

Smart Schools: Enhancing Safety and Management Through IoT and AI Technology

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ABSTRACT

The use of artificial intelligence (AI) and the Internet of Things (IoT) technology is gaining popularity in various fields, including education. However, ensuring student safety in the school environment remains a challenge. This community project aims to address this challenge by leveraging IoT and AI technology to create a safer school environment and improve school management. To achieve this goal, the project will deploy surveillance cameras and sensors throughout the school premises to collect data on student activities. The data will be analyzed using AI algorithms to identify concerning behavior or incidents of violence, bullying, or fear. This will enable school administrators to take proactive measures to prevent such incidents and manage student activities more effectively. The proposed system will facilitate data-driven decision-making by providing school administrators with valuable insights into student behavior. The collected data will help identify areas where improvements are needed and allow for the implementation of evidence-based policies and programs. The system will also enable administrators to monitor the effectiveness of their interventions and adjust accordingly. The project's contributions include developing a system that uses IoT and AI technology to enhance school management and create a safer and healthier school environment for students. The project also provides insights into student behavior and enables administrators to make data-driven decisions to prevent incidents of violence, bullying, and fear. Specific results of the project include the identification of patterns and trends in student behavior, the detection of incidents of violence, bullying, and fear, and the implementation of evidence-based policies and programs to prevent such incidents. In conclusion, this community project presents a novel solution to enhance school management and create a safer school environment. The use of IoT and AI technology provides valuable insights into student behavior, enabling administrators to make data-driven decisions and take proactive steps to prevent incidents of violence, bullying, and fear.

Introduction

In recent years, schools have been facing numerous security and safety challenges, including bullying, fighting, and school shootings. These incidents not only put students and staff at risk, but also disrupt the educational process. To address these challenges, there is a growing need for smart schools that utilize modern technology to enhance safety and management. This research paper focuses on applying the Internet of Things (IoT) and Artificial Intelligence (AI) technology to improve safety and management in schools. Specifically, the paper explores the use of AI computer vision to detect falling, fighting, and gun detection to alert school administrators and managers of potential safety threats. The aim is to create a safer school environment that prevents violence and bullying, thereby improving student outcomes and creating a better learning environment. This paper highlights the potential benefits and challenges of using IoT and AI in schools and provides insights into the implementation of smart school solutions. The research outcomes provide valuable insights for educational institutions and policymakers seeking to utilize technology for improving safety, mental, and physical health, and management in schools.

Literature Review

Bullying and violence in schools have been long-standing issues with serious consequences for both students and educational institutions. This literature review will delve into the prevalence of bullying and violence in schools and their harmful effects on students, identify the factors influencing this phenomenon, and evaluate the conclusions presented by studies and research papers to address these issues. This analysis will demonstrate the necessity of the proposed project.

The study "Injuries, Violence, and Bullying Among Middle School Students in Oman" found that bullying is prevalent among middle school students in the Sultanate of Oman, with sexual abuse being the most common form of bullying reported by both male and female students. Male adolescents are more likely to suffer injury and harm due to bullying compared to female adolescents. Students who experienced bullying were more likely to report poor mental and physical health, as well as lower academic achievement. The study concludes that there is a pressing need to address and mitigate the impact of bullying in schools. (Peyton et al., 2017)

The consequences of being a victim of bullying can include poor mental and physical health, increased symptoms of anxiety and depression, feelings of sadness and loneliness, and physical ailments such as vomiting, sleep disturbance, nightmares, headaches, and abdominal pain. Verbal bullying among female primary school students was linked to poor academic performance in writing, while physical bullying was associated with poor performance in numeracy and writing for both male and female students. Students who reported experiencing both verbal and physical bullying had lower achievement in reading, writing, spelling, grammar, and punctuation. (Al-Ali & Shattnawi, 2018)

