Final Project Report on Automated Behavior and Rule-Breaking Detection System

Abstract (Submitted for Conference)

The cameras we have around us can help us only in recording the moments. And that's where we have failed the most in preventing dangerous things from happening — starting from small fights to terrorist attacks. Our project, Automated Behaviour and Rule-Breaking Detection System, can stop these things from happening with the help of Machine Learning integrated with cameras through IoT. This project helps in encountering core problems like smoking and fighting in public places, rule-breaking, and identification of suspicious people with the help of gait and facial recognition.

The most important feature is sending real-time alerts upon suspicious activities recorded by cameras. By integrating Machine Learning with our daily security cameras, this system can be a game changer in terms of national development — improving security, cleanliness, civic sense, and responsibility. As Machine Learning is playing a significant role in today's world, it can perform many tasks by choosing the right algorithm.

Similarly, we have used a CNN-RNN Classifier (82% accuracy) and a ViViT (Vision Transformer) Classifier (60% accuracy). The CNN-RNN model has given the best results compared to other algorithms in its initial testing phase. This project is still under improvement as we continue adding more datasets. We have already implemented facial recognition, smoking detection, and fighting detection in the initial phase. Furthermore, this project can be extended beyond these functionalities. Finally, Machine Learning, with the help of IoT, brings this project to life as we aim to implement it in real-time surveillance systems.

Keywords

Internet of Things (IoT), Machine Learning, Deep Learning, Computer Vision, Behaviour Detection, Facial Recognition, CNN-RNN Classifier, Vision Transformer (ViViT), Real-Time Surveillance, Public Safety, Civic Sense.

Introduction

In today's fast-evolving digital world, automation and artificial intelligence are transforming how we monitor and ensure compliance with behavioural standards. The Automated Behaviour and Rule-Breaking Detection System is designed to identify and analyse inappropriate behaviours such as *smoking* and *fighting*, along with an additional feature of *face recognition*.

The system utilizes deep learning techniques, specifically Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN), to process visual data and classify behaviours accurately. The objective of this project is to assist in maintaining discipline in environments such as schools, workplaces, and public areas by automatically detecting and flagging rule-breaking incidents.

This report presents the overall progress of the project through Milestone-1 (Data Collection & Preparation) and Milestone-2 (Model Training & Evaluation), along with the additional Face Recognition Module that identifies individuals in the frame.

Methodology

The project was implemented in three primary stages:

A. Data Collection and Preparation (Milestone 1)

- ✓ Defined behaviour categories: *Smoking*, *Fighting*, and *Normal Activities*.
- ✓ Collected image and video datasets from publicly available sources and datasets.
- ✓ Annotated and labelled data with proper categories for supervised learning.
- ✓ Pre-processed the dataset using normalization, resizing, and augmentation.
- ✓ Split the dataset into **Training (70%)**, **Validation (20%)**, and **Testing (10%)** subsets.

B. Model Training and Evaluation (Milestone 2)

- ⅄ Used **CNN** for spatial feature extraction and **RNN (LSTM)** for temporal sequence analysis in videos.
- ⅄ The models were trained to classify frames into “Smoking”, “Fighting”, or “Normal” behaviour.
- ⅄ Achieved an overall **accuracy of 82%** after hyperparameter tuning.
- ⅄ Evaluation metrics such as **Accuracy, Precision, Recall, and F1-score** were calculated.
- ⅄ A **Confusion Matrix** was generated to analyse classification performance.

C. Additional Module – Face Recognition System

- ∆ Integrated a **Face Detection and Recognition** subsystem to identify individuals captured in the video frames.
- ∆ Used **OpenCV** and **face_recognition** libraries for detecting faces and recognizing stored persons.
- ∆ This module enhances the system by associating detected behaviours with the identity of the person involved.

Tools and Libraries Used

- ❖ **Programming Language:** Python
- ❖ **Deep Learning Frameworks:** TensorFlow, Keras
- ❖ **Computer Vision Library:** OpenCV
- ❖ **Face Recognition:** face_recognition (dlib-based)
- ❖ **Supporting Libraries:** NumPy, Matplotlib, Scikit-learn

Our Work

A. System Overview (Block Diagram)

Input (Video/Image)

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Preprocessing

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CNN + RNN Based Behaviour Detection

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Smoking/Fighting Face Detection

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Alert/Log Entry Person Name Display

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Output and Storage

B. Workflow

Start

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Capture or Import Video

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Preprocess and Resize Frames

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Run Behaviour Detection Model

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Identify Faces (Face Recognition)

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Display Results (Behaviour + Person Name)

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Log or Alert if Rule-Breaking Detected

