

Medical Imaging Teacher: A Program to Simulate X-Ray Images of the Body by Considering kVp, mAs, and FFD Values

Umit Kara^{1*}, Huseyin Ozan Tekin², Mehmet Nuri Kivrak³, Gokberk Yagci⁴

¹ Suleyman Demirel University, Vocational School of Health Services, Medical Imaging Department, Isparta, Turkey

² Uskudar University, Vocational School of Health Services, Radiotherapy Department, Istanbul, Turkey

³ Suleyman Demirel University, Fine Arts Faculty, Department of Painting, Isparta, Turkey

⁴ Suleyman Demirel University, Engineering Faculty, Department of Computer Engineering, Isparta, Turkey

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ABSTRACT

Introduction: Teaching styles and methods have been constantly changing in the recent years. In the 1980s and 90s, the world was introduced to various developed devices, such as smart boards and early generation smart phones that had an immediate innovative effect on education. These advancements has resulted in a considerable improvement in the current educational techniques. The innovations in medical techniques and their quality is of paramount importance. The aim of this study was to provide an innovative and useful software on radiological applications and contribute to the related literature.

Materials and Methods: The Medical Imaging Teacher (MIT) program was created and the prototype application was implemented on the Android platform for free use. The programming and testing of the usability of the application were performed by the users of the Google Play Store.

Results: In this program, we have developed new software to simulate the X-ray images of the body by considering the peak kilovoltage (kVp), milliamperage per second (mAs), and film focus distance (FFD) values. The application has been downloaded more than 1,000 times without paid advertising. We enrolled 131 participants, who made comments and gave 4.8 points on average.

Conclusion: It can be concluded that with innovative digital programs, such as the MIT, the medical machine-based learning and medical applications have risen to new levels. The software on medical testing and examination is gaining increasing popularity among the health-related applications for smart phones.

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Introduction

The use of radiation in medical imaging is widespread and considered essential in hospitals. Clinical ionizing radiation is applied in the diagnosis and treatment of various diseases in the medical area. Initially, the oldest imaging methods for diagnostic purposes at radiology clinics were accomplished through using the x-ray. An X-ray device that displays the results at the desired time also contributes to obtain the desired quality and quantity of the X-ray beams. To give a simplified explanation, let us imagine a patient during shooting; the patient's X-rays constitute the image. The technician has many responsibilities within the shooting process. This technique of shooting is both visual and flawless in results, which provides better quality for students and technical staff.

Mobile appliances have become useful in the health care settings, leading to quick growth in the development of medical software applications for these platforms [1, 2]. The main goal of our newly created digital X-ray application is to provide an opportunity for the students to get familiar with the radiological anatomy using the smart phones. To this aim, the peak kilovoltage (kVp), milliampere second (mAs), and film

focus distance (FFM) were used to define the value of the effect and display the image visually.

Rad-Rx is an Android application made for radiology staff, such as radiologists, radiographers, and also for emergency personnel. The Rad-Rx application facilitates fast and suitable access to the algorithms for the treatment of allergic reactions to intravenous contrast. It also includes suggestions about the dose of iodinated and gadolinium-based contrast for the patients with renal insufficiency [3].

The Radiology Assistant is another application for iPhone and Android phones that inform the users of on a wide radiological subjects covered in the peer-reviewed educational papers [4]. The subjects basically focus on joint pathology, providing an image, graph, or table followed by an explanatory text. The images are quite clear with arrows pointing at important features and diagrams, where essential. All content can be accessed offline. This can be a significant benefit in the hospitals, where there is an instant need to the respective information and the internet connections is weak.

Radiation Passport is an I-Phone application purposed to educate the healthcare professionals on

*Corresponding author: Umit Kara. Suleyman Demirel University, Vocational School of Health Services, Medical Imaging Department, Isparta, Turkey
email: umitkara@sdu.edu.tr

the radiation exposure that one can receive and the potential risk elements associated with various imaging modalities. This application is based on the published international scientific journal papers and data [5]. The practice and education are vital to achieve the desired radiation dose.

Accordingly, a miscalculated radiation dose might result in the death of cells, regeneration issues within the cells, and other damages. Therefore, this application targets all individuals from medical imaging and student technicians to medical and health school students and employees. The aim of this study was not only to provide an innovative and useful software on radiological applications, especially for the students to prevent them from unnecessary radiation exposure, but also to contribute to the literature of technological sciences.

