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Research Article

Implementation of the YOLO Algorithm for Detecting Bullying Behavior at Pesantren Bisnis SMK Skill Village Islamic School Jonggol Bogor

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Abstract: Bullying is a serious problem that can disrupt the learning process and mental development of students, including in Islamic boarding schools. Early detection of bullying is essential to creating a safe and conducive learning environment. This study aims to apply the You Only Look Once (YOLO) algorithm to automatically detect bullying through video recordings in the environment of the SMK Skill Village Islamic School Business Boarding School. The method used involves collecting a video dataset representing various types of bullying behavior, labeling the data, and training an object detection model using the YOLOv5 algorithm. The developed system is capable of detecting and classifying bullying behavior in real- time with detection accuracy reaching [accuracy value if known]. The implementation of this system is expected to assist school authorities and boarding school administrators in monitoring, preventing, and addressing bullying incidents more quickly and effectively, while also serving as an initial step in leveraging artificial intelligence technology to create a safer and more comfortable educational environment.

Keywords: Behavior Detection; Boarding School; Bullying; Vocational High School; YOLO.

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1. Introduction

Bullying remains a social problem that is frequently encountered in society. Cases of bullying are widespread, particularly within educational institutions, including Islamic boarding schools (pesantren), where Islamic values are highly upheld in daily life. Bullying is an aggressive behavior that is intentionally carried out to cause physical or psychological discomfort to others. Therefore, bullying can be defined as an act of oppression or intimidation committed by one individual against another (Nur et al., n.d.). Bullying occurs in several forms with varying levels of severity, including physical, verbal, and indirect bullying. Examples of physical bullying include punching, pushing, hitting, kicking, and biting (Hertinjung, n.d.).

Along with the rapid advancement of technology, the implementation of Artificial Intelligence (AI) has emerged as a potential solution for automatically detecting and preventing bullying behavior. AI is a field of computer science that studies human intelligence in order to create intelligent systems capable of solving problems. Computer vision is a subfield of AI that enables machines to interpret and understand visual information from the world, such as images and videos (Laia et al., 2023). In the context of bullying prevention, computer vision can be utilized to analyze CCTV footage in school environments to detect suspicious or aggressive behaviors.

Based on the discussion above, it can be concluded that bullying is a serious issue that requires special attention, particularly in Islamic boarding schools, which are expected to serve as environments for character and moral development. By leveraging technological advancements, especially in the fields of artificial intelligence and computer vision, bullying incidents can be detected through visual monitoring systems. Therefore, this study aims to investigate and implement the YOLO (You Only Look Once) algorithm for detecting bullying behavior at the Business Boarding School of SMK Skill Village Islamic School as an innovative preventive measure to create a safe, comfortable, and Islamic learning environment.

This research contributes to the fields of artificial intelligence technology and educational environment monitoring, particularly within the context of Islamic boarding schools. Unlike previous studies that mainly focused on detecting violence or bullying in general school settings, this research specifically applies the YOLO (You Only Look Once) algorithm to detect bullying behavior in an Islamic boarding school environment, which possesses unique characteristics in terms of values, culture, and daily activities rooted in Islamic teachings and entrepreneurship.

The novelty of this study lies in: (1) the integration of computer vision technology (YOLO) with Islamic values by developing an automated detection system that not only identifies physical violence but also supports the character and moral development of students (santri) in Islamic boarding schools; and (2) the implementation of an AI-based visual detection system within the context of a business-oriented Islamic boarding school, a setting that remains largely unexplored in existing literature and previous studies.

2. Literature Review

Bullying in Islamic Boarding Schools

Bullying is a form of aggressive behavior that is intentionally and repeatedly carried out to harm, intimidate, or create discomfort for individuals perceived as weaker. This behavior can take various forms, including physical violence, verbal harassment, social exclusion, and psychological intimidation. Bullying is frequently found in educational environments due to the intensive social interactions among students. If not properly addressed, bullying can gradually become a normalized culture within a group, making it more difficult to eliminate. The consequences of bullying affect not only the victims but also the overall learning atmosphere and social environment of educational institutions (Hertinjung, n.d.; Nur et al., n.d.).

Islamic boarding schools (pesantren) possess unique characteristics compared to conventional schools because they implement a dormitory-based educational system in which students interact continuously throughout the day. While such an environment can positively contribute to character development, discipline, and religious values, it may also increase the likelihood of interpersonal conflicts among students. In some cases, uncontrolled seniority practices can evolve into bullying behaviors, either verbally or physically. Victims often experience emotional distress, reduced self-confidence, difficulties in social adaptation, and mental health issues that negatively affect their educational performance. Therefore, effective prevention and early detection strategies are necessary to minimize the occurrence and impact of bullying within pesantren environments (Yani, n.d.).

In addition to its psychological consequences, bullying can significantly influence victims' academic and social development. Students who experience bullying often demonstrate decreased learning motivation, increased anxiety, and reduced social engagement. Over time, these conditions may lead to lower academic achievement and hinder healthy personality development. Consequently, educational institutions are encouraged to establish more effective monitoring mechanisms capable of identifying and addressing bullying incidents promptly and appropriately (Nur et al., n.d.; Yani, n.d.).

