Numpy in Law Enforcement

Identifying Criminal Suspects by Human Gestures Using Deep Learning

Understanding the Problem

- Criminology is the study of crime and criminal behavior, informed by principles of sociology and other non-legal fields, including psychology, economics, statistics, and anthropology.
- Gestures are used in criminology to identify criminals based on body language, eye contact and hand gestures.
- This process is done manually by experienced personnel. But, even they begin to lose the ability to identify from working throughout the day.
- Not a lot of investigators are qualified and don't have knowledge to identify criminals based on hand gestures.

The Solution

- The solution proposed by the authors of the paper is to develop a deep learning(DL) model, which can detect and identify the gestures of the suspect throughout the investigation and the give us a criminality score (The probability of being the criminal).
- This well trained and tested model gives an accuracy of 98.96%

But why Machine Learning?

Because there are no gesture recognition applications in the field of police investigation.

Basic idea.

- Gestures are classified into Positive and negative gestures.
- The positive gestures include direct eye contact with the investigator and keeping the hands stable or calm without any movements.
- Negative gestures include holding their palms, making movements often, and raising their hands up and down.
- In every case the final step to identify the criminals is by the direct eye contact.
- The model developed will identify the images into classified groups and give a percentage of predicted criminality.

Dataset

- Self captured dataset of 9159 images consisting of 4938 negative gestures, 1897 positive gesture images and 2324 non-manual combined gesture images.
- Non-manual gesture category consists of pictures that embody head dropping and shaking, shoulder shrugging, and facial feature changes, etc.
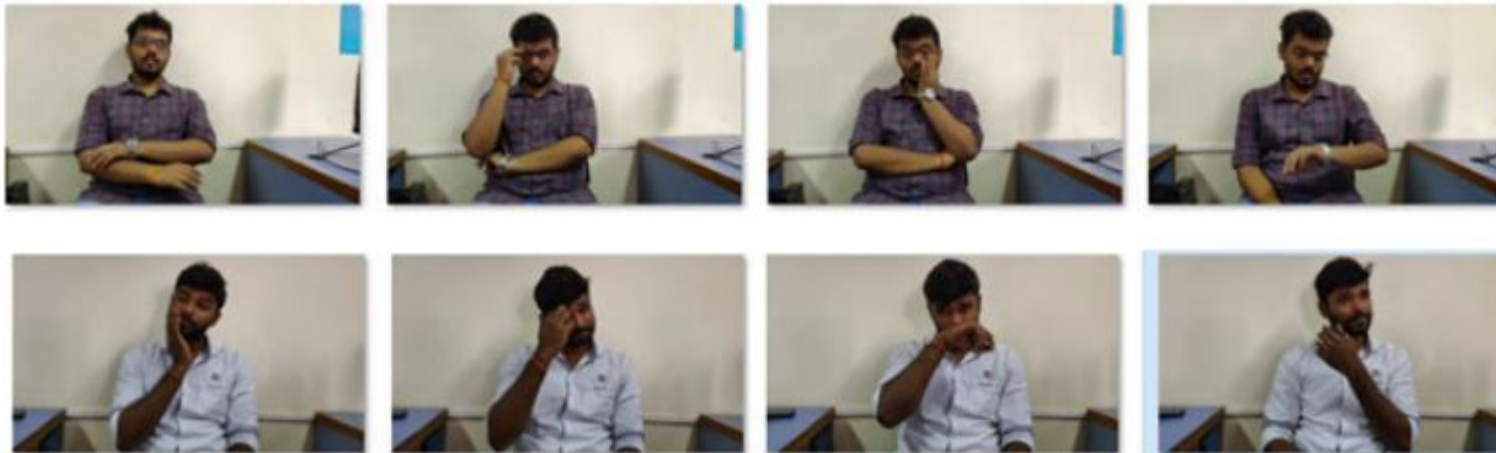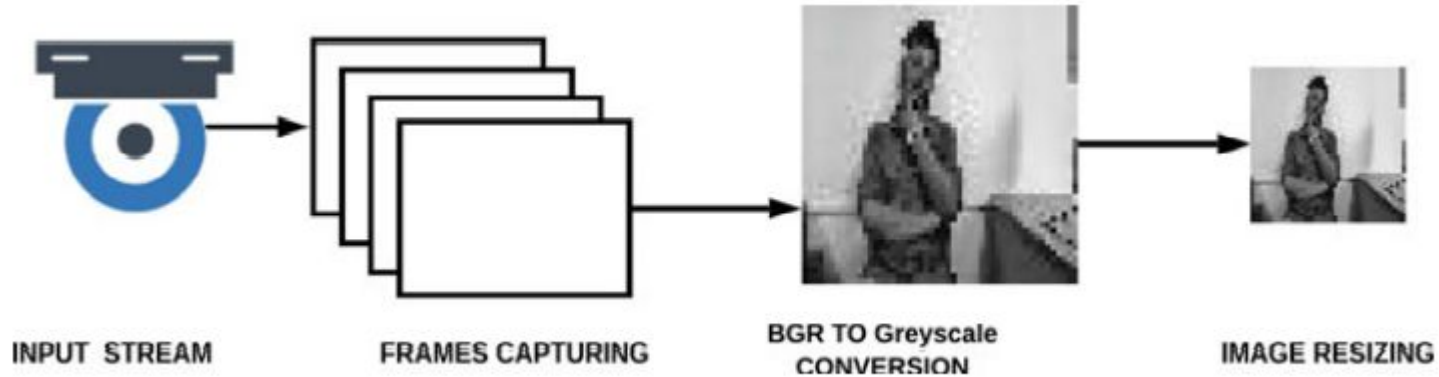- Each image is of dimension 384 x 216.

