Towards Greater Integrity in Online Exams

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Abstract

Increased growth of online education has created an additional issue of devising effective proctoring for remotely-administered online examinations. In this research project, we explore some popular proctoring methods for such exams such as live proctoring through a computer's webcam and biometrics-based proctoring that monitors a student's mouse movement, and head and eye movements in order to detect cheating attempts. Upon discussion of the various advantages and disadvantages of these two approaches, we propose an integrated proctoring technique combining the complementary strengths of both these methods. Along with potential challenges and solutions, we present an architectural design of this prototype that is currently being developed to be implemented, and mention ways of extending its benefits to exams in the traditional classrooms also. Finally, we present analyses of survey and interview data from faculty and students about their concerns for integrity in online exams and their opinions regarding our proposed proctoring technique.

Keywords

Online exams, proctoring, biometrics, survey.

Introduction

Reliable assessment is a concern for any instructional mode, but the increased adoption of and reliance on online education has created an additional issue of devising effective proctoring for remotely administered online examinations. Although some existing research suggests that exam cheating is as prevalent in traditional face-to-face classes as in online classes (Grijvala and Nowell, 2006), detecting cheating in remote online exams is harder. This is because unlike traditional students who take exams in a controlled classroom in the physical presence of a proctor, remote students typically take them in uncontrolled environments (e.g., homes, public places), where it is relatively easier to consult unauthorized sources (e.g., notes, Internet, peers) or have others take the exam for them.

Existing strategies for proctoring online exams include remote live proctors and automated biometrics-based proctoring. In this paper, we present our research on integrating the complementary strengths of remote live proctors and biometrics-based monitoring as we believe it can significantly improve the integrity in remote online exams when compared to using any of the two methods individually. Although our focus is online exams, in our discussion of the advantages and challenges of using such a unified approach, we reveal a possible strategy improving integrity in exams in traditional classrooms as well.

The rest of the paper is organized as follows. We start with an overview of the popular online proctoring techniques, followed by our proposed approach and a prototype of the implementation architecture that is currently being developed. We then discuss the associated challenges and ways to mitigate them, and present results from a survey done among faculty and students about their opinions and perceptions regarding our technique. We conclude with a discussion of how to extend this to traditional courses.

The Explosion of Online Courses and Programs

Online learning has its roots in distance education (dating to the 1840s), and many such programs are now offered online as part of regular degree programs reaching millions of students for whom traditional classes are not convenient or viable. The online education revolution is spearheaded by massive open online courses (MOOCs), designed for unlimited participation and open access via the web. The year 2012

was "the year of the MOOC," as many providers associated with top universities emerged, including Coursera, Udacity, and edX (ProctorU website).

Examinations in online courses are typically administered remotely through the web with some form of proctoring. Sometimes students take exams for online classes at designated test centers, which is often inconvenient for students who require the flexibility of distance learning. Among remote proctoring techniques available today, the most popular ones are (i) remote live proctoring, provided by companies like *ProctorU* (ProctorU website), where a human proctor watches students via webcams while they take the exam on their computer; and (ii) biometrics-based proctoring, as offered by *Proctortrack* (Verificient Technologies, Inc. 2015), where a fully automated system monitors and records the student's exam-taking session via the webcam, and flags suspicious behaviors based on the student's face, eye, and knuckle movements, as well as activities in the surrounding environment, for later review by a human being.

ProctorU verifies a student's identity at the beginning of a test session in multiple ways – via photo id and by requiring the student to answer some personal questions. Currently it is being employed in online exams at our university for the past 3 years with no reports of cheating. However, because live proctors are unable to continually monitor a student throughout the test session, instances of cheating can be easily missed. Therefore, we feel the need to make online proctoring more secure to ensure authenticity and integrity of the degree programs that the exams are part of.

Proctortrack has been used at St. George's University (SGU) for about a year and a half, and we interviewed their former program leader John Modica about their experience with this technology. According to him, in a 2015 online course at SGU, after the introduction of *Proctortrack*, online exam cheating progressively declined from 11 incidents during the first exam to 1 during the last (Verificient Technologies, 2015). Their move to *Proctortrack* was driven by a need to make these exams online and hence more convenient and cost-effective for students, along with making monitoring more secure.

Live Proctoring vs. Biometrics-based Proctoring

Human proctors' ability to observe examinees' faces in videos is more robust compared to biometrics (Phillips and O'Toole, 2014). Furthermore, a proctor can better distinguish innocent bystanders in public places from potential cheating accomplices and immediately and intervene, whereas for biometrics-based proctoring, the flagged recordings need to be watched by a human later on to detect potential violations.

