digital fundus eye images
lossless and lossy compression,
medical diagnosing

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COMPRESSION OF FUNDUS EYE IMAGES – IMPLICATIONS FOR MEDICAL DIAGNOSING

SHORT NOTE

Digital fundus eye images have been compressed in different standards. Diagnoses based merely on the uncompressed and compressed images have been made by independent ophthalmologists. The results concerning both the lossy and lossless compression effects and their impact on the diagnoses have been presented and discussed.

1. INTRODUCTION

Image compression is crucial for most application procedures, providing quick loading and accelerating transmission [1-2]. In medical applications however it may reduce the diagnostic accuracy. Proper diagnosing procedures are essential for any methodological approach in the field of digital medical image analysis (comp. e.g.[3-4]). Below we report our preliminary studies dealing with the analysis of digital fundus eye images focusing on the effects of compression on the diagnostic quality. The problem is fundamental in our attempts to elaborate an efficient methodology for objective diagnosing based on the features of the fundus images [5-8].

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2. MATERIALS AND METHODS

2.1. IMAGE DATA

The study has been carried out for sample 126 digital fundus images collected in the Ophthalmology Department at the Rydygier Hospital in Toruń with Philips ESP/200 digital camera combined with a Zeiss Retinphot Fundus Camera in non-invasive routine examinations – with only the pupil dilated to reveal the entire disc area. There are 47 images of patients and 79 of the control group members.

2.2. COMPRESSION METHODS

The original images have been collected as uncompressed bitmaps. The standard compression formats *jpg, gif, png* and *tiff* have been chosen for the study. The tools of Paint Shop Pro (version.7.04, JascSoftware) were applied to perform group conversion. Eventually the following groups of compressed images have been obtained: *jpg50 (with compression factor =50%); jpg25 (with compression factor =25%); gif (version 89a, not interlaced, 8-bit palette); png (not interlaced, 24-bit palette); tiff (with LZW compression).* All the images, both in the uncompressed and compressed formats, have been introduced into a specially designed database application, with a user friendly interface, for diagnosing and making additional comments. The images were randomly arranged thus providing proper conditions for independent diagnosing. The proportions between the image groups overall sizes (each group containing 126 items) given in bytes for the different formats are presented in Figure 1. The *bmp* format is of course the most consuming one.

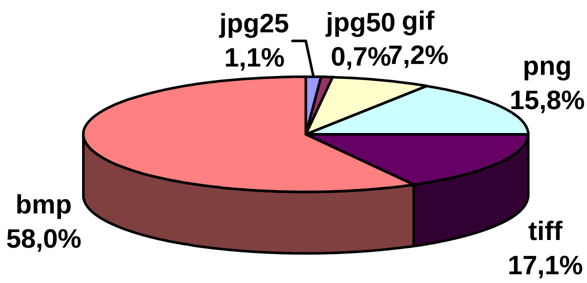


Fig.1. Contributions of different formats in the total set of the studied images (6 x 126)

3. RESULTS AND DISCUSSION

3.1. COMPRESSION EFFECTIVNESS

The compression ratios for the applied compression procedures are presented in Figures 2 (for the *jpg* standards) and 3 (for the *gif*, *png* and *tiff* standards, respectively) with the same image numbering being kept. It can be seen there are obvious differences between the standards of lossy (jpg, gif) and lossless (png, tiff) compression methods, but there are also regular differences observed for particular images .within the groups. It seems understandable considering the complexity and irregularity of the individual fundus eye images.

