Annex 2b Szczecin, 24.08.2017

Summary of professional achievements

Name and surname

Anna Lewandowska (Tomaszewska before)

Diplomas and degrees

27.04.2000 - M.Sc., Faculty of Computer Science and and Information Systems, Szczecin University of Technology (with distinction).

19.09.2003 - Ph.D., Faculty of Computer Science and Information Systems, Szczecin University of Technology; dissertation entitled „*Criteria of symmetry for digital circuits design based on multi-valued elements*"; supervisor Prof. Vladimir Shmerko, Szczecin University of Technology, reviewers: Prof. Edward Hrynkiewicz, Silesian University of Technology; Prof. Marian Adamski, University of Zielona Góra.

Information about previous employment in scientific establishments

10.07.2000 – 19.09.2003 –	Assistant/PhD student in the Department of Computer Architecture and Telecommunication, Faculty Computer Science and Information Technology, Szczecin University of Technology (now West Pomeranian University of Technology, Szczecin)
20.09.2003 – 30.11.2003 –	Assistant in the Department of Computer Architecture and Telecommunication, Faculty of Computer Science and Information Technology, Szczecin University of Technology (now West Pomeranian University of Technology, Szczecin)
01.12.2003 – 15.02.2005 –	Assistant Professor in the Department of Computer Architecture and Telecommunication, Faculty of Computer Science and Information Technology, Szczecin University of Technology (now West Pomeranian University of Technology, Szczecin)
16.02.2005 – now –	Assistant Professor in Multimedia Systems (formerly the Institute of Computer Graphics and Multimedia Systems), Faculty of Computer Science and Information Technology of the West Pomeranian University of Technology in Szczecin (formerly Szczecin University of Technology)

Science profiles

- Web of Science: J-6137-2016
- ResearcherID: J-6137-2016
- ORCID: 0000-0002-4320-4084
- SCOPUS AuthorID: 6701455862
- DBLP: http://dblp.uni-trier.de/pers/hd/l/Lewandowska:Anna
- Google scholar: Anna Lewandowska (Tomaszewska)
- ResearchGate: https://www.researchgate.net/profile/Anna_Tomaszewska2

A. Scientific achievement

Designing, analysis and perceptual experiments results in computer imaging.

As a scientific achievement in the discipline of computer science, I indicate a cycle of eleven thematically related publications titled: **Designing, analysis and perceptual experiments results in computer imaging**. The cycle includes five articles published in scientific journals from the Journal Citation Reports and six articles published in peer-reviewed conference editors such as Springer and Elsevier, indexed in the Web of Science. The publication cycle consists of the following works:

A1 **Anna Lewandowska (Tomaszewska)**, Jarosław Jankowski, (2017). The negative impact of visual web advertising content on cognitive process: towards quantitative evaluation, *International Journal of Human-Computer Studies*, 108, 41-49.

IF=2.863, IF5=2.657 (JCR 2016), 35 points of MNiSW
Number of citations: WoS – 0, Scopus – 0, Google Scholar – 0.

My own share according to the authors' declaration (65%): overall responsibility for the project, conception and design of the main paper contributions, author of idea and assumptions in the developed model, experiments for real campaigns design, experiments for real campaigns conduction, statistical analysis of the results of the real banners and the intrusive elements indication, experiments for synthetic campaigns design, experiments for synthetic campaigns conduction, statistical analysis of the results of the synthetic banners, objective metrics development for an advertisement intrusiveness level evaluation, critical revision of the results, suggestions for improvements, previous work overview, writing the paper and preparation the proof

A2 Jarosław Jankowski, Przemysław Kazienko, Jarosław Wątróbski, **Anna Lewandowska (Tomaszewska)**, Paweł Ziemba, Magdalena Zioło, (2016). Fuzzy multi-objective modeling of effectiveness and user experience in online advertising, *Expert Systems with Applications*, 65, 315-331.

IF=3.928, IF5=3.526 (JCR 2016), 35 MNISW points,
Number of citations: WoS – 1, Scopus – 3, Google Scholar – 4.

My own share according to the authors' declaration (15%): Participation in the development of the concept of the perceptual experiments utilization (to estimate online advertising intrusiveness) to develop an effective model of Internet advertising, perceptual experiments design and performance, co-operation in the paper writing.

A3 **Anna Lewandowska (Tomaszewska),** (2016). Perceptual Experiments Optimisation by Initial Database Reduction. In: *Chmielewski L., Datta A., Kozera R.,*

Wojciechowski K. (eds) Computer Vision and Graphics. ICCVG 2016. Lecture Notes in Computer Science, 9972, 49-60, Springer, Cham, URL, https://doi.org/10.1007/978-3-319-46418-35.

15 points of MNiSW (paper indexed in WoS)
Number of citations: WoS – 0, Scopus – 0, Google Scholar – 0.

Individual work, my own share: 100%

A4 **Anna Lewandowska (Tomaszewska)**, (2016). Scene reduction for subjective image quality assessment, *Journal of Electronic Imaging*, 25(1), 221–226.

IF=0.754, IF5=0.825 (JCR 2016), 20 points MNiSW,
Number of citations: WoS – 2, Scopus – 3, Google Scholar – 3.

Individual work, my own share: 100%

A5 R.K. Mantiuk, **A. Tomaszewska**, R. Mantiuk, (2012). Comparison of four subjective methods for image quality assessment, *Computer Graphics Forum*, 31(8), 2478-2491.

IF=1.638, IF5=1.9 (JCR 2012), 30 points (currently 35 points with IF 1.542),
Number of citations: WoS – 41, Scopus – 56, Google Scholar – 82.

My own share according to the authors' declaration (50%): co-author of main ideas included in the paper (comparison the four most dominant methods of quality assessment by comparing sensitivity and time effort of each, introduction the reader to the field of subjective quality assessment and outlines the most important methods for data analysis) subjective experiments designe and performance, participation in the results analysis, development a projecting pairwise similarity scores algorithm, critical revision of the results, suggestions for improvements, preparing illustrations and tables and paper co-writer.

A6 **Anna Tomaszewska**, (2012). User Study in Non-static HDR Scenes Acquisition. In: Bolc L., Tadeusiewicz R., Chmielewski L.J., Wojciechowski K. (eds) *Computer Vision and Graphics. ICCVG 2012. Lecture Notes in Computer Science*, 7594, 245-252, Springer, Berlin, Heidelberg, URL,
https://doi.org/10.1007/978-3-642-33564-8_30

10 points (currently 15 points) of MNiSW (paper indexed in WoS)
Number of citations: WoS – 3, Scopus – 3, Google Scholar – 3.

