Project no. TIP5-CT-2006-031415

INNOTRACK

Integrated Project (IP)

Thematic Priority 6: Sustainable Development, Global Change and Ecosystems

D1.2.1 Standardised Method for Converting Measured Track Data into Segments for "Virtual Tracks"

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Revision 1

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	CO

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Glossary

Abbreviation / acronym	Description
VTT	Virtual test track – a short segment of track data that is representative in one form or another of a longer track section / route from which it is derived
TRV	Track geometry recording vehicle
VTT Toolkit	Matlab based toolkit developed by MMU for the generation of Virtual Test Tracks
Top	Track vertical geometry
Alignment	Track lateral geometry
Discrete fault	Individual track faults, typically gauge, twist, large to or alignment features
Track quality	Typically expressed in the UK as standard deviation of track top and alignment in 200m lengths (not used by all railway administrations)

1. Executive Summary

This report outlines the approach to track geometry segmentation and generation of representative track sections required by deliverable D1.2.1. In particular it considers the method by which ‘representative’ track sections (alternatively termed ‘virtual test tracks’) may be generated from large quantities of track recording coach geometry data.

A toolkit has been developed in Matlab with the aim of generating a range of representative track segments from large volumes (entire routes of several hundred kilometres or more if required) of input data. By this means a short track segment, say 20 km long, can be generated that may be considered representative in one form or another of the entire route. A number of options are available in this respect as different analysis tasks may require track segments that represent different aspects of the route in question.

The toolkit is currently configured to use data from the UK track recording vehicles and will require some modification to use data from other administrations. This is not expected to present any significant difficulties.

At present the toolkit only addresses the track geometry aspects of segmentation. This only partially fulfils the requirements of ‘segmentation’ as it does not consider the duty conditions (tonnage, traffic type etc.) of the route in question.

2. Introduction

Work package 1.2 requires that a standard methodology for converting track sections into virtual segments is developed. This is critical to ensure that track conditions from various European Railway Administrations can be compared on a like-for-like basis.

This report outlines the approach to track geometry segmentation and generation of representative track sections required by deliverable D1.2.1. In particular it considers the method by which ‘representative’ track sections (alternatively termed ‘virtual test tracks’) may be generated from large quantities of track recording coach geometry data.

Comparing track types and conditions is a complex task and depends partly upon where the boundary is placed around the problem. The easiest boundary is to restrict the problem to track geometry only. This still presents considerable challenges as track geometry is collected and analysed differently by different railways. However, there is also sufficient commonality to make the problem soluble. When developing the tools described it was decided to provide a certain amount of flexibility as to what is considered ‘representative’ and thus allow the user to tailor the final track sections selected to the problem being investigated.

This approach will need further development for use in SP1. In particular the current tools need to be extended to take account of the duty cycle (tonnage / traffic type) and the maintenance regime applied to different linespeeds / track categories.

3. Description of the Virtual Test Track Toolkit

A toolkit has been developed in Matlab with the aim of generating a range of representative track segments from large volumes (entire routes of several hundred kilometres or more if required) of input data. By this means a short track segment, say 20 km long, can be generated that may be considered representative in one form or another of the entire route. A number of options are available in this respect as different analysis tasks may require track segments that represent different aspects of the route in question. These options are described in more detail below.

3.1 The Analysis Toolkit

The analysis toolkit essentially comprises a five stage process (Figure 1).