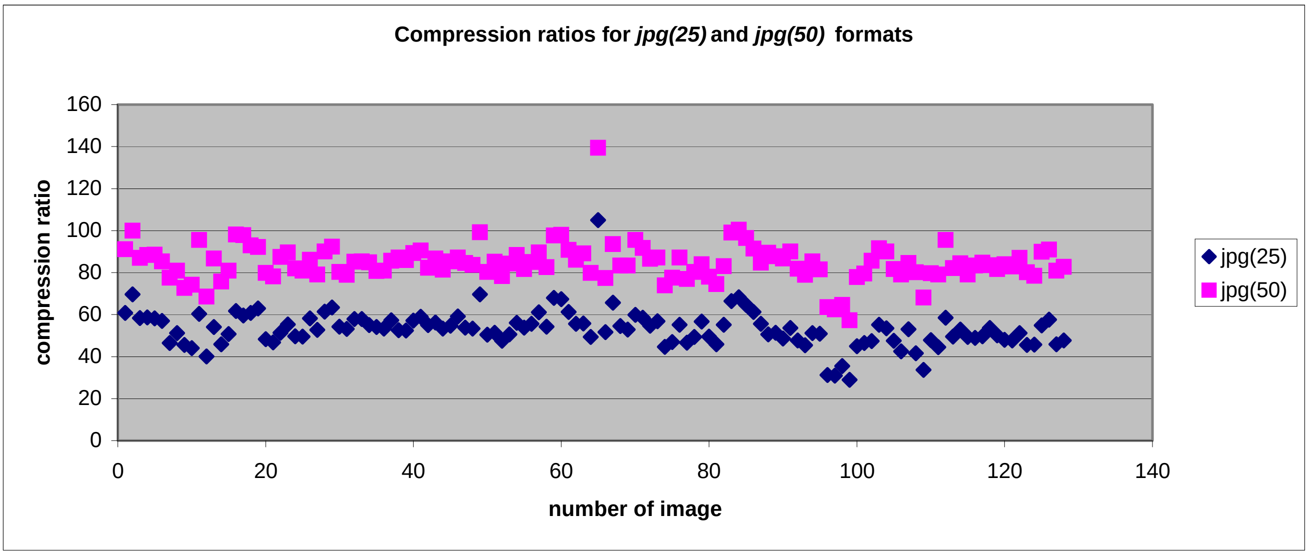


Fig.2. Sample fundus eye images compressed in *jpg* standards.