Individual work, my own share: 100%

A7 **Anna Tomaszewska**, (2012). Real-Time Algorithms Optimization Based on a Gaze-Point Position. In: Bebis G. et al. (eds) *Advances in Visual Computing. ISVC 2012. Lecture Notes in Computer Science*, 7432, 746-755, Springer, Berlin, Heidelberg, URL, https://doi.org/10.1007/978-3-642-33191-6_74

10 points (currently 15 points) of MNiSW (paper indexed in WoS)
Number of citations: WoS – 0, Scopus – 1, Google Scholar – 1.

Individual work, my own share: 100%

A8 Radoslaw Mantiuk, Bartosz Bazyluk, **Anna Tomaszewska**, (2011). Gaze-Dependent Depth-of-Field Effect Rendering in Virtual Environments. In: Ma M., Fradinho Oliveira M., Madeiras Pereira J. (eds) *Serious Games Development and Applications. SGDA 2011. Lecture Notes in Computer Science*, 6944, 1-12, Springer, Berlin, Heidelberg, URL, https://doi.org/10.1007/978-3-642-23834-5_1

13 points (currently 15 points) of MNiSW (paper indexed in WoS)
Number of citations: WoS – 12, Scopus – 16, Google Scholar – 27.

My own share according to the authors' declaration (50%): participation in conception and design of main paper contributions, conception and development of the gaze-dependent depth-of-field renderer, critical revision of the results, and suggestions for improvements.

A9 **Anna Tomaszewska**, Mateusz Markowski, (2010). Dynamic Scenes HDRI Acquisition. In: Campilho A., Kamel M. (eds) Image Analysis and Recognition. ICIAR 2010. Lecture Notes in Computer Science, 6112, 345-354. Springer, Berlin, Heidelberg, URL, https://doi.org/10.1007/978-3-642-13775-4_35

A list (in 2010), 13 points (currently 15 points) of MNiSW (paper indexed in WoS)
Number of citations: WoS – 6, Scopus – 6, Google Scholar – 7.

My own share according to the authors' declaration (80%): overall responsibility for the project, related work review, conception and design of the main paper contributions (ghost removing technique), experiments design and implementation, participation in conduction experiments, analysis of the results, critical revision of the results, suggestions for improvements, writing the article and preparation the proof.

A10 R.K. Mantiuk, R. Mantiuk, **A. Tomaszewska**, W. Heidrich, (2009). Color correction for tone mapping, *Computer Graphics Forum*, 28, 193-202.

IF=1.681, IF5=1.9 (JCR 2012), 20 points MNiSW (currently 35 points for IF 1.542),
Number of citations: WoS – 53, Scopus – 76, Google Scholar – 107.

My own share according to the authors' declaration (10%): conducting the experiments, participation in discussion on the project.

A11 **A. Tomaszewska**, R. Mantiuk, (2007). Image registration for multi-exposure high dynamic range image acquisition, International Conference in Central Europe on Computer Graphics, Visualisation and Computer Vision (WSCG'07), 49-56.

10 points (currently 15 points) of MNiSW (paper indexed in WoS)
Number of citations: WoS – 12, Scopus – 45, Google Scholar – 80.

My own share according to the authors' declaration (50%): overall responsibility for the project, conception and design of the main paper contributions: using SIFT technique for registration of the multi-exposure image sequence, conception, development and implementation of the HDR acquisition method based on the SIFT technique, development and implementation of the experiments, critical revision of the results, suggestions for improvements, participation in writing the article.

Table 1 summarizes bibliometric indicators of publications related to academic achievement.

Table 1. Bibliometric indicators of publications included in the scientific achievement

Indicator	Value
Total IF (Total 5-th year IF)	10.864 (10.808)
Number of points (MNiSW)	231
Number of weighted points (MNiSW)	106.05
Number of citations (WoS)	130
Number of citations (Scopus)	209
H index	5

Scientific work

My research interests after PhD defense at the Szczecin University of Technology (transformed in West Pomeranian University of Technology, Szczecin in 2009) in 2003, changed from the field of digital circuit design to computer graphics, image processing and human-computer interaction. My researches involved such scientific areas as HDR imaging acquisition and tone mapping, interactive simulation of visual effects dedicated to computer games based on data received from eye-tracker, perceptual experiments and human cognitive systems. My researches are part of the IT fields included in the ACM classification as human-centered computing, especially in the area of human-computer interaction, social media and visualization, as well as in computing methodologies in computer graphics domain. The researches I conducted were related to the optimization of interactive graphical algorithms, the optimal parameters for graphical algorithms selection, as well as the development of a scenario for the effective subjective experiments design and effective online advertisement. At first the results were published in national publications and then in international journals of a wide range, and presented at international conferences. The formal basis of the research presented in the monothematic cycle is the perceptual experiment (with eye-tracking utilization in some projects) and statistical analysis. In addition to the research aspect, my work has practical usage and currently being developed in collaboration with a commercial psychometric research company (FRIS, www.fris.pl), as part of joint projects.

B. Overview of the above-mentioned scientific work and the results achieved, together with an overview of their possible usage

B1. Introduction

In recent years, computer imaging techniques have become increasingly important, with particular attention being paid to achieving the desired effect. It is all the more important

that the quality of the received images is often unsatisfactory, or that the time taken to generate them is too long to meet the ever-increasing expectations. For this reason, Image Quality Assessment is currently a very topical issue for practically every discipline involved in computer imaging, such as computer graphics, nanotechnology, facial identification, medical data visualization, physical process simulations, or forensics. From the observers' point of view, not only the quality of images is important but also their visual friendliness. Images that are designed not in accordance with the audience preferences may have achieve an effect not intended by their creators. An example may be invasive online advertising, which, instead of encouraging customers to buy the advertised product, increases their irritation. This affects the reluctant attitude of customers not only to the advertised product and the company, but also to website that places too-invasive advertising. The most basic and reliable tool in evaluating image quality is the subjective ranking of quality of visual effects. For some time, there has been a strong tendency for visual support the quality of imaging algorithms evaluation by means of subjective studies in which a group of people evaluates images, indicating their preference for the methods being compared [Mantad15], [Vangorp15], [Wanat14]. It is also noticeable the subjective research utilization in the topic of evaluating the intrusiveness of online advertising [McCoy07], [Li02], [Rejer17].

In the presented series of publications I combine my scientific experience in the field of computer graphics, image processing and visual quality assessment. My research is a part of work connected with a reliable, effective and efficient way to evaluate the quality of computer image algorithms. Given that the ultimate receivers of images are human eyes, the human subjective opinion is the most reliable value for indicating the image perceptual quality in comparison with automatic approaches (objective metrices). It is worth to note that in the field of visual perception only prospective experimental studies can effectively demonstrate the existence of relationships between variables, not just coexistence. I believe that the development of formal rules for the design of effective perceptual experiments will increase their applicability.

