ProFaMI Platform for the Safety of Certain Aspects of Distance Learning

Aleksandr M. Kadan [1] and Evgeniy O. Protasov [1]

[1] *Yanka Kupala State University of Grodno, 22 Ozheshko str, Grodno, 230023, Belarus*

Abstract

The widespread introduction of distance learning systems has increased interest in such concepts as "academic honesty", "safety of the educational process" and required the use of somen The widespread ew technologies, among which "proctoring" stands out - the procedure for monitoring an online exam, where the administrator - proctor observes the course. Experts show the greatest interest in carrying out such control in an automatic mode, when the proctor is a software system that independently verifies the personality of the subject, monitors his behavior, and records incidents related to violation of the exam requirements on the exam video. Artificial intelligence algorithms should play a significant role in the operation of the automatic proctoring system. The article discusses the requirements for the organization and implementation of a semi-automatic proctoring system using elements of synchronous and asynchronous work to monitor the progress of a remote control training event. The system is implemented as an application that uses technologies for remote control of the subject's computing device and scene recognition technologies to control his workspace using intelligent video surveillance. Particular attention is paid to the confidentiality of the data of the online exam, the security of the personal data of the test subject, and his use of non-verbal communication means.

Keywords 1

Proctoring, automatic proctoring, online exam, remote work, distance learning, intelligent video surveillance

1. Introduction

An effective response to the problems of the COVID-19 pandemic, not only of educational institutions but also of many organizations of various kinds of activity, has become a sharp increase in interest in remote work technologies. At the same time, the procedure for remote control and assessment of students' knowledge and competencies of employees has become very relevant, the main technology of which is the technology of online proctoring [1, 8, 9, 21]. Online proctoring is seen as a way to confirm compliance with the rules of the remote exam. It includes observation of subjects during control activities and is actively used in various fields, including basic, secondary, higher, and continuing education.

E-learning has been studied in detail in the literature from different points of view: its features and achievements [2, 3], learning management systems [4], as well as online courses and “electronic” events [5]. However, the conduct of “electronic assessment” [6] of student performance using electronic monitoring tools is still very limited [7, 6, 8].

The purpose of this article is to present the capabilities of a platform for semi-automatic proctoring, using elements of synchronous and asynchronous work to monitor the progress of certification activities. The system is implemented as an application using the remote control of the subject's

Proceedings of VI International Scientific and Practical Conference Distance Learning Technologies (DLT–2021), September 20-22, 2021, Yalta, Crimea

EMAIL: kadan@mf.grsu.by (A. 1); protasov_eo_17@mf.grsu.by (A. 2)

ORCID: 0000-0003-3701-8100 (A. 1)

computer and scene recognition technology to control his workspace employing intelligent video surveillance. Particular attention is paid to the confidentiality of the data of the online exam, the security of the personal data of the test subject, and his use of non-verbal communication means.

2. Online Proctoring Technologies in Higher Education

2.1. Online Proctoring Support Tools

Traditionally, online monitoring events are divided into high and low-rate events. If events with a low rate are actively carried out online, then information about the mass holding of events with a high rate (exams in disciplines, the defense of diplomas, and dissertations) among foreign universities have not yet been announced [18, 19].

Selected universities in the USA and Europe practice pre-testing or a survey based on the use of Google forms or the Survey Service, written exams on the Gradescope web platform for submitting and grading assignments, simple exams with proctoring on the Zoom platform, large-scale, final exams with proctoring in Examity services, ProctorU, SmarterProctoring. Attestation of undergraduates and postgraduates is carried out remotely with the consent to register. The most popular grading system is pass/fail.

In the academic environment of the far abroad, the most popular proctoring platforms are Examity [23] (allows online identification, auto-proctoring, live proctoring, integration with MOODLE), Proctorio [24] (ensures the security of digital data, integration with other platforms, a secure browser for testing), Verificient Proctortrack [25] (implements a hybrid real-time model combining remote human proctors with advanced automatic AI intervention in cases of suspicious behavior, fraud, or student assistance), Respondus [26] (online testing modes, auto-proctoring, recognition support persons, movements and lighting, captures actions on the keyboard, mouse movements, equipment changes, all violations during the exam will be marked for the proctor). In the CIS space Examus [27] (analyzes the behavior of users of any online services using face recognition and emotion detection), ProctorEdu [28] (auto-proctoring and live proctoring, automatic assessment of trust in test results and biometric identity verification, support for mobile devices, works in a browser and does not require the installation of extensions, plug-ins, and third-party software), PROCTORU [29] (confirms the identity of the tested person, monitors through a webcam, the subject is connected with a real proctor who leads him through the process).

