Horde Battle III or How to Dismantle a Swarm

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***Abstract*—In this demo paper, we present the design of a virtual reality (VR) first-person shooter (FPS) in which the player fends off waves of hostile flying swarm robots that took over the Earth. The purpose of this serious game is to train the player in understanding networks by learning how to dismantle them. We explain the play and game mechanics and the level designs tailored to provide an engaging experience and to re-enforce the network perspective of the swarm dynamics.**

***Index Terms*—Serious Games, Graph Analysis, Network Dismantling, Virtual Reality, User-Centered Design, Boids, Swarm**

I. Overview

Motivated by the versatile perspective of graphs and networks on numerous important real-world systems, such as networks of spreading diseases or economic trade, we decided to create a serious game [1] for training to interact and manipulate networks, similar to [2]. However, in order to increase immersion, which increases emotional arousal and thereby facilitates learning [3], we decided to create an FPS in VR. In this demo paper, we explain the game, Horde Battle III, in a top-down fashion: Starting with the narrative and its presentation, we state the goals of the game, the means the player has to achieve them, the challenges posed and the level design of the game that aims at mesmerizing the player by an elaborate flow design. Due to the game's purpose, we specifically focused on swarm-related parameters such as the swarm individuals' numbers, their connectivity, or the interspersed occurrence of loot boxes which requires the player to pay close attention to his aim. We conclude this paper with an overview of the implemented design aspects and an outlook on potential future expansions and refinements.

II. Horde Battle III

Immersing oneself in the game, a narrative unfolds: Comic frames capture views of 3D scenes and tell the plot as seen in Fig. 1: Hordes of aliens have devastated the planet. Only the player can save it by battling waves of swarms to retrieve a green orb that can restore life on Earth. The player finds himself in a desert shortly after and the battle commences. Enemies drop bombs on the player or perform heads-on kamikaze attacks. Realizing a room-scale VR experience (using Oculus Quest headset and controllers), the player can step out of the line of attack, duck for cover or shield himself. Attack is, however, the best defense in the given context and a variety of ballistic weapons are at the player's disposal. Several tutorial levels ease the player into the interaction mechanics, effects of weapons and the required resource management.

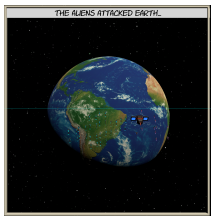

Fig. 1. Comic frames are used to tell the story.

There are three types of enemies that differ in their network topology and maintained proximity. *Tentacle* agents maintain great distances and form *scale-free networks*, which are very vulnerable when agents of high connectivity are targeted. Bee-like *Sting* agents keep close to each other and form *grid networks*, which are very robust to attacks on any specific agents. Finally, numerous small *Pin* agents are only connected to one large one to form a star network, which can be destroyed by taking out the single large, especially resilient one.

There are three different weapons (Fig. 2), that the player can cycle through on his right controller, to fight the enemies: (a) A pistol with low, $1sec$ shot frequency but infinite ammo, (b) a grenade launcher with high impact, ponderous $3sec$ frequency and very limited ammo resources, and (c) a sub-machine gun with high $0.125sec$ shooting frequency and, consequently, fast ammo depletion. While the sub-machine gun and the pistol knock the swarm agents out individually, the grenade launcher affects the primarily hit agent and its immediate neighbors in the network. The shooting task is assisted by the display of a trajectory arc (Fig. 3).

Fig. 2. (a) Pistol, (b) grenade launcher, (c) sub-machine gun.

To assist with the interaction with the swarm network, a multitool is attached to the second controller which allows the player to pursue one of the following actions at a time: (a) Extend a *shield* to deflect swarm agents on a collision course. If used for too long, it needs to recharge. (b) Shoot a *tractor beam* to pull new weapons, resource packs, or swarm agents towards the player. (c) Activate a *visor* that displays the network's edges between the swarm agents. In addition, agents with high connectivity are encircled. At the beginning of the game, the visor is always on. In level 8, this comfort feature breaks down and the player has to activate it manually,

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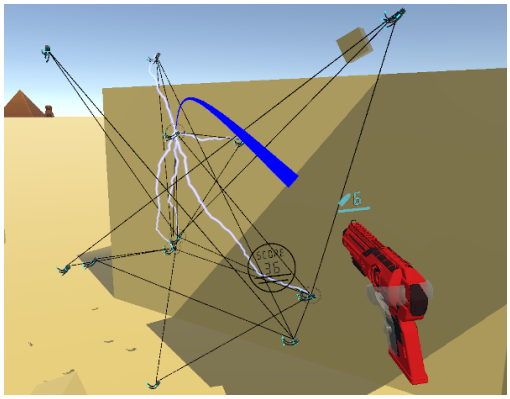


Fig. 3. A grenade knocks out several swarm agents at once.

