

Review Article

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Biometric Monitoring Using Facial Recognition, Data Collection, and Storage: Safety and Privacy Perceptions of High School Students

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Abstract

With the advent of school shootings across the United States including the murders of seventeen Marjory Stoneman Douglas High school students and teachers; school administrators, faculty, parents, and students have extensive security and safety concerns about individuals entering and exiting school grounds. A biometric technology widely used to authenticate individuals as part of campus security and safety is facial recognition.

Facial recognition overcomes one of the significant drawbacks with biometric systems since it does not require direct contact or proximity to sensors to identify personnel on the school campus. How effective facial recognition systems are in monitoring individuals' existence on campus in large part depends on student's cooperation and attitudes supporting this biometric technology. This paper explores the perceptions of high school students towards biometric monitoring using facial recognition with their concerns over privacy and safety.

This study utilizes quantitative methods to investigate how students' opinions formed in High school about facial recognition based on beliefs about informational privacy and their appraisal of school safety conditions on campus. This study provides guidance into student views and opinions on biometric monitoring that could be present throughout their high school facilities.

The results indicated that aspects of facial recognition provide concern about students' informational privacythat includes the operations, administration, and management of a biometric monitoring system by the school's faculty and staff. The implications on school systems as the result of this study suggests that school policymakers and state representatives need to carefully consider and be aware of students' perceptions on safety and privacy in consideration of school security using facial recognition.

Keywords: Immutable; Personal information; Social media; Personal data; Informational privacy

Introduction

School administrators, faculty, parents, and students have widespread concerns over effective methods of keeping track of students entering and leaving school, including classroom attendance that is crucial to campus safety and security. A biometric technology used to authenticate student presence as part of campus operations and security including efficiently maintaining student classroom attendance is facial recognition. Facial recognition overcomes one of the significant drawbacks with biometric systems since it does not require direct contact or proximity to sensors to identify individuals on a school campus. How efficient facial recognition systems are in monitoring a student's presence on school grounds in large part depends on their cooperation and attitudes with supporting this biometric technology. This paper explores the perceptions of high school students towards biometric monitoring using facial recognition and their concerns with the subsequent data collection and storage. This study utilizes a quantitative method to determine how and in what way students' opinions in High school are on facial recognition based on their experiences and knowledge of biometric technologies. This study will uncover and obtain key insight into student views and opinions on immersion into facial recognition systems that could be present throughout their high school facilities. This study explores the privacy and safety aspects of facial recognition monitoring including operations and management of data storage by the school's administration, faculty, and staff.

Literature Review

The literature review cantered around the important aspects of students' perceptions and views on biometric systems, the focus on

safety and privacy. In Figure 1, the concept map provides the essential topics targeted for the literature review and breaks down these topics of privacy and safety into distinct subtopics.

Safety

Safety is a crucial part of maintaining a productive and positive learning environment. A safe school is one in which students, faculty, and staff have a limited and very little chance of harm or subjected to fear and intimidation [1]. School safety is one of the broad categories that determines school climate. School climate is defined using the four types of academic, community, safety, and institutional environment [2]. A safe school climate is essential for high student outcomes and positive behaviours.

Safety is the most important aspect of schools today, keeping students safe has the highest priority to ensure a learning environment free of fear and hostility. School safety is the physical and emotional security provided by school staff and students, with appropriate disciplinary actions [3]. An important aspect associated with all three

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elements of school safety is verifying and identifying school students and faculty members. School safety begins with keeping track of what individuals belong while alerting staff of those persons not authorized to be on school property.

Ever since the beginning of time people recognize and accept each other's identity based on physical traits and behavior. In the early 1900's fingerprints were used in criminal investigations, today there is the Automatic Fingerprint Identification Systems (AFIS) used universally by government agencies [4]. Biometrics have expanded beyond fingerprints, now many physical and behaviours are incorporated into biometric systems.