It should be noted that the authors are not aware of open source solutions in the field of proctoring. All of the above platforms are paid commercial products and do not provide personal data protection requirements.

2.2. Problems of Using Online Proctoring

At the present stage, two main problems are put forward when using online proctoring tools. First, this is the discrepancy between the regulatory framework of the educational process and online proctoring technologies and the lack of guarantees for a reliable assessment of knowledge when using it [18, 19, 20]. Developing a legal framework for the application of high stakes online exams appears to be an important challenge. The introduction of such procedures in a short time will inevitably be accompanied by a large number of errors, both random and systematic [21]. In particular, legal regulation of the use of proctoring data should be developed, the legal status of attestation results should be determined for various violations of the attestation procedure, regulations for administrators' actions in the event of technical failures (for example, due to instability of the Internet connection) should be developed. The second is the threat of violation by the subjects of the requirements of "academic honesty", which has always been a problem in higher education [15, 16, 17]. While it is possible to turn a blind eye to this in examinations with a low rate and regulate the situation with available means, then in exams with a high rate this can entail unacceptable risks [21]. Undoubtedly, the use of the Internet and the development of user-friendly technological devices have generated concern on the part of educators, the research interest of the academic community, and created new risks of inappropriate and unethical behavior on the part of students [12, 13, 18, 19].

3. ProFaMI Platform for Secure Certification in Remote Learning Environments

Given the steady trend towards the transition to distance learning and the unpredictability of the situation with the end of the COVID-19 pandemic, at the Faculty of Mathematics and Informatics of the Yanka Kupala State University of Grodno, it was decided to develop the ProFaMI (Proctoring for Faculty of Mathematics & Informatics) platform for the safe conduct of certification activities in the form of oral or written examinations and preliminary or control tests.

When designing and implementing the platform, special attention was paid to ensuring equal conditions for all subjects, guarantees of independence for them to obtain results, protecting their data and data on the progress of the certification tests.

3.1. Organizational Requirements

The most important role is assigned to the preparation of the test subject's working space. It is required to provide a separate room, well lit, without background noise, without outside access during the certification. The workspace should be as clutter-free as possible. Otherwise, the examiner has the right to close the session and cancel the result. Prohibited items include food or drinks, headphones, gadgets such as mobile phones or tablets, notes, and books, as agreed with the examiner.

Before commencing certification, the examiner must inspect the prepared room. If the requirements are not met, the examiner has the right to both refuse to conduct certification and ask to put the workspace in order. For added safety, the examiner is encouraged to be present at his workplace throughout the certification process.

During the certification process, both live proctoring from the examiner's side and auto-procoting from the platform's side are possible. The subject is prohibited from breaking the silence, getting up, minimizing the active window on the monitor (where the attestation task is displayed), or running extraneous programs on the computer. The examiner, in case of violation of the certification requirements, has the right to complete the process of its conduct ahead of schedule.

3.2. Software and Hardware Requirements

It is assumed that a test subject passing certification remotely must have a computer, a webcam, and access to the Internet. The webcam should be installed so that the table at which the subject sits, his entire workspace, and the environment in the room are visible. The door to the room must be locked and must be within the webcam's field of view. The dealer's hands must always be in the frame.

Throughout the entire course of certification, an application must be running on the subject's computer that will track any activity that occurs on the computer: minimizing the application window, opening a new tab in the browser, launching an external program. These actions are prohibited to the test subject, and the platform will respond to them. The application can be run on platforms such as Windows, Mac OS, Linux. At startup, the system will be analyzed for the presence of other active programs. If such programs are found, the application will try to close them.

After the initial analysis of the system, the application will launch a browser with the only valid tab, from where a request will be made to the resource on which the data for attestation is located.