"The Magnitude and Impact of Bullying among School Pupils in Muscat, Oman: A Cross-Sectional Study" confirms previous research on the prevalence of bullying among school students, both male and female. The majority of bullying incidents occurred within the school environment. Many victims did not know the reason for the bullying, and only a small number sought help from school staff after the incident. The study found that bullying had a negative impact on attendance, though it did not seem to affect academic performance. (Al-Saadoon et al., 2014)

School gun violence can have severe psychological consequences for students, families, school staff, and community members. These experiences can negatively impact students' healthy development from childhood to adulthood. Additionally, school gun violence can lead to decreased student scores on standardized tests, lower grades and more disruptive behavior in students, increased illness, divorce, burnout, and career changes in teachers, and increased costs for schools to purchase school safety training, services, technologies, and liability insurance. (Kolbe, 2020)

The study "Bullying in School" found that various factors can contribute to the occurrence of bullying in schools, and there is no specific profile of students who are involved in bullying. Students who exhibit certain characteristics, such as aggression, poor family relationships, and low socio-economic status, may be more likely to be involved in the cycle of bullying at later stages. Additionally, students who have negative attitudes, difficulty with academic and social cognition, and come from low-income families may be more likely to bully others. The study also found that victims of bullying may be more likely to have characteristics such as poor self-recognition, lack of social skills, and a negative self-image. Demographic factors such as gender and ethnic or racial background, as well as socio-economic status, may also increase the risk of a student being bullied. The study also found that mental health issues, such as self-esteem, and family factors, such as the employment status of parents, may also play a role in the occurrence of bullying. (Al-Ali & Shattnawi, 2018)

In conclusion, this literature review highlights the serious and pervasive issues of bullying, violence, and school gun violence in educational institutions. The harmful effects of these issues on students' physical and mental health, academic performance, and overall well-being cannot be overlooked. There is an urgent need to address and mitigate the impact of these problems. The proposed research paper, which utilizes AI computer vision to detect falling and fighting in the school environment, as well as detect guns to enhance school safety, has the potential to signifi-

cantly improve the school environment and prevent future incidents of violence and bullying. By leveraging technology to proactively identify and respond to potential threats, schools can create a safer and more secure learning environment for students, teachers, and staff.

Literature Review 2

This literature review will describe the approach employed for fulfilling the project's objectives. Object detection is a fundamental task in computer vision that involves detecting objects within an image or a video stream and identifying their location, class, and other attributes. Over the years, various object detection techniques have been proposed, each with their strengths and weaknesses. One of the most popular object detection techniques is You Only Look Once (YOLO). YOLO is a real-time object detection system that uses a single neural network to perform both object detection and classification. It works by dividing an input image into a grid of cells and predicting bounding boxes, class probabilities, and objectness scores for each cell. YOLO has the advantage of being fast, as it can process images in real-time, and it can detect objects in different scales and aspect ratios. However, YOLO can struggle with detecting small objects and overlapping objects. Other techniques that are commonly used for object detection include Faster R-CNN, Mask R-CNN, and RetinaNet. Faster R-CNN is a two-stage object detection system that uses a region proposal network to generate candidate object regions and a classification network to classify and refine these regions. Mask R-CNN extends Faster R-CNN by adding a segmentation branch that generates pixel-level object masks. RetinaNet, on the other hand, is a one-stage object detection system that uses a novel focal loss function to balance the contribution of easy and hard examples during training. These techniques have shown excellent performance in detecting small objects and complex scenes but are generally slower than YOLO. (Li & Cao, 2020) In recent years, object detection has also been approached using deep learning-based methods such as one-shot learning and few-shot learning. One-shot learning refers to the ability of a model to recognize new objects after seeing them only once, while few-shot learning refers to the ability to recognize objects after seeing them only a few times. These techniques have shown promising results in situations where it is not feasible to have a large dataset for training. School environments can benefit from YOLO's popular object detection algorithm, which can be used to detect specific actions. One of the advantages of YOLO is that it can quickly and accurately detect objects in real-time video streams. This makes it useful for applications such as surveillance, traffic monitoring, and security. (Li & Cao, 2020) In a school setting, YOLO could be used to detect specific actions such as fighting, bullying, or vandalism. By training the algorithm on a dataset of videos that show these actions, it can learn to recognize the relevant patterns and detect them in real-time. This could help school administrators and security personnel respond more quickly to incidents and prevent them from escalating. Compared to other object detection algorithms, YOLO is known for its speed and accuracy. This is because it uses a single neural network to make predictions, rather than dividing the image into regions and processing them separately. This means that YOLO can detect objects in real-time video streams with high accuracy and minimal delay. Another advantage of YOLO is that it can detect multiple objects in a single image or video frame. This makes it useful for applications where there may be multiple actions happening simultaneously, such as in a crowded school hallway. To sum up, The YOLO method is a very effective tool for detecting specific behavior in school settings. With the algorithm trained on relevant datasets and optimized for real-time video streams, it can provide accurate and timely information that can help prevent incidents and promote a safe and secure learning environment.