Biometric monitoring physically based on features such as face, eyes, or fingerprints. Biometrics can also be used to measure human behavioural characteristics such as a gate (the way we walk), odor, how does a swipe to a computer screen, or a signature gets written. Biometrics such as facial recognition based on two human traits, distinctiveness, and permanence [4]. No two persons have identical characteristics no matter how similar, and this makes all of us different from each other or distinctive. The concept of permanence comes from our keeping our human features as we age, wear sunglasses, or apply makeup.

Verification and identification are two modes of operation for biometric recognition [5]. The first mode of verification with facial recognition is to validate identity, stating you are whom you say you are. The system captures facial characteristics and compares these to the indicated individual's stored profile located in a database, a oneto-one match operation. Identification is when your facial features are captured and compared to all the entries in a database; this would be a one-two many match operation [5].

Using this relevant school example of a student upon entering school would be involved in a verification mode by the facial recognition system, whereas walking to class the facial recognition system would perform an identity operation noting the whereabouts on campus at a time and place. Student verification is part of identity assurance, providing a checkpoint for safely admitting students and faculty based on their facial recognition pattern stored in a secured database.

For identity this would fit into campus security, ensuring that intruders who are not authorized to be on campus are detected and reported to school security. Both verifications as of identity assurance and identity scans are components of school safety, allowing students and faculty onto the campus while keeping intruders off. Safety is a crucial part of students' emotional well-being [2]. Ensuring only individuals who belong on campus is a critical part of school safety.

Privacy

Privacy is a crucial issue to understand when participating (knowingly or unknowingly) in a system that involves personal data such as a biometric authentication system with facial recognition. "Surveys show that privacy is a primary concern for citizens in the digital age" [6]. One of the critical issues with facial recognition systems is the capturing of your physiological traits and recording these personal characteristics after analysis and statistical computations. Once a measured and statistically processed a profile stored in a database, it is immutable- unlike a password, there is no recourse to take back or make changes to your biometric data.

This study is concerned with instances of informational privacy where personal information uniquely describes you. Westin [7] describes informational privacy is "the right to exercise some measure of control over information about oneself." Whether it is your date of birth or social security number, thumbprint or facial scan, how you swipe a computer screen or walk (gait), you have personal data managed by someone else. In school, your data is kept by the administration that includes the principal and staff with IT support personnel.

Another element of privacy is your whereabouts, where you are and whom you are with at certain times. This aspect of privacy is especially important to high school students, as far as whom they eat lunch and socialize with during school hours. "Those who desire to remain anonymous in any particular situation could be denied their privacy by biometric recognition" [5]. Biometric systems especially facial recognition could cause students to feel overexposure is violating their privacy along with their friends. This lack of privacy due to monitoring by a biometric system could provide a barrier for student cooperation, the presence of students and whom they associate with could be monitored and lead to negative repercussions. For instance, with biometric system monitoring, association with a fellow student charged with a crime could also lead to arrest as an accomplice.

Students are concerned with electronic monitoring systems being used to punish as well to protect. "Concern is naturally growing over whether this information might be abused to violate individuals' rights to anonymity" [5]. Students are initially hesitant leading many opting out until their perceptions evolve into one of trust in the biometric system including the secure storage of biometric data.

Research Methodology

A quantitative method of a survey distributed to students with twenty questions should take approximately twenty-five minutes to answer. The survey starts with three short paragraphs to inform students of the purpose of the study, exposure to biometrics including facial recognition. Lastly, assurances of student anonymity along with their right to opt out of the survey at any time.

There are five yes or no questions to probe the student's background and familiarity with biometrics including facial recognition. There are three demographic questions on age, ethnicity, and gender. Lastly, there are twelve questions on student school safety and privacy for a total of twenty survey questions [8,9]. A total of sixty-two high school students partook in the online survey using Google Forms, and all sixty-two of these students answered all the twenty survey questions.