During certification, one-way video and two-way audio communication between the subject and the examiner should be carried out. This will allow the examiner to both observe the progress of the certification and discuss the questions that have arisen with the examinee. The video stream of the certification progress is recorded on the platform server and is available for further viewing and analysis.

The subject does not see who his proctor is, and does not know if the proctor is currently seeing him. This will provide additional reliability to the certification results. In addition, a pre-trained neural network based on the coco-SSD model is used to assist the examiner. The task of the neural network is to analyze the video footage received from the subject's webcams to search for security incidents of prohibited items and actions. For example, if a phone or another person appears in the frame, the

platform will inform the proctor about this, at the same time adding a record of the time and nature of the incident to the attestation progress report.

3.3. Platform Architecture and Security

The architecture of the platform and the Platform includes five components through which the interaction of three working nodes is carried out: the server on which the attestation resources are located and the computers of the proctor (examiner) and client (test subject). This is:

1. Application on the side of the examiner (proctor), providing live proctoring functions.
2. An application on the side of the subject, carrying out a continuous analysis of the state of the system of his computer, the actions of the subject, and providing access to resources for passing certification.
3. Microservice verification-API for organizing work with security tokens.
4. Microservice action-API, coordinating the requests of the subject and the proctor.
5. Microservice exam-API, to create a report on the progress of certification, which allows you to conduct intelligent analysis of video stream frames and generate messages about security incidents.

To provide access to the resource with attestation materials only to authorized users (if there is a running application on the subject's side), a unique bunch of three tokens is used: a program token, a client token, and a cookie token. This helps ensure that the application is used uniquely during attestation and prevents unauthorized people from connecting to the attestation session.

The server to which requests are sent from the subject's computer, in addition to the response to the request itself, sends a cookie token a small piece of data (a randomly generated identifier) that is stored on the subject's computer and is updated with each new request. Moreover, each new cookie token is written to the database concerning the subject's identifier. The application reads the sent cookie token and sends it back to the server to confirm its status as a test subject.

The server constantly monitors the statuses of the cookie-tokens of all subjects and if any of the tokens is not confirmed within ten seconds, then the subject's status will be transferred to “frozen”. To prevent a user who does not pass the certification from connecting to the platform, a unique client token is associated with the test subject's application.

When the application is launched, a third token is generated - a program token. It is necessary to confirm the uniqueness of the use of the application launched on the subject's side. The software token and the client token are encrypted using the public key of the RSA algorithm and sent to the server, which binds the software token and the client token for the duration of the validation session.

The test-taker-side application continuously interacts with the verification-API microservice to verify the tokens received by the test-takers browser from the server-side on which the attestation takes place.

The verification-API microservice, when requested to verify the token by the user ID, verifies the token that came from the subject and the token generated by the server after the tester made a request to any resource on the server (see Fig. 1a).

The application on the subject's side, in addition to sending tokens for verification, conducts a preliminary analysis of the video stream of attestation using a pre-trained neural network. The purpose of the analysis is to find security incidents related to the work environment and behavior of the subject. Recorded incidents, along with the recognized incident type, time, and frame of the video stream, are sent to the platform database for recording. When requesting an attestation report, a request is made to the exam-API microservice, which retrieves from the database all incidents related to the attestation of a test subject in the form of a single object (see Fig.1b).