Stage 1 Flowchart

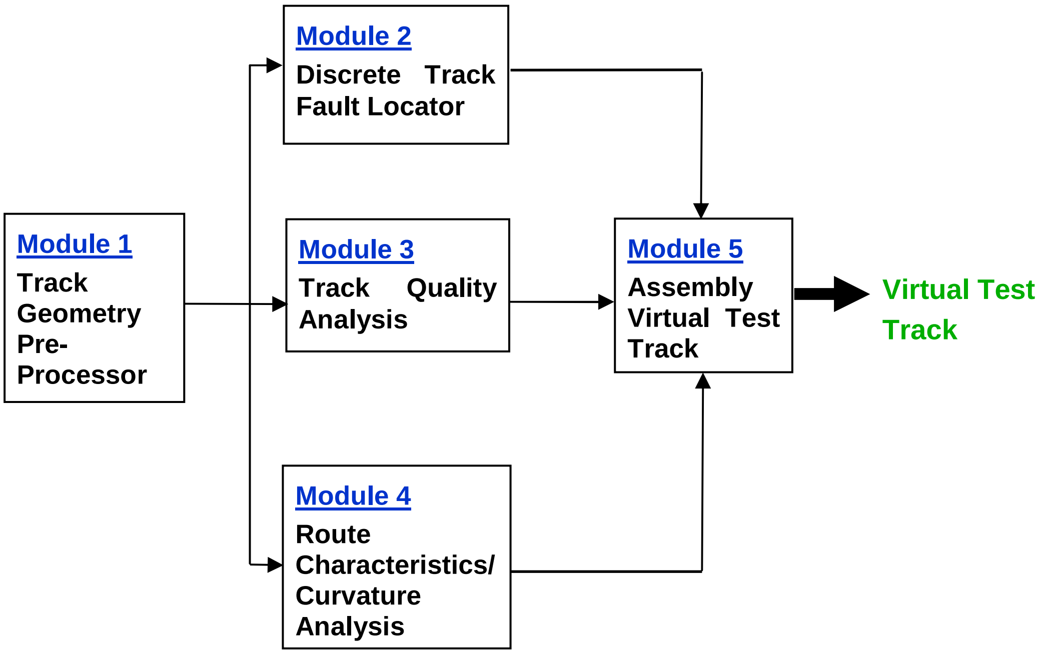

Figure 1: Virtual Test Track Toolkit Flowchart

The first stage takes raw data from the track recording vehicle (TRV) and performs a number of pre-processing functions to make it useable by the remainder of the analysis. This includes backfiltering the data to remove any phase and amplitude distortion present. This process is currently designed for UK TRV data but can be readily modified to perform the same function for data from other administrations, providing details of the required corrections etc. can be obtained.

The second stage (Figure 2) examines the track geometry for the presence of discrete defects (track twist, gauge, etc). These are logged and summarised by the toolkit. Again UK values can easily be replaced with those from other railway administrations.

Discrete Defect Summary and Log:

Type	Maintenance	L1	L2	Emergency
1	145	0	0	1
2	204	0	0	1
3	0	281	0	0
4	0	847	0	0
5	0	26	22	0

Fault codes:

1. 3m twist
2. Gauge
3. 3m gauge
4. Top
5. Alignment

Intervention Levels:

1. Maintenance limit
2. Level 1
3. Level 2
   Emergency intervention

Fault Location					
Cont dist /m	Miles	Chains	Fault Code	Intervention Level	Magnitude /mm
5.2	188	873	3	2	9
12.8	188	865	1	1	17
17.6	188	859	2	1	16
18.0	188	859	3	2	18
20.6	188	856	3	2	15
153.8	188	706	1	1	14
155.8	188	704	3	2	9
289.8	188	553	5	3	16

Combination Fault Log:

Location Start /m	End /m	Number 3mTw	Worst 3mTw	Number Gauge	Worst Gauge	Number 3m Gauge	Worst 3m Gauge	Number Top	Worst Top	Number Align	Worst Align
5.2	20.6	1	1	1	1	4	2	0	0	0	0
153.8	155.8	2	1	0	0	1	2	0	0	0	0
289.8	294.6	0	0	1	1	2	2	0	0	2	3
458.2	467.0	2	1	0	0	0	0	0	0	1	3
493.0	496.4	0	0	2	1	2	2	0	0	0	0
599.0	621.4	0	0	1	1	5	2	0	0	0	0

Figure 2: Example of Output from Module 2

The third stage calculates the vertical and lateral track quality using standard deviations of 200m lengths and provides variety of information including track quality distributions and target reports.