Method

The project will follow the least expensive and simplest way to achieve the mission, which is first, cameras will be distributed in an appropriate manner in the school, ensuring that there are no blind spots while maintaining the required privacy in some places. And during the implementation of this step, a motion sensor will be installed inside the ineffective rooms, such as storage rooms, individual skill rooms, and so on, to prevent it from being a suitable place for

bullying to occur. Secondly, monitoring tools will be linked using the Internet of Things technology with a server in the control room as it is shown in figure1, where screenshots will be processed in real time and a code alert will be issued according to the case (such as red code = violence, black code = weapon, yellow code = fall) and will The supervisor takes the necessary measures quickly and effectively according to the protocols agreed upon in the educational institutions. Third, the collected data will be used to improve the database and retrain the model to be more effective in the region and more accurate, and to identify new patterns. Later, the data can be used for statistical purposes to help decision makers make more effective and realistic decisions.

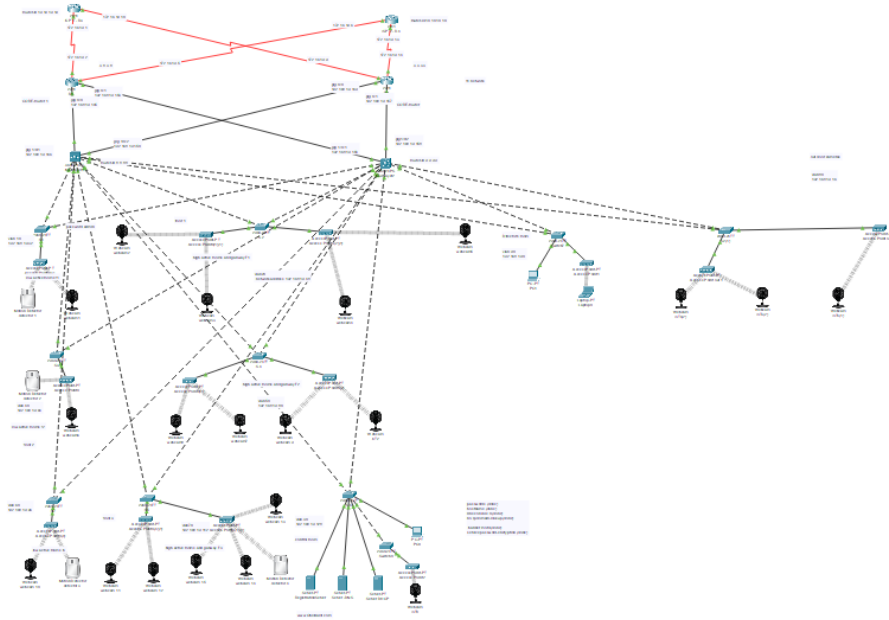


Figure 1. Network design

Results

After training the model on a database to monitor quarrels using Google Collab with only 25 images, the results were very promising, taking into account that the strength of the device's resources strongly affects the results along with the quality of the database.