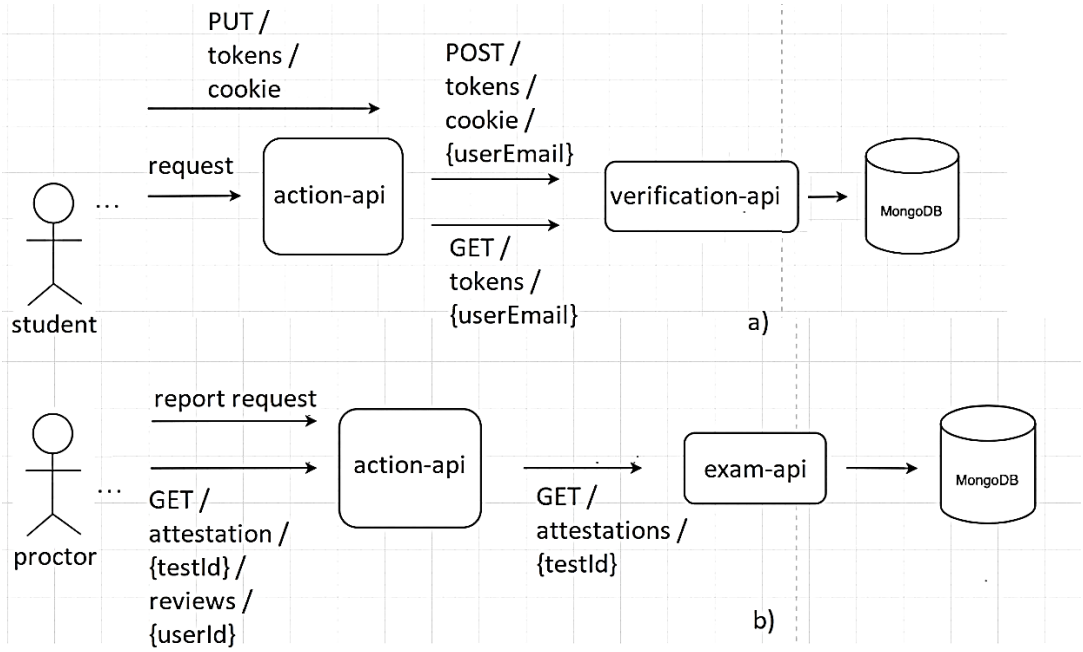


Figure 1: Requests to microservices for a) working with tokens, b) creating and receiving reports

All requests from the test taker to the resource associated with the attestation will be processed by the action-API microservice, which acts as a router that controls the work of the test taker and the proctor.

3.4. Features of Using the Platform

The examiner has two modes of attestation: in live proctoring mode and in the mode of viewing reports during/after completion of attestation (see Fig. 2a). At the moment the test subject joins the platform, his webcam, microphone, and desktop become available to the examiner (see Fig. 2b). The examiner must be present during the preparation of the test subject's workplace.

If you intend to work with several candidates for certification, it is convenient for the examiner to select the option of viewing reports. Any detected activity will be displayed in the reports: both an intermediate frame confirming that attestation is under control and no violations were found, and frames with signatures that indicate when and what type of incident was recorded (see Fig. 3).

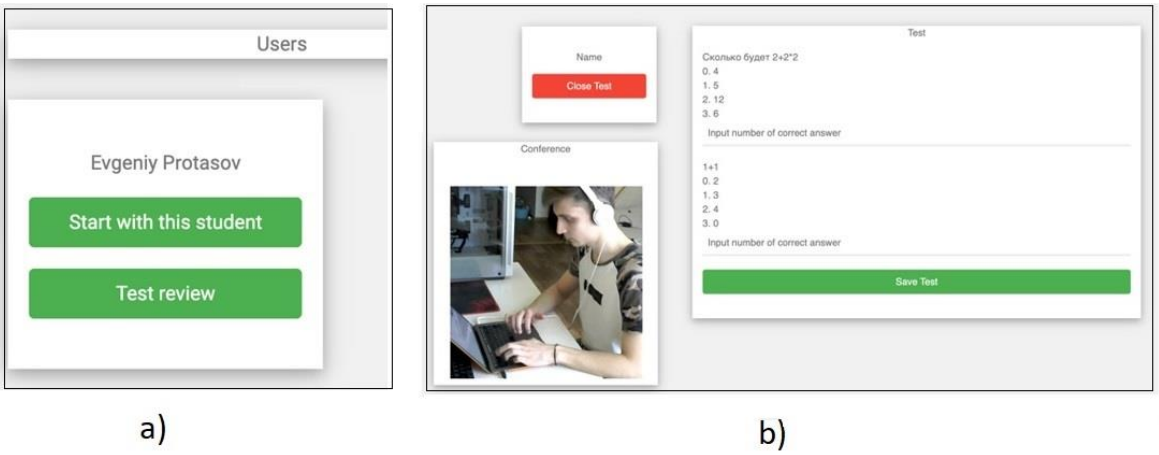
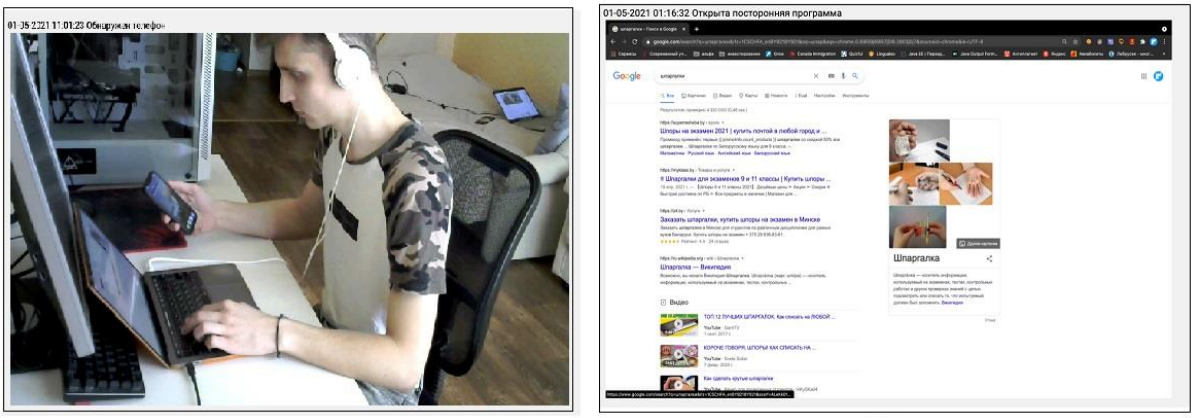