Findings

The essential question for this study is, "What are the perceptions of high school students with privacy and safety towards school usage of biometric monitoring using facial recognition and the subsequent data collection and storage?". This critical question is at the heart of the study, with the results of the student questionnaire needed to provide these valuable insights into student's perceptions and opinions [10]. There is no one question on the student questionnaire that will directly respond and answer the essential question; it will be the culmination of the data from all the questions on the way students react.

In providing insight into the study's essential question, a series of crucial follow-on questions are used to aid in answering this essential question for this study. This first question relates to student's feelings about school safety by asking "How and in what ways do students at High school realize that biometric monitoring such as facial recognition helps protect them and keep them safe?". The following question supports the responses about student's perceptions on facial recognition keeping them safe is "In your opinion, how would you describe the effects of a system that monitors students throughout school could have on the school climate concerning security and social/emotional wellbeing?". A majority of the students, 33.9% felt this is restrictive while 27.4% said it makes no difference, and 21% felt it makes the school campus secure. One survey question asks students, "In your opinion, how would you describe facial recognition as a way to gain entry into school?" to further understand if students feel this method of authentication is effective in keeping them safe from unwanted intruders that could gain access to the school campus. There are 37.7% of students that felt using facial recognition to enter school is acceptable, while 24.6% thought along those lines as well with good responses, and 21.3% did not think this as good [11].

By enrolling in a school that using facial recognition for student authentication and campus security, how and in what ways do students gain an understanding of this technology and how it affects them? One of the survey questions is focused on this aspect "What do you think Biometrics are?". Another survey question is related to students understanding of biometrics and facial recognition "When a cellphone does a fingerprint or a facial scan, where do you think the data stored once this happens?". This survey question tests students understanding of how applications with facial recognition work. Most students at 72.1% know what biometrics when asked, while the fact of 64.5% bolsters this knew that biometric data in the cell phone's internal memory is encrypted. The survey question, "In your opinion, how would you describe password-based solutions, such as an eight-secret letter word, as a way to gain entry into school?" provides students with a traditional alternative to facial recognition with a password system to discover if they feel this is an effective way to enter the school. The responses to using password-based solutions to enter the school are mixed with approximately a 50-50% split between 37.7% not good, 32.8% acceptable, 16.4% good, and 13.1% inferior.

How capable are school administrators and faculty in forming an awareness of the issues and concerns with biometric monitoring and data collection? This survey question "In your opinion, are you confident in the operation of a facial recognition system by security personnel and the maintenance of the data by school administrators?" relates directly to the opinion students have on how biometrics are managed at school by the administration. Few students are highly confident at 4.9%, with 16.1% uncertain confident, 22.6% are confident, 27.4% somewhat confident, and the largest percentage of 29% not confident. Another survey question directed at maintaining biometric data collection regarding administrators and faculty awareness of issues with a facial recognition system, "How do you feel about the storage of biometric data from facial recognition, your level of ease with security from unauthorized access or inappropriate third-party use?". A large percentage of students are concerned about the inappropriate thirdparty usage of biometric data with 25.8% strongly concerned, 33.9% concerned, 24.2% do not care, lastly 16.1% confident. In addition to these two relevant questions on the capabilities of maintaining biometric monitoring, the survey question, "Do you think that students should be able to opt out (decide not to be included) of a biometric system using facial recognition at school?". This last question queries students on their intent to opt out of a facial recognition system that relates directly to their views of administrators and faculty capabilities to maintain a biometric system. The most significant percentage of students at 29% felt they should be able to opt out of inclusion in a facial recognition system, 27.4% sometimes said yes, 22.6% were unsure, 6.5% sometimes no, lastly 14.5% stated no opting out [12].

