Padimedical: Medical Image Sharing Portal with DICOM Viewer – User Experience

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Abstract—**Digital Imaging and Communication in Medicine (DICOM) is a standard medical imaging format for medical imaging information and data. Availability to access DICOM files remotely using smartphones has shown to improve healthcare systems especially for communication between doctors from different centres. Most of DICOM files need to be viewed using conventional institutional DICOM viewer. We developed software which allows medical personnel to access DICOM images remotely from their smartphone. This newly created software platform is named Padimedical. This pilot study aims to evaluate users' satisfaction and usability. Practising medical doctors from a radiology department in a tertiary referral centre were chosen as correspondents in this study. The survey form was sent to over 30 doctors via email. A total of 24 out of 30 respondents completed the survey. The survey showed that Padimedical DICOM viewer was easily accessible (100%), compatible with OS operating system (100%), user-friendly (87.1%), and high signal to noise ratio (100%). All respondents (100%) agreed that the image viewing was smooth and responsive. All respondents would recommend to their peers (n=24). A total of 18 respondents suggested that the quality of images was high (76%) and 23 respondents suggested that the contents in this newly created platform were easy to share (96.15%). All the participants were able to make the correct diagnosis using Padimedical. Overall, the rating of our platform is 4.3 out of 5. Conclusion: Based on this pilot survey, Padimedical software was easily accessible remotely using smartphones, compatible with OS operating system, viewing images were smooth and responsive, produce high-quality image, and easy to share DICOM contents.**

Keywords—DICOM, images, software

I. INTRODUCTION

IMAGING in medicine requires high precision medical imaging. The precursor of Digital Imaging and Communication in Medicine (DICOM) was released in 1985. The aim is to standardized the medical image file format for medical purposes [1]. It is currently the most popular file format used for storing and transferring medical image data. The revised version of DICOM subsequently enables integration between medical imaging devices. DICOM is used to capture and archive image data in picture archiving and communication system (PACS) [2]. The PACS not only acts as a data storage for medical images but also provides the data management system [3]. It also enables the clinician to view patient images in multiple modalities simultaneously with the DICOM image viewer. This not only improves the efficiency of the medical image system but reduces the cost in image management.

PACS system with DICOM viewer is a very important platform. The clinicians need to view and share the images with other

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doctors to get professional opinions[4]. This is crucial as not all consultants on specific diseases are available in the same hospital. The current PACS system hospital in Malaysia only provides local intranet access. This limits access to clinicians and other healthcare workers from different hospitals. The problems are currently solved by providing patients with films to be brought to the respected consultants, which is inefficient. Furthermore, the image quality will be degraded when the image is printed using the standard radiology film. There will be no further added image annotation and image manipulation that may give further information to the referring clinician. There is also a significant loss of time for the printed images to reach relevant consultants for opinion, thus delays the patient's management.

Today, everybody uses smartphones as a mainstream device. This eloquent device is not only used as a communication tool but also has the ability for the users to use this tool to search for the latest information on disease and management on the internet. The clinicians, in general, have a lack of time to use the standard desktop computer or even laptop to view patient images. Reviewing the patient's images is of great importance for pre-planning for patient management to provide the best outcome [5].

DICOM viewer needs to be installed on the computer before it can be used to view the images. The computer must have a medium specification central processing unit (CPU) with a current operating system that supports the DICOM application without conflict [6].

Based on the abovementioned issues, we have decided to create a cross-platform software that we called "Padimedical". This application software can be used without software pre-installation and can be used in a smartphone. Padimedical Viewer users will choose the DICOM images that can be uploaded to the Padimedical server. This server is a private cloud system placed in a secured local infrastructure with in-built protection and is managed by cybersecurity experts. The Padimedical platform uses "html5" as a base to view images. It does not require any installation. It also supports all kinds of computer operating systems. This solves the issue of the need for pre-installation/ driver and the requirement of a high-end computer for image viewing.

The image sharing option using the Padimedical platform is also available within this software. The software will automatically create a link for the images once the images are being uploaded on the server. This link can be shared by the users through email or any secured cross-platform messenger. By clicking the shared link, the clinician can view the images on the computer or smartphone instantly. We imposed a download restriction policy for data protection reasons.

II. METHODOLOGY

There were 30 participants selected from a group of doctors in which were active users of DICOM file format in their daily working environment. All respondents are working in the Radiology Department in a tertiary referral institution. This cohort of doctors was selected because they were familiar with different kinds of DICOM viewers. Tutorial on how to use the Padimedical Dicom Viewer on the computer and android smartphones have been given beforehand. They also were provided with video tutorials in case they want to recap on how to use our DICOM Viewer.

The link of Padimedical DICOM Viewer was given to the participants via email. This link contains a brain CT scan of anonymous patients who have abnormalities. A set of questionnaires on the evaluation was given. The evaluation point includes participants satisfaction using our viewer, accessibility, viewer compatibility on their daily working computer, viewer smoothness and responsiveness when viewing DICOM files, sharing medical images experience and the experience of the user when they were using the viewer via their android smartphones. The participants were also being asked about the quality of images of the viewer. To further evaluate the quality of the images, participants need to make a diagnosis of the patient using our DICOM viewer.