Computer Vision in Surveillance Systems

In the book Digital Image Processing and Its Applications in Computer Vision, Agus Harjoko explains that "Computer vision is a branch of computer science that studies how computers can be endowed with the ability to see, recognize, and process objects from image or video data" (Harjoko, 2019). This field focuses on enabling computers to interpret and analyze visual information in a manner similar to human vision, thereby supporting various applications such as object detection, facial recognition, surveillance systems, and automated image analysis.

The rapid advancement of Artificial Intelligence (AI) has stimulated significant innovations in image and video processing technologies. One of the most prominent fields is Computer Vision, which enables computers to acquire, process, analyze, and interpret visual information in a manner similar to human vision. This technology integrates digital image processing techniques and machine learning algorithms to recognize objects, patterns, and activities from images or video streams. Such capabilities have positioned Computer Vision as a fundamental technology in the development of modern surveillance systems (Harjoko, 2019).

Computer Vision has been widely implemented across various sectors, including security, transportation, healthcare, industry, and education. In security applications, it facilitates automatic object and individual recognition, thereby reducing dependence on human observation. Computer Vision-based systems can continuously analyze video streams and generate real-time alerts whenever specific activities or events are detected. These advantages make the technology highly suitable for educational environments that require continuous and effective monitoring (Laia et al., 2023).

Beyond object recognition, Computer Vision can also be utilized to identify patterns of human behavior. Supported by deep learning algorithms, these systems can learn to distinguish between normal activities and potentially harmful actions. This capability creates opportunities for detecting aggressive behaviors, violence, and bullying incidents in educational settings. Therefore, Computer Vision represents a promising technological approach for developing automated bullying detection systems based on video surveillance (Achmad et al., 2025; Hadi et al., 2021).

YOLO (You Only Look Once) Algorithm

YOLO is a real-time object detection algorithm designed for efficiency and high-speed performance. The algorithm performs object detection in a single pass through a Convolutional Neural Network (CNN), making it highly suitable for real-time applications. According to Redmon et al., "YOLO applies a single neural network to the full image. This network divides the image into regions and predicts bounding boxes and probabilities for each region" (Redmon et al., 2016). This approach enables YOLO to simultaneously identify object locations and classifications, resulting in faster detection speeds while maintaining competitive accuracy compared to conventional object detection methods.

One of YOLO's primary strengths lies in its ability to balance detection speed and accuracy. Continuous improvements in subsequent versions, including YOLOv5 and YOLOv8, have enhanced the model's capability to recognize objects under various environmental conditions. Furthermore, the adoption of more efficient deep learning architectures allows these models to operate effectively even on devices with limited computational resources. These characteristics have contributed to YOLO's widespread adoption in applications requiring rapid and reliable object detection (Aini et al., 2021; Yani, n.d.).

Numerous studies have demonstrated the effectiveness of YOLO across a wide range of applications. The algorithm has been successfully employed for vehicle detection, facial recognition, face mask detection, and criminal activity monitoring. These studies indicate that YOLO can achieve high detection accuracy while maintaining efficient processing speeds. Consequently, YOLO is considered a suitable algorithm for developing an automated, real-time bullying detection system within Islamic boarding school environments (Azman et al., 2022; Susanti et al., 2023; Syaputra et al., 2023).

Previous Studies

Research on bullying detection has been conducted using various approaches and methodologies. One study utilized the C4.5 algorithm to identify students at risk of becoming bullying victims based on behavioral and psychological data. The findings demonstrated that technology-based approaches can support earlier identification of vulnerable students compared to traditional methods. However, the study primarily focused on data analysis and did not employ visual information to detect ongoing bullying incidents directly (Mulyana et al., n.d.).

The advancement of Artificial Intelligence has also encouraged researchers to apply machine learning and deep learning techniques for detecting aggressive behavior. Han et al. demonstrated that deep learning models can effectively identify aggressive behavior and cyberbullying within social media content. Their findings highlight the capability of AI systems to recognize behavioral patterns associated with bullying activities. Furthermore, AI-based solutions have been recognized as valuable tools for supporting anti-bullying policies through proactive and automated monitoring mechanisms (Djamzuri & Mulyana, 2023; Han et al., 2024).

In the field of Computer Vision, studies focusing on violence detection using YOLO have shown promising results. Sidik implemented YOLOv8 for detecting violent and bullying-related activities through video analysis and reported satisfactory performance in recognizing aggressive actions. Similarly, Abdillah et al. developed a real-time violence detection system using YOLOv5 to enhance public security and surveillance effectiveness. These findings suggest that YOLO possesses considerable potential for further development in video-based bullying detection systems (Abdillah et al., 2024; Sidik, 2024).

Beyond violence detection, YOLO has been successfully applied to numerous object detection tasks. Previous studies have utilized YOLO for vehicle classification, object recognition assistance for visually impaired individuals, and crime detection through night-vision imagery. The successful implementation of YOLO across diverse domains demonstrates its flexibility and adaptability in recognizing various object categories and human activities (Achmad et al., 2025; Nurfatikhah et al., 2025; Syaputra et al., 2023).

Research Gap

Based on the reviewed literature, most bullying-related studies have concentrated on psychological factors, victim identification, and behavioral analysis through surveys or social media platforms. Although these studies contribute significantly to understanding the causes and impacts of bullying, they rarely address automated detection mechanisms based on video analysis. As a result, bullying identification in educational institutions continues to rely heavily on victim reports and manual supervision (Han et al., 2024; Mulyana et al., n.d.)