Do student's experiences and knowledge of biometric data technology and techniques influence their acceptance of using facial recognition technology? From earlier discussed survey questions students are knowledgeable about biometrics and their applications with 71.2% knew what biometrics are and 64.5% understood how biometric data is encrypted and stored. Many students are familiar with biometrics when asked ". Have you ever heard before about biometric systems such as facial recognition (before our study)?" with over 90% answering yes (91.9%). Students experiences with biometric data begin with their encounters represented by the question:" Have you ever been exposed to facial recognition such as in an airport or using a cell phone

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(before our study)?". Students answered 82.3% in the affirmative with their exposure to facial recognition, further bolstered by the survey question "Have you traveled outside of the United States?" with an overwhelming 96.8% of students having flown internationally which exposes all travelers to facial recognition by government agencies. A survey question that queries students on their experiences with personal data asks, "Have you ever been personally the victim of identity fraud?" students responded with 93.5% have not been exposed to identity fraud unsurprisingly with students early in their financial experiences.

To query students comfort level with facial recognition, "In your opinion, are facial recognition systems an appropriate solution for monitoring the school campus for unauthorized adults and students?". Most students felt facial recognition for monitoring unauthorized individuals on the school campus was an appropriate solution with 11.3% strongly agree, 35.5% agree, while 16.1% disagree along with 12.9% strongly disagree followed by 24.2% of students did not know. Furthermore, students are asked, "In your opinion, are you comfortable using biometric-based solutions to verify your identity?". A large majority of students felt comfortable using biometrics to verify their identity with 37.7% fairly well, 24.6% quite well, and 8.2% perfectly having the remaining 18% very little and 11.5% not at all comfortable. These two questions regarding their acceptance of biometrics in school are gauged by the first two testing their knowledge of biometrics that students scored highly knowledgeable. The survey question, "In your opinion, are other biometric-based solutions (fingerprint, iris recognition, retinal scan) a suitable solution for entry into school?" uncovers other biometric solutions other than the facial recognition that students may prefer that are biometric-based. A large percentage of students thought other biometric solutions for entry into school are acceptable with 42.6% agree, 4.9% strongly agree followed by 11.5% disagree with 11.5% strongly disagreed while 29.5% did not know [13].

What is the significance of the students' parents in a STEM profession have in their perception of facial recognition and collection of biometric data? The survey question asks students "Does one of your parents or guardians work in a STEM-related field like science, technology, engineering, math or computer science?". This question probes parent/guardian background to provide a basis of influences at home to biometric systems and applications. A clear majority of students at 80.6% did not have a parent or guardian employed in a STEM-related field providing little influence at home on their perceptions towards biometrics.

Is the privacy of students threatened due to campus-wide surveillance using a facial recognition system? One question directly asks students about possible and perceived invasion of privacy. "How comfortable are you in realizing that facial recognition systems could continuously monitor the school campus?" with most students responding positively with 37.7% fairly well, 19.7% quite well and 6.5% perfectly comfortable while 14.8% are not at all and 21.3% very little comfort. The next question is probing student comfort levels with constant monitoring by "In your opinion, how would you describe the effects of a system that monitors students throughout school could have on the school climate concerning security and social/emotional wellbeing?". Many students felt it would be restrictive at 33.9%, very restrictive at 12.9% with some students saw this as a secure environment with 21% secure and 4.8% very secure while 27.4% of students felt it would make no difference [12]. Both survey questions respond directly to concerns students have with privacy while limited on providing a safe environment. The survey question, "In your opinion, how would you describe facial recognition as a way to gain entry into school?"

also delves into issues of privacy on students' opinions of using facial recognition to enter school grounds. Most students believe facial recognition is superior with 6.6%, 24.6% good, and 37.7% acceptable while some students though facial recognition would not be good with 21.3% not good and 9.8% inferior.

