

data acquisition

by Matthew Perry

FILE	2078_MATTHEW_PERRY_DATA_ACQUISITION_138915_1419137206.DOCX		
TIME SUBMITTED	17-DEC-2018 03:07AM (UTC+0000)	WORD COUNT	2978
SUBMISSION ID	97554867	CHARACTER COUNT	14810

University of Wales Trinity Saint David

School of Engineering

Driver comparison through data analysis

Race Engineering

M6X02207

Matthew Perry

P147909

17/12/2018

Abstract

In this reports it's taking a look at the data logger and what it is displayed in. To retrieve data it used a racing simulator, which involved three drivers and five laps each at a time. Many channels were used to look at the data such as braking, throttle, steering, gear selection and many more. The idea of this report is to evaluate three drivers by looking at the data and seeing where they can be improved. It also talks about what a simulator is and the advantages. It then goes on to talk about what a data logger is and why used it and the advantages. As both systems help improve the drivers skills.

Contents

Title page:	Page: 1
Abstract:	Page: 2
List of figures:	Page: 4
Introduction:	Page: 5
Literature review:	Page: 6
Methodology:	Page: 7
Results/Analysis:	Page: 8-9
Conclusion and Evaluation:	Page: 10
Appendices:	Page: 11-16
References:	Page: 17

List of Figures:

<u>Fig 1</u> Shows of the throttle to early:	Page: 11
<u>Fig 2</u> breaking too early:	Page: 11
<u>Fig 3</u> Shows throttle and breaking:	Page: 12
<u>Fig 4</u> Shows throttle and corner speed:	Page: 12
<u>Fig 5</u> throttle and breaking:	Page: 12
<u>Fig 6</u> Understeer:	Page: 13
<u>Fig 7</u> Shows understeering and steering percentage:	Page: 13
<u>Fig 8</u> G force Lateral oversteer	Page: 13
<u>Fig 9</u> vehicle losing control and spin out	Page: 14
<u>Fig 10</u> Throttle:	Page: 14
<u>Fig 11</u> scatter plot of G force long and G force lateral:	Page: 14
<u>Fig 12</u> Throttle and steering percentage:	Page: 15
<u>Fig 13</u> Throttle:	Page: 15
<u>Fig 14</u> Throttle and braking percentage:	Page: 15
<u>Fig 15</u> throttle and braking percentage	Page: 15
<u>Fig 16</u> gear selection, throttle and braking percentage	Page: 16
<u>Fig 17</u> gear selection, throttle and braking percentage	Page: 16
<u>Fig 18</u> throttle and braking percentage	Page: 16
<u>Fig 19</u> 19 gear selection, throttle and braking percentage	Page: 16

Introduction:

This report will take an inside look at three drivers and how each drivers techniques and performance are different, by looking at the differences in each drivers inputs such as steering, acceleration, braking and gear selection, improvements can be made by using a data logging system. The data logging is a system that records the driver's inputs and lap times, which then can be used to look back on by using the software programme known as MOTEC. Using the data on MOTEC means you can see what improvements can be made, even the fastest driver can improve by looking at the other drivers and seeing what sections of the track there quicker on and why. The MOTEC will be discussed, and will include why it is used and what it is needed for. This comparison of data was collected on the racing simulator using a GP2 car at the Silverstone race track, the racing simulator procedure will be discussed and how the results were collected. The comparison of data will use three drivers, the first driver sets an example of data which is used as a bench mark. The other two drivers are to compare results with the first driver and see what improvements can be made. Once the data has been assessed, any improvements that's can be made are then implemented to the driver to see if the lap times are improved. Once this is done it can then look at the differences before and after the implementations were made.

Literature review:

For the test plan to be carried out it involved using a racing simulator, but why use a racing simulator and what is a racing simulator. Once the racing simulator was used, data was then achieved by using a data logging system, which records the information and then displays it in MOTEC. What is a vehicle racing simulator, a racing simulator is a virtual reality device which allows the driver to feel as if there in a real life vehicle at a race track. There are many advantages to this such as the lower cost compared to an actual test day supported by Norfleet, D, et al, 2009. Being able to use the racing simulator means there are less situation that stop you from testing such as the track closing, limited time, weather not being permitting to use the track and the overall cost of everything involved such as transport, booking fees, fuel and tyres. If an accident was to happen which resulted in a crash the cost of the vehicle repair could be high and the safety of the driver could result in injury's, but if the testing was done on the racing simulator, it would be much safer due to not being a real life situation and if the vehicle was to crash no additional cost to fix the vehicle. Using the racing simulator, it can be used for driver endurance to see how long the driver can drive before becoming fatigue. As part of the racing simulator it has many controls such as pedals, steering wheel, and gear selection, some of the racing simulator have vehicle motion to make it feel even more closer to the real life thing. Making it feel like the real life thing includes noises and sounds as if in a car at the track, feedback through the steering wheel as if you're actually driving around the track, the surroundings of the track give the general overall feel of a real life situation. A data logging system is fitted to either a racing simulator or a vehicle depending on the test that is going to be carried out. What is a data logger, a data logger records all the vehicle information for example throttle percentage, braking percentage, steering wheel angle, what gear the driver is using and many more, by using the information recorded means that information is then used to make improvements to the vehicle and drivers performance. Anything that is recorded can then be looked back on using MOTEC software programme. Looking at the data can be done during or after testing, there are many benefits of this such as being able to look at vehicle's and driver's performances. Looking at the vehicle's performance can back up the driver's feedback if he has any issue with the vehicle. If there was a handling issue you can use the data and look at it in MOTEC, then pinpoint the location of where it occurs on the track according to Rodrigo, S, 2014. Using the data to look at the driver's performance, then as part of the performance you can then look at the different laps and see where the improvements can be made such as seeing why one driver is quicker than another. This can also help understand the driver's style and performance. As part of having the data it means the vehicle development can be improved by looking at the vehicles parameters and see what adjustments or modifications can be made to enhance the vehicle. The data logger is a very helpful device when it comes to reliability and safety due to being able to monitor oil pressure, oil temperature and water temperature. The safety factor of this is it can read, record and pick up any faults or malfunction within the vehicle while live testing or racing is under way. The tyre pressure can be monitored which has big impact on the car and safety for obvious reasons.

Methodology:

The data that is used in this report was collected by using the racing simulator, before the data sets were achieved a test procedure was discussed and agreed between the team members. The test plan was for each driver to have a warm up lap to get used to the track due to different driving experiences, for example a team member never used a racing simulator before, this person needed to get to a level of consistency. Each member of the team had different things to look at such as throttle, braking, track time, the live data on MOTEC and the driver driving. Once the warm up laps were done, the data was then collected for the three drivers. The three drivers did five laps each with the same track and vehicle to have consistent data to be able to look at the differences in the inputs and compare. Once the five laps were completed the data was then analysed to see where each driver could improve their lap times. The first driver was more of a bench mark to then compare second and third driver against the first drivers bench mark. Once the data had been examined and the improvements to be made were found, the three drivers then did another five laps each but this time before entering the racing simulator, then the improvements were given to each driver to see if the lap time will get faster compared to before. Once the driver had achieved the instructions given, if there was any more implementations to be made these were given whilst the driver was driving to see if any further improvements could have been made. The suggestions that were instructed to the driver are below.

Driver A:

- Brake later on corner sixteen.
- Corner three and four use second gear not first.

Driver B:

- Corner three and four use second gear not first gear.
- Corner six brake later.
- Corner sixteen use first gear not second.

Driver C:

- Corner seven use third gear not second.
- Corner sixteen not so hard on the brake.

Once these laps were completed you can then see the noticeable differences in the lap times before and after the instructions were given. To look at some of the data some math channels were made to work out corner speed and corner radius for this to be calculated they had to be format like below.

- 'Corr Speed' [km/h]/3.6
- ('speed M_s' [m/s]*'speed M_s' [m/s])/('G Force Lat' [G]*9.81)

Results and Analysis:

Once the data was produced it was then looked at to see where each driver could improve on their lap times, it is also going to look at before and after the improvements were made to see the effects on their lap times.

- Driver A is red line on data.
- Driver B black line on data.
- Driver C green line on data.

Fig.1 shows that driver C could improve his lap time by coming off the throttle much later compared to driver A and B in turn six, due to coming off the throttle early means driver C is also braking to early and could brake harder and later shown in Fig.2. Driver C the quicker driver can improve by also coming off the throttle later and braking later in turn six as can see in Fig.1 and 2. From turn one to just before turn three, driver C can use full throttle through the turns but instead has lifted then got back on the throttle shown in Fig 3 and driver A can come off the throttle later before entering turn three shown Fig.3. Driver C is also the first person on the brakes in this corner as shown in Fig.3. Driver C's corner speed is slower than driver A and B on corner nine this is because he has come off on the throttle more than once, rather than keeping the throttle on and maintaining the corner speed shown in Fig.4. Driver B and C brake, not like driver A who don't brake on the corner twelve and driver C is also off throttle first look at Fig.5. Coming out of corner thirteen you can see that driver C has oversteer as shown in Fig.6 all so supported by Sunder V, et al, 2000. The understeer shown in Fig.7 is due to turning to sharp and not gradually. Driver C is also seen having some oversteer as show in Fig.8 also supported by Sunder V, et al, 2000. Driver B has lost control and spun out, this can see by looking at steering percentage and throttle percentage as seen in Fig.9. Driver A could improve his fastest lap by getting on full throttle coming out of turn sixteen rather than quarter than half throttle and then on full throttle where instead he can just full throttle like driver B as shown in Fig.10. Fig.11 displays a scatter plot of G lateral and longitudinal of the fastest laps of the three drivers, looking at driver C's G force lateral at -3.5 and G force longitudinal 0.75 you can see driver C is not using the full potential of the vehicle, looking at this means this driver could increase speed going around the corners as shown in Fig.11.

