Vigion [Vigilant Vision]:
Real-Time Crime Activity detection using Intel OpenVINO, Intel NCS2 & RPi

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Problem Statement:

Surveillance is one of the prime method used by governments and law enforcement agencies for prevention of the criminal or suspicious activities.

Traditional digital video surveillance system only performs capturing & storing of video feed, where security operator has the task to look for any threat or suspicious activity by constantly watching video feeds.

Today, there are or more cameras and recorded video than ever before, due to which security operators are faced with challenge of keeping pace. Thus, human monitoring of surveillance is very tough and error-prone job.

This could lead to failure in identifying suspicious or criminal activity in progress and thus delay in response time to the incident. Which arises the critical question of public safety.

Summary:

Traditional Surveillance systems are passive and reactive. Which allow investigating the incident rather than preventing it.

- Vigion is edge intelligent device using Computer Vision and Deep Neural Network.
- It can detect real time criminal activities like Abuse, Arrest, Assault, Burglary and Fighting.
- Vigion can alert (SMS/Email) user or law enforcement agency about the incident.
- Vigion is a portable and low cost device using Raspberry Pi, Picamera and Intel NCS2.

Considering the fact that, Security and Surveillance systems are integral part of commercial and residential establishments. VIGION can play important role of maintaining public safety in such area.

Overview:

Computer Vision and AI has a power to make these traditional Surveillance systems situational aware to help them detect and classify between normal and suspicious activity.
This will help improve public safety and assist law enforcement agencies to respond quickly, to stop any escalation in critical situation.

In my recent project, I developed a real-time Video analysis application using deep neural network, which could easily, in real-time, classify between Normal and Intrusion Activity. Furthermore it records the activity on device and alerts user over SMS. To build this, we begin with creating video dataset, extracting features and next feeding this to deep neural network model to train.

We have developed this application around **RaspberryPi (Model 3B)** and **PiCamera (v1.3).** The implementation is tested using **Python (v3) with TensorFlow(V1.13.1), OpenCV(v3.4.2)** it had showed almost 97% accurate in identifying activity.

In a similar way, Vigion will be trained to classify between normal and criminal activity. This trained model will be used to detect the activity on a live feed. Upon detection of the activity, Vigion will inform security operator about the incident with location and probable type of activity.

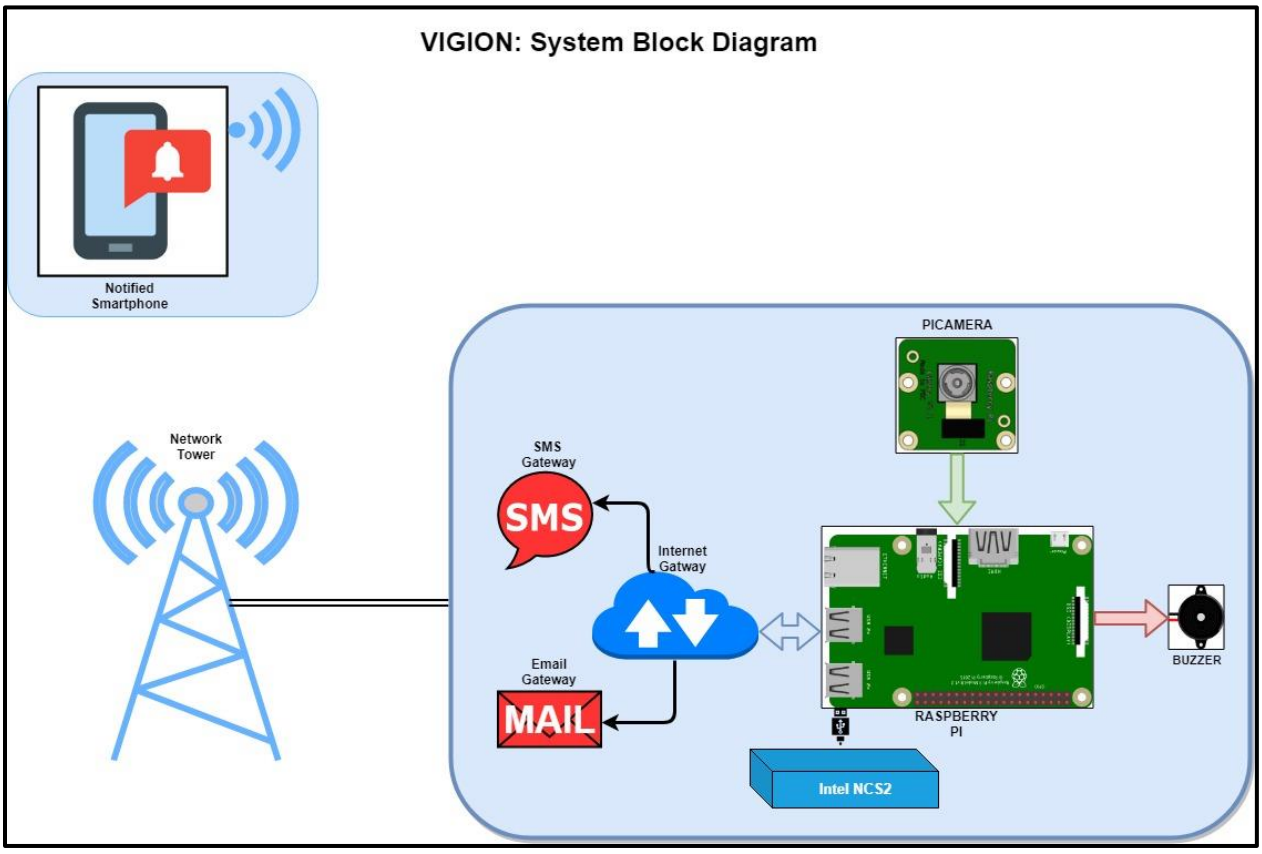
Approach:

Video classification is an interesting problem because it includes both temporal and spatial features. That is, at each frame within a video, the frame itself holds important information (spatial), as does the context of that frame relative to the frames before it in time (Temporal).

Development of VIGION:

- Obtain Video Dataset.
- Split the dataset into Train-Test [70%-30%] dataset, maintaining classes and generate Label file.
- Extract frames from each video.
- Extract feature by passing frames of the video through pre-trained CNN [MobileNetV2].
- Use extracted features to train deep neural network model.
- Save the model [TensorFlow frozen graph] at each checkpoint.
- Validate the model accuracy by testing on unseen/test dataset.
- Perform the model conversion to Deploy onto Raspberry pi with Intel NCS2 and PICAMERA.

System Block-Diagram:



System Requirements:

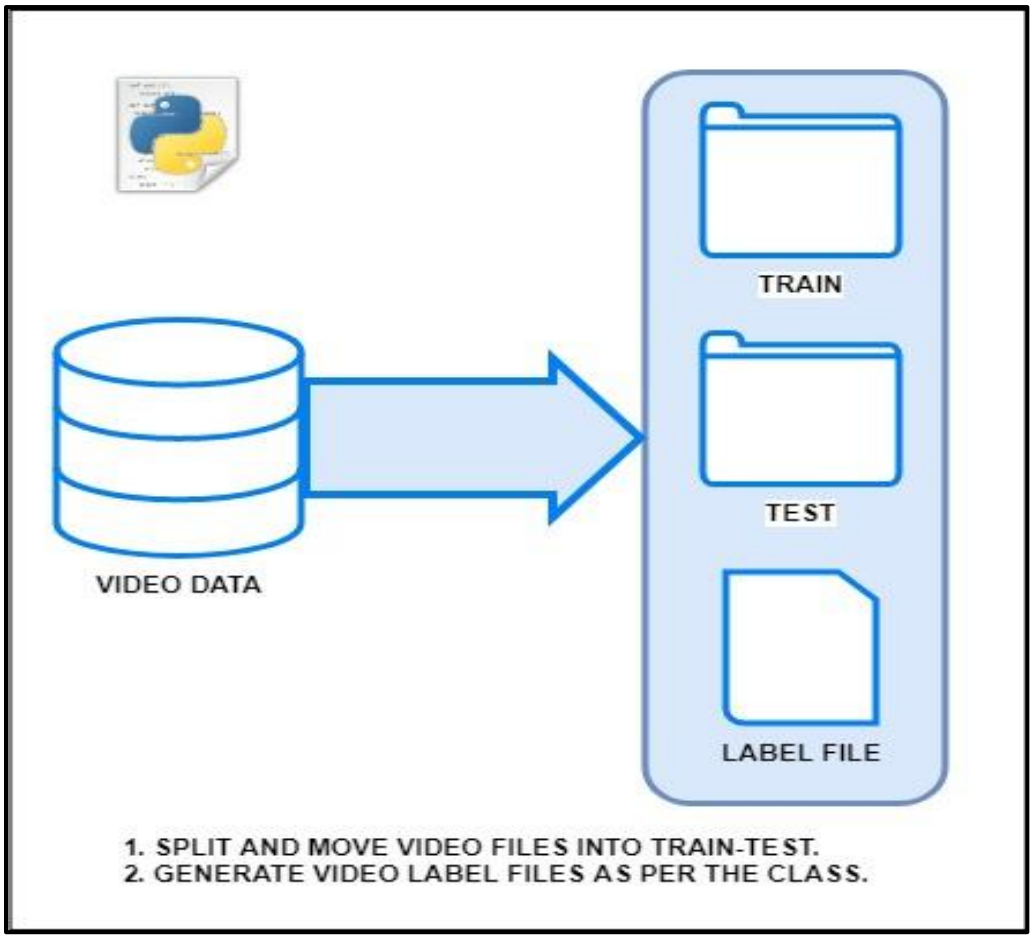
- Raspberry Pi Model 3B
- Intel NCS2
- PICamera V1.3
- Buzzer
- Power Adapter/Battery Pack
- 3rd Party SMS/Email Gateway

Required Intel Products:

- Intel® Distribution for Python for Linux
- Intel® Optimization for TensorFlow
- Intel® Distribution of OpenVINO™ toolkit
- Intel® Movidius® Vision Processing Unit (VPU) or Neural Compute Stick-NCS2 SDK

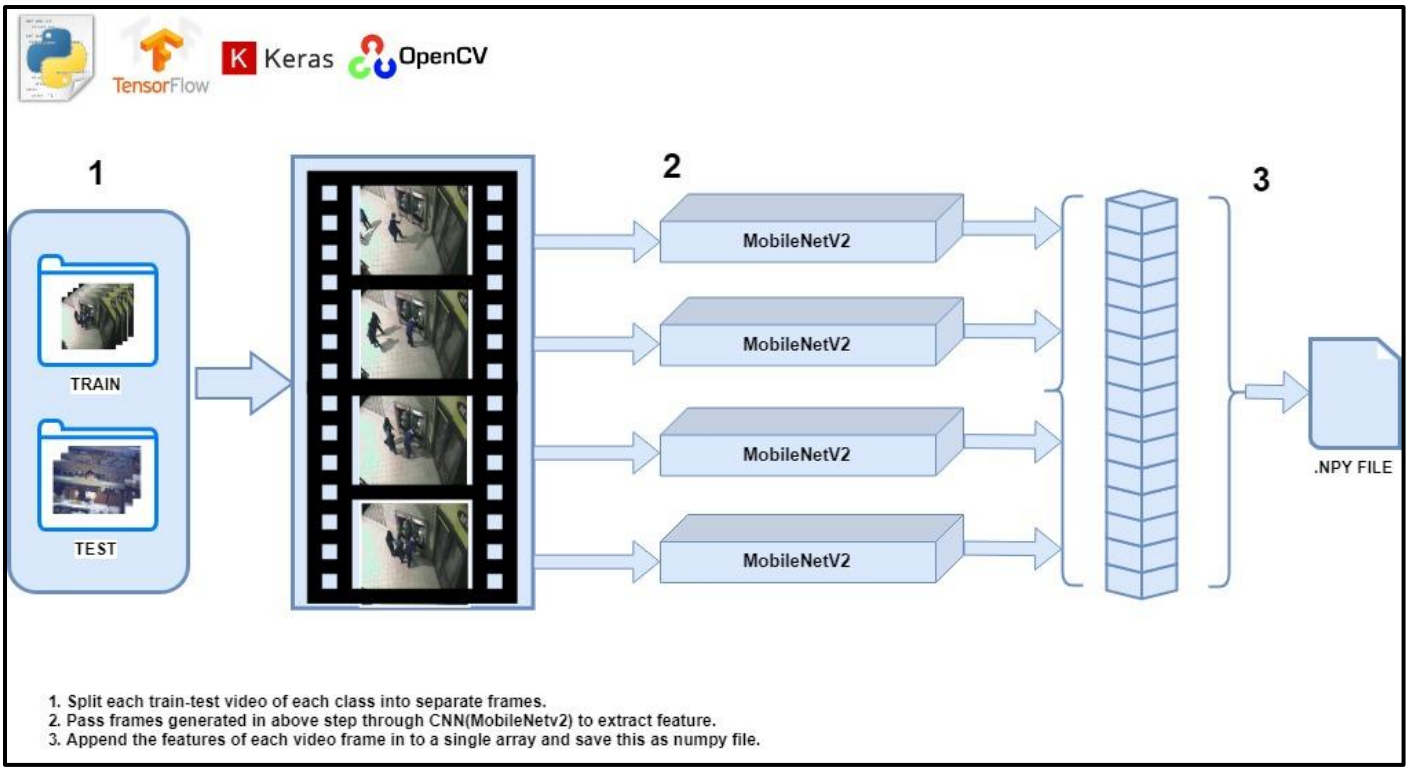
Dataset:

- I am going to use subset of UCF-Anomaly Detection Dataset mentioned in paper [1] for training and testing of the application. Copy of the dataset is available at Kaggle.
- Every video class of the dataset will be split for Train and Test task.
- Original dataset is huge and composed of 128 hours of uncut raw videos for 13 anomalous activities.
- Here we will write simple python script to move the video files to train/test folder.
- This script will also generate a file which contains.
    - Path of the video file
    - Activity Class that video belongs to



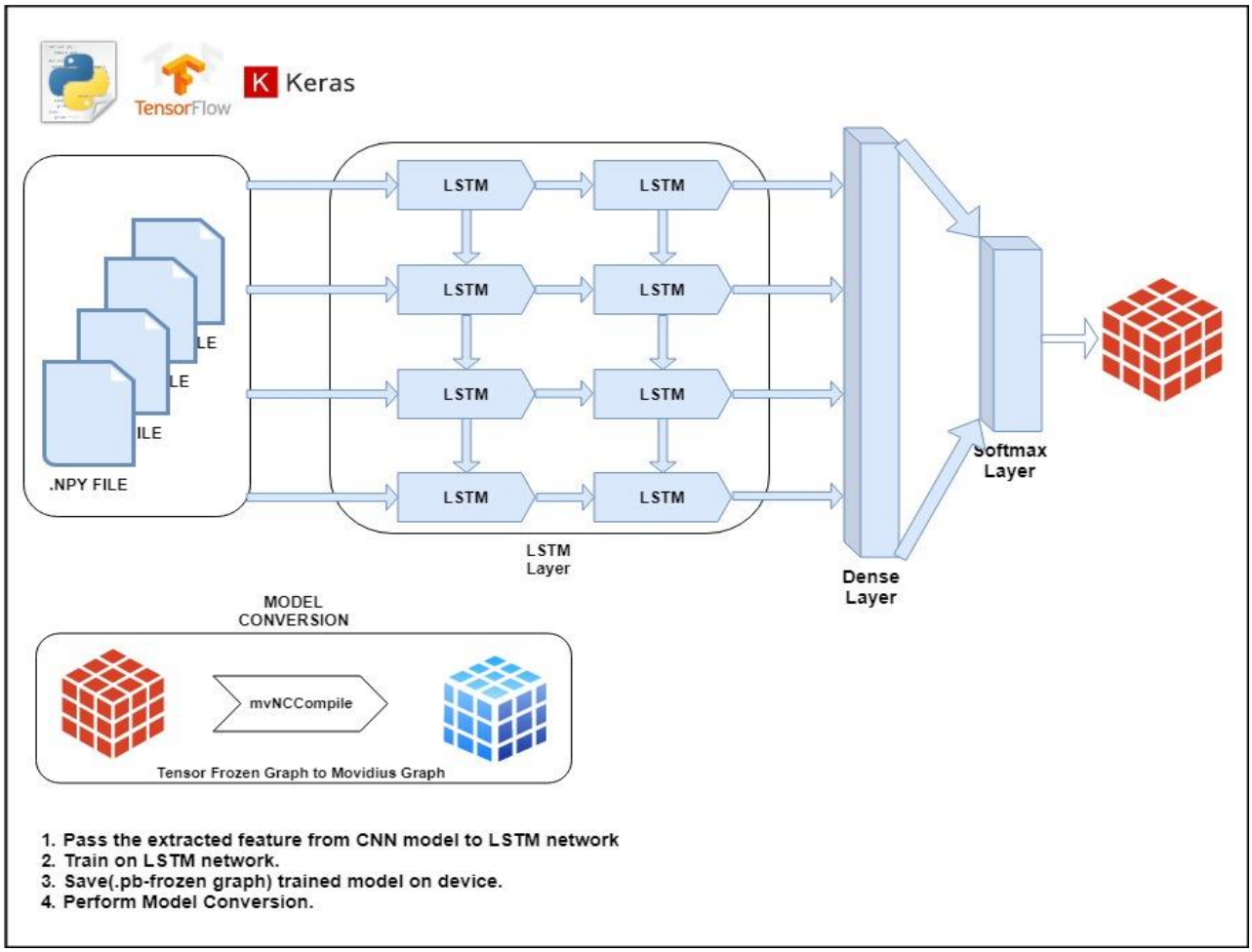
Feature Extraction using CNN:

- When it comes to the image or Video analysis, CNN is the most powerful tool to solve problem. We will use CNN to learn interpretable image features.
- More specifically we will use **MobileNetV2[2]** model. MobileNet is efficient deep CNN architecture made for mobile and embedded vision applications.
- We will use the MobileNet to extract feature from video frame by saving output from final averaging layer.
- We will build the stacked array of such a features (sequence).
- Next save those features on a device as a numpy [.npy] array file.
- Refer the Diagram below.

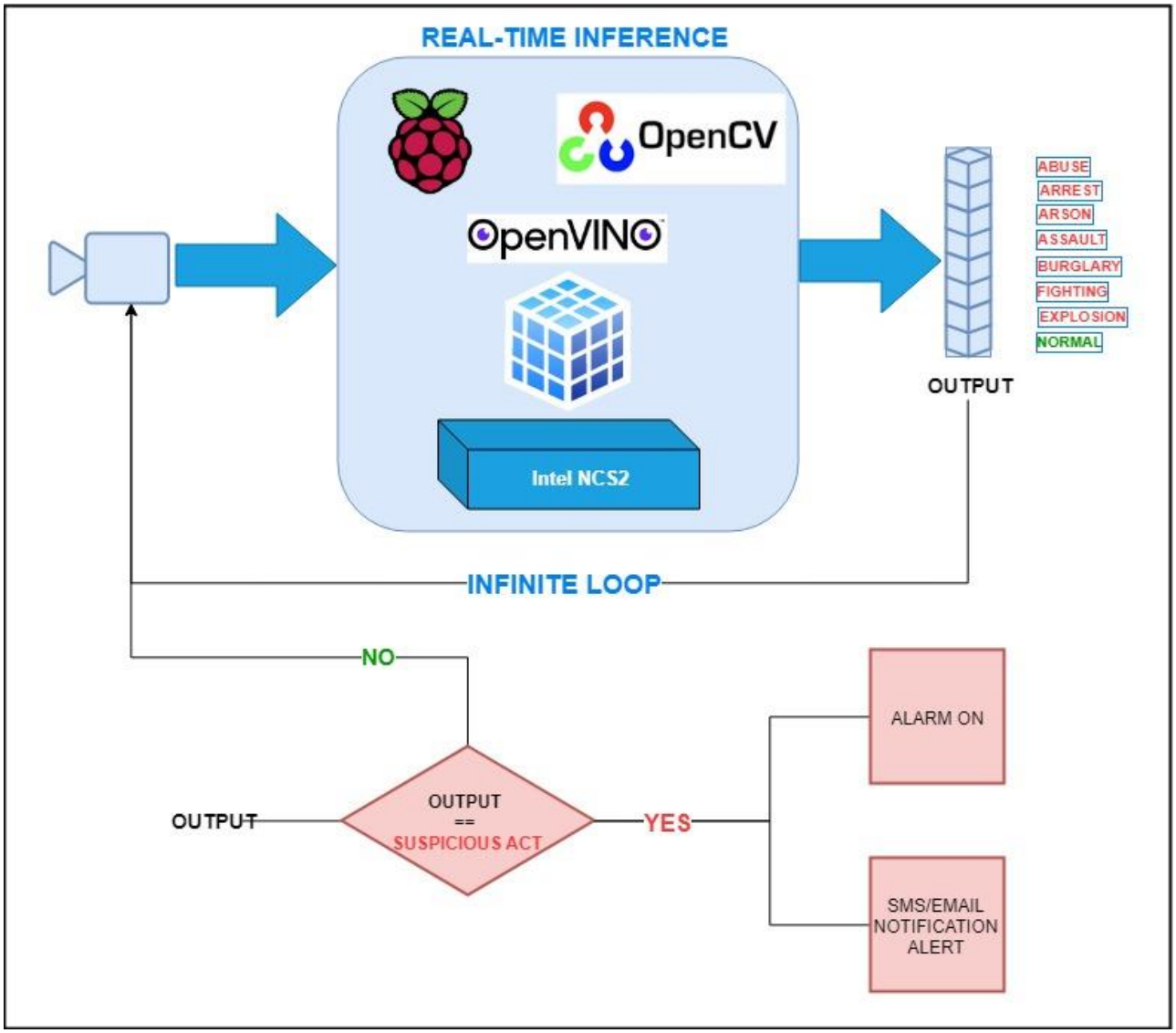


Model Training:

- Next we will feed above created sequence to Recurrent Neural Network (RNN) to learn and understand temporal dynamics of the video.
- Thanks to the keras and TensorFlow we do not require low-level coding.
- We will use **LSTM**, an extension of RNN. LSTM's enable RNN's to remember their inputs over an extended period of time [3].
- Training process is going to take lot of time. We will save the model at each checkpoint.
- Next, In order to use this trained model with Intel NCS2+RPi, we need to perform model conversion using command-line tool mvNCCompile.



Model Deployment:



- As shown in above figure, PICAMERA will stream continuous real-time Video data to raspberry pi
- We will pass this data through our trained model to predict the class of the activity.
