

# Physiognomy of Criminals

Gauri Joshi

Student at Department of Computer Engineering  
Cummins College of Engineering, Karvenagar, Pune, India

**Abstract**— Crime rate in the world is increasing rampantly. Thus, curbing crimes should be one of the top priorities. Cesare Lombroso's theory of criminology postulated that a person can be a "born criminal" and his way of performing crimes wasn't done by free will but could instead be a medical condition that forces the criminal to commit crimes. With the help of image processing and fuzzy logic we can detect the differences of the physical anomalies postulated in his theory of criminology that can distinguish a criminal from a non-criminal. Once a suitable picture of a criminal/non-criminal is captured it undergoes several refinements. After such refinements to measure the size and location of the physical anomalies we need the boundaries of the anomalies hence with the help of certain edge detection algorithms, fine edges of the picture are recorded. To measure the length of the features certain pixels are plotted and thus the distance between them is calculated by Euclidian Distance formula. These values are later put in a Fuzzy Model and distinguished as small, medium or large and based on which the conclusion of whether a person is criminal or not is given.

**Index Terms**— Edge Detection Algorithm, Fuzzy Logic, Image processing, Theory of Criminology.

## 1) INTRODUCTION

Cesare Lombroso's theory of criminology brings upon a new perspective to the crime world. He postulated that performing crimes wasn't done by free will but instead was a medical condition that forces the criminal to commit crimes. Thus this needed to be examined by experts of relevant field. Lombroso's theory of criminology could distinguish a criminals from non-criminals by multiple physical anomalies. He stated that criminals reverted to a primitive or subhuman type of man having features resembling to apes, early man and lower primates, which was in some extent preserved, in modern "savages". The behavior of such savages was opposing to the rules of modern civilized society.

Cesare Lombroso is referred to as the father of criminology. In his theory, he used concepts like physiognomy, degeneration theory, psychiatry and Social Darwinism and put forth the term Anthropological Criminology which was used to ascertain that criminality was not a free will or a "sin committed" but a medical condition that is inherited, and that someone could be a "born criminal". He identified these traits of human nature by studying physical features of a criminal like having enormous jaws, high cheek bones, prominent superciliary arches, solitary lines in the palms, extreme size of the orbits, handle shaped or sessile ears which were also seen in savages and apes.

Thus in this paper, same theory is executed in the domains of image processing and fuzzy logic, where with the help of different edge detection algorithms we trace the edges of those physical anomalies and measure the distances between their end pixels. These values are used as data in a fuzzy model, which after its calculations gives out a result concluding whether the person in the image is a criminal or not.

## 2) LITERATURE SURVEY

After extensive research it has become apparent that there is little academic literature and scarce, up to date, research on the topic of physiognomy, in particular, the aspect of facial features associated with criminality. However, a literature review of positivism, physiognomy and Lombroso has been compiled including academic journals, published papers, previous studies and published books to show what literature already exists and what knowledge can be drawn from academic sources [3]. Lombroso inspired a generation of researchers to delve critically into his 'criminal man' legacy[1], out of this some analyzed literature includes that of Galton (1869), Hooton (1939), Goring (1913), Kurtzberg et al (1978), Newburn (2007), Uberto & Alfredo (2012), Bartolucci & Lombardo (2012), Lombroso (2012 [1911]), Gabbidon & Boisvert (2012), Becker & Wetzell (2004), Adler, Mueller & Laufer, (2007) and many others.

Lombroso conducted various postmortem examinations [2]and anthropometric studies of criminals and normal individuals through years. After his studies, Lombroso became convinced that the "born criminal" could be anatomically identified by certain physical features or anomalies such as a sloping forehead, ears of unusual size, asymmetry of the face, excessive length of arms, asymmetry of the cranium etc. Lombroso's research methods were clinical and descriptive, with precise details of skull dimension and other measurements. Lombroso also postulated that criminals who commit different type of crimes can be distinguished based on their different physical anomalies. A thief presented features like an expressive face, manual dexterity, and small wandering eyes. Habitual murderers were characterized with cold, glassy stares, bloodshot eyes and big hawk-like noses. Rapists on the other hand had 'jug ears'.

