Literature Review

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Contents

1 Introduction

1.1 Defining the Scope of this Research

The term simulation can refer to a range of topics. However, the scope of this research is on models generated by computer software.

1.2 Research Question(s?)

Generating AI-driven scenarios for realistic small-unit training scenarios.

1.3 Motivation

1.4 Defining Terms

Is it really stress?

Talk about walking into a building in an Arma 3 PVP vs commanding the team

"Next 15 seconds are decisive"

What about when you know you are going to lose? The feeling immediately goes away.

Fear of the unknown.

Does there need to be a win/lose scenario?

People when they die in game immediately get their phone out and go on TikTok or Youtube Shorts.

You want to try and outsmart your equals or superiors. Sneaking up on someone in a game or making them fall for it.

2 Software-based Simulation of Stressful Situations

2.1 Introduction

When humans make decisions, this process can be impacted by factors such as oxygen levels [] and stress[].

2.2 Diving

2.3 Finance

2.4 Emergency Services

2.4.1 Firefighting with Aircraft

According to the Emergency Management Professionalisation Scheme of Australia and New Zealand, an Air Attack Supervisor (AAS) is an individual who is "responsible for for supervising aerial fire suppression activities and other tactical missions from the air". TODO:

A 2019 study found that virtual reality training exercises produce stress levels which are similar to those of a real exercise, when measured by heart rate variability (HRV). [1]

TODO: Talk about how this may be because AAS applicants are already

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experienced pilots.

2.4.2 Measuring Stress Levels of Participants in Simulated Scenarios

Data regarding the stress level of a participant can be taken by observing their heart rate, heart rate variability (HRV), how fast they are breathing, eye movement and chemical measurements. [1]

3 Military Simulation

3.1 What is Military Simulation?

"This is not a game! This is training for war! I must recommend it to the whole Army." - General von Muffling, Prussian Staff Officer, 1824.

3.1.1 Combined Arms Tactical Trainer

3.2 What is it used for?

Military simulation/simulation of stressful scenarios are used for leisure, training and prediction of possible outcomes of real-life stressful scenarios.

This can be seen in entertainment with examples such as..., training with examples such as... and predictions with examples such as... .

3.3 How Accurate are (Military) Simulations?

Military simulation software is designed to accurately replicate real life performance of things (TODO: Thing? Really? That's the word you came up with?), such as the performance of weapon systems, vehicles and other technology commonly found in the battlespace (TODO: Define this as it's not an intuitive term). Some simulators also go as far as to model the performance of humans in terms of physical performance, health and awareness (TODO: Expand on this).

However, a common experience from users is often that the majority of simulators that they play feel extremely realistic, yet perform differently when compared to each other. How can two simulators be realistic if they perform differently? (TODO: This is entirely my experience and some friends I know have said this. Maybe this is a research project to carry out?)

3.3.1 Destruction of Russian T-90 Proryv

On the 13th of January, 2024, the 47th Separate Mechanized Brigade of the Ukrainian Army reported the destruction of a Russian T-90 Proryv tank. TODO: [] While, as of 23/01/24, not all of the details have been confirmed about the engagement, it has been proven that the T-90's external systems (such as optics) were destroyed by the main cannon of a Bradley AFV, commanded by Serhiy of the Ukrainian Army. In an interview with SerhiyTODO:[], he stated that he knew which parts of the tank to fire at (to damage the external systems) as he had practised in "video games" (it is likely, although unconfirmed, that he is referring to War Thunder TODO:[]). The translation has been independently verified by Ukrainian speakers.

In War Thunder, engagements generally take place in which another player-controlled vehicle is also trying to destroy your vehicle.

3.3.2 Influence of Music while Driving test in Simulator

3.3.3 World of Warcraft Virus Outbreak

3.3.4 Treating Social Anxiety Disorder with VR

3.3.5 Training Taser with VR (AXON)

3.4 AI Adversarial Command and Control

TODO: Is the following even true or am I imagining it?

TODO: Write about how the AI knows everything but pretends it doesn't.