Now going to Look at the drivers fastest laps and see where they can improve. Driver C on corner nine has come off the throttle as shown In Fig.12 as where the other drivers have not lifted of the throttle, also looking at the steering percentage in Fig.12 you can see the percentage is higher so the car is turning shaper therefore lifting of the throttle. Looking at Fig.13 you can see that only driver B manages to get to full throttle, you can also see driver B and A come of the throttle between turn six and seven, when looking at driver C he maintains half throttle rather than on and off. Fig.14 displaying throttle, braking percentage and G force longitudinal, you can see driver C is coming of the throttle and braking way to early before corner six. Drive A can also improve coming into corner six by coming of throttle slightly later and braking harder and later like driver B shown in Fig.14. Now this report is going to look at before and after the improvement instructions were made.

Driver C:

- Corner seven use third gear not second.
- Corner sixteen not so hard on the brake.

Looking at Driver A you can see the improvement on the lap time, due to being quicker approaching corner sixteen the black line is before the improvement and the red line is after and can see by braking later on that corner means full throttle for longer as can see in Fig.15. The other improvement that has been made by using second gear into turn three and four this as also helped by coming of throttle later and braking later and harder can see by looking Fig.16.

Driver B:

- Corner three and four use second gear not first gear.
- Corner six brake later.
- Corner sixteen use first gear not second.

The red line shows after the improvement has been made, by looking at corner six you can see by braking later means driver B can full throttle for longer and brake harder later. Driver B used second gear rather than first gear in corner three and four this has improved by being able to brake harder and later, full throttle for longer as shown in Fig.17. Using first gear and not second does not have a big effect on being quicker.

Driver A:

- Brake later on corner sixteen.
- Corner three and four use second gear not first.

The red line shows after the suggestions were made driver C is not using the brakes as hard or as early. This means full throttle for longer and get to a higher speed down the straight as shown in Fig.18. Using second gear in this corner has improved the lap time and can see braking later and full throttle for longer as shown in Fig.19.

Conclusion and Evaluation:

This report has looked at three drivers using a racing simulator to produce live data, then using the data displayed in MOTEC, which key points can be found to make improvements. Using the MOTEC data displayed and picking up on where people can improve their lap times means that suggestion to the driver need to be made, which in this report has improved the drivers lap times. As discussed there many advantages to using the racing simulator for the driver such as vehicle performance and safety. Using a data logger has so many advantages as there are so many channels to look at on the vehicle which has a big impact on improving lap time. There are many advantages to using a racing simulator but there are also disadvantages to it such as not being the real thing, even though it is close to real thing as possible. In a real life situation there could be bumps or small errors on the track that alter things, also the weather could change to different weather conditions whilst driving. Outside temperature can change. Being in the car at the track, sounds and feelings are always better than a racing simulator even the vibrations of the vehicle and sense of g force lateral and longitudinal. On the racing simulator everything stays perfect where as in real life things wear and failures with components.

Appendices:

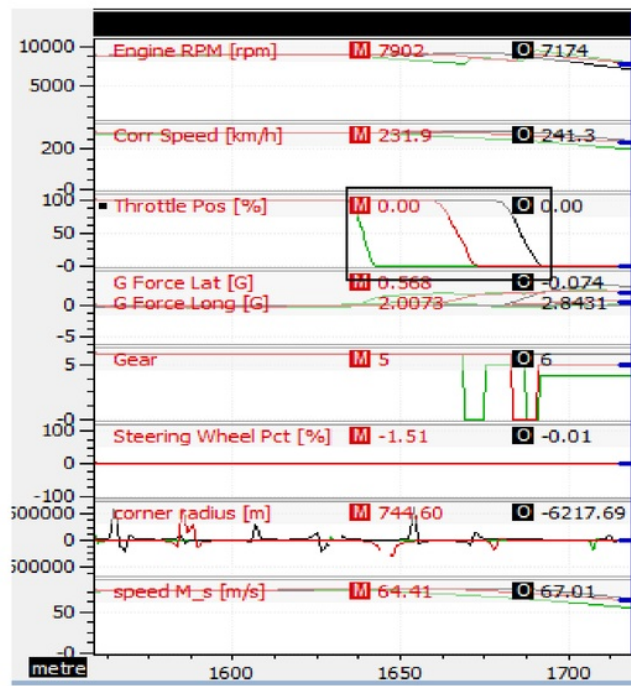


Fig.1 shows off the throttle to early

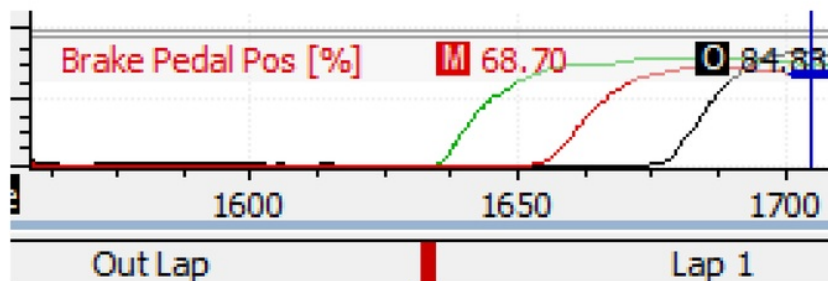


Fig.2 braking to early

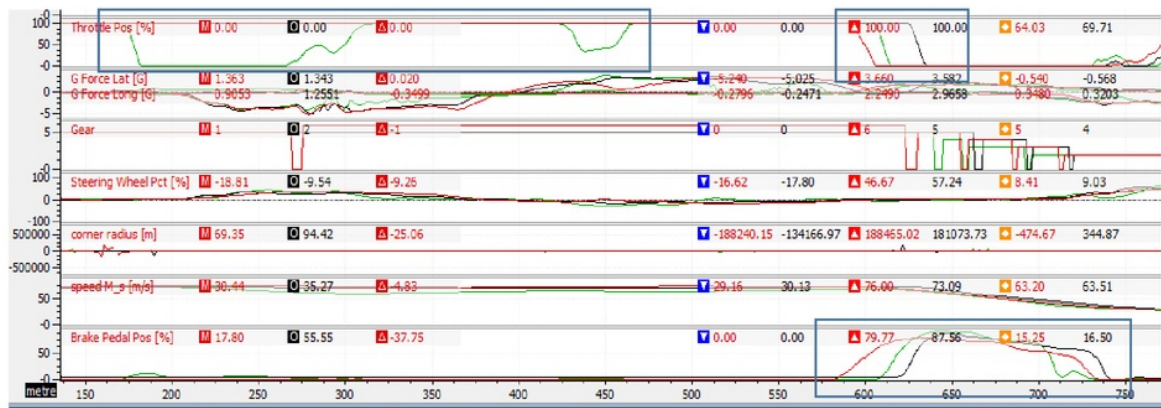


Fig.3 shows throttle and braking

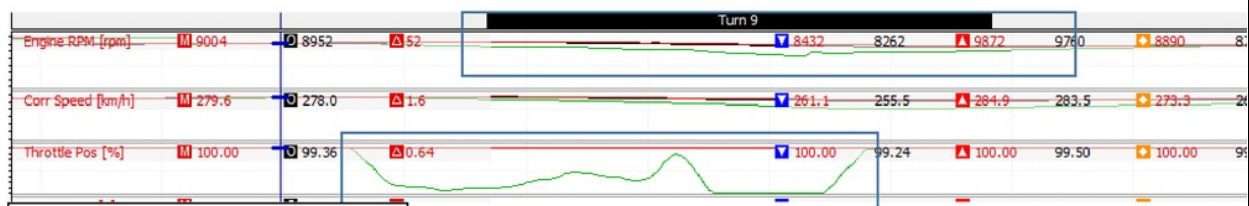


Fig.4 shows throttle and corner speed

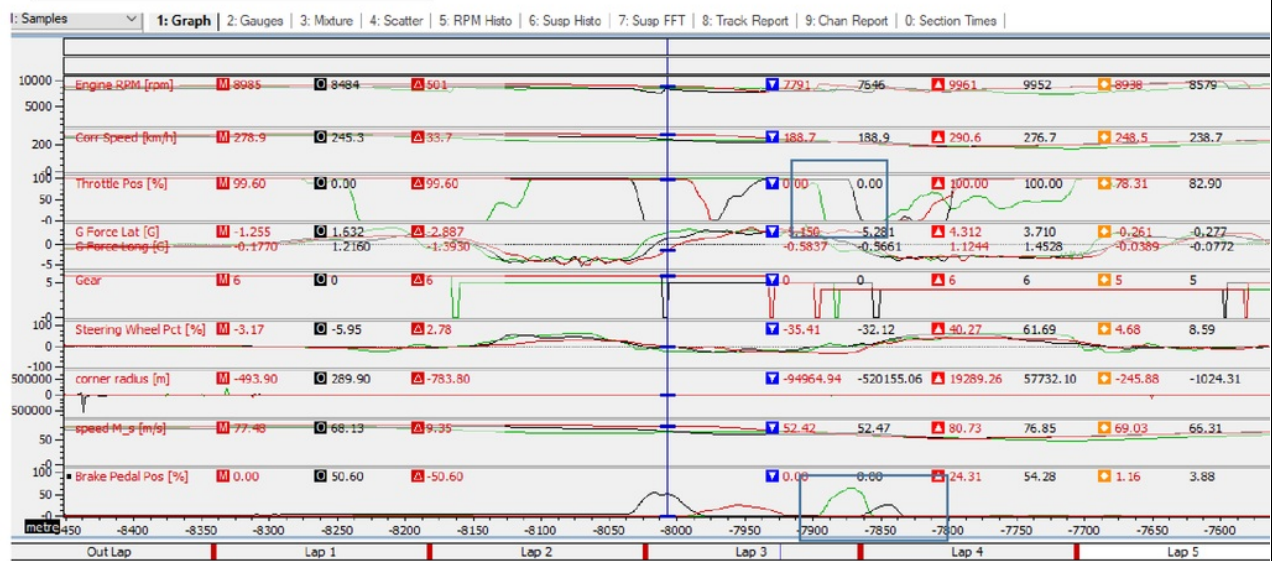


Fig.5 throttle and braking

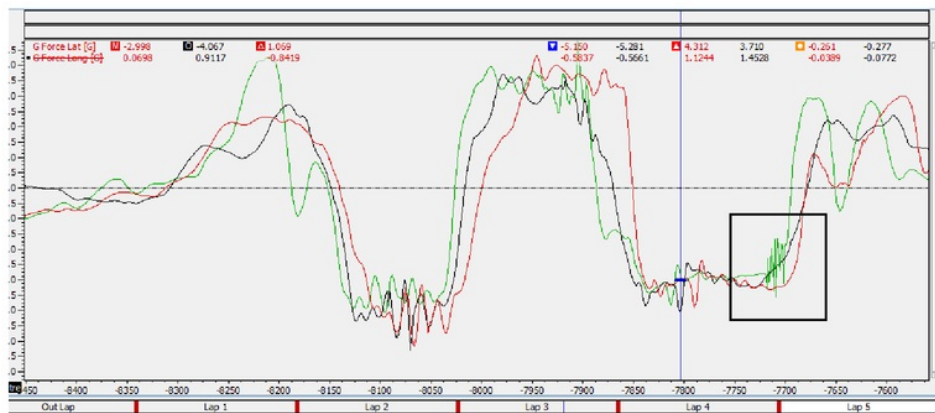


Fig.6 understeer

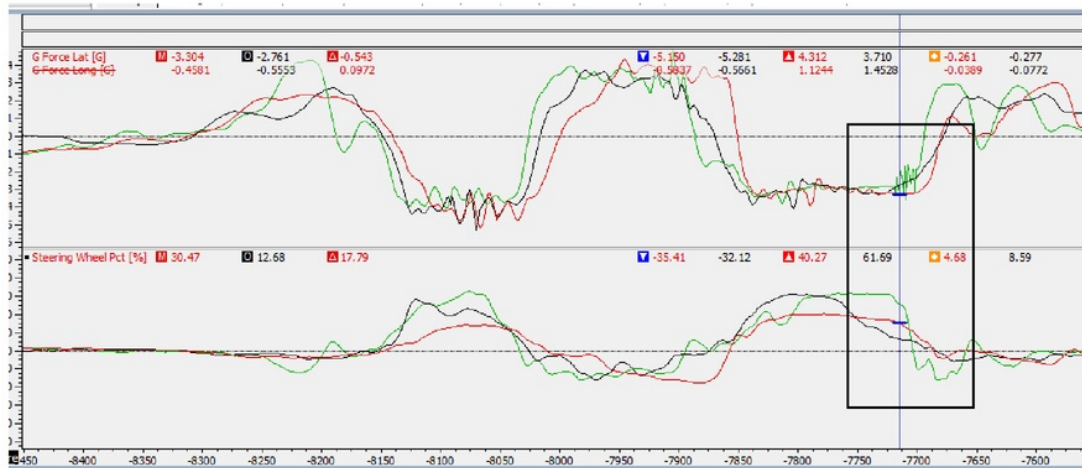


Fig.7 shows understeer and steering percentage

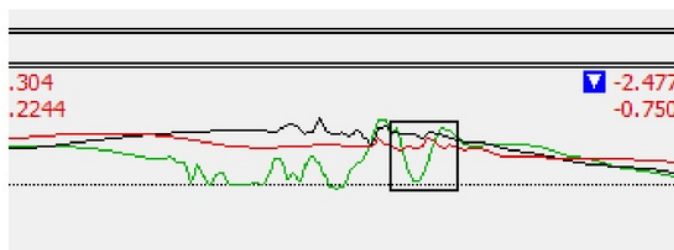