When developing a new imaging or computer graphics algorithm, there is often a need to compare the results with the state-of-the-art methods. The vast majority of publications in computer graphics rely on rather informal validation, in which several examples included in the paper can be carefully inspected and compared with the results of competitive algorithms. This is an effective method, which often provides a sufficiently convincing proof of superiority of a new algorithm, but only if the visual difference is unquestionably large. If the differences are subtle, such informal comparison is often disputable. There is also a question how a few very carefully selected and fine-tuned images generalize to the entire population of cases, which the proposed algorithm is claimed to handle. Can the judgement of the authors and several reviewers generalize to the whole population of potential users? There is definitely some lack of rigor in such endeavors. User studies are much more tedious than the informal comparison included in most papers, yet when done improperly, they do not improve generality and strength of the results.

Quality assessment would be a much easier task if a computational algorithm could perform it without the need for a subjective experiment. A large number of such algorithms, known as objective quality metrics, have been proposed over the years. [Wang06,

Pedersen11]. Unfortunately, their accuracy decreases with the growing variety of image types or distortions [Ponom09]. Given the range of images (computer graphics, medicine, microscopic, etc.), the variety of content (images, video, geometry, textures) and complex usage scenarios, it is rather unlikely that computational metrics can completely replace the need for subjective experiments in the foreseeable future. There are numerous methods of subjective quality assessment, but it is not clear which method is the most effective one and leads to the most accurate results. The experimental results are often noisy and their proper analysis and interpretation is not trivial. Finally, the user studies made by the authors with the sole purpose of proving the superiority of their proposed algorithm are likely to be biased. There is also a question how a few very carefully selected and fine tuned images generalize to the entire population of cases. In my research I focus on statistical testing, that I consider as a key for validation of data correctness.

The methodology of my scientific work is based on experiments, whose results lead to the modelling of perceptual phenomena, the matching of model parameters - so that the obtained results are most appropriate for the user's expectations, an increased effectiveness of online advertising - where its invasiveness is defined by the negative feelings of the portals readers where such advertisements occur. The main idea of the presented cycle of publications is to design the perceptual experiments that give effective and reliable results and their use in computer imaging.

B2. Overview of the most significant achievements presented in papers included in monothematic series.

When analyzing problems related to the perceptual experiments, there arises the question about the possibility of creating techniques for designing an effective perceptual experiment that would return credible results but with a much lower cost than proposed in the current solutions [ITU500], [ITU910]. Determining the minimum number of samples for which the results are reliable would introduce some guidelines for conducting the experiment. The same problem applies to the size and complexity of the context of the set of test images. Nowadays, in order to get reliable results, there is a need to test a large number of images that differ contextually. Such studies are, however, extremely time consuming and therefore useless in practical application. Reducing the size of the image test database and achieving similar results (with a high Pearson correlation coefficient of 90% -95%) to the results obtained with the use of a complete image database would undoubtedly increase the possibility of practical use of subjective research. In addition, the experiment optimization, such as reducing the number of displayed trials and thus the number of image evaluations, would also help to shorten, significantly, the duration of the experiment. The question is only whether such actions will reduce the accuracy of the obtained results. The answer to this question is one from the main goals of the presented series of publications. Having regard to the essence of the problem and the high interest in subjective study, my interests initially focused on issues related to subjective experiments in computer graphics and then in interactive marketing. The first researches included in the habilitation thesis were preliminary work on the evaluation of image quality, models definition and their parameters determination in computer graphics domain. The results are presented in the papers **[A6-A10]**. Observing the lack of strict rules regarding the image quality evaluation and the

time-consuming of the subjective research execution, I focused on developing a scenario for the design of effective perceptual experiments as described in the series of articles **[A3-A5]**. The technical contributions from previous HDR images acquisition projects facilitated the proper design of the experiments and the practical implementation of developed models of perceptual phenomena (examples in **[A9], [A11]**).

At the same time, I was involved in a model for effective online advertising development. Effective banner means the ad that will interest and not discourage the potential website readers. In the work **[A2],** my concept of utilization the subjective opinions of the web portal users to develop an effective online advertisement was used. The results from perceptual experiments together with online research have been used by my co-authors of the above paper to develop the model. The ability to assess the level of invasiveness of the advertisement from the perspective of the cognitive process interruption during contact with the editorial content and taking into account technical specifications of advertising has become another area of my research interests **[A1]**. In the research I used my previous knowledge related to design, credible subjective experiments conduction and analysis of obtained results. The basis of the project was perceptual experiment performed in order to determine the level of invasiveness of online advertising. The research conducted on real ads allowed to distinguish the most annoying elements of advertisements and to examine them on the already created synthetic ads. Based on the obtained results, I have developed objective metrics VIM (*Visual Intrusiveness Metrics*) to assess the level of invasiveness of an online advertisement (article **[A1]**).

Optimal parameters evaluation for computer graphics algorithms and optimisation of calculations used in real-time computer graphics algorithms

My first experimental study was dedicated to color correction in tone mapped HDR images (article **[A10]**). HDR image differs from standard computer image with greater accuracy of recorded data [Reinhard10]. It stores information that is characterized by a large range of brightness dynamics comparable to that of human eyesight. Such data can not be displayed directly on standard monitors because the dynamic range of current devices is too low. Therefore, in order to display an HDR image, its brightness should be compressed by contrasts reduction with algorithms called tone mapping operators. The problem with such algorithms was, that they often employ an ad-hoc color desaturation step, which improves the results, but gives no guarantee that the color appearance is preserved and requires manual parameter adjustment for each tone-mapped image. Color change after contrasts compression accompanied by color vision is a difficult process for perceptual model. In **[A10]**, based on experiments I conducted, my co-authors proposed the correction of color saturation using a sigmoidal function model. The shape of the function and its parameters were determined on the basis of the results obtained from the perceptual experiments, in which the participants task was to match the colors in the images after compression to the colors in the original HDR images. **It is worth to note that the problem of color correction after tone compression described in the article is an innovative approach, and it has been analyzed and taken into account in tone mapping operators (eg [Reinhard12]) quite recently. As well, the idea of perceptual research in computer graphics algorithms utilization was relatively new.**

Our work [A10] is pioneering in this regard. It draws attention to a new problem related to the reproduction of colors on modern displays and to the use of perceptual research in computer graphics algorithms. My contribution to this study **[A10]** was the perceptual experiments conduction and critical discussion of the results.