Figure 2: List of subjects and the choice of the operating mode, b) screen view of the subject



a) b)

Figure 3: Examples of report frames with different types of incidents: a) using a gadget, b) another application window is open

4. Conclusions

The development of the ProFaMI platform has proven to be an economically viable project since it allows the active use of remote control over certification activities without the high-cost involvement of commercial third-party products. Its use allows solving the problem of confidentiality of data on the course of certification and the personal data of the subjects. The use of the platform made it possible to reduce the threat of the test subjects violating the requirements of "academic honesty", which has always been a serious problem in higher education. Currently, the main efforts of developers are aimed at implementing a wider use of algorithms for intelligent observation of the workspace of the subject.

5. References

[1] K. Hylton, Y. Levy, & L. P. Dringus, Utilizing webcam-based proctoring to deter misconduct in online exams. Computers in Education, 2016. 92–93, 53–63. DOI: 10.1016/j.compedu.2015.10.002.

[2] A. Kumi-Yeboah, J. Dogbey, G. Yuan, Online collaborative learning activities: The perspectives of minority graduate students. Online Learning, 2017. 21. DOI: 10.24059/olj.v21i4.1277

[3] Y.-C. Yeh, O.-M. Kwok, H.-Y. Chien, et al., How college students' achievement goal orientations predict their expected online learning outcome: The mediation roles of self-regulated learning strategies and supportive online learning behaviors. Online Learning, 2019. 23, 23–41. DOI: 10.24059/olj.v23i4.2076.

[4] A. Janson, M. Söllner, & J. M. Leimeister, Individual appropriation of learning management systems-Antecedents and consequences. AIS Transactions on Human-Computer Interaction, 9, 2017. PP. 173–201.

[5] K. Bovermann, & T. J. Bastiaens, Towards a motivational design? Connecting gamification user types and online learning activities. Research and Practice in Technology Enhanced Learning, 2020. 15, 1. doi: 10.1186/s41039-019-0121-4.

[6] B. Boitshwarelo, A. K. Reedy, & T. Billany, Envisioning the use of online tests in assessing twenty-first-century learning: A literature review. Research and Practice in Technology Enhanced Learning, 2017. 12, 16. DOI: 10.1186/s41039-017-0055-7.

[7] A. S. Milone, A. M. Cortese, R. L. Balestrieri, & A. L. Pittenger, The impact of proctored online exams on the educational experience. Currents in Pharmacy Teaching & Learning, 9, 2017. PP. 108–114. DOI: 10.1016/j.cptl.2016.08.037.

[8] C. S. González-González, A. Infante-Moro, J. C. & Infante-Moro, Implementation of E-proctoring in online teaching: A study about motivational factors. Sustainability, 12, 2020. 3488. doi: 10.3390/su12083488.