Meanwhile, research involving the YOLO algorithm has predominantly focused on general object detection, security surveillance, facial recognition, and traffic monitoring applications. Although several studies have explored violence detection using YOLO, its implementation within Islamic boarding school environments remains limited. Moreover, no previous study has specifically developed a YOLO-based bullying detection system for the context of Pesantren Bisnis SMK Skill Village Islamic School (Abdillah et al., 2024; Sidik, 2024).

Therefore, this study aims to address this research gap by developing a Computer Vision-based bullying detection system using the YOLO algorithm. The proposed system is expected to automatically identify aggressive behaviors through surveillance video analysis, thereby assisting school administrators in improving monitoring effectiveness and implementing early intervention strategies against bullying incidents.

3. Research Methods

Research Data

The data used in this study consists of a CCTV video recording dataset collected from the environment of the Business Boarding School at SMK Skill Village Islamic School. This dataset is categorized as a private dataset because it was collected directly from the boarding school environment with permission and supervision from the relevant authorities.

The dataset is categorized as an object detection dataset, rather than a classification or segmentation dataset. Therefore, each video frame containing bullying actions was manually labeled using bounding boxes on the perpetrator and victim objects, along with annotations for action types such as hitting, pushing, or kicking.

Several important attributes of this dataset include: 1) Video resolution. 2) Duration of each recording. 3) Number of action frames (bullying).

Methodology Implementation

The methodology used in this study follows the AI model development cycle, consisting of the following stages:

a) Dataset Collection

Data collection was carried out by obtaining CCTV videos from the boarding school environment, particularly in public areas such as courtyards, dormitory corridors, and other open spaces.

b) Data Labeling

Each relevant frame was extracted from the video and labeled using tools such as LabelImg or Roboflow. Bounding boxes were applied to areas indicating whether a person was identified as fallen or not (e.g., person and fallen person), and then stored in a format compatible with YOLO.

c) Model Training

The system reads a configuration file containing the dataset, train split, and class label list. The preprocessing stage is performed automatically, including horizontal flipping, hue/saturation (HSV) adjustments, and mosaic augmentation to enrich data variation.

d) System Implementation

The trained model was implemented into a prototype system capable of receiving CCTV video input and providing output when bullying actions are detected.

Testing Design

The testing design was developed to address the Research Questions (RQ) and Research Objectives (RO) as described in the RP-RQ-RO Matrix Table. Testing was conducted through the following stages:

Table 1. Testing Design.

RQ / RO Code	Testing Indicator	Method / Measurement Tool
RQ1 / RO1	YOLO's ability to detect non-verbal bullying actions	Precision, Recall, and Accuracy on test videos
RQ2 / RO2	Accuracy and efficiency of the detection system	mAP (mean Average Precision), FPS (Frames Per Second), and Latency
RQ3 / RO3	Technical and non-technical challenges during implementation	Observation and documentation of the training and testing processes

4. Results and Discussion

Implementation and Testing

The following section presents the detailed results of each stage of the methodology implementation, including the implementation and testing outcomes obtained throughout this undergraduate research project.

Dataset Preparation

At this stage, dataset preparation was carried out by collecting a total of 365 images available on the Kaggle website as training data for the system. These images were used to train the model so that it could more effectively detect fallen objects based on the training results. The system performed adjustments to the downloaded images, as shown in the following figures:

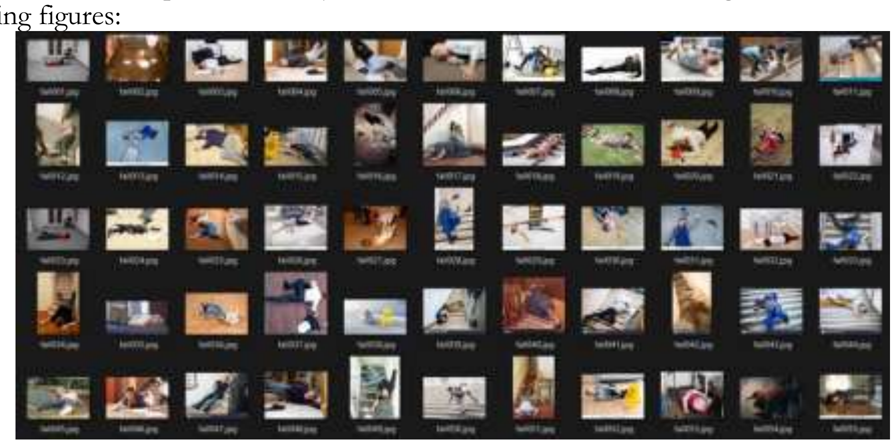


Figure 1. Adjusted Image Dataset.

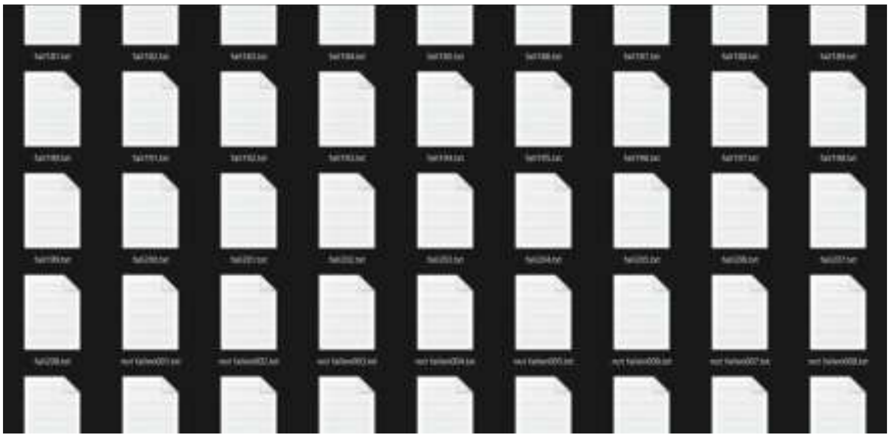


Figure 2. Adjusted Label Dataset.

