Short Paper: Calory Battle AR: an Extensible Mobile Augmented Reality Exergame Platform

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***Abstract*—We proposed an extensible mobile augmented reality exergame platform which utilizes augmented reality and sensors to connect virtual game content to the real world. We analyzed the current state of augmented reality and exergaming research before describing the Calory Battle AR concept along with its technical details. Extensibility of the platform is threefold: 1) players can create and share game maps; 2) developers can create new task types for game maps; and 3) developers can create context-sensing modules based on wearable technologies.**

Keywords—augmented reality, exercise, game, architecture

I. Introduction

According to the World Health Organization worldwide obesity has more than doubled since 1980 and more than 40 million children under the age of five were overweight in 2010 [1]. OECD's [2] future projection on overweight suggests that the trend continues. It is important to focus on childhood obesity because physical activity engagement during childhood has been associated with physical activity in adulthood [3]. One prominent way of motivating children are games. Recently, *exergames* have emerged as a way of combining exercise with digital gaming and have been shown to yield physical, psychological, cognitive and academic benefits [4]. Until now most exergames were created for specific tasks, thus they were not extensible to host different tasks for different purposes. To alleviate this, we propose an extensible exergame platform which uses augmented reality as a visualization and interaction technology.

II. Background

Augmented reality has been defined as a case where a real environment is augmented with virtual elements [5]. Augmented reality traditionally means adding virtual visual elements to a live camera feed. As Haller, Billinghurst and Thomas suggest [6], an application needs to know where the scene is located in relation to the camera. This means the camera has to track something, which can be a real object or fiducial marker. Fiducial markers make the tracking task easier, as the application knows exactly what it is looking for. A good example of a modern device using augmented reality is Google's Project Glass [7].

Many mobile exergames have been proposed to motivate people to move. In "Zombies, Run!" [8], the player is a runner getting supplies from the outside world which has been overrun by zombies. Another example is "Health Defender" [9]. In it the player plays a game inspired by Space Invaders while exercising. The game connects to a heart rate monitor and the player is given bonuses if his/her heart rate rises enough. "Shakra" [10] is an activity tracker that uses fluctuation in GSM signals and the cell information to keep track of the user's location. Once it has been trained to the user's area, it can accurately tell if the user is standing still, walking, or running. In "GeoBoids" [11], the player traverses the world searching for virtual GeoBoid creatures. The goal is to capture them and exercise by running to them. Of all these games only Geoboids uses augmented reality.

Based on background analysis, previous games are not likely to be extensible. Also, in GeoBoids the player may not be motivated to run between the flocks; it would be fine to walk. Health Defender requires the user to wear a specific heart rate monitor that can connect to the phone via Bluetooth. Shakra is merely an activity tracker without game elements.

III. The Calory Battle AR concept

Calory Battle AR is a mobile augmented reality exergame built for the Android platform that aims to promote physical activity. Many exergames are non-portable and make the user stay inside the house to play (e.g., Nintendo Wii games). Unlike stationary games, Calory Battle AR's game play is tied to the real-world context and is designed to be played outside. No special hardware is needed; all the user needs is his/her smartphone and the printed image targets.

A *map* is a container that holds all tasks related to a game map. This includes the models and textures used along with the task data. By *task*, we refer to a single activity that the user needs to perform. Each task is connected to a unique image target which is deployed in the real world, thus a task is also assigned a geographic coordinate pair. Users can create and share maps using a dedicated editor.

When the game starts, the first thing the user has to do is to log in, or create an account. He is then presented with the main menu. If it is the first time running the game, the user will need to install a map first. The user finds and selects the map, and map data files are requested from the server. Once it is installed, the user can start a new game by clicking the button in the main menu. Next the user chooses the map to play. After loading the resources, the game starts. The user will first see the map view, which has been implemented using Google Maps API v2 for Android. The map shows the user's current location and the tasks' locations. By pressing the information button, the user can get information about the current map.

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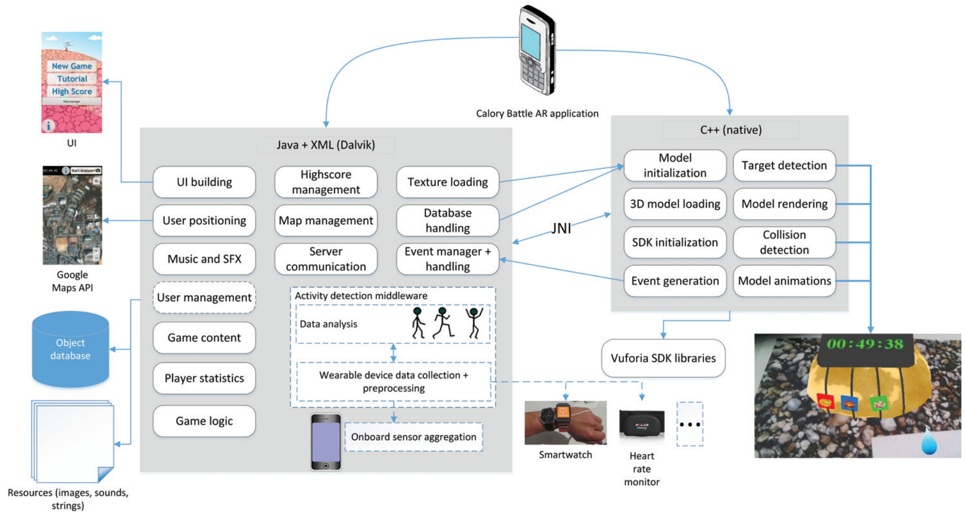

Fig. 1. Architecture of the client application

Also, by clicking on one of the targets on the map, the user can get more info about the task. Once the user finds one of the tasks in the real world, he must press the “Start Analyzer!” button to change to the analyzer view. The analyzer view detects image targets and presents the user with the assigned task. At the moment there are two different task types but more can be added because of the extensible architecture.

IV. Technical Design and Implementation

The game client is implemented on Android and it uses Qualcomm’s Vuforia SDK for augmented reality. Fig. 1 illustrates the client architecture where dotted lines represent unfinished modules. C++ code handles AR content rendering, collision detection, target detection, 3D model loading, Vuforia SDK initialization and event generation. Java code handles everything else such as game logic and UI. It communicates with the C++ code by Java Native Interface and uses on-device database to store the map objects. HTTP is used for map retrieval from the server. The activity detection middleware utilizes wearable sensors and other contextual data to infer the user’s activity (e.g. running, walking, jumping) in real time.

The platform was designed to easily adapt to different kinds of content that would be added later. A task is represented by an abstract class that must be extended for each task type. These tasks can implement event listeners that are called at certain events, for example when a 3D object collides with another. Naturally anything can be an event listener, not just tasks. The six primitive events are: Collisions starting / ending, image targets coming into / going out of view, and frame markers coming into / out of view. Composite events can be created by combining these.

V. Conclusion

The platform was created primarily to support exergaming but it has potential in other fields as well. The platform’s extensibility has three dimensions. Firstly, users can create and share game maps which are embedded with content and tasks relevant to specific location and purpose. This also makes the platform portable. Secondly, relating to the first dimension, developers can create new task types which can later be used in game maps. Thirdly, developers can create and attach new context-sensing modules to support for example a wider range of wearable technologies.

The platform still has some limitations to be addressed. Interaction between devices is not possible, rudimentary game engine lacks many features, and it only supports Android.

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