Chapter 7
Augmented Reality in Surgery:
A New Approach to Enhance the Surgeon's Experience

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ABSTRACT

In the surgical field, the patient's needs and requirements increasingly follow the newest technological developments. Nowadays it is still problematic to implement different types of technologies in operating environments due to the drawbacks that these can bring to their users and their longstanding learning process. A research was carried out with the objective of clarifying concepts and gathering some existing approaches to the solution of these problems as well as the respective technologies used. This chapter addresses a new concept of mobile applications for surgical planning using augmented reality technologies. The proposed solution aims to help the surgeon from the planning stage to the surgery intervention itself. In addition to some examples and practical demonstrations of the solution, its implementation process and system architecture are described and explained. Based on the developed prototype, the advantages of its use in a surgical context are discussed, being pointed out some improvements to be made.

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INTRODUCTION

Nowadays the patient is more a customer than a real patient, who wants to be treated by a medical team specialized in his condition and which uses state-of-the-art technologies to address his problem.

Most surgeries are preceded by a planning phase and its success is intimately related with it. This phase consists in the patient's pre-evaluation and it is supported by its existing clinical information and other studies, which will establish a surgical procedure suitable to him. One of the current major problems is the lack of solutions which help surgeons to better reproduce what they did in the planning stage inside the operating room. Solutions such as the Surgery Navigation Systems (SNS) appeared. Initially, these systems have been implemented only with the purpose of helping and increasing the surgeon's field of view through micro cameras, microscopes and tracking screens during surgeries. The technological advances and another facts such as the increasing interaction, manipulation and visualization of information, were the main triggers for the development of Augmented Reality (AR) technologies (Pelargos et al., 2016) and for their implementation in SNS systems. At the same time, mobile technologies have followed this evolution assuming an increasing role in multiple domains of society. However, one of the less explored field has been their use for practical medical solutions.

Despite of the initial success of SNS solutions, some limitations were detected and pointed over time, many of them associated with mobility and portability issues. The extensive configuration process, the complexity of devices' manipulation (not users' friendly) and the slow learning process are some of the described disadvantages along with the high investment they require.

In this chapter the authors present an approach which combines the potential that AR technologies bring to their users along with the issue of mobility and remote access to graphic information and data sources. The designed solution may have the possibility to acquire an important and useful status in the clinical procedures in which it would be apply by solving the above pointed limitations in an intuitive, simple, viable and inexpensive way. The importance of this work is reflected on the enlargement and improvement use of the current technological resources for medical surgery area in order to enhance the quality of clinical interventions as well as the experience between patient and physician.

The presented work in this chapter started with a research on the AR techniques already implemented on surgical level and a survey of their users' requirements. Meanwhile, the authors analysed some existent literature associated with these technologies in order to clarify some concepts and know the development state of another existing projects related to them. Then, image process studies were performed to find an efficient and easy way to execute the calibration process of the tracking device, a fundamental process for any AR application (developed and explained in the "Augmented Reality Process" section). Afterwards, was designed the application workflow and conceptualized its implementation architecture. At the same time, a survey of the necessary tools and software that fit the project requirements was made. A prototype application and a web server were developed in order to test and verify the efficiency and usability of the proposed solution. Finally, after the tests and simulations were carried out an evaluation of the presented solution was made in conjunction with a survey of directions and improvements to be considered in the future.

The next section of this chapter explains briefly some important concepts needed to know the state and evolution of the existing technologies in the field as well as clarify and describe the target users and implementation environment. Issues and problems are summarized in the following section and the existing solutions are reviewed. The authors proposed solution, called by ARPEEK, is presented and in