AI POWERED SURVEILLANCE SYSTEM USING JETSON NANO

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Abstract

The evergrowing demand for robust security solutions has paved the way for advancements in intelligent video surveillance systems. This project delves into the exciting realm of AI by proposing the development of an AI powered surveillance system using compact and powerful NVIDIA Jetson Nano platform.

By leveraging the Jetson Nano's on-board processing capabilities, the system performs real-time video analysis at the network edge, eliminating the need for constant cloud communication. The integration of AI algorithm empowers the system to analyze video streams in real-time, enabling immediate detection of potential threats. This could include unauthorized personnel entering restricted areas, abandoned objects or suspicious behavior patterns.

Upon detecting anomalies, the system can trigger pre-programmed actions such as generating alerts, capturing images or video footage, and notifying security personnel. This allows for a swift and targeted response to potential security breaches. The compact form factor of the Jetson Nano facilitates the deployment of the system in diverse environments. Additionally, the modular design allows for easy integration with multiple cameras, enabling comprehensive surveillance coverage.

Introduction

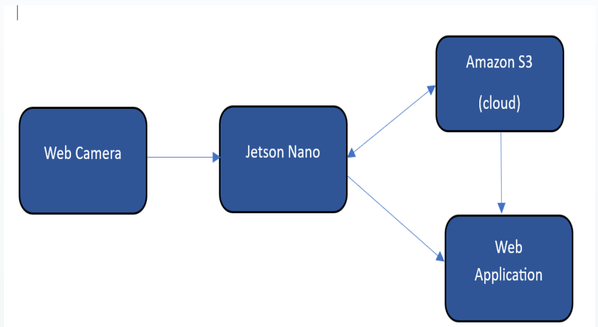
Artificial Intelligence has become an essential component of surveillance systems in an age of growing security concerns and changing threats. In addition to improving our capacity to keep an eye on and protect our environment , the combination of AI algorithms with surveillance technologies is revolutionizing proactive threat detection and response.

The widespread use of surveillance systems highlights how important it is to protect vital infrastructure, prevent criminal activity, and ensure public safety. But traditional surveillance methods frequently have drawbacks like a heavy reliance on human monitoring, a high rate of false alarms, and data analysis inefficiencies. On the other hand, AI-powered surveillance systems use state-of-the-art technologies to get around these obstacles and enable intelligent, autonomous decision-making processes that improve response times and situational awareness.

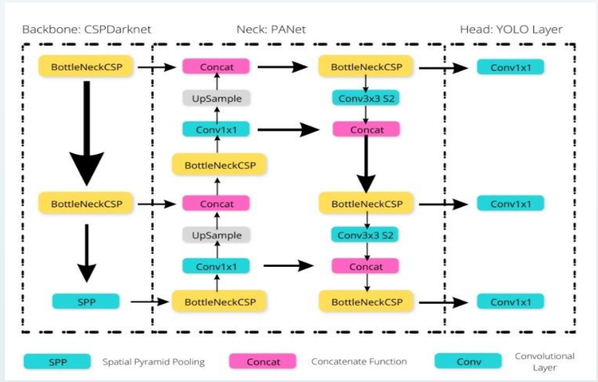
Our AI-based surveillance system's core is the combination of advanced AI algorithms and cutting-edge hardware, most notably the Jetson Nano. This compact yet powerful edge computing platform, developed by NVIDIA, empowers our system with unparalleled computational capabilities, enabling real-time analysis and inference at the network's edge. Our system achieves exceptional efficiency and scalability by utilizing the hardware acceleration characteristics of the Jetson Nano, which makes it suitable for deployment in a variety of applications and locations.

One of the key components of our AI-based surveillance system is the integration of the You Only Look Once (YOLO) algorithm. YOLO is a state-of-the-art object detection algorithm that excels in real-time detection of objects within images and video streams. Its unique architecture enables simultaneous detection and classification of multiple objects with remarkable accuracy and speed. By incorporating YOLO into our system, we enhance its ability to detect and track objects of interest in real-time, thereby enabling proactive threat detection and response.

Proposed System - Block Diagram



YOLOv5 Architecture



Model Deployment

The proposed model using YOLOv5 was implemented through the following steps:

1.Creating a custom dataset: Yolo uses pretrained weights from COCO dataset for object detection. COCO dataset has 80 classes. For customizing the object detection to detect only the items that we require with improved accuracy, a modification of the dataset is required.