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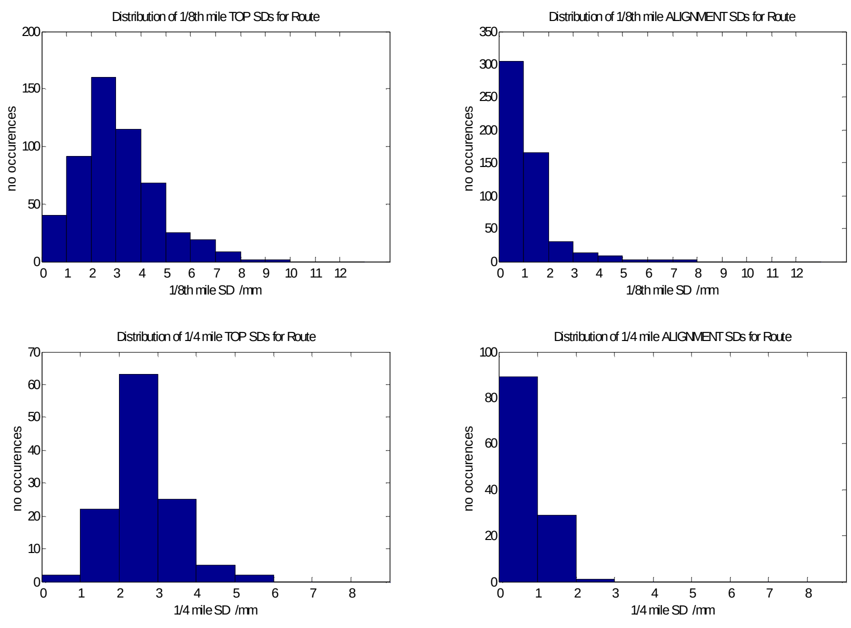

Figure 3: Module 3 Output, ⅛th and ¼ Mile Top and Alignment Distributions for Rou te

The fourth stage analyses the fundamental design characteristics of the route. Each data point is labelled by track type (tangent, curve, compound curve, S&C etc.) and this information is saved for later use. The distribution of left and right hand curves are calculated as are breakdowns of cant and cant deficiency by curvature.

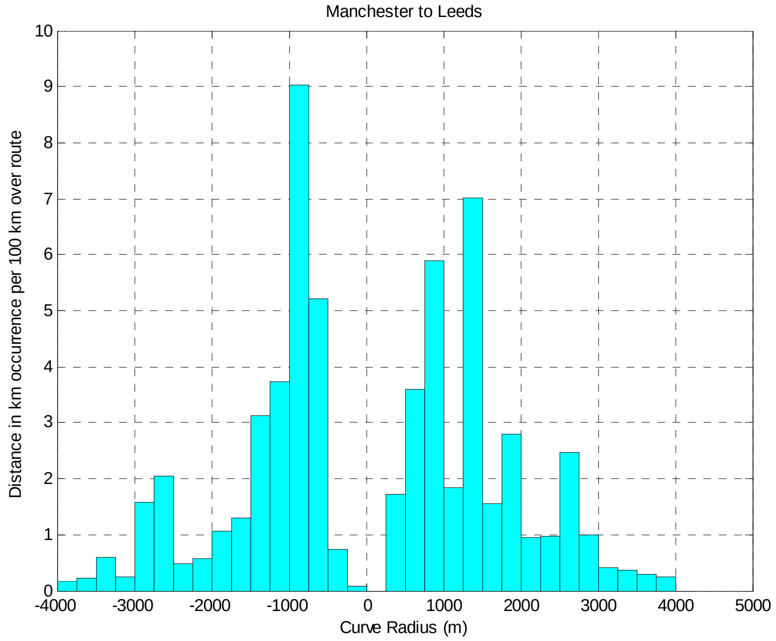

Figure 4: Module 4 Output, Distribution of Curve Radii for Route (Straights Omitted, Transitions Included)