Materials and Methods

Due to the lack of education in monitoring the radiologic positions in Turkey, we decided to resolve the issue so as to assist the medical imaging students and technicians. Therefore, the Medical Imaging Teacher (MIT) program was created, and the prototype application was implemented on the Android platform for free use. Usage of this application were performed by the users of the Google Play Store.

The radiological anatomy describes the regional body systems, particularly in relation to the practice of radiology. The kVp and mAs values are significantly important magnitudes for X-ray-based imaging methods. Kilovoltage peak is the peak voltage applied to the X-ray tube during the imaging process, which

describes the maximum energy of X-ray photons. The kVp magnitude is responsible for the acceleration of electrons from cathode to anode. The mAs is a unit of radiographic exposure equal to the product of the miliamperage and the exposure time in seconds. Finally, the focus film distance (FFD) is the distance between the X-ray tube and the film in radiological application.

Currently, the feasibility and acceptability of the application are being used by evaluating the radiologic anatomy, position, radiation doses and kVp, mAs, FFD with Android-based smart phones. This application can provide different outputs for X-rays of selected body parts by clicking. The areas embodying specific actions were developed using the Java programming language for each selected body part. The programming language can be seen in Figure 1. The interface was devised using the Adobe Illustrator and Adobe Photoshop. The realistic anatomical model was created with Poser Pro, the anatomical reconstruction program that is vital for authentic visuals.

The user can access the application through downloading it from the Google Play Store. The MIT application logo is shown in Figure 2a., and the ranking displayed in the Google Play Store is illustrated in Figure 2b. As a user, the next step would be to click on and open the application. Figure 3 presents the first interface design to be encountered. In the SETTINGS tab, the users have access to the content of the tab or tabs on the startup. If the users click on the SETUP (a) tab, they will see the English or Turkish language options (Figure 4). The users continue after selecting the preferred language.