TODO: Write about developing AI which reacts to information which is only gathered the "Real way" through command and control

4 Computer Science Approaches to Improving Military Simulation

4.1 AI Command and Control through Decision Making

4.1.1 Individual Unit Approach

4.1.2 Alien Isolation's Alien

4.1.3 Mutually Supporting Units Approach

4.1.4 AI which can adhere to the Law of Armed Conflict

4.2 Immersive Scenarios

An immersive scenario is one in which the user/player/trainee is able to 'forget' that they are controlling a character in a virtual world; the less the user is immersed, the more aware they are of the reality of the situation.

4.3 Necessary Features of an Immersive Scenario

4.3.1 Realistic Units

TODO: Look into whether realistic vehicles are necessary TODO: Look into whether people can tell different things apart. Can the average person on the street tell a NATO tank apart from a Russian one? Are people's perspectives changed by WW2 films? Talk about when the girls at the beach thought that the WW2 re-enactors were recruiters and couldn't identify a uniform which was 80 years old.

TODO: According to a study which I completed called...

TODO: Source? Says who?

4.4 Audio and Visuals

Audio and visual work to confirm the content of each other to the observer [2].

4.4.1   Audio

4.4.2   Diegetic Sounds for Atmosphere

[2]

Wolfenstein: Enemy Territory

"The general consensus was that if you had a Thompson, it was slower but harder hitting and if you had an MP40 it was faster but it was waker." - 1

"Uhh the Thompson was sort of like this more boxy, smaller, it sort of had like a I dunno a sturdier kind of feel to it." - 2

"You'd use it until you couldn't then begrudgingly get the MP40" - 3

4.4.3   Visuals

"often identical and lack the same indications of individuality as the heroes' avatars"

Talk about how in games with enemies, often the most difficult fight and more meaningful fight is against the one who you know and have met. For example, generic bad guy number 1, who cares but talk about the boss fights in Grand Theft Auto or Star Wars.

4.5   Data Analysis for Performance Review

TODO:

- Add a source for how counter-battery is trained using radar

The nature of simulations is such that vast amounts of data can be collected and subsequently analysed in a way which isn't possible in real world scenarios. Although technology exists for collecting and analysing data in real-world scenarios, the sheer flexibility of simulated data is not yet matched.

For example, data regarding the source of indirect fire, such as artillery and mortars shells, can be collected and analysed by technology such as Radar, Field Artillery, No. 15 (Cymbeline). The purpose of this system is to determine the origin of the indirect fire, based on information sourced through determining the shell's velocity and trajectory. This information can then be relayed to friendly elements for use in the counter-battery role.

In the context of training for the counter-battery role as a field-gun crew in a live exercise, without simulation, a physical installation would be required to train on, including real projectiles being fired through the air and further real projectiles needing to be fired at the source to determine the effectiveness of the field-gun crew's performance.

With a military simulation, these actions can all be carried out virtually, with the ability to gather instant, qualitative and quantitative data on the performance of the crew, (providing the simulation was accurate).

5 AI Solutions to Problems with Training Effectiveness

6 Potential AI for those Solutions

6.1 Decision Trees

6.2 Genetic Algorithms

Genetic Algorithms provided the solution for optimising the layout of a military operations centre, as explained by Wenbi Wang in hl"Layout optimization of a military operations center using a genetic algorithm".

This task consisted of the optimisation of the layout of a command centre for the Canadian Armed Forces, consisting of 68 staff (likely a mix of all ranks although these details are omitted).

6.3 Proximal Policy Optimisation

Proximal Policy Operation (PPO) is a reinforcement learning algorithm, which can be utilised for decision making in order for task completion. [3]

7 Metrics

7.0.1 Observing Short-term Stress Levels

Short-term stress levels can be observed through monitoring variable

8 Existing Studies

9 Potential Studies

10 Simulator Sickness

References

[1] Rory M.S. Clifford, Sungchul Jung, Simon Hoermann, Mark Billinghurst, and Robert W. Lindeman. Creating a stressful decision making environment for aerial firefighter training in virtual reality. In *2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR)*, pages 181–189, 2019.

[2] Durotul Ngazizah. The use of diegetic sounds in building a jump scare in the a quiet place (2018) movie. *CLLIENT JOURNAL*, 3(2), 2021.

[3] John Schulman, Filip Wolski, Prafulla Dhariwal, Alec Radford, and Oleg Klimov. Proximal policy optimization algorithms, 2017.