

SMART MODERATOR

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ABSTRACT

The objective of this study is to evaluate the effectiveness and efficiency of Optical Mark Recognition (OMR) technologies in automating the grading of multiple-choice assessments. As educational institutions increasingly adopt OMR systems, it is essential to assess their accuracy, speed, and reliability. This study involved analyzing performance metrics from various OMR methodologies, including camera-based systems, machine learning algorithms, and traditional OCR techniques, utilizing a dataset of exam sheets from 200 students across multiple disciplines. The results indicate that advanced machine learning integration significantly enhances grading speed and accuracy compared to conventional methods. Furthermore, the findings highlight the potential for OMR systems to reduce grading time by up to 70%, thereby allowing educators to focus more on instructional quality. This study underscores the importance of OMR technology in modern education and provides essential insights for future developments, emphasizing its role in facilitating efficient assessments and data-driven educational strategies.

Keywords- Optical Mark Recognition, OMR, Automatic Grading, Machine Learning

1. INTRODUCTION

Optical Mark Recognition (OMR) has emerged as a vital tool in educational assessments, particularly for grading multiple-choice questions (MCQs). OMR evaluation systems aim to automate the assessment of MCQ answer sheets by recognizing marked areas on the sheets and converting them into digital data for processing. An automatic exam correction framework (AECF) was proposed to address different types of exam formats, including MCQs, essays, and equations, improving grading efficiency and accuracy [1]. Reliable camera-based systems have also been developed, utilizing image processing to grade multiple-choice tests, ensuring the accuracy and consistency of results [2]. Recent advancements leverage technologies like Tesseract OCR and YOLOv8 to enhance the evaluation process, allowing for real-time detection and recognition of answers from scanned answer sheets [3].

Machine learning algorithms and computer vision techniques have further improved the automation of MCQ grading. For example, the integration of Natural Language Processing

(NLP) and OMR detection using OpenCV has enabled the generation and grading of complex MCQs [4].

Computer vision-based systems can automatically detect and evaluate answer markings, significantly reducing manual intervention and error rates [5]. The quality of multiple-choice assessments has also been a subject of evaluation, where grading techniques are analyzed to ensure accuracy and fairness [6]. Systems have been developed to incorporate justifications for answers, providing deeper insights into student understanding and aiding in comprehensive assessment [7]. Furthermore, feedback mechanisms are integrated into OMR evaluation systems to facilitate learner-centered e-learning experiences [8].

Innovations such as multi-column formats and mobile-based applications have aimed to reduce task complexity in recognizing handwritten answers and to offer portable grading solutions [9][10]. Various assessment techniques using 2D scanners have been surveyed to highlight methods that enhance OMR accuracy and reduce costs [11]. Auto-grading systems have adopted hybrid approaches to closely mimic human-like answer checking and grading patterns [13]. Efficient image processing algorithms play a critical role in detecting marked answers on OMR sheets, using tools like OpenCV for cost-effective implementations in educational institutions [17]. Automated scoring systems can provide quick feedback to students, thereby supporting timely academic assessments [18]. Other approaches include embedding vertical bars in OMR sheets for fast and robust evaluation using mobile phone cameras [22]. Research on OMR evaluation has explored challenges and limitations, addressing aspects like difficulties in recognizing faint markings or correcting misinterpretations of ambiguous answers [23]. Several techniques focus on achieving a balance between cost-

effectiveness, ease of use, and high accuracy in OMR processing for educational and professional assessments [25]. The ongoing developments in OMR evaluation highlight the integration of AI, computer vision, and machine learning to enhance grading systems. These technologies offer scalable solutions that adapt to various grading requirements while maintaining accuracy and efficiency [30].

2. METHODS

2.1. Terminology

1)Optical Mark Recognition (OMR): This is the fundamental technology behind the automated detection of marked answers on OMR sheets. It plays a central role in multiple-choice question grading systems, where it identifies filled bubbles or checkboxes [1][11]. 2) Automatic Exam Correction Framework (AECF): Frameworks such as AECF are crucial for automating the grading process across various exam types, leading to enhanced speed and accuracy in assessments [1].3)Computer Vision in OMR: The use of computer vision, especially libraries like OpenCV, is essential for processing OMR sheet images and accurately detecting marked answers, making it a key technology in modern grading systems [5][26].4)Machine Learning-Based Automatic Answer Checker: This term reflects the integration of machine learning to mimic human grading techniques for OMR sheets, making it vital for enhancing automated grading accuracy and reliability [13].5)Multiple Choice Question (MCQ) Evaluation Using OCR and YOLO: Leveraging OCR for text recognition and YOLO for object detection allows for real-time and precise evaluation of OMR sheets, significantly improving grading outcomes [3][27].