Fig.8 G force Lateral oversteer

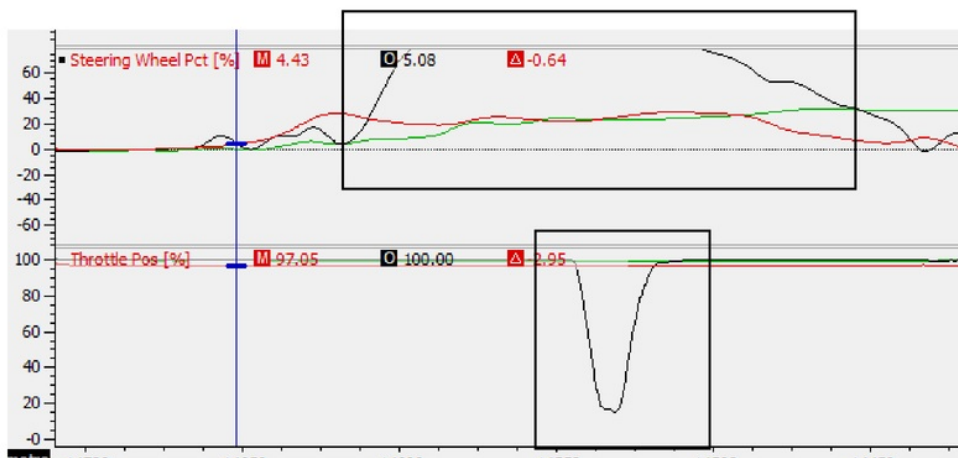


Fig.9 vehicle losing control and spin out

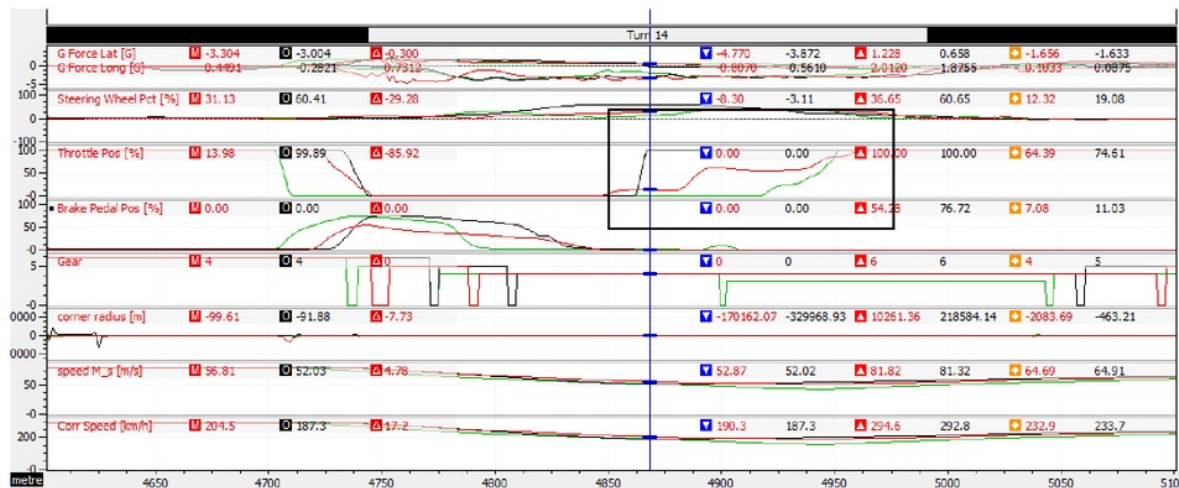


Fig.10 throttle

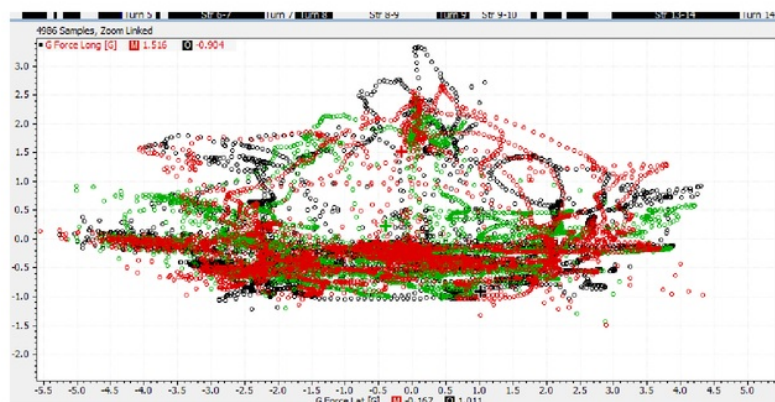


Fig.11 scatter plot of G force long and G force lateral

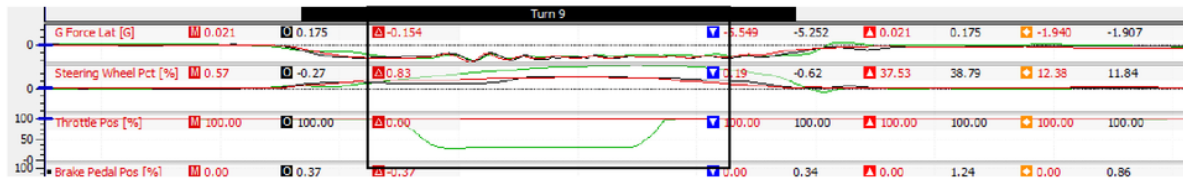


Fig.12 Throttle and steering percentage

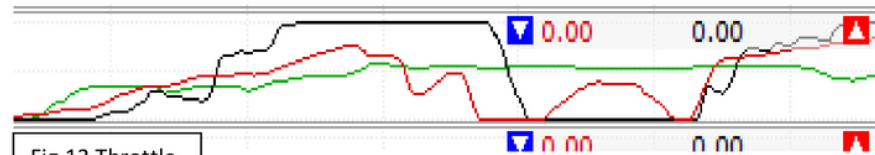


Fig.13 Throttle

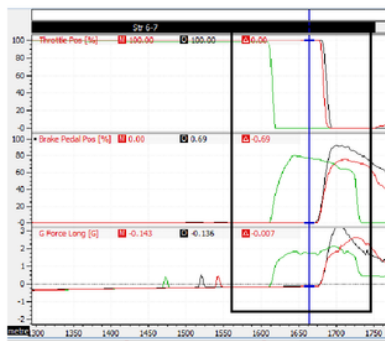


Fig.14 Throttle and braking percentage

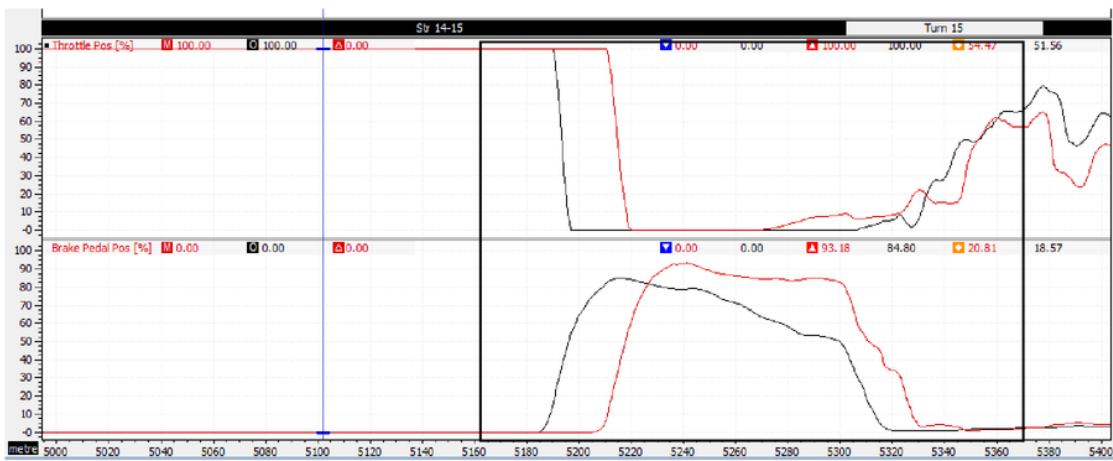


