Z-DOC: A Serious Game for Z-Plasty Procedure Training

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Abstract: We present Z-DOC, a (prototype) serious game for training plastic surgery residents the steps comprising the Z-plasty surgical procedure. Z-DOC employs touch-based interactions and promotes competition amongst multiple players/users thus promoting engagement and motivation. It is hypothesized that by learning the Z-plasty procedure in an interactive, engaging, and fun gaming environment, trainees will have a much better understanding of the procedure than by traditional learning modalities.

Keywords: Serious games, z-plasty, plastic surgery, game-based learning.

Introduction

Z-plasty is a fundamental plastic surgery technique used to improve the functional and cosmetic appearance of scars by transposing constricted or unsightly soft tissue into a better functional position or into alignment with a natural skin fold or line of least skin tension [6]. In the basic Z-plasty procedure two triangular flaps of equal length and dimension are oriented at 60 degrees to a central limb containing the scar or defect to create a “Z-like” incision. The two triangular flaps are then transposed, changing the orientation of the central limb and augmenting its length [6]. Although the actual procedure may be simple, the pre-operative planning is crucial to the intended end result and application of these techniques involves complex reasoning and 3-dimensional mental reconstruction [3]. Although most surgeons possess the dexterity required to perform the operation, many find it difficult to understand the geometry (flap orientation, size, and angles) required to best treat a defect in a certain area. Furthermore, residents are typically first introduced to the procedure using “traditional” educational methods such as textbook readings which are not ideally suited for teaching or practicing visual-spatial relationships inherent in the method [2].

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The rising popularity of video games has seen a recent push towards the application of video game-based technologies to teaching and learning. A serious game can be defined as “video games that do not have entertainment, enjoyment, or fun as their primary purpose” [4]. Serious games “leverage the power of computer games to captivate and engage players/learners for a specific purpose such as to develop new knowledge or skills” [1] and with respect to students, strong engagement has been associated with academic achievement [8]. They allow users to experience situations that are difficult (even impossible) to achieve in reality due to factors such as cost, time, and safety concerns [7].

1. Overview

We present a prototype of an interactive, serious game we call Z-DOC for the purpose of training the Z-plasty procedure. Although Sifakis et al. [8] developed a real-time virtual “local flaps” simulation environment (based on finite element methods) intended for tissue cutting and manipulation. However, in contrast to method of Sifakis et al., being a serious game, we emphasize the fun, and engaging components to better motivate learners to learn about the procedure. Players (users) will be able to demonstrate their knowledge of the procedure before attempting to perform the procedure on a physical simulator or a real patient. To keep the player’s interest, competitive elements will constantly remind them of how they compare to their fellow peers and friends.

The Z-plasty procedure training lends itself to a tablet computer and touch-based interaction to connect the player and gameplay. Players use multiple fingers on both of their hands to zoom, rotate, and zoom-in on randomized scars and deficiencies. Multiple tools, such as scalpels, sutures, and skin hooks, are selected and used to perform the actual procedure. Points are awarded based on the player’s speed, linearity, and proper use of the limb’s angles to correct the scar’s orientation towards the skin’s relaxed skin tension lines. A heart monitor is available within the operating room environment (see Figure 1), and its accompanying sounds are heard in the background, constantly pushing the player forward and keeping a high-speed pace to the gameplay. The task of the player is to perform properly perform the Z-plasty procedure (i.e., create the two triangular flaps of equal dimension and transpose them). The series of steps (cuts, etc.) performed by the player are compared to the ideal procedure and scoring is adjusted accordingly (i.e., the closer to the “ideal” procedure, the higher the score). Player scores are also compared against other players thus motivating players to achieve a higher score and the corresponding “bragging rights” associated with the highest score. Screenshots are provided in Figures 2-4.

Figure 1. Sample screenshot. (a) Heart monitor. (b) Model patient head with scar that requires the Z-plasty procedure circled in red. (c) Game-play screenshot.
2. Summary and Future Work

In this paper we described the preliminary development of Z-DOC, an interactive, serious game for the purpose of providing Z-plasty procedure training in a fun, interactive, and engaging manner. Future work will include alpha testing with human participants in a focus group setting in order to examine initial functionality of the game, clarity of content, ease of use, and the user interface. Participants will be provided a brief (five minute) overview of the serious (purpose, how to use it, etc.), followed by a 20 minute exploratory period that will involve using the game and freely exploring its interface/options. Participants will then complete a brief questionnaire comprised of a subset of questions from the Questionnaire for User Inter-action Satisfaction (QUIS) whose purpose is to assess users’ subjective satisfaction with specific aspects of the human-computer interface and several “open-ended” questions [5]. Upon completion of the alpha testing (and any changes made to the game as a result of the alpha testing), a usability study will be carried out with plastic surgery residents using a pre- and post-testing experimental design to test the effectiveness of Z-DOC.

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References