After adjusting the image dataset obtained from Kaggle, a video dataset was collected in accordance with the research title, namely simulation videos of bullying incidents recorded by CCTV cameras within the environment of the Business Boarding School at SMK Skill Village Islamic School, Jonggol, Bogor. An example of the CCTV footage used as a bullying case sample is shown below:

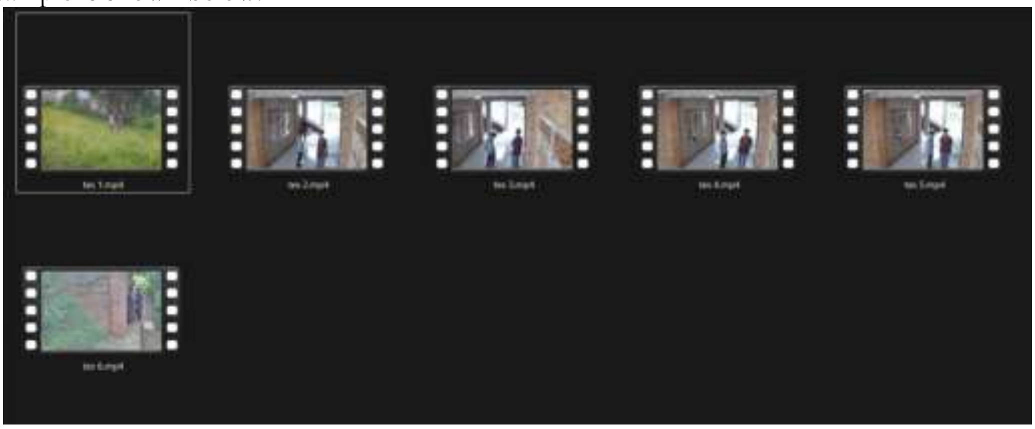


Figure 3. CCTV Video Sample.

Dataset Class Creation

The purpose of creating dataset classes was to simplify the process of image dataset categorization. Two different classes were created, where the dataset was grouped into two categories: 0 for person and 1 for fallen_person within a file named fall.yaml, as shown in the following figure:

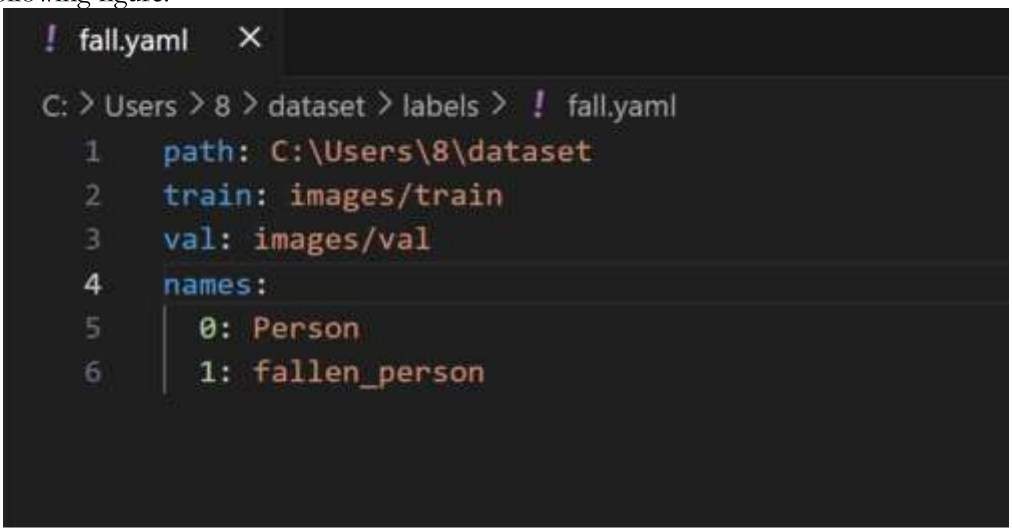


Figure 4. Dataset Class Classification.

Model Training

The YOLO model training process for fall detection was conducted by creating an environment in Anaconda Navigator, activating the environment through Anaconda Prompt, and installing the required libraries.

Figure 5. Creating an Environment in Anaconda Navigator.

Figure 6. Environment Activation and Library Installation in Anaconda Prompt.

After the environment was activated, a dataset containing two classes, namely person (standing person) and fallen_person (fallen person), along with labels in YOLO format specified in the fall.yaml file, was prepared. The dataset was divided into train and val folders for training and validation purposes. A pre-trained YOLOv8 model was used as the base model, and training was conducted for 30 epochs using an input image size of 416 × 416 pixels.

At the end of each epoch, the model was validated using the validation dataset to monitor its performance. The best-performing model was saved as best.pt, which was subsequently used for video testing.

