Abstract The ubiquity of camera phones provides a convenient platform to develop immersive mixed-reality games. In this paper we introduce such a game which is loosely based on the popular card game “Memory”, where players are asked to match a pair of identical cards among a set of overturned cards by revealing only two cards at a time. In our game, the players are asked to match a “digital card”, which corresponds to a scene in a virtual world, to a “physical card”, which is an image of a scene in the real world. The objective is to convey a mixed-reality sensation. Cards are matched with a scene identification engine which consists of multiple classifiers trained on previously collected images. We present our comprehensive overall game design, as well as implementation details and results. We also describe how we constructed our scene identification engine and its performance. Finally, we present an analysis of player surveys to gauge the potential market acceptance.

Keywords Mixed reality · Scene identification · Memory game · Mobile phone

1 Introduction

The increase in functionality and processing power of mobile phones in conjunction with the massive bandwidth afforded by advanced telecommunication networks allow a plethora of innovative and interesting game applications to be developed for mobile phone users, e.g., [1, 11]. In addition, the existence of high-resolution cameras on many mobile phones opens up another interesting direction for games based on image or video processing techniques.

In this paper we describe an innovative game application which exploits cameras on mobile phones. Our game consists of using the phone camera as an input interaction modality (a way for the user to interact with the game). The aim of our game, apart from the obvious role of providing entertainment, is to convey a feeling of “mixed reality” (i.e., a seamless interchange between a virtual world and the real world) to the user. Indeed our design approach is based on providing similar input modalities for interacting with the virtual world and with the real world. The game is inspired by the popular card game “Memory”, where players are asked to match a pair of identical cards among a set of overturned cards by revealing only two cards at a time. In our game, the players are asked to match a “physical card”, which represents the real world, to a “digital card”, which is a token of the virtual world.

The game begins with the process of collecting a digital card: The player goes to a pre-determined location, and, with
the aid of a custom software on the phone which exploits orientation sensing hardware, points the phone camera at a pre-determined direction and orientation (i.e., at a “virtual scene”). This is to simulate a photo taking experience in the virtual world, and it is emphasized that the corresponding real-world scene at which the player is inadvertently guided to aim is inconsequential for the game. Upon “snapping” the virtual scene at the right vantage point, the player receives the digital card which is actually an image of a real-world scene in a separate location.

Drawing from his familiarity of the local geography or guidance from the system, the player proceeds towards the location inferred from the digital card. Upon reaching the correct area, the player attempts to capture the scene with an image (the physical card) which resembles the digital card contents as closely as possible. The physical card is then transmitted to a service provider which employs a scene identification engine to verify the card. If verification is obtained, the player has successfully matched a pair of cards, and he can continue to collect the remaining card pairs (by first receiving directions to the next digital card). In a competitive setting, the player who collects all cards first is the winner.

We call this game “Snap2Play”, and the overall success of the game is indicated when the player, apart from being entertained, is immersed during the interchange between the physical and virtual world, i.e., he is only mildly aware of the differences between capturing the digital card and the physical card. The main components to achieve this are interaction techniques and devices that provide mixed-reality feelings, and a image-based scene identification engine.

The rest of the paper is organized as follows: Sect. 2 describes in detail the rules and flow of the game. Section 3 describes a very important aspect of the game which is how we design and implement interaction techniques and devices that are capable of simulating a photo taking experience on a mobile phone for collecting the digital card. Section 4 explains the other major aspect of our game which is how our scene identification engine is constructed. Section 5 reports empirical results of the scene identification engine, and also an analysis of player surveys. Finally, the conclusion is drawn in Sect. 6.

2 How the game works

Snap2Play can be implemented as a single- or multiplayer (co-operative or competitive) game. The player interacts with the game through a mobile phone installed with the Snap2Play application. The overall flow of the game is coordinated through the mobile phone network (i.e., GPRS) by a game server (henceforth, the “game system”). Upon starting, the player is first introduced to the rules and objectives of the game, and is prompted to select his preferred game trail based on the descriptions provided by the application. The design of the game trail allows the incorporation of various vested interests, e.g., introduction to tourist spots or shopping precincts, promotion of physical fitness. The player then proceeds to hunt for the first digital card by receiving, from the game system through the phone network, a message with the rough location of the card. The aim is for him to enter the “Primary Search Area (PSA)” of the card; see Fig. 1.

The system will automatically detect when the player enters the PSA, after which a 2D digital compass which points to the direction of the digital card is activated on the phone. Based on the guidance by the compass, the player moves towards the digital card until he eventually reaches a “Reduced Search Area (RSA)”. This is the pre-determined physical location, with a certain level of tolerance, where the digital card is embedded at a pre-defined orientation in space. The above steps are achieved through using GPS navigation.

Fig. 1 The Snap2Play game scenario