories around the highest value category to contain 85% of the total confidence data.
  - Similar use to variance in statistics
- Gives a measure of reliability of the FDM and ADM in calculating the GDM and can be used to weight the GDM calculation
View Input & Focus Options

Focusing

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Result Window: ADM

ADMi Plot

ADMc Plot
Result Window: FDM

FDMi Plot
(Derivatives applied)

FDMc Plot
Result Window: GDM

\[ GDM(f) = \sqrt{ADM(f)^2 + FDM(f)^2} \]

**GDMi Plot**

**GDMc Plot**

This two files:

- \( EX \) for \( \geq 12\% \)
- \( VG \) for \( \geq 35\% \)
- \( G \) for \( \geq 40\% \)
- \( F \) for \( > 7.5\% \)
- \( P \) for \( \geq 2.5\% \)
- \( VP \) for \( 0\% \)
Grade Spread View

@ 13.0% Of total confidence data

Grade Spread value

Grade/Spread Threshold
Threshold

Grade/Spread
quantification of data comparisons
Varying the Threshold

Same value for ADM, FDM, GDM

@ 85.0%
Of total confidence data (default value)
FSV Tool: 2D Analysis

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Focusing Window

Focusing Section
Trend: ADM

ADMi Plot

ADMc Plot
Feature: FDM

FDMi Plot

(Derivatives applied)

FDMc Plot
Global Value: GDM

This two files:
- EX for $\geq 2.5\%$
- VG for $\geq 5.0\%$
- G for $\geq 18.0\%$
- F for $> 25\%$
- P for $\geq 30\%$
- VP for 15%
Summary

• Quantification of data comparisons
  – ADMi/c Amplitude difference
  – FDMi/c Feature difference
  – GDMi/c Global difference
  – Grade & Spread visual data

• Portability (Java version)

• Free (at present) upon request
Next Steps

• Vector FSV-1D: Analyze and compare more 1D data sets together.

• Vector FSV-2D: Analyze and compare more 2D data sets together.
Contacts

• Prof. A. Orlandi,
  – antonio.orlandi@univaq.it
• Engineer F. de Paulis
  – franceco.depauleus@univaq.it
• Engineer D. Di Febo
  – danilo.difebo@univaq.it

Website

http://orlandi.ing.univaq.it/uaq_laboratory/index.html