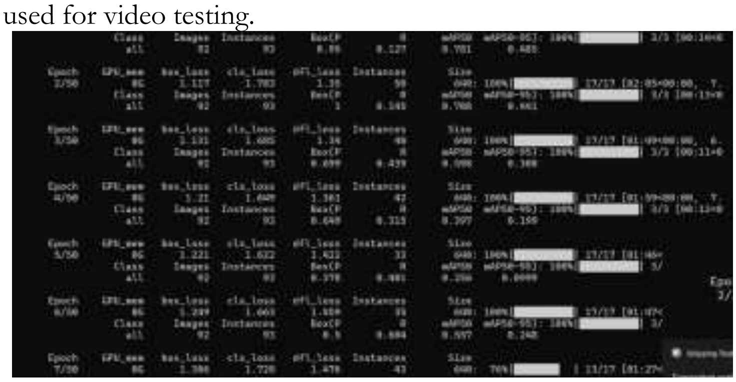


Figure 7. Model Training Process.

The following figures present sample results from the model training process:

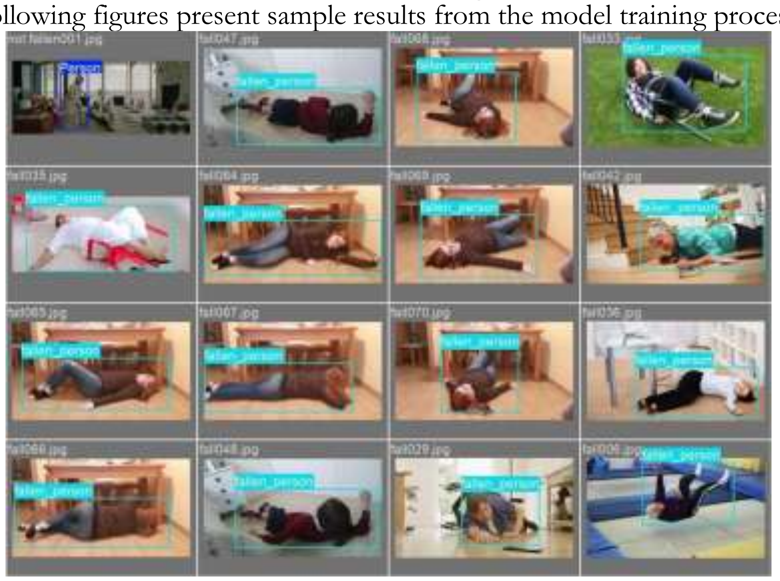


Figure 8. Training 1.

Figure 9. Training 2.

Figure 10. Training 3.

Figure 11. Training 4.

Figure 12. Training 5.

Figure 13. Training 6.

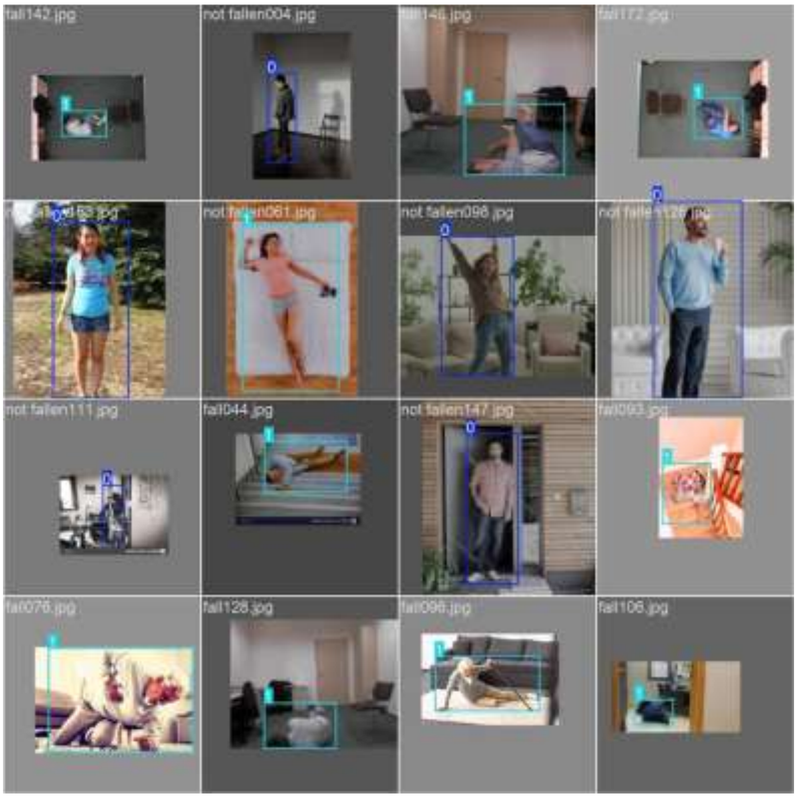


Figure 14. Training 7.