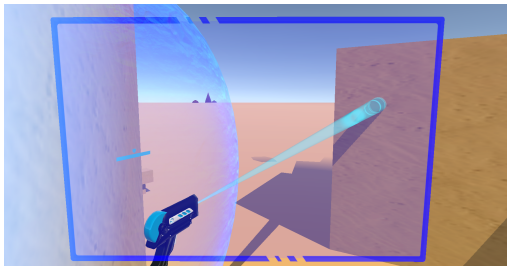
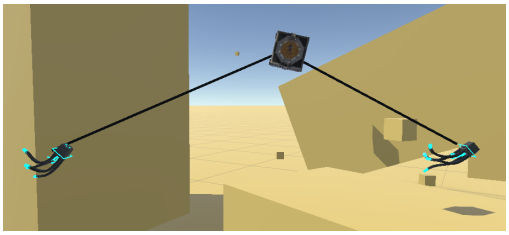
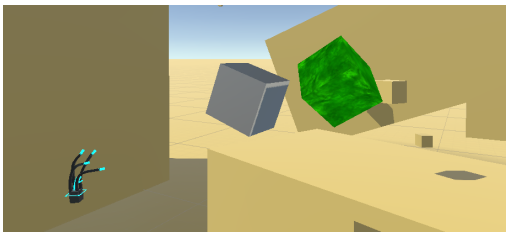


Fig. 4. Multitool with shield, tractor beam and visor.



(a)



(b)

Fig. 5. (a) A lootbox is carried by two swarm agents. (b) Resource packs cut loose can be picked up by the player.

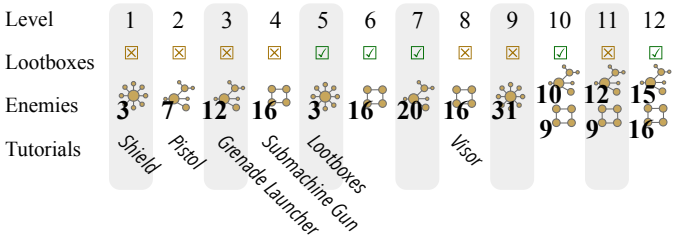


Fig. 6. Lootbox information, number of enemies and tutorials of each level. The enemies' topologies are represented symbolically as well: Star, scale-free and grid networks are first encountered in levels 1, 2, and 4, respectively.

forced to actively decide which multitool functionality is best in a given situation.

The player has to pick up health packs to cure injuries and ammunition packs that are carried by the swarm. If the carrying agents are taken down, the packs drop and the player can collect them using the tractor beam. If, by accident, the player shoots a lootbox (Fig. 5), it is destroyed. Therefore, attention has to be paid to the different nodes in the network and its careful dismantlement—in analogy to, for instance, freeing hostages in military operations.

Each level of the game follows the same routine: A swarm flocks along a given path and attacks the player when in his vicinity. The player uses his tools and wits to destroy it. When all the connections of a swarm agent are cut by knocking out its neighbours, the agent also becomes dysfunctional and falls to the ground. When the swarm is destroyed, the level is cleared and the player is challenged by the next of 12 levels in total (Fig 6). In levels 10 to 12, two instead of one swarm engage with the player. The continuous motion and intermittent attacks of the enemy swarm combined with the different opportunities of interaction result in a generally fast paced gameplay and open a vast space of interwoven parameters for level design. Especially the arrangement of peaks and plateaus of the pace often correspond closely with the difficulty of the game.

III. Conclusion and Future Work

This demo paper presented the design of a VR FPS with the purpose of training network dismantling. We adopted a well-known narrative to engage the player, decided on neutral but lively representations of the swarming enemies, made the network topologies (star, scale-free and grid networks) of the swarms the core game element that different means of interaction (weapons), visualisation (visor) and player affect (attacks, strength based on degree of connectivity) were built upon. We introduced these game elements in a step-wise fashion by means of interactive tutorial levels and intermittently scaled up the challenge of the waves of swarms the player has to face. In order to foster the game design, we want to conduct more external play tests, potentially also harnessing mass testing if permitted by the outlet platform of our target system, and thus to improve balancing, extend the playtime and increase the variety of experienced environments.

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