Do students perceive that the facial recognition system could be used to punish them doing something wrong in place of protecting them from outside intruders? This survey question directly relates to the operations at the school of a biometric system "In your opinion, are you confident in the operation of a facial recognition system by security personnel and the maintenance of the data by school administrators?". Many students are not confident of school administrators operating facial recognition systems with 29% not confident, while 27.4% are somewhat and 22.6% and confident. There are 16.1% of students that are uncertain confident and 4.9% highly confident having administrators maintain facial recognition systems. This survey question, "How comfortable are you in realizing that facial recognition systems are continuously monitoring the school campus?" also queries students on their beliefs on the proper use of facial recognition systems. Many students are perfectly comfortable at 6.5%, quite well at comfortable with 19.7%, and 37.7% fairly well comfortable being monitored by school facial recognition systems. Some students at 14.8% were not at all comfortable with 21.3% very little comfort monitored by facial recognition systems at school.

Does the age, ethnicity, or how students identify their gender influence their opinions on biometric monitoring use with facial recognition? The survey questions, "What is your age?", "I consider my ethnicity to be:" and "I identify myself as:" survey questions explicitly ask about students age, ethnicity and gender identification. These three demographic survey questions can be used to find strong correlations between student responses and demographics possibly leading to cause and effect. Many students taking the survey are White at 45.2% and Asian/Pacific Islanders at 32.3% with 6.5% Latino. Most of the respondents are Male at 64.5% with Female at 24.2%. Age evenly distributed with the largest group being 17 years old at 33.9%, then 16 years at 25.8%, and 18 years or older at 24.2% followed by 15-year-old at 12.9%.

Together these twenty survey questions provide data that supports understanding the essential question, "What are the perceptions of high school students with privacy and safety towards school usage of biometric monitoring using facial recognition and the subsequent data collection and storage?". By collecting student's opinions and views of biometric monitoring especially using facial recognition, the primary users as well benefactors of this technology in schools, perceptions can be understood more clearly.

Discussion

To answer the study's essential question "What are the perceptions of high school students with privacy and safety towards school usage of biometric monitoring using facial recognition and the subsequent data collection and storage?", sixty-two high school students participate in a twenty-question survey. There are a series of eight supporting underlying questions that aid in understanding how the survey outcomes respond to the study's essential question. By analyzing the data results relevant to the underlying questions, the data results about the essential question can be readily understood.

How and in what ways do students at High school realize that biometric monitoring such as facial recognition helps protect them and

keep them safe? Many students felt it would be restrictive while some thought it made the campus more secure. Students also confidently thought that facial recognition system would be an effective way of granting students and teachers entry into school.

By enrolling in a school that using facial recognition for student authentication and campus security, how and in what ways do students gain an understanding of this technology and how it affects them? The majority of students at over 72% understand biometrics and facial recognition, while there was an even split between students who believed a password-based system was ineffective to those who thought this method of authentication would be fine.

How capable are school administrators and faculty in forming an awareness of the issues and concerns with biometric monitoring and data collection? Students lacked confidence in the administering of a facial recognition system when asked: "In your opinion, are you confident in the operation of a facial recognition system by security personnel and the maintenance of the data by school administrators?". These sentiments from students on the lack of confidence in the facial recognition system administration with responses to the question "How do you feel about the storage of biometric data from facial recognition, your level of ease with security from unauthorized access or inappropriate third-party use?". A large percentage of students (25.8% strongly concerned, 33.9% concerned) are troubled by the possible unauthorized use of their biometric data by a third-party. When students asked should they be allowed to opt-out of a facial recognition system at their school, 29% said yes, and 27.4% sometimes said yes.

Do student's experiences and knowledge of biometric data technology and techniques influence their acceptance of using facial recognition technology? We know from querying students on facial recognition and applications a vast majority of over 72% are knowledgeable. An overwhelming proportion (91.9%) of students have known and exposed to biometric systems including facial recognition either in international airports or by cell phone authentication schemes (82.3%). Students at the same time did not accept using a password-based system for entry into school with 37.7% stating not good, 32.8% acceptable, 16.4% good, and 13.1% inferior. The data indicates that students that participate in the survey are knowledgeable and have experiences with biometrics including facial recognition while seeing the vulnerabilities of using a password for authentication when entering school grounds.