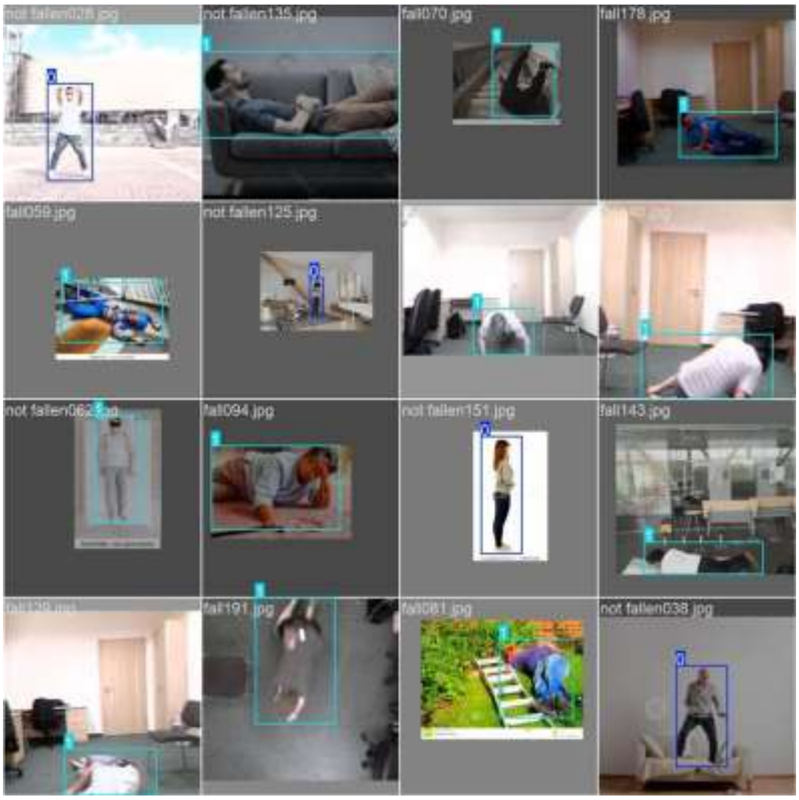


Figure 15. Training 8.

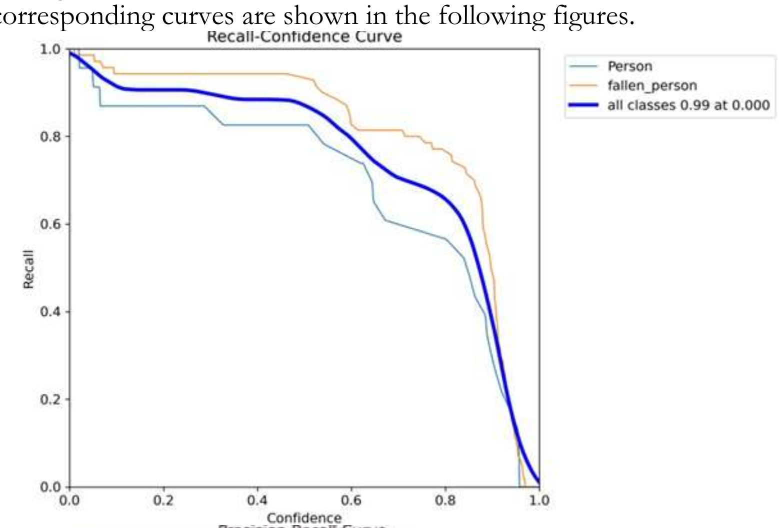
The evaluation results obtained from the Precision–Recall Curve, Recall–Confidence Curve, F1–Confidence Curve, and Precision–Confidence Curve indicate that the developed detection model achieved excellent performance. The overall mAP@0.5 value reached 0.942, with the fallen_person class achieving a precision of 0.969 and the person class achieving 0.915.

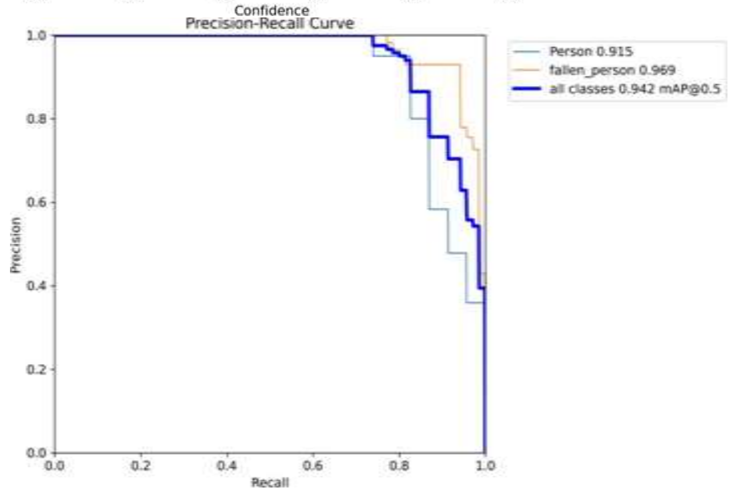
These results indicate that the model consistently maintains a balance between precision and recall. The Recall–Confidence Curve demonstrates that the average recall for all classes remains around 0.99 at low confidence levels, meaning that the model almost always detects the target objects even when confidence scores are relatively low. The fallen_person class exhibited more stable recall performance than the person class across different confidence levels.

In the F1–Confidence Curve, the highest F1-score was achieved at a confidence level of approximately 0.47, with a score of 0.90 for all classes, indicating the optimal balance between precision and recall. The Precision–Confidence Curve shows that at high confidence levels (≥ 0.84), precision reaches 1.0, meaning that detections are almost always correct when the model is highly confident.

Overall, these results demonstrate that the model is not only accurate but also possesses strong generalization capabilities, particularly in detecting fallen_person objects. Therefore, the model is suitable for implementation in a non-verbal bullying detection system within the Islamic boarding school environment.

The corresponding curves are shown in the following figures.