In the next task relevant to HDR imaging, I focused on the images acquisition for dynamic scenes, where objects change their positions during scene recording (**[A6]**). The method of composition of HDR photos from a sequence of traditional photographs depicting the same scene, recorded with different exposures, is the most common approach. The method was introduced in 1993 [Mann93] and is the most popular method for HDR images acquisition, despite the fact that cameras for HDR images registration have been developed. The reason for this is the fact that HDR cameras are not very popular (as opposed to the presented technique), too expensive or they cover too narrow dynamic range. HDR image composition approach gives satisfactory results if the recorded scene is static and a tripod was used during sequence of input images registration. Scene recording without a tripod is already described in literature [WL03]. Nevertheless, even the most carefully taken images, without shifts and rotations, cannot guarantee a consistent result image. During the registration of natural scenes, undesirable movement can be carried out not only by the camera, but also by the elements of the recorded scene. This problem is visible in the form of artifacts referred to in the literature as "ghosts". On a final image, the artifacts look like partially transparent fragments of dynamic objects, that were registered in different places on successive images taken with different exposures. **Therefore, ghost removal from input images was the goal of my paper [A6].** The technique uses a sigmoidal function that is used to map the likelihood of a ghost occurring in a given constituent image. To specify the shape of the deghosting comparison function, I performed the perceptual experiment, allowing for such parameters selection for which the experiment participants indicated the obtained image as the best result. These studies were conducted using the Forced Choice technique, which dominates image quality assessment [ITU500], [ITU910]. The technique involves choosing a better quality picture from a pair of displayed images. Observers are always forced to choose one image even if they do not see any difference between them. There is no limit time for making a selection. The method is simpler and more accurate than rating methods, as I described in **[A5]**. The results of ghost removal were positively verified by the HDR VDP metric [Mantiuk95].

Next, I focused on selection of optimal parameters values for developed real-time computer graphics algorithms, dedicated to computer games. I have analyzed algorithms for subsurface scattering **[A7]** in partially transparent objects and realistic visualization of visual depth effects presented in co-author article **[A8].** In both cases I have used the gaze point position, which plays a key role in the way people perceive images. It enabled me to optimize the algorithms calculations. In developed an interactive method for visualizing the effect of subsurface scattering in partially transparent objects, to encode the thickness of the object I used the harmonic spherical functions (**[A7]**). To properly select parameter values such as the number of SH factors needed to decode the thickness of an object, I conducted subjective experiments using the Single Stimulus technique. During the experiment, the results of the developed algorithm with different settings were presented to the user on a display. The task of the experiment participants was to indicate the image

with a more realistic, in they opinion, visualization of the effect. I conducted the experiment in accordance with the formulas defined in [ITU500], [ITU910]. Analysis of the results allowed me to choose the algorithm parameters for which obtained effect was as realistic as possible with the least amount of computational effort. In addition, the experiments were performed to validate the developed algorithm with existing solutions [Green04], [Patro07], [Sloan03]. Participants of the experiment indicated developed solution as the most realistic. Accurate calculations were made only for selected fragments of the image in which the observer's attention was attached.

The next subject I of my interest was interactive visualization of depth of field. Simulation of the effect was made on the basis of the thin-lenses model. Taking into account the eye accommodation, closely related to the objects that a human looks at, requires the use of gaze point position. In the work, a depth-of-field simulation algorithm was developed based on perceptual experiments that have been performed to select appropriate eye accommodation parameters - the diameter of the shutter for which the effect is considered to be the most realistic. My contribution to the study was a participation in a concept of developed model, where the effectiveness of the proposed technique was obtained through the perceptual experiments utilization. I have proposed to perform the experiments based on the Single Stimulus technique in accordance with the guidelines defined by the ITU. The approach is presented in the co-author paper **[A8]**. Similar to the previous approach, eye-tracker data were used to optimize the algorithm calculations.

For described approaches, both the realistic visualization of subsurface scattering and the depth-of-field effects, the perceptual experiments results enabled to improved the approach results quality, with particular attention paid to the computational efficiency and quality of obtained images. The calculations optimization was made based on an eye-tracker data. An important issue is how to simplify the calculation to be not noticeable by the observer.

Effective perceptual experiments

Perceptual experiments carried out and described in the tasks described above have become the basis for research focused on a choice of proper metrics for a particular application. The research, which I coordinated, I conducted under the NCN grant (NN516 193537). I considered the following questions during the work: Which experimental method is the most efficient and accurate? Are the results, returned by dominant metrics used for the quality of images and video signals evaluation, comparable or different in the accuracy of the results returned? How much time is spent on each metric, and how large a population should be examined to get the correct metric for a given metric? How big a test database should be included in the research to get reliable results? In the analyzed literature, I have not found any answers. There were also no statistical tools needed to analyze the correctness and reliability of the results gathered in one place. I have included and presented the answers in a series of publications: **[A3-A5]**. The most important basic publication containing the results of studies and analysis corresponding to most of the above questions is the co-author paper **[A5]**. Publications from the habilitation cycle **[A3-A4]** complement it.

The objective of the research was to develop techniques for effective design of perceptual experiments taking into account the specificity of computer graphics applications [A5]. Design of effective perceptual experiments need to include a test scenario that enables obtaining reliable results at the lowest possible cost. It means utilization of a procedure that eliminates the degree of freedom of the entire design cycle that introduces an noise that distorts the credibility of the obtained results. Incorrectly performed tests produce result with poorly selected model parameters or incorrect evaluation of image quality generated by the analyzed algorithms. In this situation, the experiments are useless and mislead users of the developed approaches. Hence, it is important for the experiments to be carried out in accordance with formal requirements [ITU500], [ITU910] and in a manner that minimizes the noise. We have collected and presented the most important methods for data analysis in the paper **[A5]**. It is difficult to find such information in one place and it often requires referring to several lengthy standard documents. The methods and their modifications have been presented in an orderly manner, creating a scenario for the design of effective subjective research. Among the issues related to the development of a new scenario for the efficient design of perceptual experiments, my contribution was to design, implement and participate in perceptual experiments. Besides me, the study was also done (by the first co-author of the paper) at the University of Bangor (*Bangor University*) in the UK. In order to make it easier (for researchers) to design their own experiments, I compared and, together with the first co-author, analyzed four of the dominant methods in image quality assessment (IQA): Single Stimulus (SS), Double Stimulus (DS), Forced Choice (FC), and Similarity Judgment (SJ). The study was conducted in accordance with the developed scenario, providing information on the most accurate, reliable and time-efficient way of conducting the experiment. When choosing an experimental method, it is important to evaluate sensitivity and reliability of each experimental method and that every measurement reflects a proper result for analyzed algorithm or parameter only in some limited range. The rest of the range is completed by unknown random error. According to the definition, the measurement is reliable if, in relation to the error, it reflects mainly the true result. **The assessment of the sensitivity and reliability of each experimental method has become one of the main objectives of my research.** A more accurate method should reduce randomness in answers, making the pair of compared conditions more distinctive. A more accurate method should result in more pairs of images, which quality can be said to be different under a statistical test. In the available literature, the issue of comparison of experimental methods was most often performed using the width of confidence intervals [Redi10] or the standard deviation [Ponom09]. Such measures, however, are not the most suitable as the scale of quality values can vary significantly between experimental methods. Even if the data is linearly scaled to match the same range of values, there is no guarantee that the score distribution is the same for each method. A more robust, yet still very simple method is the *effect size,* which is the difference between quality scores normalised by a common standard deviation. The larger the effect size is, the higher the statistical power is. The highest sensitivity was achieved by the Forced Choice pairwise comparison method, whose effect size was statistically different from both ranking methods (**[A5]**). The good performance of the Forced Choice method confirms that the method is a good choice when the sensitivity is the major concern. The Forced Choice method was also