Fig.15 throttle and braking percentage

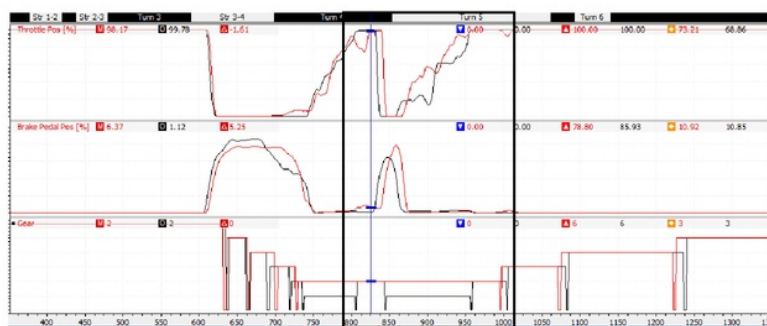


Fig.16 gear selection, throttle and braking percentage

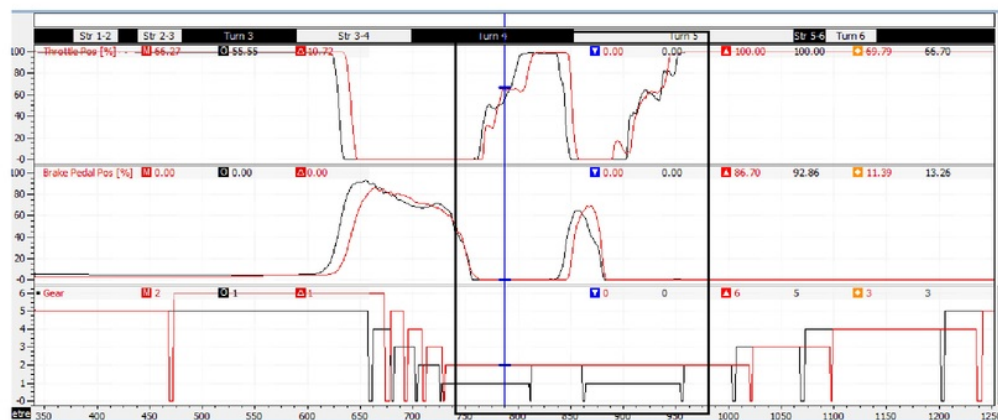


Fig.17 gear selection, throttle and braking percentage

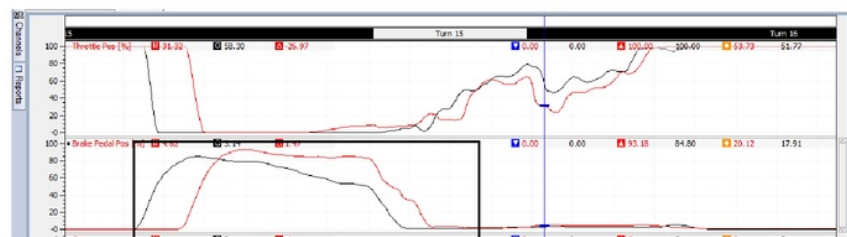


Fig.18 throttle and braking percentage

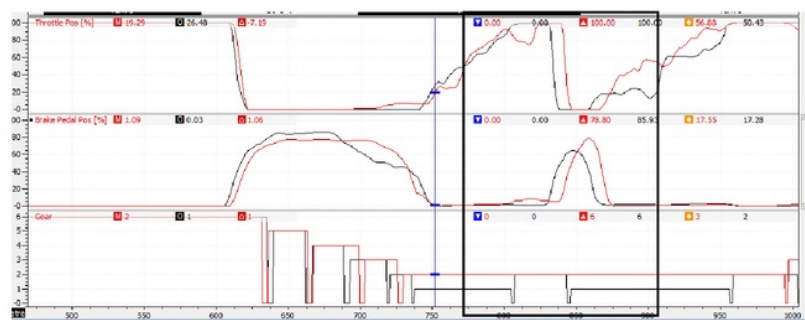


Fig.19 gear selection, throttle and braking percentage

References:

Waeltermann, P., Michalsky, T., and Held, J., "Hardware-in-the-Loop Testing in Racing Applications," SAE Technical Paper 2004-01-3502, 2004