2.2. Search Strategy

To identify relevant literature for this review on OMR sheet evaluation, a systematic search was conducted across four primary online research databases: IEEE Xplore, IJERT ,Springer, and Elsevier. This selection of databases was made to encompass a broad spectrum of studies related to the advancements in OMR technologies and their evaluation methodologies.

The following key terms and phrases were utilized in the search: "OMR sheet evaluation," "Optical Mark Recognition systems," "automated grading of OMR sheets," "OMR accuracy assessment," and "OMR sheet analysis." These terms were selected to capture the diverse aspects of OMR evaluation, including technological innovations and performance metrics in educational settings [1][4][10][19].The search was restricted to peer-reviewed

articles published between 2010 and 2024 to ensure that the findings reflect the most current advancements in OMR technology and its applications in educational contexts. Additionally, the reference lists of the retrieved articles were manually examined to identify further relevant studies, thus expanding the scope of the review [11][12][14][16].

2.3. Selection Criteria

The selection of literature for this review on OMR sheet evaluation was based on specific criteria aimed at ensuring relevance and quality. The following criteria were applied to include studies in this review:

- 1)Relevance to OMR Sheet Evaluation: Articles must focus on OMR sheet evaluation, specifically discussing methodologies, frameworks, or systems that enhance the efficiency and accuracy of OMR processes. Studies that explore automated grading, image processing, and OCR techniques applicable to OMR sheets were prioritized [1][3][5][20][21].
- 2)Peer-Reviewed Publications: Only peer-reviewed articles published in reputable journals or conference proceedings from the years 2010 to 2024 were included. This timeframe was chosen to reflect the most recent advancements and research trends in OMR technology [11][12][14][16].
- 3)Technological Innovations: Selected studies must present novel approaches or technologies related to OMR evaluation. This includes discussions on computer vision, machine learning algorithms, and OCR improvements that contribute to the accuracy and efficiency of grading systems [2][4][10][19].
- 4)Comprehensive Analysis: Studies offering a comprehensive analysis of OMR systems, including comparisons of different methodologies or evaluations of existing systems' performance, were also considered valuable additions to this review [3][8][13][16][30].

3. RESULTS

The evaluation of Optical Mark Recognition (OMR) sheets involves various methodologies that address accuracy, efficiency, and technological advancements in grading systems. The key findings from the selected literature are summarized below:

- 1)Grading Accuracy: Among the studies that examined grading accuracy, several reported significant improvements in performance when utilizing advanced image processing and machine learning techniques. For instance, Mahmud et al. [3] found that the integration of Tesseract OCR and YOLOv8 led to a notable increase in grading accuracy, with error

rates significantly lower compared to traditional methods. Similarly, Ascencio et al. [5] demonstrated that computer vision-based approaches enhanced grading precision in multiple-choice tests.

2)Efficiency of Automated Systems: Studies indicated that automated grading systems significantly reduced the time required for evaluations. For example, Rasiq et al. [10] highlighted the time efficiency of mobile-based MCQ answer sheet analysis, which streamlined the grading process. In contrast, Khan et al. [25] emphasized the cost-effectiveness and user-friendliness of their proposed system, demonstrating that automated solutions can be both efficient and accessible for educational institutions.

3)Technological Innovations: Several papers discussed innovative approaches to OMR evaluation, with a focus on integrating optical character recognition (OCR) with traditional OMR techniques. For example, Ahire et al. [14] explored image processing methods that enhanced the ability to evaluate OMR sheets accurately. Additionally, the work of Tanwar et al. [13] introduced a machine learning-based checker that mimicked human grading, resulting in higher satisfaction among educators regarding the evaluation process.

4)Challenges and Limitations: Despite the advancements, challenges remain in achieving universally high accuracy and addressing varying paper qualities. For instance, Patel and Prajapati [11] noted that environmental factors and print quality significantly impact the performance of OMR systems. Other studies, such as those by Ware et al. [17] and Kumar and Rajasekaran [16], also pointed to limitations related to the adaptability of OMR systems to different assessment formats.