reported to be the easiest for the observers, as it only requires directly comparing two simultaneously shown images and a quick decision. Overall, the methods that require a simpler task from observers tend to give more coherent results. This stage of analysis I conducted together with the first co-author of the article.

When choosing an experimental method, it is important to consider not only the sensitivity of a statistical test, but also the time that observers need to complete the experiment. The analysis of the time factor was my own contribution to the paper **[A5]**. Even less accurate methods can result in smaller confidence intervals if more measurements are taken at a given time. For pairwise comparison techniques, the number of trials can be limited using a sorting algorithm [Silver01]. After optimization, the Forced Choice technique has been competitive and even faster than the rating techniques. **To achieve that, data recovery algorithm after optimizing the number of iterations in pair-wise techniques is required.** Development of the algorithm (my contribution), enabled to shorten the experiment time. Based on the results (presented in **[A5]**), we have introduced a hierarchy of the most commonly used image quality assessment metrics. The ranking was based on parameters such as sensitivity, understood as the ability to distinguish images of similar (very similar) quality and reliability of the results. My analysis of the study time, taking into account the optimization algorithms included in the designed experiments, was an important element used in the ranking of metrics. The Forced Choice method has proven to be most sensitive to detecting even small differences in the quality of the images being analyzed.

After selecting an experimental method, one of the first important issues in the developed scenario is to prepare an experience plan in which the main effects are not correlated. In other words, it is essential to design a stimulus representing only the analyzed problem. Another important element is an input database definition. When choosing an experimental method and following the time criterion, another problem may appear. The experiment can be attractive under time criteria for a small number of analyzed scenes and algorithms. Unfortunately, with the increase in the number of rated scenes, the experiment becomes time consuming and expensive, which makes it impractical for most image applications. The selection of the right set of images, as well as their number, is a nontrivial problem. Ideally, we should consider as many images as possible for the most representative sample of possible scenes. However, for practical reasons, testing large image sets is often not feasible, especially in academic projects. Even when considering much smaller image sets, we need to decide whether it is more desirable to collect fewer measurements for a larger number of images, so that the sample is more representative, or rather collect more measurements for fewer images, so that the measurements are more accurate and their statistical power is higher. The scene reduction may be a useful solution especially when it gives reliable results. So far developed approaches are either impractical because of the absence of full automation [Pitrey12a], or the accuracy of the results obtained after the reduction was lost [Pinson08] [Pitrey12b]. **To complement the design of effective experiments, I focused on the problem of reducing the number of total scenes. In [A4] I proposed a method that can significantly reduce the experimental effort with quality of obtained results preservation.** Instead of studying a large number of scenes, I

proposed to focus the measurement on a few scenes that differ the most in their quality scores. The rationale is that measuring two scenes that result in very similar quality scores does not contribute to better understanding of how image content affects quality. On the other hand, there are images for which the assessed quality differs significantly from the rest of the results. This means that measuring individual scenes can reveal important insights into the algorithm performance, which would be lost if the measurements were averaged across the scenes. **The main goal of my work described in [A4] was the number of images reduction in the input database. The database was reduced to representative images, which became input images for the main experiment.** The number of representative images (based on clustering algorithm) was determined on the basis of Pearson's correlation between the reduced and the full database. This approach has been coplemented by validation of that on well-known databases for quality assessment: TID2008 [Ponom09], TID2013 [Ponom15], CISQ [Lar10], IVC SubQualityDB [Strauss09] and LIVE [Sheikh06] (see paper **[A3]**).

In statistical analysys, there is usually no access to all images in the whole population. This is due to the size of the population or the high cost of performing measurements for all objects. As a result, important decisions are made on the basis of a relatively small number of cases. The sample obtained from the study is an estimator of a certain characteristic of the whole population. An important issue with the quality of the proposed experiment is the size of the sample, which should be taken into account in order to receive correct results – i.e. how many observers and/or how many repetitions are necessary to collect reliable data. The method of selecting the minimum number of participants in the experiment was previously proposed in the literature. In an attempt to find the minimum number of observers, Winkler [Win09] collected data from 5 different quality assessment experiments and ran simulations to find that at least 10 observers are needed to measure quality score variability (standard deviation) with sufficient accuracy. But this number does not necessarily guarantee that the quality difference between a pair of conditions is statistically significant. Statistical power analysis is the method for estimating the sample sizes that give desirable sensitivity levels. The problem is that the power analysis requires prior knowledge of the differences in quality scores and their variance, which are usually unknown in advance. A well-planned experiment must provide enough test power to detect reasonable difference from the hypothesis H_0 (images have equal quality). **In a study to estimate the typical sample size, retrospective power analysis was used to find pairs of images not only strongly different in qualities, but also with low quality difference.** I conducted the data analysis together with the first co-author of **[A5]**. Without knowledge about the results prior to the study, the only possibility was to use the scores obtained in the experiments that had already been conducted. During the analysis, all cases were checked, also those where a statistical difference is invisible (very little difference in quality). In this situation, due to the small value of a size effect, it was necessary to make a very large number of evaluations. In such cases it is safe to assume that the quality difference may not be found. The analysis showed that the number of measurements needed for both pairwise comparison methods is on average lower than for the ranking methods. The median condition data suggest that the experiment must be repeated at least 26–38 times on a single scene and a set of conditions to collect sufficient evidence for ranking images in case

of a larger quality difference. But even 29–66 are needed in case of smaller quality differences. **I believe that the obtained data may assist researchers in making decisions regarding the choice of the experimental method and may give an idea of the number of samples needed to obtain reliable results. The obtained results can be a useful guide for designing experiments using one of the four methods presented.**

The developed scenario of designing effective perceptual experiments has been noted by the scientific world. The work [A5] was cited 41 times (according to the Web of Science) and has become the basis for publications on image quality assessment and perceptual experiments.

