3D Trajectory Viewer - Data Input Specification

1. Introduction

The 3D Trajectory Viewer and our other analysis programs program accept mtion path data from a single disk file. This data can have been supplied from any of several sources, including simulation programs or vehicle data loggers. Provided the data is provided in the standard format defined here the viewer will display it regardless of its source.

The standard format for the data input file is as follows. The file is an ASCII text file, containing two lines of header data, followed by the vehicle motion path data.

2. File Header Data

The first line in the file contains a single text string, surrounded by double quotes. This is a general description of the file contents. It should be read as a single string of text. The second line contains information relevant to the data contained in the file. This line contains 4 comma-delimited items of information.

The first value is an integer indicating how many lines of vehicle data are contained in the file. Each line of data contains a single record of information about the car's condition at a single point in time. This is an integer value, so cannot go beyond 32,767 lines of information (about 21.8 hours of information, if recorded at 25 frames per second).

The second value is a floating point number indicating the data rate for the following data in the file. This can be interpreted as either the sampling rate or the replay frame rate, depending on the specific application using the file. This would typically be a value around 20 to 30 frames per second. It is provided to one decimal place (eg. 25.5 or 31.0).

The third value is an integer number indicating the units being used for the file data. A value of zero (0) indicates metric units are being used, while a value of one (1) indicates imperial units. By default metric units are assumed.

Finally, the fourth item on the line is a file name (text string). This is for a Vehicle Parameter File (VPF), which will contain dimensional and performance data for a vehicle. This is used for more detailed analysis of the motion path data. By default it is set to "CAR1.VPF", but would otherwise be set to a particula vehicle file data set.

3. Vehicle Data

The vehicle data is presented as a number of comma-delimited values, with one set of data (or record) values per line in the file. Metric units are assumed to be the default case, as indicated below. Each line contains 30 items of data, as follows,

1	Frame Number		(integer)
2	Time	time	(seconds)
3	X Position	X	(metres)
4	Y Position	Y	(metres)
5	Z Position	Z	(metres)
6	Pitch Angle	AY	(degrees)
7	Roll Angle	AX	(degrees)
8	Yaw Angle	AZ	(degrees)
9	Heading	Hdg	(degrees)
10	Distance Travelled	Dist	(metres)
11	Speed	Vel	(kilometres per hour)
12	Longitudinal Acceleration	GX	(G)
13	Lateral Acceleration	GY	(G)
14	Engine Speed	RPM	(rpm)
15	Gear		(integer)
16	Steering Angle	Sang	(degrees)
17	Throttle Position	Throt	(percent)
18	Suspension Position FR	sFR	(millimetres)
19	Suspension Position FL	sFL	(millimetres)
20	Suspension Position RR	sRR	(millimetres)
21	Suspension Position RL	sRL	(millimetres)
22	Aerodynamic Balance	AeroT	(percent)
23	Mechanical Balance	MechT	(percent)
24	Front Axle Vertical Force	FvF	(units)
25	Rear Axle Vertical Force	FvR	(units)
26	Spare #1		
27	Spare #2		
28	Spare #3		
29	Spare #4		
30	Comment		(string)

Most of these data values should be obvious. Four spare channels are included to allow for the recording of additional, user-specific information.

The master time base for this data is the "frame". This is a number starting at 1 and incrementing to some final integer value. This can be converted to time in seconds by simply dividing the frame

number by the frame rate (defined in the file header data). That is, frame 30, with a data rate of 25 frames per second, would correspond to a time of (30 / 25) = 1.2 seconds.

A separate "time" channel is also provided, for the situation where finer, or different, time increments may be required. In this case the "time" channel can be used as the master time reference and the "frame" channel then becomes simply a data record number.

4. Data Standard

The following list displays the range and sense of the various data values.

1	Frame Number	integer	always a positive value
2	Time	float	always a positive value
3	X Position	float	positive to right when looking down
4	Y Position	float	positive up when looking down
5	Z Position	float	positive vertically up
6	Pitch Angle	float	positive nose up (accelerating)
7	Roll Angle	float	positive left side down (right turn)
8	Yaw Angle	float	positive for left turns
9	Heading	float	positive for left turns
10	Distance Travelled	float	always a positive value
11	Speed	float	always a positive value
12	Longitudinal Acceleration	float	positive for acceleration
13	Lateral Acceleration	float	positive for right turns
14	Engine Speed	float	always a positive value
15	Gear	integer	always a positive value
16	Steering Angle	float	positive for a right turns
17	Throttle	float	number between 0 and 100
18	Suspension Position FR	float	positive for upward deflections
19	Suspension Position FL	float	positive for upward deflections
20	Suspension Position RR	float	positive for upward deflections
21	Suspension Position RL	float	positive for upward deflections
22	Aerodynamic Balance	float	number between 0 and 100
23	Mechanical Balance	float	number between 0 and 100
24	Front Axle Vertical Force	float	positive for downward load
25	Rear Axle Vertical Force	float	positive for downward load
26	Spare #1	float	n/a
27	Spare #2	float	n/a
28	Spare #3	float	n/a
29	Spare #4	float	n/a
30	Comment	string	n/a

5. Parameter Description

The specific meaning of each data channel is as follows.

Channels 1 (Frame Number) and 2 (Time) are the time reference for the vehicle data. Time can be defined in two different ways, as the frame number or an explicit time value, hence the provision for two values here.

Channels 3 (X Position), 4 (Y Position) and 5 (Z Position) are the location coordinates, in 3 dimensional space, of the centre of gravity of the vehicle.