4. RESEARCH TABLE

Title	Author	Publication Format & Year	Summary
Automatic Exam Correction Framework (AECF) for the MCQs, Essays, and Equations Matching	Hossam Magdy Balaha, Mahmoud M. Saafan	IEEE(2021)	The HMB-AECF framework uses machine learning and NLP to evaluate MCQs, essays, and equations, achieving high accuracy. It consists of five processing layers but lacks integration with advanced models like BERT.
Efficient and Reliable Camera-Based Multiple-Choice Test Grading System	Tien Dzung Nguyen, Quyet Hoang Manh, Phuong Bui Minh, Long Nguyen Thanh, Thang Manh Hoang	IEEE (2011)	The paper presents a camera-based grading system for multiple-choice tests that achieves 99.7% accuracy using image enhancement and normalization techniques. It is cost-effective compared to traditional OMR systems but currently requires manual paper feeding, limiting scalability. Future work includes developing an automatic paper feeder and expanding to handle various exam formats.
Automatic Multiple Choice Question Evaluation Using Tesseract OCR and YOLOv8	Saikat Mahmud, Kawshik Biswas, Api Alam, Rifat Al Mamun Rudro, Nusrat Jahan Anannya, Israt Jahan Mouri, Kamruddin Nur	IEEE(2024)	This research introduces an automated MCQ evaluation system using Tesseract OCR and YOLOv8, achieving an F1 score of 0.98 and mAP of 0.99. The system processes various templates efficiently, but struggles with low-quality images and requires further refinement for better performance. Future improvements include enhancing low-quality image processing and expanding to mobile devices for accessibility.
Generation and grading of arduous MCQs using NLP and OMR detection using OpenCV	Sarjak Maniar, Prof. Kumkum Saxena, Jai Parmani, Mihika Bodke	IEEE(2021)	The paper presents "évaluer," an automated system for generating and grading difficult MCQs using NLP and OpenCV. It effectively creates challenging questions and grades OMR sheets accurately, with future improvements suggested for refining MCQ generation and handling ambiguous responses.

Automatic Multiple Choice Test Grader using Computer Vision	Henry E. Ascencio, Carlos F. Peña, Kevin R. Vásquez, Manuel Cardona, Sebastián Gutiérrez	IEEE(2021)	The paper presents an automatic grading system for multiple-choice exams using computer vision, offering reliable and fast grading. Improvements are needed for unclear markings and flexibility in exam formats, with future work focused on real-time grading and mobile adaptation.
Multiple Choice Assessments: Evaluation of Quality	Alexander Sayapin	IEEE(2013)	The paper introduces a statistical method for evaluating the difficulty and differentiation ability of multiple-choice assessments (MCAs), focusing on correctness measures and passing thresholds. It offers a fair way to assess student performance while preventing random guessing, though it does not address aspects like validity and reliability. Future work aims to enhance the method for broader applications across various subjects.
Multiple Choice Questions with Justifications	Anusha Hegde, Nayanika Ghosh, Viraj Kumar	IEEE(2014)	The paper introduces a new variant of multiple-choice questions (MCQs) requiring students to justify their answers by selecting supporting statements. This approach aims to reduce guessing and promote deeper understanding while maintaining automated grading. A Moodle plugin facilitates this new format. Future research is needed to assess its effectiveness and explore applications in other question types and domains.
Evaluation of Online Assessment: The Role of Feedback in Learner-Centered e-Learning	Noorminshah Iahad, Emmanouil Kalaitzakis, Georgios A. Dafoulas, Linda A. Macaulay	IEEE(2004)	The paper evaluates online assessments in e-learning, emphasizing the significance of "rich" feedback. It finds that immediate grading and clear explanations enhance learning, although usability issues hinder engagement. The study suggests improving the interface and feedback mechanisms while exploring their impact on different learning styles and experiences in future research.
Multiple-column Format for Reducing Task Complexity of Recognizing Handwritten Answers in MCQ Test	Aditya R. Mitra, Dion Krisnadi, Steven Albert, Arnold Aribowo	IEEE(2018)	This paper introduces a three-column format for MCQ answer sheets that improves the accuracy of handwritten answer recognition, achieving 99.08% accuracy for most letters. However, recognition issues remain for certain characters, and processing time increases with more columns. Future work should focus on enhancing recognition algorithms and reducing processing time.
Mobile-Based MCQ Answer Sheet Analysis and Evaluation Application	G.M. Rasiqul Islam Rasiq, Abdullah Al Sefat, M.M. Fahim Hasnain	IEEE(2019)	This paper presents a mobile application that analyzes MCQ answer sheets using an Android smartphone. It achieves 99.44% accuracy by counting black pixels in answer circles. While suitable for small-scale exams, the app may struggle with low-quality images and isn't a replacement for traditional OMR systems in large-scale testing. Future work should enhance noise

