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Subjective Image Quality Assessment: A Pre-Assessment on Visual Distortion of Medical Images by Clinicians and Radiologists

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Abstract—Interdisciplinary researches are increasingly significant in the current global situation. Image Quality Assessment, or IQA, is a process to determine the level of accuracy to a single image. In IQA, usually, two essential assessments will involve, which are Subjective IQA and Objective IQA. This paper proposes a novel 'pre-assessment' approach, combining with Subjective IQA, aiming for researchers to receive relevant knowledge which is beyond their principle professional fields, so that they can design and plan the formal Subjective and Objective IQA suitably and accordingly. In the paper, a practised example named 'Predict the Impact of Visual Distortion on Medical Images' has been introduced throughout, which has demonstrated the efficiencies of supposed pre-assessment methodology, by necessary statistics and analysis. The paper also summarises several circumstances where recommend researchers to consider to conduct a pre-assessment, especially under interdisciplinary researches.

Keywords-Pre-Assessment; Image Quality Assessment (IQA); Subjective IQA; Medical Imaging; Visual Distortion;

I. INTRODUCTION

Image Quality Assessment (IQA) is a process to determine the level of accuracy to a single image [1]. Generally, an IQA consists of two mandatory assessments: Subjective Image Quality Assessment (Subjective IQA) which human being will be involved, and Objective Image Quality Assessment (Objective IQA) which mathematical models will be merely involved [1]. Subjective IQA and Objective IQA are equivalently important, and both are indispensable when evaluating the quality of an image overall.

Recent decades, medical imaging techniques are used in worldwide hospitals and relevant healthcare institutions increasingly [2]. Similar to natural images, it is more significant to ensure the good quality of medical images so that doctors can result in suitable clinical decisions and corresponding treatment plans to patients according to medical data [3]. In Medical IQA, the doctors should be only participants in Subjective IQA. Specifically, the participants can be clinicians and radiologists [4], [5]. A classic process

of Subjective IQA in medical discipline can be: clinicians and radiologists are required to give a decision to the level of quality of a single medical image [6]. However, if the assessment organiser is not a profession in medical community, e.g. computer science discipline, possibly he or she needs to conduct a pre-assessment suitably so that assisting them to target on more specific places along the whole IQA.

This paper will present how a suitable pre-assessment can be constructed before formal Subjective IQA. Specifically, under the topic of 'Predict the Impact of Visual Distortion on Medical Images' [7]. Additionally, the received data and analysis of a pre-assessment from doctors (including clinicians and radiologists) will also be demonstrated and analysed in the paper.

II. METHODOLOGY

A suitable pre-assessment for Subjective IQA can provide broad knowledge for researchers on the specific field, especially when they are conducting the interdisciplinary researches. For example, when computer science professionals would like to conduct research on 'Predict the Impact of Visual Distortion on Medical Images', they need to have basic knowledge of distorted medical images and are aware of how they work in actual circumstances [7]. This possibly involves in the glossary of medical terms. The intervention from the medical community will help the researchers and improve the quality of the research. From aforementioned perspective, a pre-assessment is necessary in the interdisciplinary research.

The following methodology will illustrate how a suitable pre-assessment can be constructed before formal Subjective IQA, by introducing an interdisciplinary research on 'Visual Distortion on Medical Images', which aims to find the impact of visual distortion of medical images in clinical area [7]. In [7], it adopts a four-step methodology to implement the aims and objectives, including dataset construction, Subjective IQA, Objective IQA, and comparative analysis. The methodology in this paper will target to the pre-assessment in the Subjective IQA.

A. Confirm Goals and Objectives

At the very beginning, the researchers should be fully aware of what information they would like to receive from the pre-assessment they are going to conduct. The information receiving from pre-assessment should assist them to conduct Subjective IQA, or even Objective IQA smoothly. In other words, it is unnecessary to have a pre-assessment if only duplicated information will be received or they cannot persuade themselves with strong goals and objectives which are distinct from formal Subjective IQA's.

In the case of the interdisciplinary research on 'Predict the Impact of Visual Distortion on Medical Images', the researchers have merely computer science background, which means they have to find a way to learn about essential medical knowledge, especially relevant to medical imaging. The researchers will construct a medical images dataset in Subjective IQA, consisting of distorted and distortion-free images; however, they firstly have to find what types of distortion happened in reality (not just in computer science discipline), i.e. in hospitals or healthcare institutions. This is a distinct objective from Subjective IQA, and a pre-assessment is essential from this view.