Perceptual experiments for effective online advertisements evaluation

Online marketing, once a niche experimental area, has evolved within the past few years, into one of the most explored forms of communication with customers [Lilien06]. Much effort is expended on the design of online media and interactive content in order to improve results and gain conversions using persuasion, colors, animations and call-to-action messages [McCoy07]. Due to the high intensity of marketing activities, a balance is created between consumers avoiding advertising and companies trying to reach customers in every way. Increasing visibility of online marketing content attracting web user attention often leads to a growth of intrusiveness and degraded user experience due to interruptions of the cognitive processes [Ha97], [Li02]. Research on the invasiveness of the advertising content is related to the analysis of selected factors, such as frequency and area of flashing areas [Zha14]. Most researches use custom-designed commercial content verified in simulated environments or field experiments. Measures have been created to evaluate the intrusiveness level [Li02], [Moe06]. Generally subjective measures are seldom dealt with detailed technical specification of active content used in real campaigns. **The next goal of my research was the attempt to provide an objective measure of online advertisement intrusiveness. The study evaluates the level of intrusiveness from the perspective of interruptions of cognitive processes during contact with the editorial content, using technical characterization of such content (co-author paper [A1]), as well as design an effective model of advertisement (co-author paper [A2]).** We interpret intrusiveness of marketing content as its property causing irritation and annoyance resulting from active features of the visual content.

Perceptual experiments (described in article **[A1]**) were conducted focusing on selected elements of advertising: flashing frequency, flashing area and animation. These parameters were selected based on the literature [Shady04] indicating factors significantly affecting the interruption of the human cognitive system. Our approach combines two different information-gathering techniques used in perceptual experiments performed on real or synthetic data. In the first step, in which the experiment participants' task was to read the displayed text, 150 real ads were examined. In the meantime, an ad appeared in the peripheral area. Research confirmed negative feeling with large flashing area (over 40%), which was blinking above 4Hz. In my analysis, I also proved that the animation only

apparently does not affect the negative perception of the advertisement. Participants of the experiment reported increased invasiveness of the ad, also in the case of an animation when the flashing frequency was above 4Hz and the flashing area was more than 40%. The test was designed using the Single Stimulus technique because it would not be possible to compare the same advertisement with different parameters for real banners. In the second stage, experimental studies were conducted using specially prepared synthetic ads, which included the analyzed parameters in three different ranges. In this case, it was possible to include different combinations of ad parameters for the same scene and to design an experiment with Forced Choice. The stage of designing experiments using synthetic advertising and the results analysis were my contribution in the described work **[A1]**. The research confirmed results from real ads. **Thanks to the possibility of using the Forced Choice as experimental method, sensitive for even slight differences in the obtained scores, I have developed the objective metrics VIM (Visual Intrusiveness Metrics) that estimates the level of invasiveness of the analysed advertisement. This metric can be used by advertisers to indicate the elements and range of values for which the advertisement will perform its role without being too invasive at the same time.** High invasiveness can irritate the customer and affects the reluctant attitude not only to the advertised product but also to the company. **This approach may be useful as a reference for evaluation of the visual intrusiveness of commercial content, or for website owners wishing to prevent the loss of customers driven away by the use of excessively invasive banners.**

The development of a model of an effective online advertising based on the experimental research to estimate the level of invasiveness of advertising, as well as on online research, to assess the effectiveness of advertising is presented in **[A2]**. In the work, my contribution concerns participation in the development of model concepts, designing and conducting perceptual experiments and results analysis. In my perceptual experiments, I used the Single Stimulus technique. I have researched five different contextual ads online (with 10 different settings) representing different industries: fitness, computer games, travel, virtual world and social networking. Incorporation of these experiments allowed the co-authors to develop model of effective online advertising **[A2].** The model is a compromise between the impression of advertising invitations reported by the experiment participants and their effectiveness represented by the interaction of users with the ad. The conducted simulation allowed estimation of the impact of the change of banner content for users of the service and the estimation of advertising revenue growth without over-invasive elements.

Technical contributions

Articles presenting engineering solutions that have a major impact on my subsequent scientific research complement the cycle of publication. It is worth to note that the application described in the co-author article **[A11]** met with great interest of the scientific community. In article [**A11**] a fully automatic method for eliminating misalignments between a sequence of hand-held photographs taken at different exposures is proposed. The key component of the technique is the SIFT method [Low04] that was employed to search for

key-points (or feature-points) in consecutive images to eliminate shifts between images in an effective way. The work [**A11**] drew attention to the specific problem of recording images during HDR images acquisition and was frequently cited (12 times by WoS, 44 by Scopus).

Continuing the problem of HDR acquisition, an approach for HDR images registration for a dynamic scene was presented in [**A9**]. (The problem I described above in *Optimal Selection of Graphics Algorithms and optimisation of calculations used in real-time computer graphics algorithms*, in description of [A6] position). My contribution to this work [**A9**] concerns development of a method for acquiring HDR images for scenes with moving objects and results analysis.

B3. Summary

The main achievements in presented cycle of publications include:

- Development of the objective metrics for evaluating the intrusiveness of online advertising on the basis of complex perceptual studies - **VIM (*Visual Intrusiveness Metrics*) [A1].**
- Introduction of the concept of perception to the developed models of effective online advertising **[A2].**
- Development of a new scenario for design of effective perceptual experiments:
    - ⇒ Introduction of the hierarchy of the most commonly used image quality assessment metrics. Based on the accuracy, sensitivity and credibility of the results returned - I analyzed and compared the four most frequently used metrics of subjective image quality assessment **[A5].**
    - ⇒ Development of a data recovery algorithm after optimizing the number of iterations in pair-wise techniques to reduce the time of an experiment **[A5].**
    - ⇒ Definition of the minimum number of samples needed to obtain reliable results **[A5].**
    - ⇒ Analyses of perceptual experiments results taking into account the reduction in the number of iterations during the experiment conduction **[A5].**
    - ⇒ Original technique of reducing the number of images in the input database used in the perceptual experiment **[A4].** This approach has been complemented by validation of that on well-known databases for quality assessment: TID2008 [Ponom09], TID2013 [Ponom15], CISQ [Lar10], IVC SubQualityDB [Strauss09] and LIVE [Sheikh06] **[A3]**.
    - ⇒ A clear visualization of the results of perception experiments in the form of graph **[A5]**.