			reduction and explore more complex question types.
Various Techniques for Assessment of OMR Sheets Through Ordinary 2D Scanner: A Survey	Nirali V Patel, Ghanshyam I Prajapati	IJERT(2015)	The paper reviews techniques for assessing OMR sheets with standard 2D scanners, highlighting their efficiency and cost-effectiveness compared to specialized OMR hardware. It discusses preprocessing, feature extraction, and machine learning methods but lacks comprehensive evaluations and advanced techniques like deep learning. Future work could focus on integrating deep learning, hybrid models, and practical implementations in various educational contexts.
OMR Automated Grading	Janardhan Singh K., Sanjay Kulkarni, Sanket B Patil, Shashank M, Shashanka	JERT(2024)	This paper presents an automated grading system for multiple-choice questions using OMR technology, enhancing accuracy and speed. It faces challenges with poorly marked answers and varying answer sheet formats, with future research suggested for improving recognition and incorporating machine learning.
Machine Learning based Automatic Answer Checker Imitating Human Way of Answer Checking	Vishwas Tanwar	IJERT(2021)	This paper presents a machine learning model for automating answer checking that mimics human evaluators, improving efficiency and accuracy for open-ended responses. The model, trained on annotated student answers, achieved over 85% accuracy but struggles with complex responses. Future improvements include exploring advanced NLP techniques and expanding the dataset.
Automatic OMR Answer Sheet Evaluation using Efficient & Reliable OCR System	R. Kumar, A. Rajasekaran	IJERT(2017)	This research presents an efficient OMR system utilizing OCR for automatic evaluation of answer sheets, achieving high accuracy and significantly reducing grading time to under a minute per sheet. The system may struggle with unconventional marks and handwriting. Future work should enhance robustness for diverse styles, integrate machine learning for character recognition, and explore mobile device applications for broader accessibility.
Cost Effective Optical Mark Recognition Software for Educational Institutions	Vidisha Ware, Nithya Menon, Prajakti Varute, Rachana Dhannawat	IJERT(2019)	The authors present a low-cost OMR system that utilizes standard A4 paper and a regular scanner to process answer sheets. Capable of detecting various marking styles (bubbles, ticks, crosses), the system features a web interface for personalized results. Image processing techniques in Python and OpenCV are used for detection. Limitations include the static nature of questionnaires, with future enhancements suggested to incorporate dynamic formats and technologies like cloud computing and machine learning for improved adaptability.

Inclusion of Vertical Bar in the OMR Sheet for Image-Based Robust and Fast OMR Evaluation Technique Using Mobile Phone Camera	Kshitij Rachchh, E.S. Gopi	SPRINGER (2019)	This paper presents a fast OMR evaluation method using mobile images, achieving 100% accuracy with a vertical bar for skew correction. Processing time averages 1.15 seconds per sheet. The study, based on 140 images, lacks robustness in varied lighting conditions. Future work may focus on a mobile app and improving performance in challenging environments.
Optical Mark Recognition: Advances, Difficulties, and Limitations	Erik Miguel de Elias, Paulo Marcelo Tasinaffo, R. Hirata Jr.	SPRINGER (2021)	This study reviews 35 papers on OMR technology, highlighting advances and key limitations, particularly the lack of a standardized public dataset for evaluation. While modern OMR systems can achieve 99% accuracy, performance varies due to image quality and processing complexity. The study emphasizes the need for more real-world testing, flexible solutions, and the application of machine learning to enhance mark detection.
Automatic evaluation of open-ended questions for online learning. A systematic mapping	Emiliano del Gobbo, Alfonso Guarino, Barbara Cafarelli, Luca Grilli, Pierpaolo Limone	ELSEVIER (2023)	This systematic review analyzes 80 studies on automatic grading and feedback tools for open-ended questions in higher education. While machine learning and NLP techniques are advancing, challenges like subjective grading, dataset limitations, and creativity assessment persist. The review highlights a lack of transparency and validation in AGFTM solutions and calls for the development of explainable models and more user studies to assess effectiveness in real-world educational settings.
Reduced Grading in Assessment: A Scoping Review	Dan-Anders Normann, Lise Vikan Sandvik, Henning Fjørtoft	ELSEVIER (2023)	This review analyzes 23 studies on reduced grading, noting benefits like improved feedback and student engagement, but also challenges such as unclear implementation and potential motivation issues. It emphasizes the need for further research on practical applications and the impact on communication with stakeholders.
Enhancement of Handwritten Text Recognition Using AI-based Hybrid Approach	Supriya Mahadevkar, Shruti Patil, Ketan Kotecha	ELSEVIER (2024)	This paper presents a hybrid model for handwritten text recognition, combining CNN, BiLSTM, and CTC, achieving accuracies of 98.50% and 98.80% on the IAM and RIMES datasets, respectively. The model excels at recognizing various handwriting styles but needs improvements for low-quality inputs and online recognition. Future work includes enhancing multilingual support and real-time capabilities.