This curve illustrates the relationship between precision and recall at various threshold values: 1) The high mAP@0.5 value (0.942) indicates that the model effectively maintains a balance between precision and recall. 2) The fallen_person class achieved slightly better performance than the person class, indicating that the model is more accurate in detecting fallen objects.

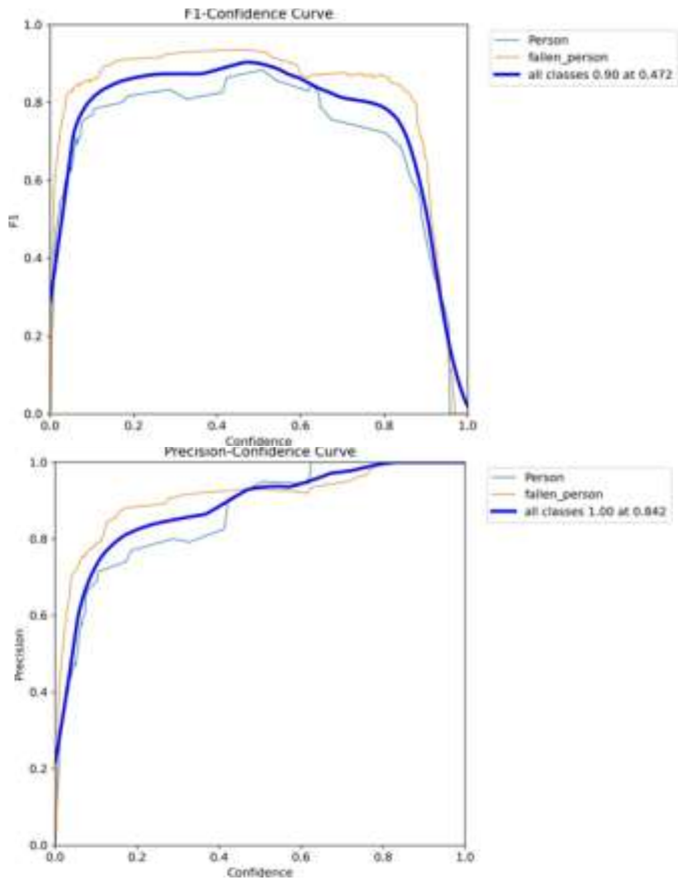


Figure 16. BoxR Curve.

This curve shows how well the model maintains recall at different confidence levels: 1) High recall values (close to 1) at low confidence levels indicate that the model almost always identifies objects, although false positives may still occur. 2) The fallen_person class maintains very high recall over a wider confidence range compared to the person class.

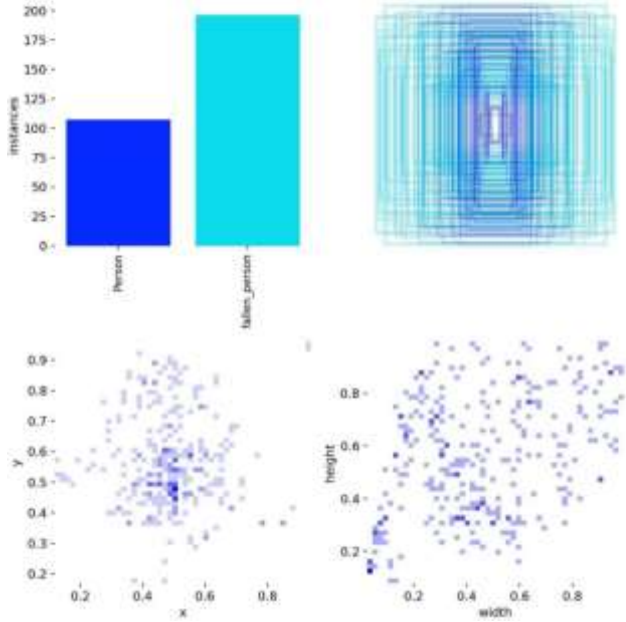


Figure 17. Labels.

System Implementation / Testing

After model training was completed and the best.pt file was generated, the next step was testing to ensure that the model could detect objects according to the research objectives.

At this stage, the best.pt model was loaded and evaluated using test data consisting of images or videos that had not been used during training. The system processed each frame to detect the presence of person and fallen_person objects according to the trained labels.

Detection results were displayed using colored bounding boxes, complete with class labels and confidence scores.

From this process, detection accuracy, classification errors, and processing speed were analyzed to evaluate overall system performance.

During testing, three CCTV video recordings were used. When the model detected a person standing upright or walking, a dark blue bounding box labeled person was displayed. When the model detected a fallen individual, a light blue bounding box labeled fallen_person was displayed. The implementation results from the CCTV video recordings are presented below:

Figure 18. First Trial (Standing Model).

Figure 19. First Trial (Fallen Model).

Figure 20. Second Trial (Standing Model).

Figure 21. Second Trial (Fallen Model).

Figure 22. Third Trial (Standing Model).

Figure 23. Third Trial (Fallen Model).

Testing

Based on the training results, the system demonstrated positive outcomes consistent with the research objectives. The YOLO model successfully distinguished between normal conditions (person) and fallen conditions (fallen_person) based on the provided data.

Following these results, testing was extended to real-time scenarios using an external webcam or CCTV camera. This experiment aimed to verify that the system could function not only on image and video datasets but also in real-world situations.

Real-time testing was conducted using an external camera connected to the system. The results showed that the model accurately detected objects labeled as person and fallen_person according to their actual conditions.