[9] K. K. Hollister, M. L. & Berenson, Proctored versus Unproctored online exams: Studying the impact of exam environment on student performance. Decision Sciences Journal of Innovative Education, 7, 2009. PP. 271–294. DOI: 10.1111/j.1540-4609.2008.00220.x.
[10] Joseph A. Rios & Ou Lydia Liu, Online Proctored Versus Unproctored Low-Stakes Internet Test Administration: Is There Differential Test-Taking Behavior and Performance? American Journal of Distance Education, 31:4, 2017. PP. 226-241, DOI: 10.1080/08923647.2017.1258628
[11] Sandra Gudiño Paredes, Felipe de Jesús Jasso Peña & Juana María de La Fuente Alcazar, Remote proctored exams: Integrity assurance in online education?, Distance Education, 42:2, 2021. PP. 200-218, doi: 10.1080/01587919.2021.1910495
[12] Oskar R. Harmon & James Lambrinos, Are Online Exams an Invitation to Cheat? The Journal of Economic Education, 39:2, 2008. 116-125, DOI: 10.3200/JECE.39.2.116-125
[13] Donald L. McCabe, Linda Klebe Trevino & Kenneth D. Butterfield Cheating in Academic Institutions: A Decade of Research, Ethics & Behavior, 11:3, 2001. 219-232, DOI: 10.1207/S15327019EB1103_2
[14] G. Ravasco Technology-aided cheating in open and distance e-learning. Asian journal of distance education. 2012. Vol.10, № 2. PP. 71-77.
[15] V.F. Yakovlev, Countering Students' Academic Dishonesty in Distance Learning. Open and distance education. 2016.Vol. 61, No. 1. P. 14-19.
[16] V.F. Yakovlev Effective measures to counteract the use of ghostwriter services by students in distance learning. Open and distance education. 2017. No. 4 (68). DOI: 10.17223/16095944/68/8
[17] McCabe, D. L. (2005). Cheating among college and university students: A North American perspective. International Journal for Educational Integrity, 1. DOI: 10.21913/IJEI.v1i1.14
[18] Mohammed Juned Hussein, Javed Yusuf, Arpana Sandhya Deb, Letila Fong & Som Naidu. An Evaluation of Online Proctoring Tools. Open Praxis, vol. 12 issue 4, October–December 2020, pp. 509–525 (ISSN 2304-070X)
[19] International experience in conducting intermediate and final certification of university students during the COVID-19 coronavirus pandemic. URL https://enic-kazakhstan.kz/files/1586779981/sistema-proktoringa-mezhdunarodnyy-opyt-cbpiam.pdf
[20] N. V. Tuneva, A. A. Resenchuk, Organization and implementation of intermediate certification in conditions of distance learning. Professional education in Russia and abroad, 4 (40) 2020. PP. 223-228
[21] D. Foster, & H. Layman, Online proctoring systems compared. 2013. URL: https://caveon.com/wp-content/uploads/2013/03/Online-Proctoring-Systems-Compared-Mar-13-2013.pdf
[22] Assessment of the quality of education in the context of distance learning: the experience of the pandemic with the school systems of the post-Soviet countries. Compiled and scientific editors V.A. Bolotov, T.A. Mertsalova. M.: Alex (IP Polikanin A.A.), 2021. 390 p. URL: https://eaoko.org/upload/library/21_Distance_WEB.pdf
[23] Online proctoring on your terms. – Examity, 2021. URL: https://examity.com.
[24] Proctorio: Securing the integrity of your online assessments. 2013-21. URL: https://proctorio.com.
[25] Verificient Technologies. Welcome, 2013-21. URL: https://testing.verificient.com.
[26] Solutions for Higher Ed – Respondus, 2021. URL: https://web.respondus.com/he/
[27] Examus analysis of user behavior, 2013-21. URL: https://ru.examus.net/
[28] ProctorEdu | Контроль онлайн тестов, 2016-21. URL: https://proctoredu.ru/proctoring
[29] ProctorU - The Leading Proctoring Solution for Online Exams, 2008-21. URL: https://www.proctoru.com/