- Enhancement of a ghost removal algorithm for HDR images, recorded for dynamic scenes [A9] based on results of perceptual experiments **[A6]**.
- Development of the real-time method for realistic visualization of the subsurface scattering effect in partially transparent objects **[A7]** based on eye-tracking data and results of perceptual experiments.
- Perceptual experiments design and conduction for an interactive depth of field visualization including gaze point position **[A8]**.
- Development of the ghost removal algorithm for HDR images, recorded for dynamic scenes **[A9]**.
- Perceptual experiments design and conduction for color correction in tone mapped HDR images **[A10].**
- Pay attention to the practical importance of properly recording photos when creating HDR images and developing a SIFT-based recording technique **[A11]**.

In the realized projects, I started topics that were next exploited by the scientific community related to computer graphics and imaging.

Current research issues include work on issues such as color correction when changing the contrast in the HDR image tone mapping operator, correction of shifts between series of camera-free shots for HDR images acquisition, evaluation of the invasiveness of Internet advertising from the perspective of interruption of the cognitive process [Reinhard12], [Wanat14], [Vangorp15], [Mantiuk15], [Zha14].

Apart from the research aspect, my work is of an applied nature and is currently being developed in cooperation with a commercial research company (FRIS, www.fris.pl) from psychometrics area, as part of joint project.

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Other scientific and research achievements

Scientific and didactics achievements

After graduating in 1995 from A. Asnyk's Secondary School, no V, in Szczecin (mathematical and physical profile), I started my studies at the Faculty of Maritime, Technology and Transport of the Szczecin University of Technology in Computer Science Department. In the years 1996-2000 I received a scholarship of the Minister of National Education. I started my scientific work in the third year of study, under the supervision of prof. Vladimir Shmerko, PhD Eng. In 2000, I received a master's degree in Computer Science. My master's thesis entitled "Information theory for decision-making" was conducted under the supervision of prof. Vladimir Shmerko, PhD Eng. The results obtained during the thesis were presented at the EEE International Symposium on Multiple-Valued Logic. I graduated with a second result at the University and was recorded in the Golden Graduates Register down.

After graduation in 2000 I was employed in the Department of Digital Circuits, Faculty of Computer Science and Information Technology of the Szczecin University of Technology and started there my doctoral studies. During this time, I conducted research under the supervision of prof. Vladimir Shmerko, PhD Eng. on the occurrence and usage of symmetry in multiple-valued logic systems. The results have been published in the Journal of Multiple Valued Logic and Soft Computing. Within the Doctoral Studies in the years 2000-2003 I conducted classes - laboratories with students of the Faculty of Computer Science and Information Technology of the Szczecin University of Technology. In the years 2003-2004 I was the Secretary of master's thesis defences.

On September 19, 2003, I defended my doctoral dissertation, titled: "The *criterion of symmetry in digital circuits based on multi-valued elements*" and I received a PhD in Technical Sciences in Computer Science. In February 2005 I was transferred to the Department of Computer Graphics of the Szczecin University of Technology and was employed as an Assistant Professor.

In the years 11.2009 - 05.2012, I was a Coordinator of the research project funded by the Ministry of Science and Higher Education (No grant - NN516 193537, Title of the grant - Perceptual analysis of digital images based on the human vision characteristics) (*Annex 3, point IIJ*). The results were published in papers included in my habilitation cycle (*Annex 2b, papers* [A5-A9]). I also participated in the implementation of the grant in the years 11.2006 - 11.2008 (Grant No - N206 015 31/2355, Title of the grant - *Perceptual analysis and processing of images with high dynamic brightness*) (*Annex 3, point IIJ*). The result of the participation in the project is publication from the habilitation cycle (*Annex 2b, paper* [10]). I am currently participating in the grant (2016/21 / B / HS4 / 01562, title of the grant: *The process of spreading marketing content in social media support*) (*Annex 3*, point IIJ). The results are included in the publication of the habilitation cycle (*Annex 2b,* paper [A1]).

In addition to the topics presented in the series of publications for habilitation, I focused on the tasks connected with use of a graphics processor for the fast processing of graphical data and GPGPU computing. I focused on acquisitions and HDR image processing, natural image analysis, higher order statistics closely linked to the Human Visual System (HVS) and utilization of sorting algorithms to optimize pair-wise experiments as well. In addition, I

have been involved in projects related to improving the quality of images by reproducing image noise information as well as subject of multi-valued digital circuits (*Annex 3, points II A and II E*).

For my scientific activity in 2010-2011 I received an individual award of Rector of West Pomeranian University of Technology in Szczecin, first and third degree respectively. As a Member of the Scientific Committee I have been Reviewer of the CESCG conference (http://www.cescg.org/) (since 2009), IADIS Computer Graphics, Visualization, Computer Vision and Image Processing (CGVCVIP) (http: //www.cgv- Conf.org/) (in the years 2008-2011) and the ICCVG conference (http://iccvg.wzim.sggw.pl/default.asp) since 2014.

During the period 10.2012-10.2013 and 09.2014-02.2016, I was on maternity leave. My total absence from work was about 3 years. However, in the meantime, I tried to conduct my researches that resulted in the publication cycle in 2016 (*Annex 2b,* papers [A2-A4]*).* Currently, the mainstream of my research is perceptual evaluation of the quality of computer images and the intrusiveness of online advertising. I am also involved in perceptual research for FRIS (https://fris.pl/) company.

Cooperation with institutions and scientific centers in Poland and abroad

In 2000, I started my work at the University of Calgary, Canada. Within the cooperation I completed an internship at the University in 2000. The result of the cooperation is *Linearity of word-level representations of multiple-valued networks* publication, which is a continuation of the doctoral thesis (*Annex 3, point A, paper [IIA1]*).

Then, in 2003, I worked with the scientific researchers from Max Planck University for Computer Science in Saarbruecken, Germany (prof. Karol Myszkowski, PhD. Eng., Rafal Mantiuk, PhD. Eng.), dealing with subjects related to the assessment of images with high dynamic range (HDR) based on natural statistics. As part of the cooperation, I completed postdoctoral research at Max Planck (15.10.2007-31.01.2008). In addition to HDR technology researches, I started to work on the topic of perception in evaluating the quality of computer images. This resulted in another collaboration with The University of British Columbia, Vancouver, Canada (Prof. W. Heidrich) and a joint publication in the Computer Graphics Forum, Color correction for tone mapping (Annex 2b, paper [A10]).

