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Evaluating the Usability of a Mobile Platform for Scoliosis Screening Assessment

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Abstract. Scoliosis is curvature of the spine, often found in adolescents, which can impact on their quality of life. In recent years, smartphone applications (apps) and web-based applications may help the parents with the doctors' supervision in scoliosis screening and monitoring, thereby reducing the number of in-person visits. This paper suggests the usage of the SCOLIOSIS system to detect the onset of scoliosis. This tool is being developed for simple use on mobile devices and as a web-based monitoring system for doctors, which will be an interactive tool for the patients and doctors that will provide data, information, and knowledge. The study conducts a usability assessment of the mobile application by doctors and non-clinician users. User test application developed for the android platform and the results show that this has the potential to be applied in medical practice.

Keywords. Mobile applications, Image processing, eHealth, Scoliosis

1. Introduction

Idiopathic scoliosis is the most common cause of three-dimensional deformities of the spine and the most common cause of pediatric spinal deformities, comprising 80% of all scoliosis. By age group, the incidence of adolescent idiopathic scoliosis in patients aged 10–14 years was 0.821% compared to 0.029%, 0.192%, and 0.709% for those patients aged 0–2, 3–9, and 15–19 years, respectively [1].

Available medical assessment tools include physical examinations and radiographs [2]. Physical examinations assess shoulder height, waist asymmetry, thoracic cavity asymmetry, and rib and breast deformity. Most cases, further radiographic examinations may be necessary. Moreover, repeated radiographic examinations are required for monitoring AIS progression, which may carry unwanted consequences of increased radio exposure.

Several advantages to both patients and health professionals brings the use of smartphone apps and web applications for spinal curvature assessment and scoliosis

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progression monitoring [3]. The measurement of body angles from photographs is also considered the most accurate and rapid way to assess global posture quantitatively in a clinical setting [4]. An early diagnosis of scoliosis just by using the camera of a smartphone may be very practical, painless, and it has the great advantage of being easy to obtain in daily practice [5]. Our goal is to examine the best practices of a scoliosis screening examination using a mobile device.

2. Materials and Method

SCOLIOSIS project designed and implemented a system for estimating scoliosis through image processing techniques which could be used as the initial examination of patients and their referral for detailed examination, using conventional diagnostic methods, when this is deemed necessary. SCOLIOSIS was developed to facilitates patients in conveniently and securely inputting their measurements via its dedicated mobile application. By harnessing the power of mobile technology, it empowers individuals to actively participate in the measurement process, fostering a patient-centric approach to data collection.

2.1. System and Features

The SCOLIOSIS system is an automated, non-invasive system for: a) posture analysis, shoulders' asymmetry measurement, Adam's Bending test measurement, and digital scoliometer measurements to provide the risk assessment and their correlation with the degree of scoliosis and/or related quantitative measurements. An appropriate infrastructure for the storage and transmission of the data has been developed. An SQL database was used in order to store the data from devices. For the server communication we used PHP and created RESTful API. SCOLIOSIS is available using common commercial devices (e.g. android mobile phones/tablets) for the required hardware elements of the system and in this way the user is more familiar with the system. The system's structure is presented in Figure 1. The architecture-level functions workflow is presented identifying the services in each layer and highlighting their features.

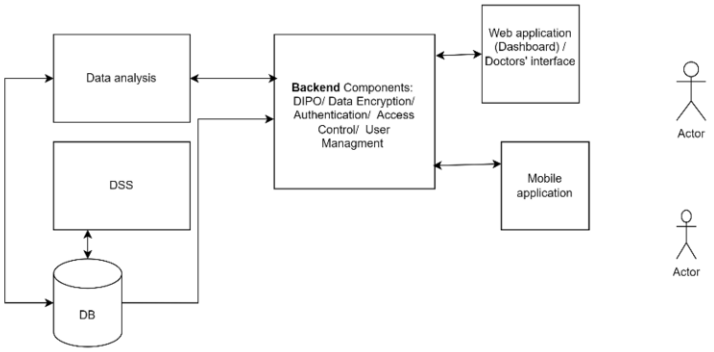

Figure 1. SCOLIOSIS system architecture

After the registration, the user can manage the SCOLIOSIS app, as seen in Figure 2. For the system's implementation we used Java and the MediaPipe library in Android Studio. The mobile app collects patient measurements for the pose detection as well as