B. Choose Pre-Assessment Form

The second step is to choose a suitable form of pre-assessment. There are various types of form to conduct a pre-assessment, such as a questionnaire (online, on-site), an interview (online, on-site) and other types. The form can be any of them as only as the intended goals and objectives prescribed can predict to be achieved eventually. Additionally, researchers should also consider the accessibility of the pre-assessment to the target respondents.

In the case of the interdisciplinary research on 'Predict the Impact of Visual Distortion on Medical Images', a form of the online questionnaire has been finally chosen. As the objectives of the pre-assessment are to understand the types of distortion that happened in hospitals, there will not involve any restricted assessments controlling time, location and environmental factors. Thus, an online questionnaire containing necessary questions is enough. Besides, due to the outbreak of COVID-19, an online form will ease the workload of doctors. Also, doctors are more willing to participate in the research through the form of 'online questionnaire' - contribution made but the time cost is relatively low.

C. Choose Respondents

The third step, also the most important one, is to choose suitable respondents. Normally, under the same topic, the type of respondents of pre-assessment and formal Subjective IQA possible are the same or at least, similar. For example, they are all doctors (but possibly unnecessary to be the same objects). Additionally, their responses usually will be closely related to personal experience, current emotions and other influential factors. The assessment organiser should pay attention to these when conducting the pre-assessment. We will discuss more about influential factors in the following section: Construct the Contents.

In the case of the interdisciplinary research on 'Predict the Impact of Visual Distortion on Medical Imagess', the respondents of the pre-assessment have been set to doctors, especially clinicians and radiologists, which are receivers of medical images in hospitals or healthcare institutions at most of time. Therefore, they are expected to have plentiful and professional knowledge relevant to medical imaging.

D. Construct the Contents

With the clear answers of steps aforementioned, the contents of the pre-assessment should be constructed accordingly. Several factors, including the time, the location, the number of questions, the contents of questions should be well considered.

1) Time: Two 'time' relevant issues should be considered. The first 'time' issue is when should the respondents take this pre-assessment. The second 'time' issue is how long should the respondents take for the pre-assessment.

2) Location: The location of the pre-assessment should be relevant to the section: Choose Pre-Assessment Form. If the pre-assessment is setting to be held online, then it will be easier. However, if the form of on-site has been chosen, then a suitable and precise location should be well considered, as the location will potentially influence the quality of the responses.

3) Number of Questions: It is extremely significant to have an 'adequate' number of questions, which covers most of the topics that the assessment organisers expect to know and the respondents can accept. For example, respondents are more willing to answer a questionnaire which the expected answering time is 5 minutes or less.

4) Contents of Questions: Two 'content' issues should be considered. The first 'content' issue is what specific topics should the questions cover. The second 'content' issue is what form of questions should be chosen, i.e., MCQs, True or False, or short-answer questions. However, respondents possibly prefer MCQs instead of short-answer questions. Please note that all decisions here will influence the responses of respondents, positively or negatively, especially the form of questions.

III. SAMPLE AND STATISTICS

According to the methodology aforementioned, we have conducted a pre-assessment on the research 'Predict the Impact of Visual Distortion on Medical Images'. We aim to find what exact types of distortion happened in hospitals or healthcare institutions, as there are various types in the computer vision field and all of researchers have only computer science background. The respondents of the pre-assessment are doctors or healthcare workers who involve

medical images during their daily working. Following the potential answers from the pre-assessment, we can plan and design Subjective IQA and Objective IQA more suitably.

The pre-assessment is an online questionnaire, consisting of 11 questions. We divide all questions into two sections according to their functions, 'Personal Background Information' section (4 questions) and 'Medical Imaging Related' section (7 questions).

In the first section, several questions related to personal information are presented. Because we only want the answers from medical personnel, especially clinicians and radiologists, we will remove all the answers from other groups of people. Additionally, two questions relevant to personal experience ensure that we can receive relatively high-quality responses.

In the second section, the questions start from a basic one: Have you ever encountered the problem of medical images distortion? On the condition that the respondent chooses 'Yes', the following questions will be presented.

