Telemetry-based Optimisation for User Training in Racing Simulators

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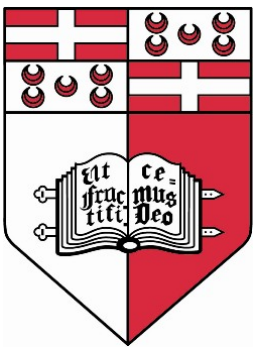

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Abstract

This project will be looking into applying serious games in the training of motorsports race drivers. The goal is to improve a driver's lap times in a simulation race game via a pedagogic feedback system. Researching serious games, techniques employed by racing drivers on track, racing simulation games and hardware, will be the foundations for the user case study which is to be carried to evaluate the effectiveness of the developed system

1 Acknowledgements

Luke for racing rig

Keith for PC

Contents

2 Other tables and lists

3 Table of abbreviations

4 Introduction

Introduce the area and the FYP without assuming that the reader has any special knowledge in the area. The aims and goals of the project. Any non-aims of the project (e.g. in a purely theoretical project, the development of an artifact would not necessarily be an aim). The approach used. Any assumptions. A high level description of the project.

The gamification of areas of activity such as marketing, problem solving and education [7] has validated the use of serious games beyond their initial military use in training strategic skills [5]. Serious games simulate real-world processes designed for the purpose of solving a problem, making their main purpose that of training or educating users. Their popularity has been steadily increasing, as has their adoption, with military [5] and emergency service providers (e.g. firefighters [7]) employing them to train for specific scenarios that might be encountered on the respective jobs. Motorsports cover a broad range of activities and vehicles, and as with all major forms of sporting activities, require training and dedication, with a pedagogic aspect arising in rote learning and mentoring by experts. The arenas in which motorport events take places are called circuits; there is a large selection of the latter, ranging from purposely built race tracks to public roads to natural formations such as hills and quarries. There is also a diverse selection of vehicles that take part in motorsports, with the greatest demarcation existing between motorbikes and cars. The focus of this dissertation is that of unifying serious games and motorsport racing; specifically, it will try to show whether a serious game is a powerful enough pedagogical tool that can be used to tangibly improve the performance of race drivers. The scope of the project is limited to four-wheeled cars racing on purposely-built confined circuits with a smooth tarmac surface.

4.1 Motivation

The training process for race drivers has stabilised during the last decade, with rote learning playing a very important part. Starting at an early age, a driver

would compete in lower leagues, such as go karting, and undergo training that is mostly founded on trial and error. A mentor, or coach, would correct obvious mistakes and suggest ways for improvement based on experiential knowledge and related literature. The extensive hours of practice serve to hone the skills of a driver and help in the acquisition of the same experiential knowledge of the mentor. Such learning methodology is very resource consuming in that it requires both time and money; often it is geographically-constrained as well, where no suitable training track is available in the locality of the driver. Although simulators, such as those employed by professional racing teams, have helped mitigating traveling and car setup times, they are inadequate for use in more amateurish environments due to cost and logistical problems: setting up such a simulator requires adequate space seldom available to everyone. Democratising the learning process such that proper car control and racing techniques can be mastered by a larger demographic an important motivation behind this work.

4.2 Why the problem is non-trivial

The problem at hand is best described as an optimisation problem. Telemetry data provided by the car instrumentation system can be analysed to help identify driving patterns, specifically car-handling mistakes. The identification of these behaviours, which traditionally employs pattern recognition techniques, represents a challenge in itself. Behaviour recognition is key to providing corrective measures in order to improve the driving performance of a given user. In particular, it is the starting point in building a model which maps telemetry data to corrective measures for presentation to the user in real-time and deferred fashion, where even the visualisation of feedback is critical to the success of such a system.

5 Background Work

Backgroud This section may describe such things as: the wider context of the project, the anticipated benefits of the system, the likely users of the system, any theory associated with the project, the software/hardware development method(s) used, any special diagramming conventions used, 13 existing software (or hardware) that is relevant to the system,

LR An extensive study in the area of interested, highlighting the strengths and weaknesses of existing methods. A review of the state-of-the-art published material in the area. A summarization of the published material in the area. A critical analysis of exiting material and methods. An explanation showing why the literature chosen to review is relevant to the FYP.

5.1 Motorsport racing

In sports individuals or groups compete to be first to achieve a particular objective. In the case of circuit motorsport races, in which motorised vehicles go round a course. Each racing discipline or series has its own rules. However, at the core, all disciplines participants aim to complete a full lap of the circuit in the least amount of time. Some disciplines focus on achieving one fast lap, such as time trials, while others focus on achieving the least amount of time across a fixed amount of laps, such as FIA's Formula 1 series. This dissertation will focus on confined car racing taking place on smooth asphalt surfaces in purpose built race tracks.