Kaemmer, D., Benwick, I., and Porter, S., "Development of an Effective, Low-Cost Internet-Based Motorsport Driver Simulation," SAE Technical Paper 2008-01-2960, 2008

Norfleet, D., Wagner, J., Alexander, K., and Pidgeon, P., "Automotive Driving Racing simulators: Research, Education, and Entertainment," *SAE Int. J. Passeng. Cars – Electron. Electric. System.* 2(1):186-193, 2009

Bessant, M. and Knight, P., "Development in Onboard Data Acquisition, Display and Radio Telemetry for Motor Racing," SAE Technical Paper 920821, 1992

Lighthall, J., Pierce, J., and Olvey, S., "A Physiological Profile of High Performance Race Car Drivers," SAE Technical Paper 942479, 1994

Jawad, B. and Nagy, K., "Remote Data Acquisition Using Audio, Video and Data Transmission," SAE Technical Paper 2001-01-2467, 2001

Vaduri, S. and Law, E., "Development of an Expert System for the Analysis of Track Test Data," SAE Technical Paper 2000-01-1628, 2000

<http://racingcardynamics.com/data-acquisition-fundamentals/>

https://www.researchgate.net/publication/281593035_Advantages_and_Disadvantages_of_Driving_Racing_simulators_A_Discussion