The following screenshots illustrate the detection results:

Figure 24. Detection of a Standing Human Object (person).

Figure 25. Detection of a Fallen Human Object (fallen_person) with a Confidence Score of 0.76.

Figure 26. Detection of a Human Object in a Normal Standing Position.

Figure 27. Detection of a Fallen Human Object (fallen_person) with a Confidence Score of 0.62.

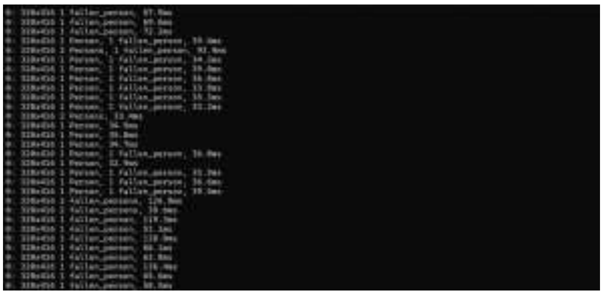


Figure 28. Real-Time YOLO Execution from Anaconda Prompt.

Final Testing Results

Based on the conducted research, the model underwent training and testing processes using data prepared according to the research methodology. This process included dividing the data into training, validation, and testing datasets to ensure optimal performance under various conditions.

The results were visualized through graphical representations to facilitate performance analysis. These graphs illustrate trends in performance metrics during training and serve as indicators of the model's success in achieving the predefined objectives.

The final testing results are presented in the following infographic:

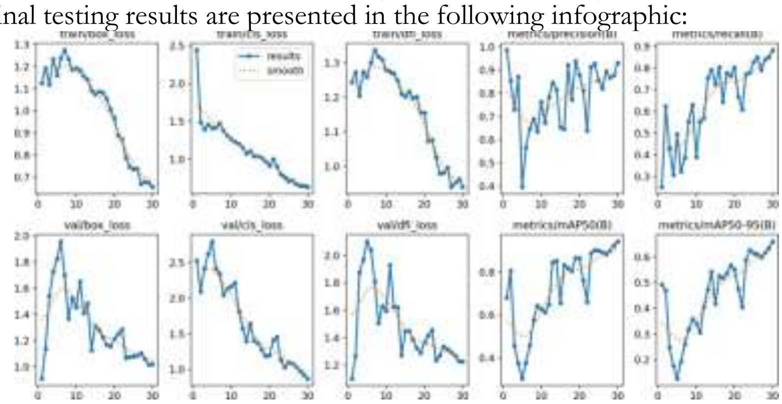


Figure 29. Final Infographic Results.

Overall, the graphs demonstrate that the model was successfully trained. All loss metrics for both training and validation datasets exhibited decreasing trends, while precision, recall, and mAP metrics showed consistent improvement.

These results indicate that the model did not merely memorize the training data but was also able to generalize its learned knowledge to detect objects in new validation data with high accuracy. The dashed (smoothed) lines in several graphs represent moving averages that provide a clearer visualization of performance trends.

Based on the research findings and discussions presented in the previous chapters, several conclusions can be drawn:

This study successfully implemented a non-verbal bullying detection system in the environment of the Business Boarding School at SMK Skill Village Islamic School using the You Only Look Once (YOLO) algorithm. The developed model was capable of recognizing two object classes, namely person and fallen_person, and provided real-time detection results through CCTV recordings.

The testing results demonstrated strong model performance. This was evidenced by decreasing loss values on both training and validation datasets, along with increasing precision, recall, and mean Average Precision (mAP) values throughout the training epochs. These findings indicate that the model was not only capable of learning the training data but also of generalizing effectively to new data with high accuracy.

Several limitations were identified in this study, including the limited amount of original data collected from the boarding school environment, which required supplementation with external datasets from Kaggle; variations in CCTV camera angles that affected detection accuracy; and the need for adequate hardware specifications to ensure optimal training and detection performance.

This research contributes to the advancement of artificial intelligence technologies, particularly in the field of computer vision, to support bullying prevention efforts in Islamic boarding school environments. The integration of YOLO into a CCTV monitoring system has proven to be a promising preventive solution that can assist boarding school administrators in creating a safe and conducive learning environment in accordance with Islamic values.

5. Conclusion

Based on the results and discussions presented in the previous chapters, the following conclusions can be drawn: 1) The implementation of the YOLO (You Only Look Once) algorithm for detecting non-verbal bullying behaviors in the environment of the Business Boarding School at SMK Skill Village Islamic School was successfully carried out. The developed model was capable of recognizing two object classes, namely person and fallen_person, and provided real-time detection results through CCTV recordings. 2) The accuracy and effectiveness of the detection system demonstrated satisfactory performance. This was evidenced by the decreasing trend of loss values in both the training and validation datasets, as well as the increasing values of precision, recall, and mAP. These results indicate that the model not only learned the training data effectively but was also capable of generalizing to new, unseen data. 3) Several challenges were encountered during the study, including the limited availability of original datasets collected from the boarding school environment, which required supplementation with external datasets from Kaggle. Other challenges included variations in camera viewing angles that affected detection accuracy and the need for adequate hardware specifications to ensure smooth processing and optimal system performance.

Overall, the YOLO-based detection system implemented in this study has the potential to serve as a preventive solution for monitoring and preventing bullying, particularly within Islamic boarding school environments, thereby contributing to the creation of a safe and conducive learning atmosphere.

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