Channels 6 (Pitch Angle), 7 (Roll Angle) and 8 (Yaw Angle) are the orientations, in 3 dimensional space, of the vehicle about its centre of gravity.

Channel 9 (Heading) is the direction the vehicle is travelling (the direction of the velocity vector). The difference between this and the Yaw Angle is the Slip Angle.

Channel 10 (Distance Travelled) is a value indicating the distance travelled by the vehicle, generally used as a reference value for display only.

Channel 11 (Speed) is the velocity of the vehicle along the motion path.

Channels 12 (Longitudinal Acceleration) and 13 (Lateral Acceleration) are the accelerations applying to the vehicle in the X-Y plane.

Channel 14 (Engine Speed) is the rotational speed of the engine, generally used as a reference value for display only.

Channel 15 (Gear) is the number of the transmission gear currently being used. This is generally used as a reference value for display only.

Channel 16 (Steering Angle) is the average angle of the front wheels with respect to the "straight ahead" position.

Channel 17 (Throttle) is the engine throttle position, defined as a percentage, where 100% is fully open and 0% is fully closed.

Channels 18 (Suspension Position FR), 19 (Suspension Position FL), 20 (Suspension Position RR) and 21 (Suspension Position RL) are the suspension displacements, with respect to some arbitrary reference zero position.

Channels 22 (Aerodynamic Balance) and 23 (Mechanical Balance) are balance locations residing somewhere between the front and rear vehicle axle lines. These are specific positions somewhere along the vehicle longitudinal centreline.

Channels 24 (Front Axle Vertical Force) and 25 (Rear Axle Vertical Force) are the specific loads acting on the front and rear wheels.

6. Data Storage

In order to be able to predict how much data can be placed in computer memory we will make an estimate here of the storage requirement for a single line (record) of vehicle data. When the data is loaded into a program it will be stored in memory in a binary format. Typically an integer will occupy 2 bytes of storage and a floating point number 4 bytes.

The first line in the file is a variable length text string. The second line contains 2 integer values, a floating point number and a string. Each integer value would occupy 2 bytes of memory, for a total of 4 bytes, plus 4 bytes for the real number and typically 12 bytes for the VPF file name. This gives a total of 20 bytes.

For each line of vehicle data there are 30 items. Of these 27 are real numbers, two are integers and one is a string. A real number occupies 4 bytes of storage, an integer 2 bytes, and the string might typically be 8 bytes, so the numeric items would occupy, in total, 120 bytes.

This information can be used to roughly estimate memory requirements. For example, how much data could we fit into 10 megabytes of system memory? In bytes, 10 megabytes is

$$1024 \times 1024 \times 10 \quad = \quad 10{,}485{,}760$$

Allowing, conservatively, for 200 bytes in the first line of the file,

$$10{,}485{,}760 - 200 \quad = \quad 10{,}485{,}560 \text{ bytes}$$

Now, allowing for 120 bytes of data per record,

$$10{,}485{,}560 / 120 \quad = \quad 87{,}379 \text{ records}$$

Finally, assuming a data rate of 25 frames per second,

$$87{,}379 / 25 \quad = \quad 3{,}495 \text{ seconds}$$
$$= \quad 58 \text{ minutes}$$

So 10 megabytes of computer memory could store just under an hour of data, stored in computer memory and available for real-time replay.

7. Example

The following is a short section of a typical data file. This should help to illustrate a little better the format described here. This file contains 2140 data records, in metric units and at a sample rate of 20 samples (frames) per second.

```
"MTC File: D:\TEMP\MOTEC\CONV\LAP3-20.CSV"
2140, 20.0, 0, "Car1.VPF"
1,0,0,0,0,0,0,2.1,0,0,194.2,.1,.09,6318,4,-.4,103.9,.8,2.6,6.5,2.5,0,0,0,0,0,0,0,0,""
2,.0488,0,0,0,0,0,1.4,0,0,194.1,.09,.09,6300,4,0,103.9,8.3,8.2,9.2,6.5,0,0,0,0,0,0,0,0,""
3,.0977,0,0,0,0,0,2.2,0,0,193.9,.09,.09,6300,4,0,103.9,6.9,10.5,13,11.4,0,0,0,0,0,0,0,0,""
4,.1465,0,0,0,0,0,2.8,0,0,194.4,.09,.1,6348,4,-.4,103.9,9.2,11.3,12.7,11.7,0,0,0,0,0,0,0,0,""
5,.1953,0,0,0,0,0,2.9,0,0,195.1,.09,.1,6348,4,-.4,103.9,5.8,8.1,13.7,12.3,0,0,0,0,0,0,0,0,""

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2137,104.2969,0,0,0,0,0,1.7,0,0,193.8,.09,-.05,6276,4,-.4,103.9,2.8,4.2,5.5,3.5,0,0,0,0,0,0,0,0,""
2138,104.3457,0,0,0,0,0,2.7,0,0,193.9,.09,-.01,6342,4,-.4,103.9,2.7,3.7,7.3,6.2,0,0,0,0,0,0,0,0,""
2139,104.3945,0,0,0,0,0,2.8,0,0,193.8,.09,-.01,6342,4,-.4,103.9,.7,2.3,6,4.3,0,0,0,0,0,0,0,0,""
2140,104.4434,0,0,0,0,0,2.7,0,0,194.1,.09,0,6330,4,-.4,103.9,.6,.7,5.8,4.1,0,0,0,0,0,0,0,0,""
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