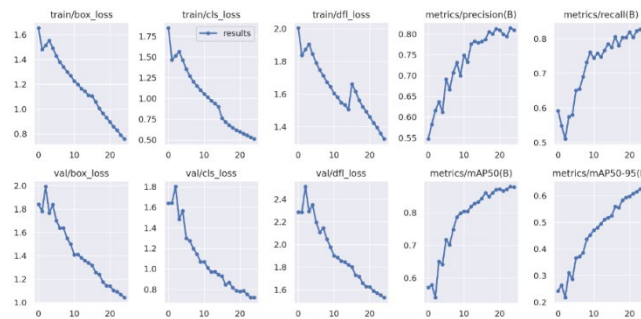


Figure 2. AI model statistic

As can be seen in the graphs, the model works well, and a lot of training and improvement will lead to very excellent results. Also shown in the second figure are signs that the device requirements must be higher than they are to obtain excellent performance in a short time.

Discussion

The utilization of IoT and AI in the education system to enhance safety and management has gained prominence in recent years. The present research paper focuses on the application of AI computer vision to detect falling, fighting, and gun detection in schools to alert school administrators and managers of potential safety threats. The literature review revealed that bullying, violence, and school gun violence have significant adverse effects on students' physical and mental health, academic performance, and overall well-being. Therefore, the implementation of smart school solutions is crucial in addressing these issues.

The proposed AI computer vision solution for smart schools has the potential to significantly improve the school environment by proactively identifying and responding to potential threats. Object detection is a fundamental task in computer vision, and various object detection techniques have been proposed, including the Faster R-CNN, YOLO, and SSD. Among these, the YOLOv4 model stands out due to its speed, accuracy, and ability to detect multiple objects simultaneously. However, this approach requires powerful hardware, which can be a challenge for some schools.

The implementation of AI computer vision technology in schools also poses some challenges, including privacy concerns and ethical considerations. Therefore, it is essential to ensure that the technology is used responsibly and transparently. School administrators and policymakers must take measures to ensure that the technology is not misused, and the privacy of students and staff is protected.

For school safety and management, computer vision can be used to detect falling, fighting, and gunfire in schools. This approach has the potential to prevent future incidents of violence and bullying and create a safer and more secure learning environment for students, teachers, and staff. However, the implementation of this technology must be done responsibly and transparently, considering privacy concerns and ethical considerations. The proposed research outcomes provide valuable insights for educational institutions and policymakers seeking to utilize technology for improving safety, mental, and physical health, and management in schools.

Conclusion

The use of modern technology, specifically IoT and AI, in schools can significantly improve safety and management, thereby creating a better learning environment for students, teachers, and staff. This research paper has explored the implementation of AI computer vision for detecting potential safety threats such as falling, fighting, and gun detection to alert school administrators and managers.

The literature review has highlighted the prevalence and harmful effects of bullying, violence, and school gun violence on students' mental and physical health, academic performance, and overall well-being. The proposed approach, which leverages technology to proactively identify and respond to potential threats, has the potential to significantly improve the school environment and prevent future incidents of violence and bullying.

The findings of this paper are valuable tools for educational institutions and policymakers seeking to improve safety, mental and physical health, and management in schools using technology. As technology continues to advance, it is crucial to explore its potential application in improving safety and security in educational institutions. The implementation of smart school solutions can create a safer and more secure learning environment, ultimately improving student outcomes and creating a better future for our society.

Limitations

Firstly, the success of the project is highly dependent on the reliability and accuracy of the AI computer vision system. While advancements in AI technology have been promising, there is still a risk of false positives and false negatives. This could potentially lead to unnecessary interventions or missed incidents, ultimately affecting the overall effectiveness of the system.

Secondly, the implementation of such a system requires significant financial investment in terms of hardware, software, and maintenance. This may not be feasible for all schools, particularly those in low-income areas or with limited resources.

Lastly, the system should not be solely relied upon as a solution for school safety. It should be complemented with a comprehensive approach that includes preventative measures, such as anti-bullying programs and mental health support for students, as well as emergency protocols in case of incidents.

However, it is important to acknowledge the limitations and challenges associated with implementing AI systems in schools, even though they have the potential to enhance safety and management.

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