In 2008 I started cooperation with the Comenius University in Bratislava, which resulted in the publication of a joint publication in 2010 (*Annex 3, point II E16*).

In 2010 I resumed co-operation with prof. Rafal Mantiuk, PhD. Eng., from Bangor University in the United Kingdom. Another collaborative paper was published in the Computer Graphics Forum (*Annex 2b,* paper [A5]). Currently I am continuing my cooperation with Rafal Mantiuk, PhD. Eng. (Senior Lecturer at the University of Cambrige) in perceptual quality assessment of digital images.

As part of a new project related to the assessment of thinking styles, based on perceptual experiments, I started cooperation with the Department of Clinical Psychology and Psychopharmacology of the University of Szczecin (Assistant Professor Agnieszka Samochowiec). The project is developed in close cooperation with the FRIS commercial company (Anna Samborska-Owczarek, PhD. Eng.). The research results will be used to create a product for validating psychometric test dedicated for people's thinking styles evaluation. Up to this time an original image database was created and pilot studies were

carried out.

On behalf of BLStream, I conducted an expert opinion on the project "MobiAR - An Innovative Tool to Support the Creation of Mobile Systems in Reality", approved by the PAED from the Innovative Economy Operational Program 2007-2013 and an expert opinion on the project "FRISeye" - an innovative tool for HR support. Human Resources) commissioned by FRIS, 2016.

Science popularization activities

I actively participate in the popularization of science in the scientific community as well as for students in primary, lower and upper secondary schools. Throughout the three editions of the Szczecin Game Show (2010, XI 2010, XI 2011), I organized meetings and created a stand where students presented games created at the Faculty of Computer Science. The stand met with great interest, especially from junior high school students and post-gymnasium students facing the choice of the university and the direction of study. I have also systematically taken part in the promotion of my home Institution, Faculty and University in popular science festival: “Moc Naukowca” in 2010-2011 and “Moc Nauki” in 2017. Supervising the students who started work in the field of computer graphics, I was the supervisor of their articles and coordinated and participated with the students in the international CESCG (Central European Seminar on Computer Graphics for Students) conference in Slovakia (2005-2010) as their tutor and a Member of the Scientific Committee of the Conference.

I pay particular attention to present the results of my researches at prestigues scientific conferences. The results obtained during my research work were presented at 18 national and international thematic conferences. The results were presented in the form of oral presentations (16) (*Annex 3, point II L*) and poster presentations (6) (*Annex 3, point II L*). My scientific publications in wide-ranging journals have been noticed by the international community, which is reflected in the number of citations of my work by foreign authors. Particularly 3 papers have been pioneering, and now they are basic items cited in articles related to shifts compensation between images (*Annex 2b* paper [A11]), color correction in HDR tone operators (*Annex 2b* paper [A10]) and perceptual assessment of image quality (*Annex* 2b paper [A5]).

Apart from scientific activity I also conduct active didactic activity, trying to engage in research work of students. The result is the promotion of 36 engineering and master thesis and joint scientific publications. I conduct lectures, laboratories and design exercises for students of the following disciplines: Informatics, Bioinformatics, Engineering Digitalization and Management and Production (Annex 4, point Q). In the years 2003-2005 I was Advisor of the First Year of Computer Science.

Regardless of scientific and didactic activity, I am active in the field of organizational activities. This means an active participation in the development of content in IT studies and the involvement in research and development cooperation with external subjects. For five years I have been Chairman of the Recruitment Commission for part-time studies. In 2008-2014, I was Chairman of the Commission for the Evaluation of Employees in the Faculty of Computer Science. In addition, in 2009-2011 I was the Coordinator of the Erasmus Program on the Faculty of Computer Science. Currently, I am a Member of the Faculty Committee on Prizes and Awards.

Summary of academic achievements

My academic achievements after completing a doctorate degree include **30** published articles, including **6** articles published in JCR journals. The total IF for post-doctoral work is **11.244** (IF from publication year) and **11.188** (IF5-year). The total number of citations by Web of Science for all publications that I am author or co-author of, is **139** (without self-citations **119**). The total number of MNiSW points is **349** and the number of MNiSW points according to my own share is **212.05**. Hirsch's index of my work is **5**. **In Table 2**, the bibliometric indicators after PhD defence are shown (based on the list of publications in **Appendix 3**).

A list of journals in which scientific papers and articles indexed in the Web of Science (WoS) were published on 24.08.2017.

Table 2. Indicators of total academic achievement after obtaining a doctorate

Journal title	Year of publication	Publications number	IFa)	IFb)	Poins number MNiSWc)	Number of citations w WoS
After PhD defence						
International Journal of Human-Computer Studies	2017	1	2.863	2.657	35	0
Advances in Intelligent Systems and Computing	2017	1	--	--	15	1
Expert Systems with Applications	2016	1	3.928	3.526	35	0
Journal of Electronic Imaging	2016	1	0.754	0.825	20	2
Lecture Notes of Computer Science	2016	1	--	--	15	0
	2014	1			10	1
	2012	4			4x10	3,1,3,4
	2010	1			13	6
Int. Conf. on Knowledge Based and Intelligent Information and Engineering Systems	2016	1	--	--	15	0
Computer Graphics Forum	2012	1	1.638	1.9	30	41
	2009	1	1.681	1.9	20	53
Int. Conf. on Serious Games Development	2011	1	--	--	13	12

and Applications						
Pomiary, Automatyka, Kontrola	2011	2	--	--	2x9	0
	2010	2			2x6	0
	2009	1			6	0
	2007	1			6	0
	2006	2			2x6	0
Seeing paradoxical images, InterFace, Humanities and Technology	2010	1	--	--	2	0
Metody Informatyki Stosowanej	2009	1	--	--	4	0
SCCG '08: Proceedings of the 24th Spring Conference on Computer Graphics	2008	1	--	--	2	0
Journal of Environmental Studies''	2007	1	--	--	2	0
Int. Conf. in Central Europe on Comp. Graphics, Visualisation and Computer Vision, WSCG	2007	1	--	--	10	12
Elektronika	2007	1	--	--	4	0
Int. Journal on Multiple-Valued Logic and Soft Computing	2004	1	0.38*	0.38*	10	0
Suma		**30**	**11.244**	**11.188**	**349**	**139** (without self-citations **119**)

a) Total Impact Factor according to the Journal Citation Reports database (JCR) according to the year of publication

b) 5-year Impact Factor based on Journal Citation Reports (JCR) according to the year in which the summary was prepared (2015)

c) The number of points according to the list of scientific journals of Ministry of Science and Higher Education according to the year of publication.

* IF appeared after publication

Information about educational achievements and scientific dissemination achievements are presented in **Annex 4**.