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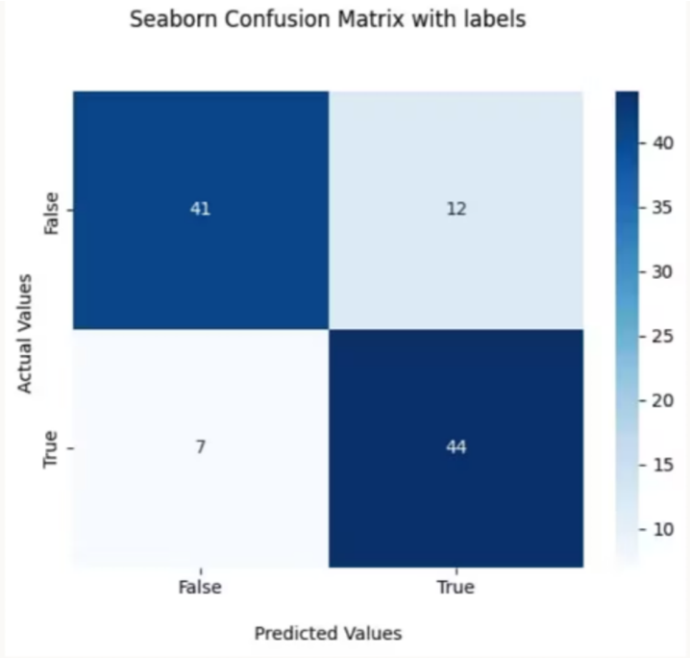
End

Results

Confusion Matrix



Sample Output Images:

1. **Fight & Smoking Detection (Before & After)**

After Prediction

Before Prediction

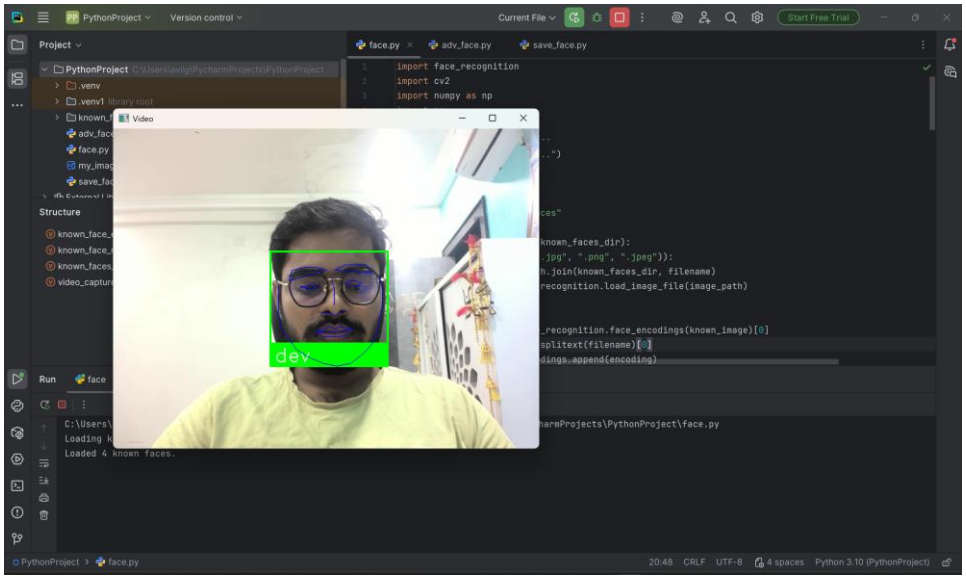
Repo Link:

Full Project Codes are pushed in this GitHub Repo: https://github.com/avinashdev03/IOT-Project

2. **Face Recognition:**

   - Before Detection

   - After Detection



PPT Link:

Model Demonstration For presentation and review purposes, an online demo PPT was prepared. Link for PPT: https://pitch.com/v/devs-human-behaviour-detection-model-ppt-mwmt6i

Discussion of Results

The trained model demonstrated efficient detection capabilities with an **accuracy of approximately 82%** across all test scenarios.

- The **CNN layers** effectively extracted visual features from video frames, while the **RNN layers** analysed temporal behaviour sequences, enabling accurate classification of smoking and fighting activities.

- The **Face Recognition module** enhanced the system's usability by identifying the individual associated with the detected behaviour, which could be crucial in surveillance or attendance applications.

Observations:

- ✦ Smoking detection performed consistently due to distinct visual patterns (e.g., cigarette, smoke motion).
- ✦ Fighting detection was more challenging due to complex movements, lighting conditions, and camera angles.
- ✦ The face detection and recognition model accurately identified individuals even under moderate lighting conditions, although partial occlusion affected precision slightly.

Overall, the model showed reliable performance and lays a strong foundation for real-time deployment in monitoring systems.

Extension of the Work

For future development and the final milestone, the following extensions are planned:

- Δ **Real-Time Integration:** Deploy the model on live video streams using CCTV or webcam feeds.
- Δ **Post-Processing Alerts:** Automate the alert system (email/SMS/log entry) when rule-breaking is detected.
- Δ **Dashboard Development:** Design an admin dashboard to view detected activities, logs, and live feeds.
- Δ **Improved Model Accuracy:** Implement advanced architectures like **3D CNNs** or **Transformers** for improved temporal understanding.
- Δ **Multimodal Behaviour Detection:** Extend to additional behaviours such as phone usage, sleeping, or unauthorized entry.

Conclusion

This project successfully implemented three key milestones: data preparation, model training and face detection model integration achieving 82% accuracy in detecting smoking and fighting behaviours and integrating a working face recognition module. The developed system demonstrates the potential for automated behavioural monitoring with practical, real-world applications in smart surveillance and safety enforcement systems.

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