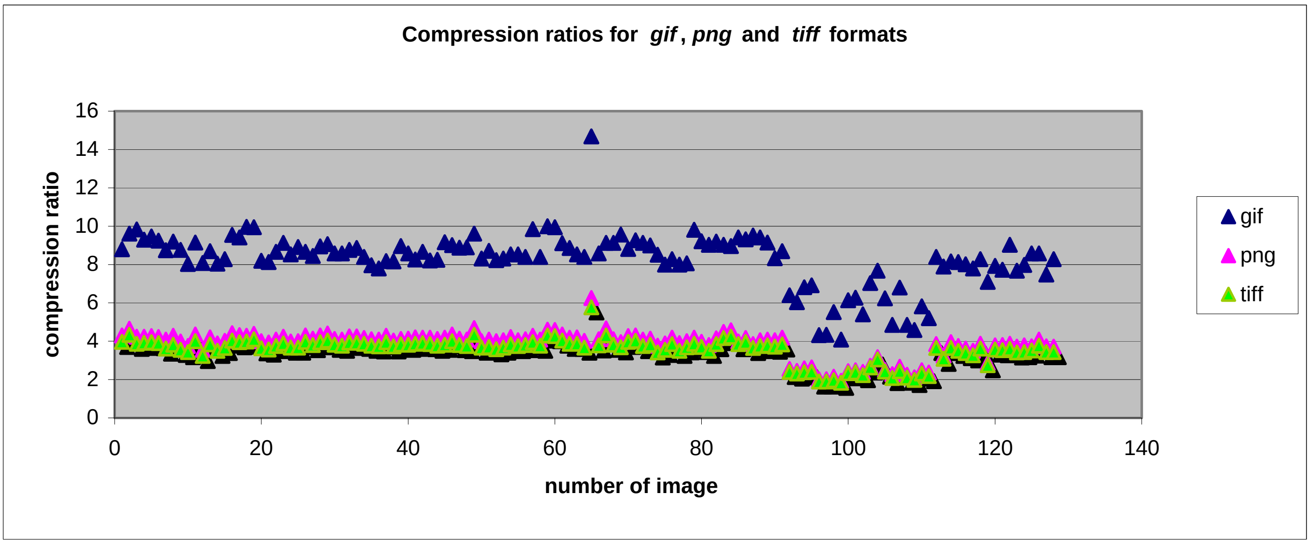
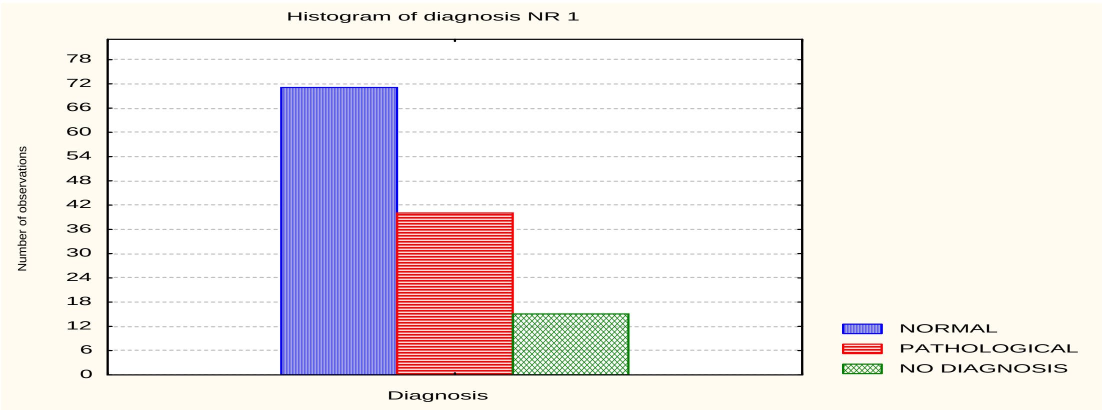
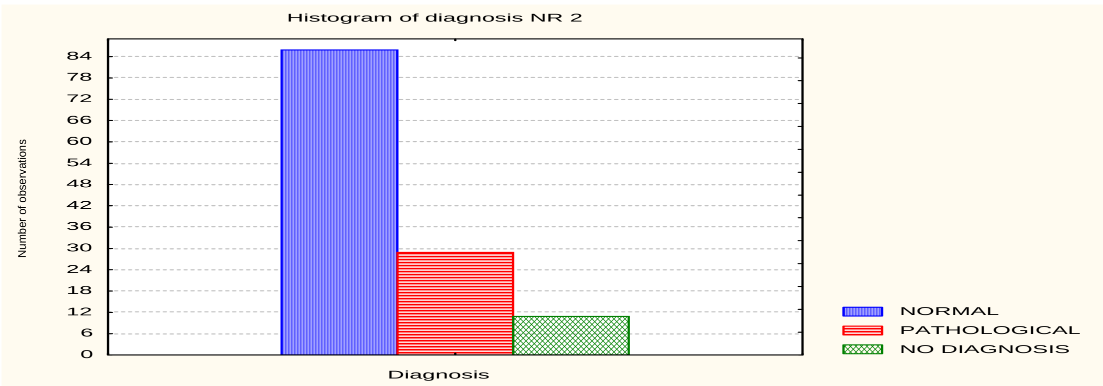


Fig.3. Sample fundus eye images compressed in *gif, png and tiff* standards

3.2. DIAGNOSES

The main intention of our study was to perform diagnosing procedures based merely on the fundus images by independent teams, enabling a proper statistical analysis and providing an insight into biasing compression factors. In Figure 4 diagnosis results for *bmp* images are presented for three independent experts: NR1, NR2 and NR3.





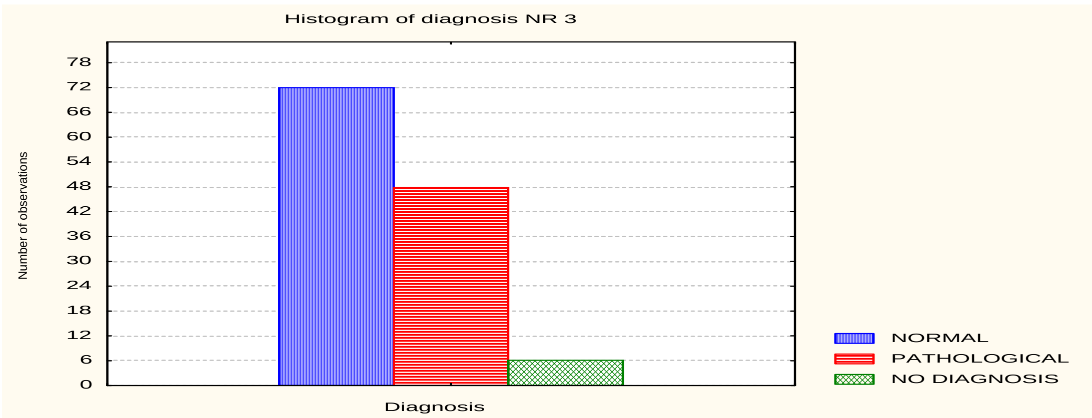


Fig.4. Diagnosis made by three separate ophthalmologists for *bmp* types of fundus images