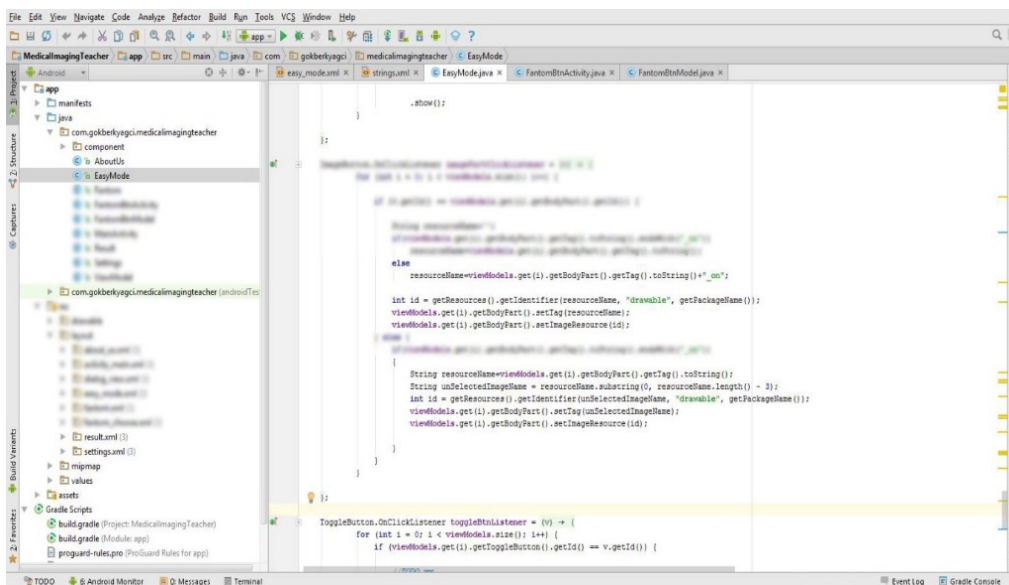


Figure 1. Programming language



Figure 2. a) Application logo, b) Medical Imaging Teacher in Google Play Store

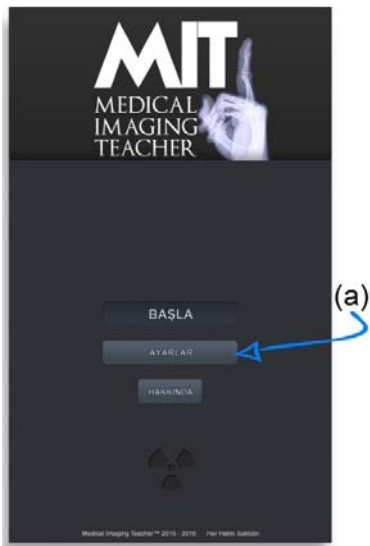


Figure 3. Menu of the application

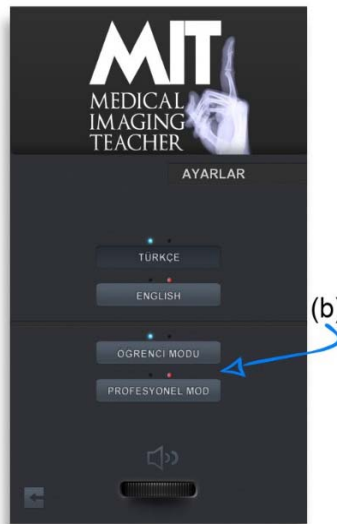


Figure 4. Languages and modes

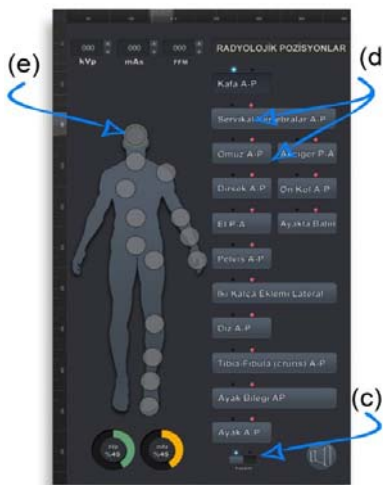


Figure 5. Radiographic positions

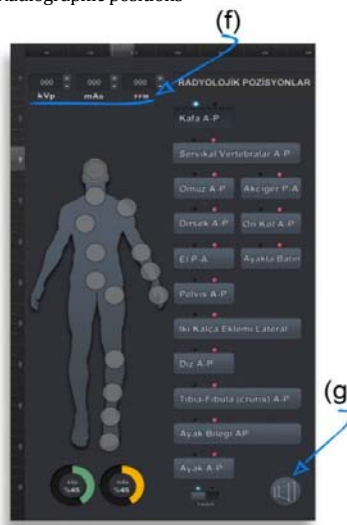


Figure 6. Radiographic positions (2)

The same tab (Figure 4) under mode (b) options can change the application's content to the STUDENT MODE that is chosen. If the user chooses the STUDENT MODE, Figure 5 would appear on the screen. Subsequently, the application will open with the start command, and the status will be in accordance with two different requests. In the first case, the HELP button (Figure 5), is represented by the letter c. If the user activates the HELP button (Figure 5) with the letter d, which is provided to help the user to select one of the radiological positions on the body, the anatomy regions (e) will appear, and the user chooses the region corresponding to this position.

If c is closed, when users click on any of the d positions, indicated by the respective letter, they must click on the correct part of the body manually. In cases where the body region and the selected part are clicked wrongly, the program will give a warning and do not allow the radiographs. The next step for the users is indicated by the submenu which also can be seen in figure 6. The kVp, mAs, and FFD values must be set in the same way as in a real X-ray process. The user does not change these values that are going to be shot with the optimized radiological doses.

Another important benefit of the program is that these values are changable. A user is authorized to increase and decrease the values. After the value is selected, the lower right corner of the X-ray will be performed if the letter g button is clicked (Figure 6). Then, the radiography results will appear on a new page.

These results may vary according to the f button given in Figure 6. The radiation dose will be seen in darker or lighter shades according to the high- or low-optimized radiation dose (Figure 7). Figure 8 is shown to the students or users in order to inform the technicians and patients on whom the radiography was performed. There are also instructions and information on shooting, position, kVp optimization, as well as mAs and FFD values (h).