Fig 1: *Negative gestures Type-I and Type-II.*

Fig 2 : *Non-manual /other gestures*

Methodology

Preprocessing

INPUT STREAM   FRAMES CAPTURING   BGR TO Greyscale CONVERSION   IMAGE RESIZING
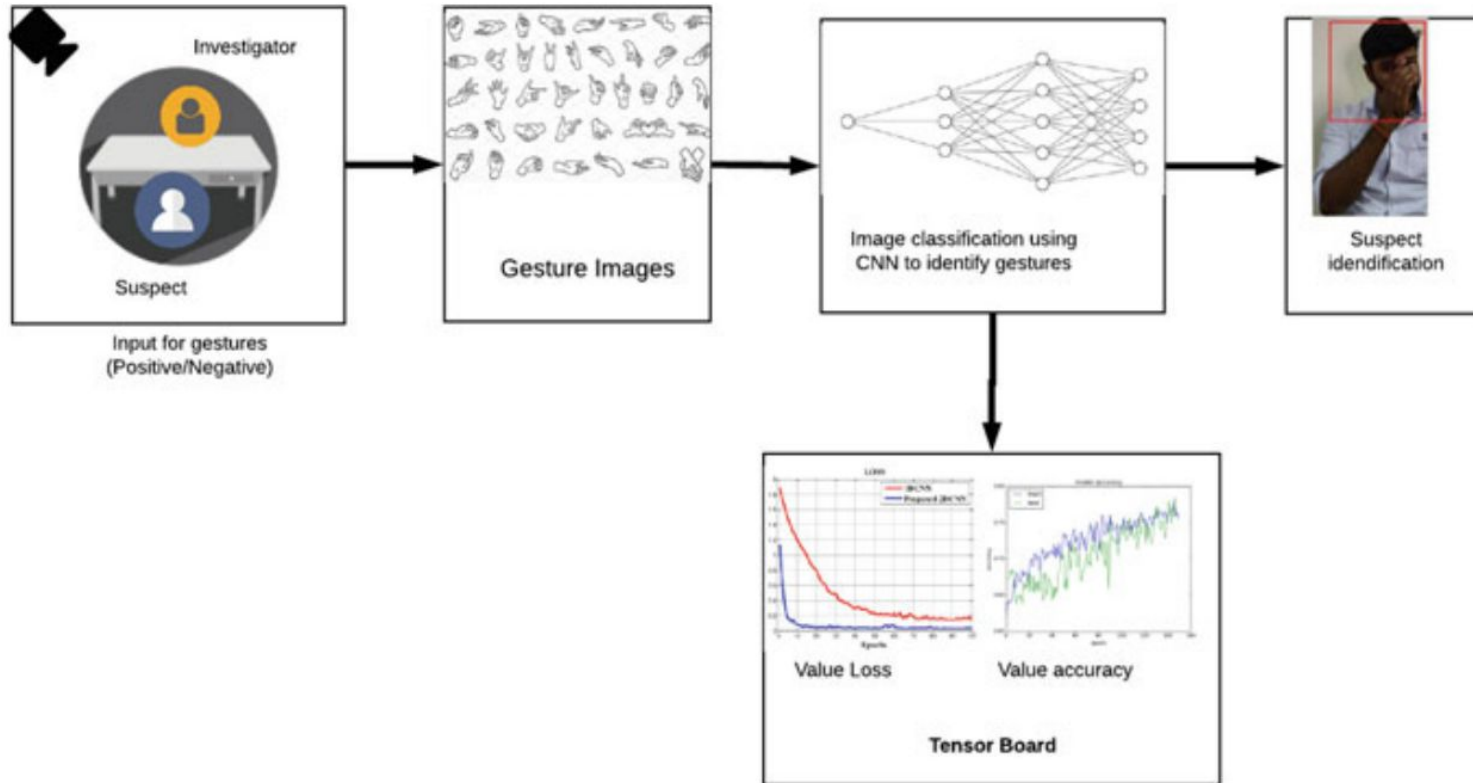
The CNN Model