III. RESULT

The response rate was approximately 80% (24 out of 30 participants). There was no reply from the rest of the 6 participants. We designed a set of questionnaires basically to assess the usefulness of padimedical.com, image quality and commendation/ endorsement (Table I, Table II, Table III). The result showed that Padimedical DICOM viewer scored 100% marks in question 1- 4, and question number 6 (Table I). A total of 24 out of 24 (100%) respondents were satisfied with the compatibility, easy access, user-friendliness, and the responsiveness of this newly created software on computer OS; however, there were 5 respondents (19.22%) who did not find it easy to use in android OS based smartphone. The score on the quality of the viewed images was 76.92% (n= 18) (Table II). One of our main goals in developing this software is to share the DICOM images contained in a more secure method, between medical doctors. The score was 96.15% (n=23) in easy to share DICOM images using padimedical.com (Table III). The webpage initial appearance is as shown in Figure I.

The participants were also given a sample case with pathological findings (Figure II). They need to evaluate and give a correct diagnosis. The result shows that all the participants gave the correct diagnosis. The overall rating that was given by the participants is 4.3 out of 5.

TABLE I. SIMPLE QUESTIONNAIRE TO EVALUATE THE USEFULNESS OF PADIMEDICAL.COM VIEWER

Question	Result (%)	
	Yes	No
1.Do you find that padimedical.com viewer is easily accessible anywhere?	100.0	0.0
2.Is padimedical.com compatible with your working computer OS?	100.0	0.0
3.Do you find Padimedical DICOM viewer user-friendly?	100.0	0.0
4.After all images are fully loaded, do you find the image viewing smooth and responsive?	100.0	0.0
5.Do you find it easy to use in smartphones (Android OS only)?	80.77	19.23
6.Would you recommend padimedical.com to your colleagues?	100.0	0.0

TABLE II. SIMPLE QUESTIONAIRE TO EVALUATE IMAGE QUALITY

Question	Result (%)	
	High	Low
7.How is the quality of medical images in Padimedical DICOM viewer?	76.92	23.08

TABLE III. SIMPLE QUESTIONAIRE TO COMMENDATION/ENDORSEMENT

Question	Result (%)	
	Easy	Difficult
8.Is it easy to share DICOM images with colleagues using padimedical.com?	96.15	3.85

IV. DISCUSSION

Padimedical DICOM Viewer was developed to overcome multiple problems faced by doctors in viewing medical images. This software has been created by a group of doctors from the radiology department of Universiti Putra Malaysia in collaboration with software engineers. The main aim of this project is to make medical imaging easily accessible anywhere and provide diagnostic quality to the doctor hence help improve the healthcare system.

All participants agreed that Padimedical DICOM Viewer has made medical imaging easy to be accessible wherever they are if they are accessible to the internet. This is because our software is made using html5 base system that is compatible with most of the computer and mobile smartphone operating systems. It is also user-friendly, which provides the important basic function in medical imaging evaluation such as the ability to change windowing, switch between imaging sequences, measure structure, zoom in and out, annotations and much more [7]. Another important criterion is to make image viewing experience smooth and responsive as medical imaging involves a huge amount of data [8]. A slow and less responsive system makes users less likely to use the system as it will be time-consuming. Padimedical has detected this issue and overcome it during its development. It is solved with the help of a system that temporarily downloads the images to their system before they start reviewing the images. All participants feel that Padimedical DICOM Viewer is smoother and responsive.

Quality is among the important features that the DICOM viewer needs to have. This is to ensure that the small details of important pathology are not missed out during the evaluation [9]. This will affect patients, diagnosis and management. We have focused on this feature from the beginning of our

development. From the survey, 76.92 % agreed that the Padimedical DICOM viewer provides high-quality medical imaging.

With the current trend of technology, most doctors use smartphones as their main device not only to communicate but to find information regarding diseases. This is eased with the advancement of mobile internet service which provides fast and smooth internet access almost everywhere. Due to this advancement, we have developed a DICOM viewer that is compatible with the smartphone operating systems (OS)[10]. Currently, we are compatible with Android OS and we are still developing for it to be compatible with Apple OS. During the survey, 80.77% feels that it is easy to use Padimedical DICOM Viewer in their Android OS smartphones.

From Padimedical DICOM Viewer, doctors can create a link and send it to a specific doctor using email or direct message. By clicking the link, they can open the images using smartphones or computers. A total of 96.15% of respondents agreed that it is easy to share cases between doctors using Padimedical DICOM Viewer.

Communication and image sharing between doctors is very important. Easier and secure accessibility of image sharing will give better access to managing doctors to seek expert opinions from their colleagues and other specialists, ultimately the patient will receive the best management.

V. CONCLUSION

Our pilot survey showed most of the participants have given a good evaluation to Padimedical DICOM Viewer. The overall rating of our software is 4.3 out of 5. This shows that Padimedical DICOM Viewer has great potential to be accepted by the medical fraternity. Further development of this application is important and will certainly help medical doctors improve their patient's outcomes. We are confident that the system is relevant to healthcare providers.

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