- If you have ever encountered the distortion of medical images, how often does this happen?
- If you have ever encountered the distortion of medical images, what kind(s) of following possible distortion was it (were they)?
- If you have ever encountered the distortion of medical images, what kind(s) of following negative effects have brought you?
- When there is a problem with the image, are you more inclined to actively communicate with the relevant clinician / radiologist?
- Do you think that the distortion on medical images is a serious problem for the medical community?
- Optional: Would you like our team to talk with you further? If you are willing, please leave your contact information here, or please simply skip this question.

Including the first section and the second section, all of the questions are in MCQ form except the final one. Please note that the final question aims to find potential doctors for the later formal Subjective IQA. This will be an on-site assessment and need extra time. Therefore, we would like to record the contact information if a respondent is willing to be a volunteer.

We eventually have received 59 responses (51 desired and valid responses). The pre-assessment intends to be completed within between 3 and 5 minutes. However, according to the responses, the average answering time is dramatically lower than this. The pre-assessment results were slightly different from what we (a group of computer science background researchers) used to think. 92% respondents (47 of total valid responses) says they have encountered medical imaging distortions. 82% clinicians and radiologists (42 respondents) prefer to communicate with each other when the distortion happens. 86% respondents (44 respondents) think the distortion in medical images is a serious problem

Table I
RESPONSES TO TYPES OF DISTORTION
AND POTENTIAL NEGATIVE EFFECTS

Distortion		Negative Effects	
Types	**Respondents**	**Types**	**Respondents**
Contrast	43% (22)	Disease misdiagnosis	55% (28)
Blurry	76% (39)	Missed diagnosis	63% (32)
Obscured	31% (16)	Inaccurate judgement of disease severity	63% (32)
Compression	16% (8)	Inaccurate treatment plan	35% (18)
Other	12% (6)	Other	2% (1)

for the medical community. Additionally, 9 respondents would like to have the further activity on Subjective IQA with us. For the distortion types and caused negative effects, please refer to Table I for details. Please note that the percentage data in Table I is after rounding.

With the results of the pre-assessment, consequently, various factors of the formal IQA in the whole research have been modified and appended, as below:

1) Change the types of distortion and corresponding numbers of images (portions) in medical images dataset, according to the responses shown in Table I. Namely, the research dataset will include the original, the blurred, the contrast-distorted and the obscured (have been changed to noisy later) medical images;
2) Confirm the identities of research respondents, i.e. clinicians and radiologists;
3) Find the potential candidates for conducting the following Subjective IQA successfully;
4) Increase our confidence to conduct this meaningful research because of predictable and possible solutions to the severe problem in the medical community - potentially influence the development of human being and the Earth positively.

IV. EVALUATION AND DISCUSSION

As mentioned above, the results of the pre-assessment for the prescribed topic were indeed different from the previous thoughts and assumptions raised by researchers. Under this topic, now we can assume, the researchers with mere computer science knowledge will not target to the right research objectives, without the pre-assessment (in the aforementioned form or other adequate forms). Therefore, it will possibly result in the findings or solutions which are not extremely convincing.

From the macro perspective, it is encouraged to conduct pre-assessment(s) when at least one of the following rules matches:

1) Under an interdisciplinary research, researchers do not have relevant academic knowledge or training in at least one of the involved aspects of the research;
2) Under an interdisciplinary research, researcher do have the relevant knowledge, but they require more specific

information under the current case;

3) Need a pre-assessment which is similar to the formal assessment, to prevent predictable flaws, errors, and failures in the formal assessment and cause catastrophe;

4) Other circumstances that are necessary to conduct a pre-assessment.

However, the rules summarised here may not cover all possible situations. The researchers have the responsibility to evaluate their researches and decide with their fellows and line manager (if applicable) whether they should conduct a pre-assessment in advance, before they officially initiate the research.

V. CONCLUSION

In this paper, we present a novel 'pre-assessment' approach joint with Subjective IQA. A pre-assessment can provide various basic information for researchers so that they can design and plan the following Subjective IQA and Objective IQA suitably and accordingly, especially for interdisciplinary research and the researchers who have merely academic knowledge on one of the related fields. A practised example named 'Predict the Impact of Visual Distortion on Medical Images' has been introduced throughout the paper. According to the statistics, we can prove the pre-assessment indeed has improved the quality of the whole research. The future works will focus on the studies of improving the methodology of 'pre-assessment' under different academic topics.

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