additional measurements calculated using the sensors (e.g. accelerometer) of a smartphone, storing them securely in the database. These data serve as training inputs for machine learning algorithms, allowing the app to provide precise scoliosis diagnosis and display results [6].

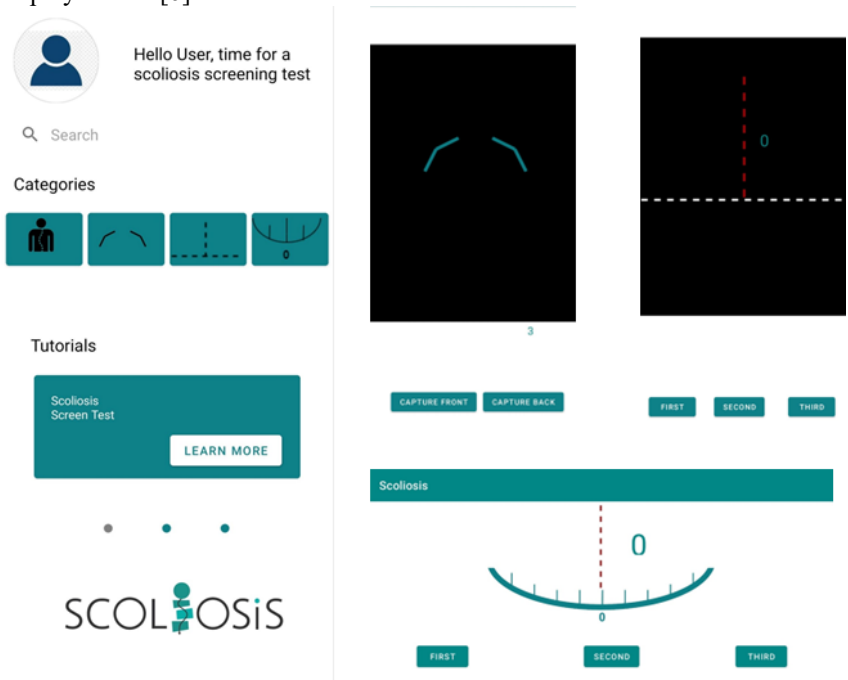

Figure 2. SCOLIOSIS mobile application

Doctors can also monitor data by a web application with ease, logging in through their secure accounts. Once logged in, they gain access to a comprehensive dashboard where they can view scoliosis measurements and Artificial Intelligence(AI)-derived insights for their assigned patients. This user-friendly interface simplifies the process, enabling healthcare professionals to stay up-to-date with their patients' progress and treatment needs. The integration of AI insights enhances their ability to make informed decisions, ultimately leading to more personalized and effective scoliosis management for each patient under their care.

2.2. Usability Validation and Satisfaction assessment

This study was conducted using a sample consisting of 11 doctors at 3rd Orthopaedic Unit of Papageorgiou General Hospital in Thessaloniki and 7 non-clinician users. Doctors were classified into 2 groups according to their clinical experience. The groups were comparable. Five senior orthopedic surgeons and six doctors who practice orthopedic surgery participated in the study. The simple users were selected in a random procedure (n=7). A usability assessment measure effectiveness, efficiency, and satisfaction. A questionnaire for participants was created on SUS questionnaire with ten Likert scale questions. The SUS now has widespread use as a questionnaire of choice when assessing perceived usability, in surveys as well as in usability studies. The response scale in all cases ranges from 1 (strongly disagree) to 5 (strongly agree). Hands

on session was facilitated by an independent coordinator (a doctor) as well as an observer (developer). A demonstration of the SCOLIOSIS mobile application was conducted, introducing to the participants the platform's modules (standing test, angles' measurement; bending test; accelerometer) as well as the integrated component (video tutorials; doctors' assignment). Hands-on sessions introducing some of the exercises took place in the pilot sessions with the help of instructors. The evaluation of the sessions was also based on open questions in order to achieve better interaction between the participants.