Live proctors also present disadvantages. Different proctors have different styles (e.g., strictness levels), and dishonest proctors can collude with students. A proctor's alertness may wane as the exam progresses due to boredom or exhaustion. Moreover, many live proctors monitor several online exams at the same time, often for different subjects and with different rules (e.g., open book vs. closed book), which scatters their attention. Finally, it is impractical for a proctor to analyze changes in mouse/keyboard usage patterns, which being unique can be used to detect impersonation.

Biometrics-based monitoring treats all examinees equally, cannot collude with students, can monitor eye and mouse movements during the exam that the live proctor cannot, offers continuous identity verification of the test taker and does not experience reduced alertness due to tiredness or boredom. This overcomes some of the significant weaknesses of live proctors. Moreover, biometrics is a burgeoning field and we anticipate future technology to enhance monitoring.

Our Approach: Consolidating Power

We propose combining live proctors and biometrics-based proctoring for enhancing the integrity in online exams. Such an exam session begins with a proctor visually verifying the examinee's identity via a photo id and his/her answers to some personal questions, and the biometrics software verifying an examinee's face, voice, and keystroke/mouse patterns. Hence, identity is verified in multiple, independent ways. To allow biometrics-based identity verification, students register their biometric data with the proctoring company upon enrolling in a course.

During the test, the biometric software continually monitors the students' face/eye movements and keyboard/mouse patterns to detect suspicious behavior. This thwarts many forms of cheating, including hidden accomplices using keyboards/mice attached to the examinee's system (i.e., the software will detect a mouse/keyboard pattern mismatch) and suspicious eye movements while corresponding with another person. Meanwhile, the live proctor watches the student and the contents of his/her screen (to ensure

he/she does not use unauthorized software). He/she can use notifications from the biometrics software to focus attention on a student's behavior - flag suspicious events missed by the biometric software, or mark suspicious events flagged by the software as benign. The entire session is recorded and reviewed by a third party or instructor to detect proctor-examinee collusion and other suspicious activities missed by the proctor. This also addresses the problem of a proctor's attention being scattered across multiple test takers and waning due to boredom or exhaustion; the biometrics software watches constantly without getting tired. Therefore, the two approaches work together in tandem and compensate for each other's weaknesses, thus creating a stronger overall proctoring platform.

Despite the benefits of combined approaches, some students may perceive such measures as excessive, though they may turn out to be a pedagogical asset. SGU students stated that *Proctortrack* was excessive, but this perception, according to Mr. Modica, deterred cheating. Based on this, the integrated system is expected to be perceived as even more excessive and can become be an even greater deterrent to cheating.

Proposed Implementation Architecture

We are currently in the process of implementing a prototype system based on our proposed approach. Figure 1 gives the system architecture, which comprises three key components:

- **Student client software:** the program installed on the student system sends the video from the webcam, sound from the microphone, the keystrokes and mouse movements captured from the keyboard and mouse, respectively and the capture of the student's screen contents to the proctoring company's server. The software can also execute the commands of the remote live proctor such as starting/ending/pausing the exam. In addition, the software enables the student to log into his/her account and supply biometric data to be used for biometric recognition during the exam session.

  Before the session begins, the client program checks to make sure that the system does not contain multiple mice, keyboards, and screens that can be used by hidden cheating accomplices. The client also checks to ensure that it is not running inside a virtual machine in an attempt to deceive/subvert the monitoring process. Finally, the client can block certain applications while the exam is in progress, as set by the live proctor.

- **Proctoring Company Server:** the proctoring company's server is the nexus of the exam session activity. It receives the video, audio, keystroke and mouse movement and screen capture data and records it. The data are encrypted using AES-256 algorithm to help protect the student's privacy. The data is analyzed for cheating attempts, and forwarded to the live proctor.

  Face and voice recognition algorithms are used to constantly verify a student's identity and to ensure that no other people are visible/audible around the test taker and to detect suspicious head/eye movements and detect student leaving the exam. Mouse movements and keystrokes are also analyzed to detect changes in typing rhythms and mouse movement patterns, which can be signs of the test taker being replaced. Detected potential cheating attempts are recorded for later analysis and are forwarded to the proctor. If the proctor suspects cheating, he/she can warn the student, or pause/end the exam. The proctor's commands are sent to the server, where they are logged, and are forwarded to the student's client.