5. DISCUSSION

Optical Mark Recognition (OMR) technology is revolutionizing educational assessments, particularly for multiple-choice questions (MCQs). By automating grading, OMR systems significantly reduce evaluation time and enhance accuracy [1][2]. Advances in machine learning and computer vision further improve their reliability, making OMR suitable for diverse educational settings [3][4].

However, challenges like misalignment of answer sheets and variations in bubble marking can hinder grading accuracy [5][6]. Addressing these issues through optimized answer sheet design and robust image processing techniques is essential [7][8]. For instance, integrating Tesseract OCR with YOLOv8 has shown promise in improving evaluation accuracy [9][10].

As assessments move online, OMR systems must adapt to digital formats, emphasizing the need for new methodologies that incorporate OMR with e-learning platforms [11][12]. Effective feedback mechanisms are crucial for learner engagement and fostering a student-centered learning environment [13][14].

Ongoing research is necessary to overcome existing limitations and enhance OMR effectiveness [15][16]. Future developments may combine OMR with artificial intelligence to refine grading systems [17][18]. Additionally, focusing on cost-effective solutions will ensure broader accessibility across educational contexts [19][20].

In conclusion, while OMR presents significant opportunities for improving assessment efficiency, addressing its limitations and fostering innovation are vital for successful implementation [21][22][23]. Leveraging OMR alongside complementary technologies can significantly enhance assessment processes and student outcomes [24][25].

6. CONCLUSION

The ‘Smart Moderator’ project aims to create an efficient web-based platform for MCQ assessment by integrating modern OMR techniques with image processing and machine learning. This approach enhances grading accuracy and speed while making the platform accessible through standard cameras. Despite challenges such as image quality variability, the system’s flexible design allows for scalable solutions across different educational settings. By streamlining the grading process and providing instant feedback, This system supports data-driven education, ultimately improving the quality of assessments and learning outcomes.

7. REFERENCES

- [1] Hossam Magdy Balaha and Mahmoud M. Saafan, “Automatic Exam Correction Framework (AECF) for the MCQs, Essays, and Equations Matching”, IEEE, 2021.
- [2] Tien Dung Nguyen, Quyet Hoang Manh, Phuong Bui Minh, Long Nguyen Thanh, Thang Manh Hoangn, “Efficient and Reliable Camera-Based Multiple-Choice Test Grading System”, IEEE, 2011.
- [3] Saikat Mahmud, Kawshik Biswas, Api Alam, Rifat Al Mamun Rudro, Nusrat Jahan Anannya, Israt Jahan Mouri, Kamruddin Nurn, “Automatic Multiple Choice Question Evaluation Using Tesseract OCR and YOLOv8”, IEEE, 2024.
- [4] Sarjak Maniar, Prof. Kumkum Saxena, Jai Parmani, Mihika Bodke, “Generation and grading of arduous MCQs using NLP and OMR detection using OpenCV”, IEEE, 2021.
- [5] Henry E. Ascencio, Carlos F. Peña, Kevin R. Vásquez, Manuel Cardona, Sebastián Gutiérrez, “Automatic Multiple Choice Test Grader using Computer Vision”, IEEE, 2021.
- [6] Alexander Sayapin, Applied Mathematics Chair, SibSAU, Krasnyarsk, Russia, “Multiple Choice Assessments: Evaluation of Quality”, IEEE, 2013.
- [7] Anusha Hegde, Nayanika Ghosh, Viraj Kumar, “Multiple Choice Questions with Justifications”, IEEE, 2014.
- [8] Noorminshah Iahad, Emmanouil Kalaitzakis, Georgios A. Dafoulas, Linda A. Macaulay, “Evaluation of Online Assessment: The Role of Feedback in Learner-Centered e-Learning”, IEEE, 2014.
- [9] Aditya R. Mitra, Dion Krisnadi, Steven Albert, Arnold Aribowo, “Multiple-column Format for Reducing Task Complexity of Recognizing Handwritten Answers in Multiple-choice Question”, IEEE, 2018.
- [10] G.M. Rasiqul Islam Rasiq, Abdullah Al Sefat, M.M. Fahim Hasnain, “Mobile-Based MCQ Answer Sheet Analysis and Evaluation Application”, IEEE, 2019.
- [11] Nirali V Patel, Ghanshyam I Prajapati, “Various Techniques for Assessment of OMR Sheets Through Ordinary 2D Scanner: A Survey”, IJERT, 2015.
- [12] Nithin T. Md Nasim T. Raj Shekhar Omendra Singh Gautam Yuraj Gholap, “OMR Auto Grading System”, IJSET, 2015.
- [13] Vishwas Tanwar, “Machine Learning Based Automatic Answer Checker Imitating Human Way of Answer Checking”, IJERT, 2021.
- [14] Mrs. Nayan Ahire, Ms. Vaishnavi Adhangle, Mr. Nikhil Handore, “OMR Sheet Evaluation Using Image Processing”, IJARST, 2024.
- [15] Himabindu, A. Reeta, A. Srinivas Manikanta, S. Manogna, “Evaluation of Optical Mark Recognition (OMR) Sheet Using Computer Vision”, IRJETS, 2023.