What is the significance of the students' parents in a STEM profession have in their perception of facial recognition and collection of biometric data? Most students were not influenced at home by parents or guardians with over 80% not employed in a STEM-related field. Students perceptions and experiences with biometrics had to do with their exposures to the airport or cell phone application using biometrics.

Do students feel their privacy threatened because of campus-wide surveillance with a facial recognition system? When students asked, "How comfortable are you in realizing that facial recognition systems could continuously monitor the school campus?". Overwhelmingly responded that they were comfortable, yet when asked "In your opinion, how would you describe the effects of a system that monitors students throughout school could have on the school climate concerning security and social/emotional wellbeing?" the majority of students responded they felt it would be restrictive. Students did feel they would be comfortable with a facial recognition system while there would be restrictions due to the constant monitoring, students did believe a facial recognition system would make them more secure on school grounds. When asked "In your opinion, how would you describe facial recognition as a way to gain entry into school?" most students felt facial recognition is a superior way of providing students entry into school.

Do students perceive that the facial recognition system could be used to punish them doing something wrong in place of protecting them from outside intruders? Most students are comfortable with being monitored on campus with a facial recognition system with perfectly comfortable at 6.5%, quite well at comfortable with 19.7%, and 37.7% fairly well comfortable. Students are troubled when asked "In your opinion, are you confident in the operation of a facial recognition system by security personnel and the maintenance of the data by school administrators?" with 29% not confident, while 27.4% are somewhat and 22.6% and confident. Students are comfortable with the facial recognition monitoring throughout the campus but lack confidence in the operations and maintenance of the system [11].

Does the age, ethnicity, or gender identity of students influence their opinions and views on biometric monitoring using facial recognition? The results of the study are from a majority of male students, White and Asian/Pacific ethnicity from ages of 15 to 18 years old. These demographics from the survey are more to do with the type of students enrolling in STEM courses that can be associated and correlated with responses and trends due to individualized groupings.

Conclusion

The safety of students on campus and their privacy regarding informational data are vital concerns when evaluating the applicability of a facial recognition system for school safety and security. The successful deployment of a facial recognition system on school grounds must include the support and cooperation of students, especially since students are the vast majority of individuals on campus. Consequently, one of the more critical aspects of understanding the viability of a biometric system for school security is student's perceptions and views.

Students' perceptions and opinions of a biometric system for campus-wide security are of vital interest to this study. The data from the student survey shows that students are knowledgeable about biometric data technology and techniques, hence adding significance to the student perceptions and views on ways a school deploys and manages school security using biometrics especially facial recognition. Students view a facial recognition system as a superior way of providing entry into school with additional campus-wide safety features; while some students felt uncomfortable due to additional restrictions imposed by monitory throughout the campus.

It is clear from the data collected from the student surveys that students have significant concerns on the management and operations of a biometric system that captures and stores their facial profiles for both verification and identification. In light of recent data breaches at Yahoo, eBay, Target, and Equifax to name several, students are entitled to feel anxious about the collection and storage of their informational data that includes biometrics. Once an unauthorized third-party compromises informational data, this data being immutable can be used throughout a student's lifetime for detrimental reasons. Therefore, it is of vital interest that students feel confident that their informational data is managed in a secure environment safeguarding all aspects of data privacy.

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Future Work

Protecting student privacy while providing the utmost safety in schools today is a challenging goal that needs additional safeguards in place to keep student informational data protected and secure. Best practices for the operations, administration, maintenance, and provisioning of a biometric system that includes facial recognition must be adherred to and communicated in a way that gives students the utmost confidence that their personal data will be kept private. The implications on school systems as the result of this study suggests that school policymakers and state representatives need to carefully consider and be aware of students' perceptions on safety and privacy in consideration of school security using facial recognition.

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