

# N.U.K.E.

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**Abstract**—In this paper, we developed an AR game inspired by the tower defense franchise *Orcs Must Die*. It is aimed to be played with a mobile device and it was developed with the Vuforia engine. In terms of gameplay, the user may place different traps using physical markers which need to be bought in the in-game store. Overall, the group believes that the game still has room for improvement, however, all the goals established in the project proposal were met.

**Keywords**—Augmented Reality, Vuforia, Unity, Game Development, Blender, Tower Defense

## I. PROJECT DESCRIPTION

This project is an AR game inspired by the tower-defense franchise *Orcs Must Die*, where players place traps and guardians in order to prevent a never-ending army of orcs from reaching each level's rift.

It aims to mimic this premise and apply it in an augmented reality scenario. The player may position traps by arranging markers on the scene. By surviving a wave and killing minions, the player gains currency. It may then be spent by purchasing one of three possible traps: a floor spike trap, an acid sprayer on the wall and a turret which fires at enemies in range.

## II. STORYLINE

The player takes the role of an evil scientist who attempted to create a deadly army of robots. Yet upon activation, his robots wanted no violence but to do good and started rushing for the huge N.U.K.E. (Nourishment Understandment Kindness Empathy) button at the end of the scientist's laboratory, releasing peace upon humanity.

When the main premise is revealed to the user, it is worded so that the player thinks he is the hero in the story (the wording on the button is purposefully grim to ensure so).

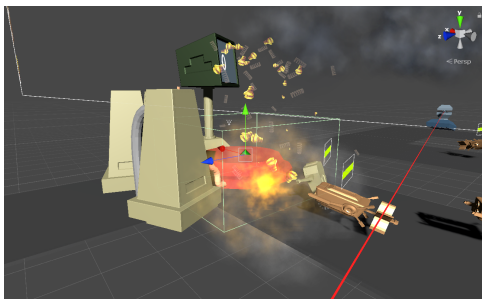


Fig. 1. Robots exploding upon reaching the rift

## III. GAMEPLAY

### A. Markers

We've designed four different markers, with three of them having five variants to ensure unique detection.

The player may purchase multiple traps from the same type (e.g. two spike traps), so there was a necessity for designing unique markers which are different enough for Vuforia to be able to distinguish them apart while ensuring players could intuitively understand they'd belong to the same type.

We found supplying Vuforia with the same images of traps where the only variant is the number would be enough to ensure quick detection.



Fig. 2. Spike trap marker no.4

### B. Game flow

At application launch the user is prompted to point the camera towards the *Level Map Marker* and only then the countdown time until game start will activate. Waves run for the time displayed on the center top and always have a preparation phase, both being variable in length.

A help button was made available at all times at the top right of the screen which pauses the game and explains the base premise and a summary of all gameplay elements.

### C. Enemies

There are two types of enemies: land and flying. Land enemies traverse through the map at half the speed yet possess double the health of the flyers.

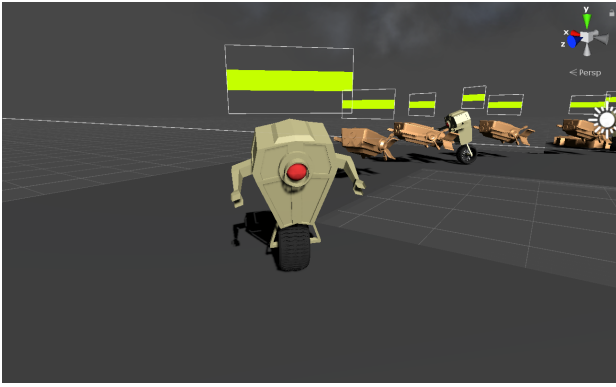


Fig. 3. Walker enemy in the front, group of flyers in the back

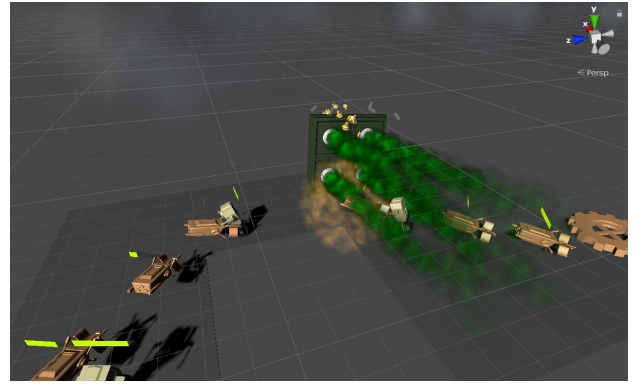


Fig. 4. An acid sprayer triggering

#### D. Shop

Both after eliminating an enemy and completing a wave, the player is awarded currency (bolts) to spend on the shop. To purchase a trap, tap on the respective icon and a new marker will be available for detection. The marker indexes available match the current inventory for a given trap. For instance, if the player has purchased two spike traps, only spike trap markers no. 1 and no. 2 are available for detection. For selling purposes, hold the same icon for one second.

#### E. Traps

Like mentioned previously, the player is able to place three different types of traps in the game field.

1) *Spike trap*: The spike traps cost 5 cogs and are placed horizontally on the field. Whenever a robot passes through it, the trap will be activated and will deal 50 damage to any robot on top of it. After it is activated, it has a cooldown of 2.5 seconds before it can be used again.

2) *Acid sprayer*: An acid sprayer is placed vertically and it costs 10 cogs. Like the name states, it sprays acid in the front of it and deals 10 damage per second to any robot that passes through it. It sprays for 1.5 seconds and has a cooldown of 1 second.

3) *Turret*: The turret costs 5 cogs and is placed horizontally on the playing field. It is equipped with a laser which locks onto the closest target in its range and fires every 0.5 seconds. Each laser hit deals 50 damage.

#### IV. PLATFORM AND HARDWARE

The selected game engine was Unity alongside the Vuforia AR engine. All models are original and were made in Blender. The target platform is Android.

#### V. EXTERNAL DATA

OpenWeatherMap's REST API was used to extract weather information on a specific location and trigger different particle systems embedded in the game which attempt to match the weather outside. The application attempts to retrieve the device's location (latitude and longitude) and pass it to the API for accurate results. If no GPS permission has been granted by the player or for some reason the request is invalid, the default weather for Porto is considered. The weather may only be at one of three different states at all times: cloudy, rainy and sunny. A polling rate for weather updates is also configurable.

#### VI. LIMITATIONS

The whole workflow of testing an AR Android application has proven itself to be a challenge. In order to test on the target device instead of on the Unity editor, the application had to be built on every change - big or small - which often took over a minute to complete. Debugging on the desktop was also rough, as Vuforia's engine would flatout not identify image targets due to laptop webcams' subpar quality as well as non-optimal lighting having a major influence on overall detection.

Vuforia was pretty hit-or-miss for the entirety of the project and even after ensuring max rating on all image targets, it'd still ignore markers at optimal lighting conditions.

#### VII. FUTURE WORK

There's definitely room to expand with different maps, unique enemies and new traps. Due to limitations in debugging AR and development time, the project scope had to be fairly downscaled yet remains viable as a prototype to the possibilities of the idea.