It may be noticed that there are different verdicts of the ophthalmologists – the numbers of pathological normal and non-diagnosed cases do not remain at comparable levels. Below, in Figure 5, the summary of the diagnoses is presented in a graph – indicating that for the *bmp* images only in

61% of cases the diagnostic statements are in agreement with each other and the situation becomes worse, with only 53% of agreement, for *jpg* images.

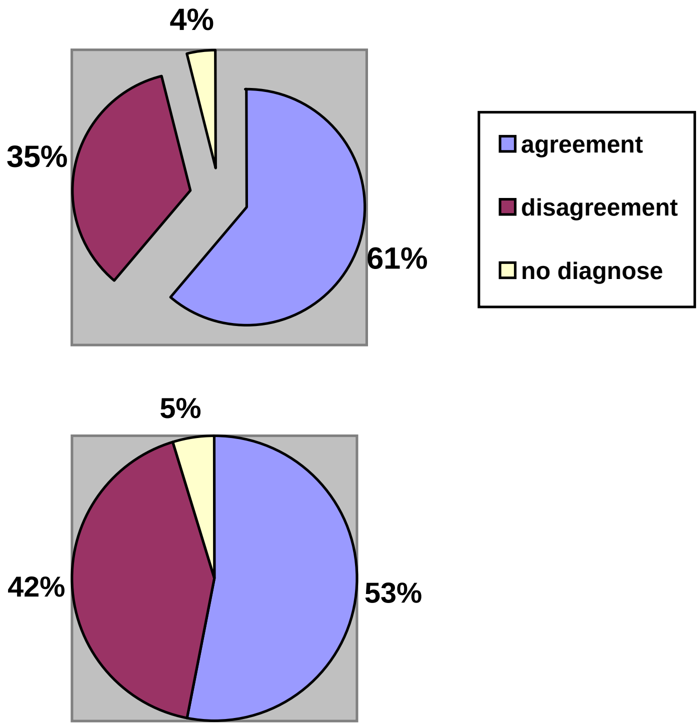


Fig.5. Summary of diagnostic statements for the set of 126 fundus *bmp* (top) and *jpg* (bottom) images

The same trends of discrepancy may be observed when estimating the correlation coefficients of the diagnostic statements of the experts (being equal to 0.27 for diagnoses NR1 versus NR2; 0.53 for NR1 versus NR3; and 0.31 for NR 2 versus NR3, respectively) – indicating comparatively weak correlations. On the other hand, it is interesting to note that for the same person making the diagnosis the correlation coefficients of the diagnosing statements remain high, being of the order:0.7-0.8 when comparing the *bmp* image based diagnoses with those for the compressed files. E.g. for NR3 it is equal to 0.73 for *bmp* versus *jpg25*, 0.78 for *bmp* versus *gif*, and 0.80 for *bmp* versus *tiff* .

4. CONCLUSIONS

Our studies confirm that manual interpretation of fundus eye images is extremely subjective and different results (i.e. weak correlations) are observed also for experienced ophthalmologists. In this context the effects of compression may be even less important, particularly when limiting to lossless compression methods. However a deeper analysis of the image compression algorithms is necessary when considering fundus images transmission for diagnosing purposes. In general, our results indicate that diagnosing procedures based on fundus eye images require refined tools to provide the reproducibility of results. In particular, additional medical data would be needed when planning a proper methodological approach. The importance of the problem is related to the fact that fundus images contain essential information not only for ophthalmologist, but they are also crucial for nephrology and neurology e.g., where monitoring the changes on the bottom of the eye allows to observe in non-invasive way, on the one hand, symptoms of various pathologies and, on the other hand, the effects of applied therapy.

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