- **Live Proctor Client Software:** this program runs on the proctor's system. It allows the proctor to start, end, and pause the exam. During the session, the proctor can view the student's video, hear the sounds in the student's environment, and view the contents of the student's screen. The proctor can also block applications on the student's system. Finally, if the proctor suspects cheating, he/she can flag the part of the session, which is recorded by the server for further scrutiny.

All communications between the clients and the server take place through the Transport Layer Security (TLS) protocol which encrypts and authenticates all in-transit data.

Challenges and Solutions

Like many new pedagogical ideas, our approach may be deemed controversial by faculty and students and face vast challenges before being accepted. Such challenges include concerns over false positives, privacy, and costs. While these concerns are inherent in the proposed approach, they can be mitigated.

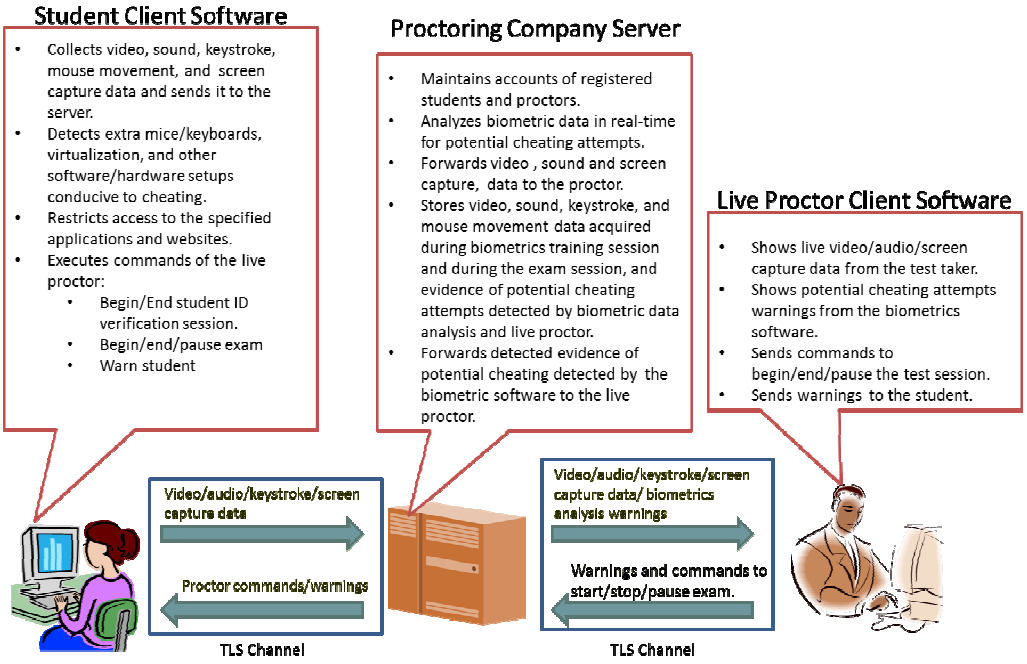

Figure 1. Architecture of the system implementing our approach.

False Positives: For biometrics-based proctoring, the software only flags suspicious activities that are reviewed by a live person to detect whether they are actually instances of cheating or not. Similarly, a proctor's accusations can be crosschecked against the evidence from the software recordings. Thus the integrated approach has the potential to reduce false positives drastically.

Privacy: Privacy infringement is perhaps the greatest objection to both live and biometrics-based proctoring. Many students feel uncomfortable being watched by unknown proctors in their homes or with software recording their biometric data. This is evidenced by past studies (Karim et al., 2014), student complaints regarding *ProctorU* (Ibarra and Mahmoud, 2015), and reports of anti-*Proctortrack* student protests at Rutgers. In fact, privacy concerns are likely to be stronger in case of biometrics monitoring. One way to alleviate privacy-related concerns is through transparency, clear documentation and communication of the proctoring company's FERPA-compliant policies and regulations. Educating faculty and students about the benefits of the proposed approach is also critical in creating wider acceptance.

Cost: Implementing the combined system can be expensive for customers (like, educational institutions). However, there will be much overlap in hardware and software used for the integrated system (for instance, a webcam can be used for live proctoring and eye-tracking for the biometrics system). Another potential way to drive down costs is to employ available open-sourced technologies (free). So we estimate that the cost of the integrated system will not be significantly more than $15 per student for a one-hour exam (that is charged by both *ProctorU* and *Proctortrack).*

Hardware issues: One concern regarding a fully online proctoring system is hardware failure during the exam. To minimize this, the proctoring company can compile a list of hardware specifications (such as, camera resolutions) and certify it for use with the system that the institution will mandate for the students enrolled in a course where such a system is deployed.