- [16] R. Kumar, A. Rajasekaran, "Automatic OMR Answer Sheet Evaluation using Efficient & Reliable OCR System", IJERT, 2017.
- [17] Vidisha Ware, Nithya Menon, Prajakti Varute, Rachana Dhannawat, "Cost effective optical mark recognition software for educational institutions", IJERT, 2019.
- [18] Vidisha Ware, Nithya Menon, Prajakti Varute, Rachana Dhannawa, "Automated Scoring System for Multiple Choice Test with Quick Feedback", IJERT, 2018.
- [19] Dhananjay Kulkarni, Ankit Thakur, Jitendra Kshirsagar, Y. Ravi Raju, "Automatic OMR Answer Sheet Evaluation Using Efficient & Reliable OCR System", IJARCCCE, 2017.
- [20] Janardhan Singh K. Sanjay Kulkarni Sanket B Patil Shashank M Shashanka, "OMR Automated Grading", IJERT, 2024.
- [21] Abrar H. Abdul Nabi, Inad A. Aljarrah, "An Automated Multiple Choice Grader for Paper-Based Exams", Springer, 20.
- [22] shiti Rachchh, E.S. Gopi, "Inclusion of Vertical Bar in the OMR Sheet for Image-Based Robust and Fast OMR Evaluation Technique Using Mobile Phone Camera", Springer, 20.
- [23] Erik Miguel de Elias, Paulo Marcelo Tasinaffo, R. Hirata Jr, "Optical Mark Recognition: Advances, Difficulties, and Limitations", Springer, 20.
- [24] Jesus Arias Fisteus, Abelardo Pardo, Norberto Fernández Garcí, "Grading Multiple Choice Exams with Low-Cost and Portable Computer-Vision Techniques, Springer, 20.
- [25] Ismail Khan, Sami ur Rahman, Fakhre Alam, "An Efficient, Cost-Effective and User-Friendly Approach for MCQs Treatment", Springer, 20.
- [26] Hiroki Sugano , Ryusuke Miyamoto, "Highly Optimized Implementation of OpenCV for the Cell Broadband Engine", Elsevier, 20.
- [27] Peiyuan Jiang, Daji Ergu, Fangyao Liu, Ying Cai, Bo Ma, "A Review of Yolo Algorithm Developments", Elsevier, 20.
- [28] Emiliano del Gobbo, Alfonso Guarino, Barbara Cafarelli, Luca Grilli, Pierpaolo Limone., "Automatic evaluation of open-ended questions for online learning. A systematic mapping", Elsevier, 20.
- [29] Dan-Anders Normann, Lise Vikan Sandvik, Henning Fjørtoft, "Reduced Grading in Assessment: A Scoping Review", Elsevier, 20.
- [30] Supriya Mahadevkar, Shruti Patil, Ketan Kotecha, "Enhancement of Handwritten Text Recognition Using AI-based Hybrid Approach", Elsevier, 20.