A race driver needs to figure out how to go round a piece of asphalt in the minimum amount of time [6]. In order to do so, he or she needs to develop techniques for more advanced vehicle control. One such technique is that of mastering the race line, which is considered the the fundamental skill a race driver must understand and master before moving on to anything else [6]. The racing line is the best path through a circuit, it is the one which takes the least time while keeping the higher average speed [4]. The trickiest part of the racing line to master is that of a corner. This is split into two parts, identifying the

line which should be taken and staying on the line. The first part refers to being able to visualise the racing line while the later refers to actually being able to control the car so that it stays on the line.

5.2 Video games and Serious Games

Baranowski et al [9] define games as a physical or mental contest with a goal or objective, played according to a framework, or rule, that determines what a player can or cannot do inside a game world. The definition covers the setup of a game, while a physical or mental contest, played according to specific rules, with the goal of amusing or rewarding the participant the reward aspect of games.

Video games are built on top of these core values with the addition of having the game world confined to some sort of digital medium. The first video game was created by William Higinbotham; it was a tennis game to be played on a television set [8]. From the early days of video games, their main aim was always to provide some degree of entertainment. The entertainment value is achieved in various ways depending on the gaming platform, game genre and the target audience. Modern video games are simply made up of three fundamental components: story, art and software [10].

Moving on to serious games this type of games are considered a mix of simulation and game to improve eduction [3]. The idea behind a serious game is to connect a serious purpose to knowledge and technologies from the video game industry [7]. The boundaries of serious games are debated, mostly due to the fact that serious games attract multiple domains making it hard to come up with a common boundary. However, the common denominator across all domains seems to be serious game designers use people's interest in video games to capture their attention for a variety of purposes that go beyond pure entertainment [5].

The main contrast between video games and serious games is the use of pedagogic activities which aim to educate or instruct knowledge or skill [10] in serious games as opposed to the pure leisurely aspects of the video game.

Pedagogy is given preference over the amusement value which in some cases might not be found in serious games [10].

5.3 Sim Racing as a Serious Game

Simulation racing games (sim racing) such as Asseto Corsa [1] and Project CARS [2] , which are off-the-shelf products, provide a sim racing experience within budget for the average video game consumer. The aim with such games is to replicate real life cars, race car dynamics and track locations to amuse and entertain the player. The challenge aspect is achieved by pitting the user against other computer drivers known as AI players, or in multiplayer online races, which are played against other human players. In some cases, a user can compete against oneself by taking on a ghost - a recording of the player's best lap for a particular track. Sim racing the definition of what a video game is however, they miss the pedagogy activities which would qualify them as serious games. Most of the modern sim racing games do aid the player to improve by means of implementing aids. Such aids might include showing the racing line while also highlighting the braking and acceleration points. Other aids include anti lock brakes, traction control and stability control, these are implemented in a passive way. With the exception of the racing line, the player is not told when and what is being done wrong. This results in users having to figure out their own mistakes by means of practicing without any guidance or feedback from with the game. This final year project aims to implement a module which is plugged into an off the shelf racing simulator which. This module trains users by letting them know what is being done wrong, when it's being done wrong and most importantly how to avoid making the same mistake.

6 Specification and design

The purpose of this section is to give the reader a clear picture of the system/artifact/project/work that has been created in the FYP and why it has been created in the way chosen. Details: Fine details, specifically details of the system (software or hardware) should be left out. Also, any complete rigorous specification is better relegated to an appendix. Using diagrams (including but not limited to flowcharts and system level block diagrams) is strongly recommended. Any design choices have to be justified (e.g. by discussing the implications of different design choices and then giving reasons for making the choices made). The design of the project will almost certainly have evolved during development. Focus should be made on the project as it is in its final state but often there are good reasons for describing intermediate states too (e.g. to discuss details of the design method used).

********** Hardware

Steering wheel, pedals and shifter Rig and seat Displays and sound output PC

********** **********

Software

Supporting Apps, Track data Editing tool, TTS,

Spatiasl query complexity

Feedback system workings, how will it determine the algorithm

Software Project Structure IPC Input Common Shared Layer Output Pluggable modules

Racing game Assetto corsa Other games which where considered

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7 Methodology

7.1 Evaluation

User study

7.1.1 Surveys

Participants will be accepted from any background and level of relevant experience. It is beneficial to be able to distinguish between clusters of participants who are experienced with sim racing, those who play other forms of racing games, those who don't have any experience at all and anyone who has real life experience with motorsport. By gathering this information it will be possible to identify characteristics such as whether the feedback given was more beneficial to a particular group, whether the rig setup was more problematic to use for some and if real life motorsport experience can be translated onto the sim setup.