3. Results

Participants (n=18) were navigated the SCOLIOSIS app and completed a usability questionnaire. The mean score on usability indicated that the participants were confident (mean 3.83 ± 0.62) in using the SCOLIOSIS app. They also reported that various functions were well integrated (mean 3.78 ± 0.94) and that most people would learn to use this system very quickly (mean 4.00 ± 0.77) (Table 1).

Table 1. System Usability Scale (SUS) on the use of Scoliosis mobile app (n=18)

	Mean score	Standard deviation
Q1. I think that I would like to use this system frequently	3.83	1.04
Q2. I found the system unnecessarily complex	2.17	1.15
Q3. I thought the system was easy to use	3.94	1.11
Q4. I would need the support of a technical person to be able to use this system	1.83	1.15
Q5. I found the various functions in this system were well integrated	3.78	0.94
Q6. I thought there was too much inconsistency in this system	2.72	1.23
Q7. I would imagine that most people would learn to use this system very quickly	4.00	0.77
Q8. I found the system very cumbersome to use	2.44	1.15
Q9. I felt very confident using this system	3.83	0.62
Q10. I need to learn a lot of things before I could get going with the system	2.39	1.50

A thorough analysis of any differences between the groups was conducted in order to investigate the discrepancies between non clinicians and doctors' groups: i) Senior orthopedic surgeons reported high self-confidence in using the SCOLIOSIS mobile application however they may not use this very often; ii) On the other hand, junior doctors reported that they would use the SCOLIOSIS app frequently and rated high self-confidence in using this; iii) Non-clinician users reported being very confident in using the system due to its ease of use and learnability as well as the various functions were very well integrated. The final SUS score for senior orthopedic surgeons is 59% and for junior doctors is 61%. It seems that they should be encouraged to integrate SCOLIOSIS into their clinical routine. Non

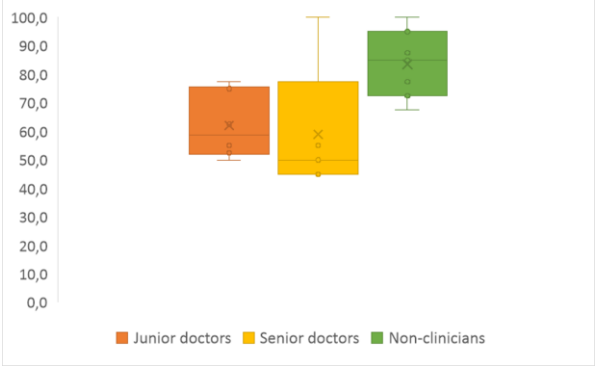

Figure 3. Evaluation per target group

clinician users assess the usability of the mobile app above 80%. It was well-accepted among simple users (e.g. parents of a person with scoliosis, different ages and digital competencies).

4. Conclusion

The purpose of this study was to examine the usability of a mobile scoliosis screening tool. The participant's assessment was classified according to their experience in clinical diagnosis of scoliosis. Usability assessment of our pilot descriptive study is promising. The usability assessment helped the team to understand the design flaws of SCOLIOSIS mobile app especially the users' preference for a digital screening tool. The data helped the team to validate the self-confidence and usability questionnaire for future clinical trials. Some limitations in our study were: a) the analysis was based on quantitative feedback from a single evaluation tool based on a brief demonstration; b) The sample size was small. Qualitative feedback would have added valuable depth and details to our analysis and are planned to be carried out. Our next step is to test the SCOLIOSIS mobile app for its efficacy in a clinical trial.

5. Acknowledgment

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