- Upon detecting criminal or suspicious activity alarm will be raised and E-Mail/SMS notification alerts will be sent to the user or operator.

Tech Stack:

Top Left corner of the above shown diagrams indicates the type of python libraries/framework used to complete the defined task.

Application Areas:

- Government
- Smart Cities
- Retail
- Industry

Crimes in India is a extremely critical issue compared to other developing nations. Current reports by NCRB, India shows that for past couple years crimes in India have seen spikes in all parts of the nation. In 2016, according to NCRB data, total 3 Million crimes were recorded.

VIGION is my small effort to help reduce the crime in India and World. If law enforcement agencies could detect or get notified about the crime in progress, quick response to such situations will definitely help reduce the crime rate. Criminals will be brought to justice and law-order will be maintained in the society.

References:

[1] Real-world Anomaly Detection in Surveillance Videos

[2] Mark Sandler, Andrew Howard, Menglong Zhu, Andrey Zhmoginov, Liang-Chieh Chen , MobileNetV2: Inverted Residuals and Linear Bottlenecks

[3] S. Hochreiter and J. Schmidhuber, “Long short-term memory,” in Neural Computation. MIT Press, 1997

Real-time object detection on the Raspberry Pi with the Movidius NCS

Five video classification methods implemented in Keras and TensorFlow