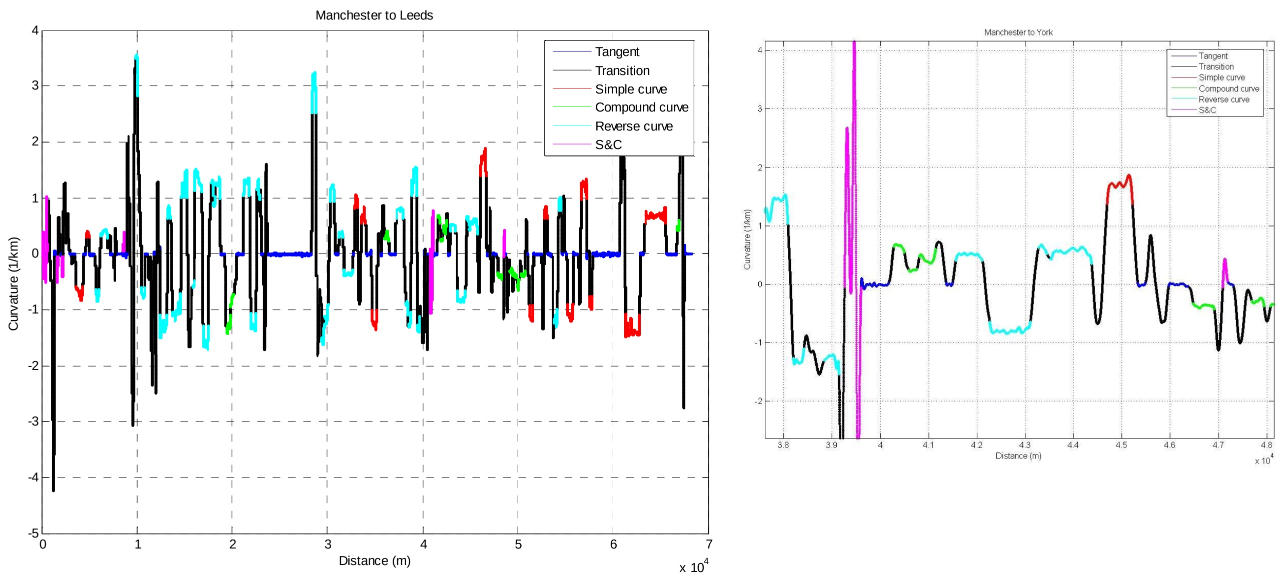

Figure 5: Module 4 Output, Classification of 70km Route by Track Type

The fifth and final stage of the process is to assemble the required track segment. At this stage, data from all the previous stages is combined to allow the required track segment to be generated. The length of the required track segment can be defined by the user. The analysis will then generate a track segment of the required length that matches the distribution of curvature and the vertical and lateral track quality to that of the original route. Lateral and vertical alignment distributions are measured in terms of 200m standard deviations, though other methods are possible.

The user can specify a number of options for the type of track segment required. These include:

- The length (default 20km)
- The order in which the selected 200m sections are arranged (best-worst, random etc.)
- The linespeed for which the selection is made
- Whether a matching representative curvature and cant profile is required

In addition to these options the user can ask the Toolkit to generate track sections meeting the requirements of UK vehicle acceptance standards or of UIC518. A number of further options are under development.

This type of 'representative virtual test track' is probably the most relevant for analysing route segments from a variety of administrations.