Results

Various quirky trends concerning the use of mobile tools and applications in health care have been predicted for the future. Since better health results is the eventual goal of the health care system, such applications will be needed to meet that purpose [6]. The main objective of our newly created application was to provide proper educational information, especially regarding the radiological anatomy, while simultaneously drawing close attention to the necessary value of doses in Turkey.

In addition, the application was designed to be a resource for the students who do not have the opportunity to practice in a hospital. This application is free of charge and can be downloaded from the Google Play Store. Furthermore, the accuracy of the MIT program was investigated by comparing the

simulated images via changing such imaging parameters as kVp, mAs, and FFD. As an example, Figure 9 demonstrates the three different simulated images of thorax with different kVp values.

The normal imaging parameters for an average patient are 60 kVp, 30 mAs, and 120 FFD. Figure 9a depicts the normal image of the thorax, which was simulated with optimum imaging parameters (i.e., 60 kVp, 30 mAs, and 120 FFD). In contrast, Figure 9b and 9c shows the darker and lighter images of the same thorax region, which was simulated with higher and lower kVp values, respectively.



Figure 7. Different results (darker, lighter)

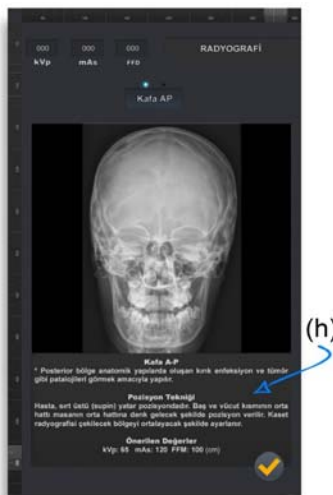


Figure 8. Result of Radiography

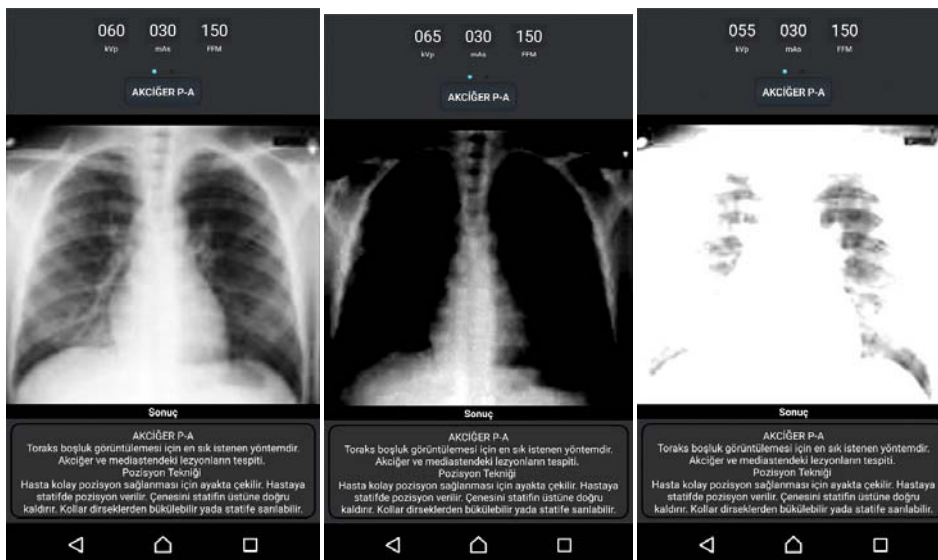


Figure 9. a) Normal image (60 kVp), b) Darker image (65 kVp), c) Lighter image (55 kVp)

Discussion

The application designed in the present study can facilitate the elimination of the undesirable situations by providing a handy and trustworthy resource. The studies for this application were initiated in February 5, 2015. The design and testing of this application were launched on April 5, 2015. Numerous participants were enrolled to collect feedback and comments, and the scores were collected and checked.

The application has been downloaded more than 5,000 times without paid advertising. In addition, this application can be helpful in cases the technical staff forget the shooting techniques and doses or lack the necessary knowledge. The average score is an

important criterion for the quality of the application. So far, we have recorded averagely 4.8-5.00 points from the 149 application users.

Conclusion

A free and user-friendly software program was presented for obtaining the X-ray images of the body parts. The MIT facilitates almost instant predictions with medical images in a wide-range of tube-potentials. This program is of interest to those working with X-ray tubes in the diagnostic radiology field as a research and educational tool.

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