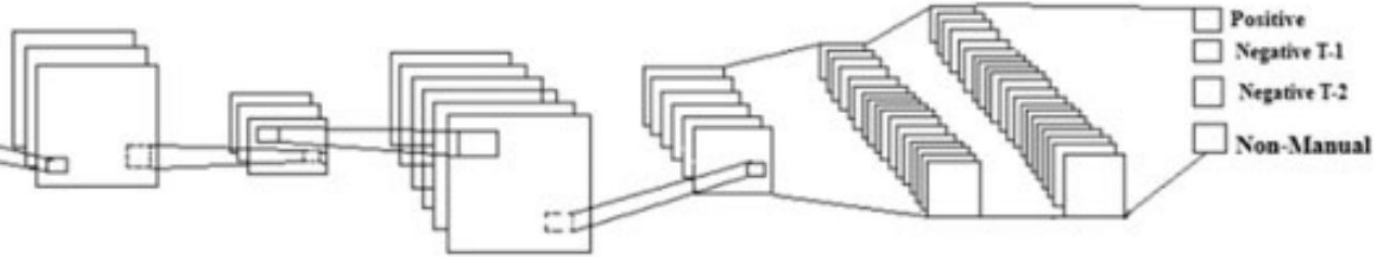**Fig 3 :** *The System architecture*

Fig 4: *CNN architecture*

The CNN Layers perform the filtering of the input data to get the relevant features which propagates through the network's convolution layers.

Results.

- The result from the CNN will be displayed with the percentage of the criminality level.The probability value of the suspect will be determined based on the gestures indicating the level of criminality.
- The results show an accuracy of 98.96% with 50 epochs, and learning rate 0.01.

Table : Results

Epoch value	Batch size	Learning rate	VAL_Accuracy %	VAL_Loss %
50	64	0.01	98.96	0.62

But where's Numpy?

- Numpy is a well optimized multi-dimensional array handling package for python.
- Its very efficient in handling huge amount of data.
- In this research, all the primary data are handled by the numpy.
- Primary data includes all the pre-processed frames from the captured footage of the suspect.
- This data is fed into the CNN which does the identification process.

    NOTE:The CNN model is built with tensorflow, which doesn't use numpy arrays internally but, it just works with numpy arrays. This shows the importance and commonality of numpy in scientific community and it is at the base of all the scientific advancements done using python.