Post expiremnts

7.1.2 Experiment structure

Participants are to be split randomly into two groups. One group will be referred as the feedback group, while the other will be referred to as the base group. All participants, regardless of in which group they have been assigned, will be given one hour slots in which they are asked to race around a track. The one hour slots are to be divided in sub sessions to be carried out in the following order. Five minutes to get the rig setup and adjusted for the participant. This might require having to move the seat further back or forward in order for the participant to be more comfortable. During this time the participant will also be asked to fill in the pre-experiment survey, be given information about the racing rig and how the one hour is divided. Ten minutes of driving are then carried out, the aim of this session is to allow the participant to get familiar with the rig, track and car. Once the first session of driving is carried out the participant is told in which group he/she has been assigned. The participant is also shown a picture of a

typical race line through a corner and a brief explanation is given. This is done to make it easier on the feedback group to better understand the auditory race line feedback which might be given. As for the base group, the same picture and information are given out as to have both groups provided with the same information and having any learning done by means of the feedback system. Another ten minutes of driving follow, with the same setup as the previous one. Then, there is a final 5 minutes of driving, during this session no one has the feedback enabled. The aim of this session is to give the participant a final chance to improve upon his/her time. in addition for the feedback group, data from the last five minutes could point out if the participant was able to learn any techniques and use them with out being given further feedback. Finally the participant is given the post survey to fill.

The track and car choice is to be the same for everyone, the choice is to be made before the start of the experiments.

Car choice Track choice

8 Implementation

In case of a software development describing of all the code in the system should be avoided as well as large pieces of code. Complete source code listings should be put on the accompanying digital media (e.g. CD or DVD). In case of hardware the system should be divided into sub systems or circuits that may be easily described and analysed. One must be especially critical to the operation of the system. Mentioning unforeseen problems encountered during implementation. Explanation of a seemingly disproportionate amount of project time taken up in dealing with such problems. The implementation section gives you the opportunity to show where that time has gone.

VR Compatibility issues VR not being able to render on screen native assetto corsa apps Having to go with audio

How did you determine corners and straights?

Spatial Data querying, quad trees.

Feedback Modules Braking Race line Handling Gear shift

Debugging and Testing Debug Info Unit Tests

Find something on how to best describe visualy to the user the racing line

9 Evaluation

One has to make sure and explain why all tests used to evaluate the system are relevant, using evidence from the literature about similar systems, and justifying any deviations from standard approaches; Demonstration that system works as intended (or not, as the case may be); Include comprehensible summaries of the results of all critical tests that have been made; If the student has not had time to carry out fully rigorous tests (in some cases, the student may not have had time to produce a testable system) suggestions as to what tests would be and why they are relevant is important; The student must also critically evaluate the system in the light of these tests results, describing its strengths and weaknesses; Ideas for improving it can be carried over into the Future Work section; Comparison of practical with theoretical results and their interpretation.

10 Evaluation strategy

10.1 Experiment setup

10.2 User study

Users are to be divided into two groups at random. One group of users will be asked to drive around the track without having any feedback provided by the system. This will evaluate how much a user can improve on their own. While the second group will also be asked to drive around, but this time the system will provide feedback on where and how the user can improve. A set of questions will be asked to the user once the test is complete. The questioner is meant to collect data on the users' racing experience prior to taking the test. Telemetry data will also be collected for both groups. Statistical analysis will be carried to determine if lap times do improve.

11 Future Work

Whether by the end of the project all the original aims and objectives have been completed or not, there is always scope for future work. Also the ideas will have grown during the course of the project beyond what the student could hope to do in the time available. The Future Work section is for expressing these unrealised ideas. It is a way of recording 'I have thought about this'. A good Future Work section should provide a starting point for someone else to continue the work which has been done.

At present only negative feedback is given, a good idea would be to look into the benefits of letting the user know when a particular task has been completed correctly.

12 Conclusion

The Conclusions section should be a summary of the project and a restatement of its main results, i.e. what has been learnt and what it has achieved. An effective set of conclusions should not introduce new material. Instead it should draw out, summarise, combine and reiterate the main points that have been made in the body of the dissertation and present opinions based on them.

13 Glossary

14 Appendices

References

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