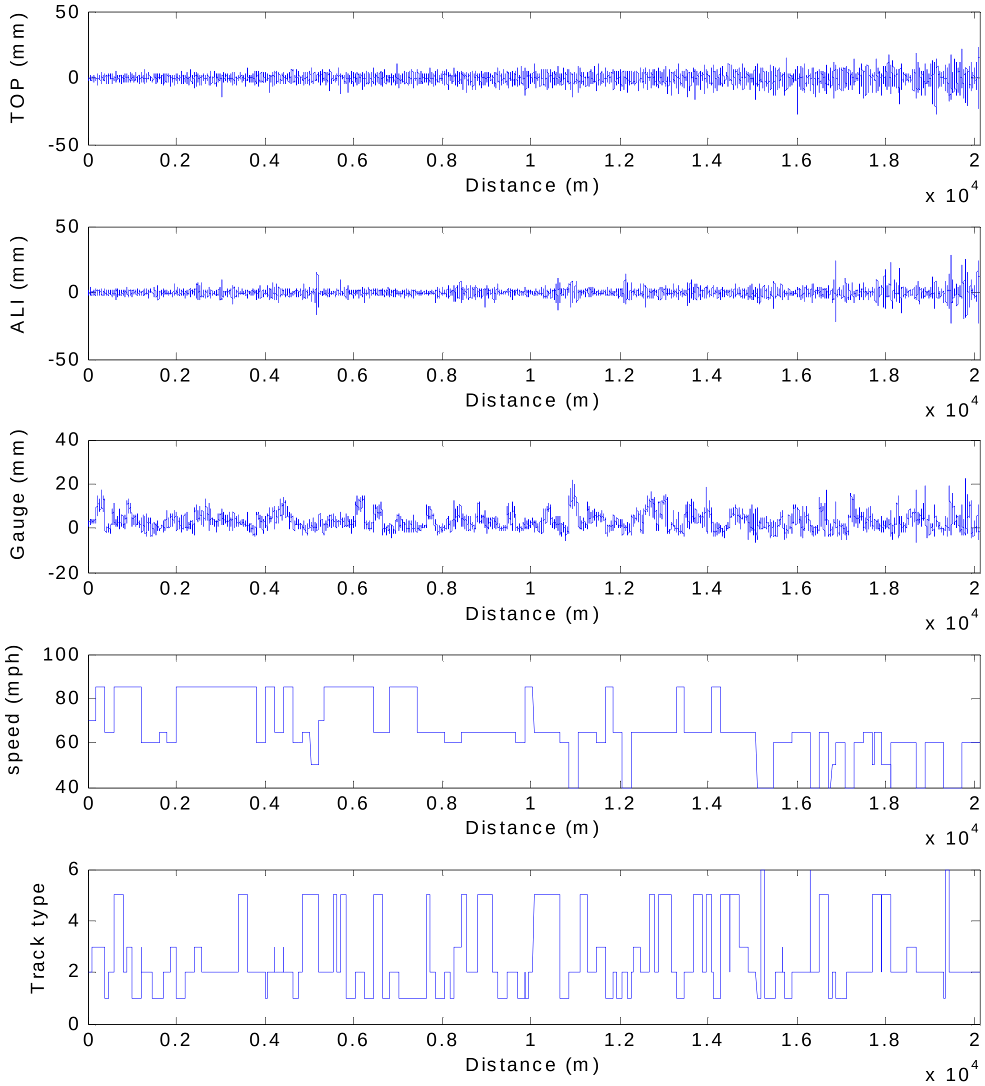

Figure 5: Module 5 Output, 20km 'Virtual Test Track' (All Linespeeds, Data Arranged from Best to Worst by Track Top)

4. Conclusions

The Virtual Test Track Toolkit provides a means of distilling large volumes of track data to provide a short segment (or ‘virtual test track’) that is representative of one or more features of the original dataset. Typically this would produce a short test track that matches the distribution of track quality and/or curvature of the original route.

The Toolkit therefore provides an initial means of generating the deliverable required for this work package. Further enhancement will be required to use data from other partners / railway administrations. The modular nature of the toolkit makes this relatively straightforward. Consideration will need to be given to other non-geometry features that may also require inclusion in the analysis such as traffic type and tonnage if truly comparable test segments are to be generated.

5. Bibliography

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