2. Collection of images for dataset: The creation of a custom dataset for YOLO involves several steps. Initially, a diverse collection of images representing the objects intended for detection is gathered, ensuring variability in angles, lighting, and backgrounds. A total of 904 images were collected. Out of these 904 images, 150 were of Amal, 166 where of Ananthan, 172 where of Sagar, 165 where of Salini, 87 where of Fire, 261 where of Fall.

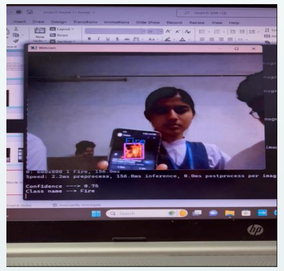
3.Labelling of images: These images are annotated by delineating bounding boxes around the target objects. The different classes are: Amal, Ananthan, Sagar, Salini, Fire, Fall. RoboFlow was used to annotate files in YOLO's prescribed format: each line contains the object class index and normalized coordinates (center x, center y, width, height).

4.Splitting folders for training and validation: The dataset is then split into training and validation sets adhering to ratios of approximately 70% and 30% respectively. 904 photos were divided into 641 training images and 263 validation images.

5. Training and output: Adjustments to hyperparameters are made as necessary, and the model's efficacy is evaluated on the test set for real-world validation. This iterative process often necessitates refinement through multiple iterations to achieve optimal detection accuracy.

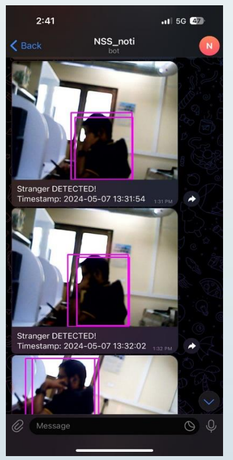
Results

(a) Custom model detection

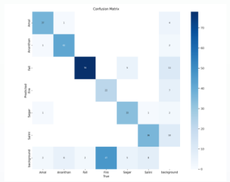


(b) Fire detection

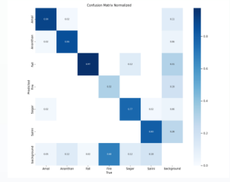
(c) Fall detection



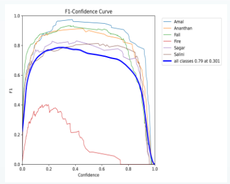
(d) Stranger detection



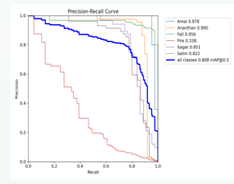
(e) Confusion matrix



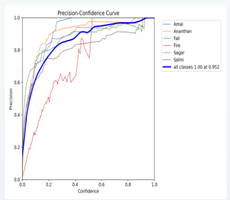
(f) Normalised Confusion matrix



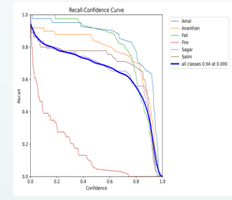
(g) F1-confidence curve



(h) Precision-Recall curve



(i) Precision-Confidence curve



(j) Recall-Confidence curve

Conclusion

Beginning from running the pretrained yolo models and using available datasets, we then progressed to creation of custom dataset and created a custom model which performed reliably and consistently. We deployed the pretrained yolo model in Jetson Nano and then the custom model was deployed on Jetson Nano and objects were detected. Upon detection, real time alerts were sent to the user via telegram bots. Pricing the Jetson Nano system at an affordable cost instead of the subscription method of Airtel XSafe makes this accessible for the common people. As a part of doing this project, a lot of new information has been learnt, from the working of Convolutional Neural Networks like YOLO to the method of deployment of a model on an edge device.

In conclusion, the integration of an AI-based surveillance system utilizing Jetson Nano and the YOLO algorithm represents a significant advancement in security technology. This system offers real-time object detection and tracking capabilities, enhancing monitoring efficiency and accuracy. With its compact size and low power consumption, it provides a cost-effective solution for various surveillance applications. However, it's essential to address privacy concerns and ensure responsible usage to maintain ethical standards in deploying such systems. Overall, the implementation of this AI surveillance system marks a promising step forward in safeguarding public safety and security.