Survey Data Analysis

Faculty Interviews: Among the 5 instructors that we interviewed, majority had integrity concerns about online exams (3 out of 5). They were willing to adopt biometrics-based proctoring and felt that such an approach would be more effective than a live proctor for detecting cheating attempts. Almost all of them felt that such a proctoring technique is likely to cause concerns for intruding upon student privacy due to constant monitoring of behavioral patterns, as expected, whereas some (2 out of the 5 interviewees) expressed concerns about the effectiveness of the technique. One specific comment is: *"I like biometrics based proctoring, but feels that alone it is not enough."*

Most of the participating faculty agreed that our integrated approach of combining biometrics and live proctoring would be definitely more effective than any of the two individual methods. One faculty

particularly mentioned that given the proliferation of biometrics in different security applications, its dominance in proctoring solutions is inevitable in the near future.

***Student Surveys**:* Among 30 students (22 undergraduates and 8 graduates) who completed the survey, there were 22 females (73%) and 47% belonged to the age group of above 40. Moreover, 40% were Caucasians and 30% Hispanics. Most of them had taken more than 10 online courses.

As expected, the major concern among students seemed to be in regards to privacy. 43% of the students mentioned that they were not comfortable taking an online exam while being monitored via biometrics and 63% agreed that such monitoring intrudes on their privacy. Furthermore, statistical analyses revealed no significant differences in the level of privacy concerns among groups of students by gender (p-value = 0.45), age (p-value = 0.87), ethnicity (p-value: 0.24) or class level (p-value: 0.83).

Unlike the faculty, 45% of the students did not believe that a biometrics-based proctoring system will be effective in preventing cheating in an online exam although 50% of them believed that an integrated approach may be more effective that either of these individual proctoring methods (Table 1).

Answer	Response (n=30)	Percent
More effective than just a live proctor in preventing cheating	8	27%
More effective than just biometrics proctoring in preventing cheating	7	23%
Less or equally effective than either of the two proctoring techniques	15	50%

Table 1: Survey responses to the question on the effectiveness of the combined technique.

One student particularly commented: *"If it helps to ensure the integrity of online exams, I am open to the idea. But I believe that maintaining the human element in the process is also essential."*

Hence our proposed system seems to have considerable potential in ensuring integrity of online exams, more so than any currently available method, despite valid concerns regarding the invasion of privacy.

Conclusions and the Future: Extension to the Traditional Classroom

Solutions are needed to combat cheating in online exams. We consider synergizing two existing solutions - remote live proctoring and biometrics monitoring - to offer more effective proctoring for online exams. Broadly, we estimate that our integrated system can reduce incidences of cheating by an additional 5-8% over biometrics-based proctoring that reports 91% reduction in online exam cheating (Verifiicient Technologies, 2015). Moreover, we believe that a similar integrated proctoring system can be developed for traditional classrooms where cheating is prevalent as well (King et al., 2009), via seamless integration with Learning Management Systems. This can provide additional support for instructors who typically must simultaneously watch many students. Furthermore, wider applications should lead to better acceptance as faculty and students become familiar with the underlying techniques and their advantages. Addressing the concerns of privacy will go a long way toward making the system a successful reality.

REFERENCES

Grijvala, T.C. and Nowell, C. 2006. "Academic Honesty and Online Courses," *College Student Journal* 40:1, pp. 180-186.

Ibarra, N. and Mahmoud, Y. 2015. "Online Proctoring Raises Privacy Concerns" (September 7, 2015), *Daily Spartan*. Accessed September 1, 2015. Web link: http://spartandaily.com/119401/online-proctoring-raises-privacy-concerns

Karim, M.N., Kaminsky, S.E. and Behrend, T.S. 2014. "Cheating, Reactions, and Performance in Remotely Proctored Testing: An Exploratory Experimental Study," *Journal of Business and Psychology* 29:4, pp. 555-572.

King, C.G., Guyette, R.W. and Piotrowski, C. 2009. "Online Exams and Cheating: An Empirical Analysis of Business," *The Journal of Educators Online* 6:1, pp. 1 – 11.

Phillips, P.J. and O'Toole, A.J. 2014. "Comparison of Human and Computer Performance across Face Recognition Experiments," *Image and Vision Computing* 32:1, pp. 74-85.

ProctorU Website. http://www.proctoru.com/.

Verificient Technologies, Inc. 2015. "Case Study Ensuring Medical School Excellence".