To apply and detect such physical anomalies through technology techniques such as edge detection algorithms and graphical representation of images through pixels are used. Detecting the edges is the primary step as its correct detection makes it simpler to locate the pixels of the necessary area. Thus correct selection of edge detection operator is a must.

The authors of the paper [6], mentioned comparisons of many such operators displaying its advantages and disadvantages. Thus, making it easier to select the best amongst all. Canny edge detection [4], a multi-stage algorithm used to detect the thinnest edges is the most prominent amongst them. It's an algorithm that is optimal with regards to the following criteria-

- Criteria: 1. Detection: There should be maximum probability of detecting real edge points and minimum probability of falsely detecting non-edge.
- 2. Localization: The real edged and detected edges should be as close as possible.
- 3. Number of responses: One real edge should not result in more than one detected edge.

To create a fuzzy model of pixel values plotted on the edges, fuzzy logic domain is referred. Creating a fuzzy model is the key step towards finding the solution. The theory of criminology doesn't have much of research or survey hence available data for reference is low comparatively less. Fuzzy logic [5] does not need lots of data to train as long as the domain to model is known efficiently. It does not need huge amount of data to train or test its data, a small but enough amount is sufficient. It also handles problems with imprecise and incomplete data

### 3) PROPOSED METHODOLOGY

- STEPS:

- Step 1- Accept Image

We need to make certain assumptions to standardize the values found out from all the set's of images.

- Assumptions-

1. The images should be of the same window size.  
Ex. 1000x1000
2. The type of the file of all the images used should be the same. Ex. jpg, gif, png, etc.
3. The images used should be of the same camera resolution.
4. The images of the criminals/non-criminals will only consist of the front view or side view of the face which will be cropped and placed in a fixed window size.
5. Pixel present at the tip of the nose of the criminal / non-criminal is the pixel of intersection of the diagonals of the image.
6. Same rules are followed if a side view of a criminal is considered with modifications according to the type of photos is considered.

- Step 2- Edge detection algorithm

It is an image processing technique for finding the boundaries of objects within the images. The process of this technique is to detect the discontinuities in brightness of an image, which is where the edges get marked. Different types of edge detectors can be used in this process. Ex. Sobel Operator.



Fig 1: Edge detection on criminal faces

- Step 3-Pixel Co-ordinates

Location of a pixel is its physical coordinate. After we have decided a fixed window size and chose an image whose edges have been detected through the edge detection algorithm then we plot the co-ordinates of every single pixel in the image. Firstly the four corner pixels of the image are calculated. It is a standard assumption that the top left most corner of the image's pixel is (0, 0). Considering this pixel as the starting pixel and after fixing the size of the window the other three corner pixels can be calculated easily. Similarly the neighboring pixels are calculated according to fig 2.

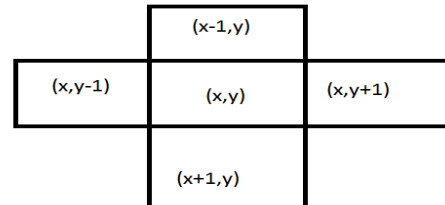


Fig 2: Neighbouring pixels calculation.

- Step 4- Pixel Measurement

Pixel co-ordinates can be found out through different softwares like QtCreator, photoshop, etc where using various tools like gimp, etc can give out the exact location of the pixel. The Euclidean distance DE known from classical geometry can be used to find distance between two pixels p and q. It is defined as-

$$DE(p,q) = \sqrt{(i-h)^2 + (j-k)^2}$$

$$DE((i,j),(h,k)) = \sqrt{(i-h)^2 + (j-k)^2}$$

The distance between two points can also be expressed as the minimum number of elementary steps in the digital grid which are necessary to move from the starting point to the end point.

- Step 5- Fuzzy Logic

Fuzzy logic is defined as non-boolean logic which is based on degrees of truth. Such a logic is based on the perception of truth, rather than the usual (1 or 0) true or false. Approach the task in two ways, training on a set of data stored in the fuzzy model and later testing on a new set of data of the fuzzy model to draw the accurate conclusions.

a) Training-

A data set consisting of the measurement and distance of various features of physical anomalies of people is recorded by following steps 2, 3 and 4. The minimum and the maximum values amongst the complete data set are calculated and the entire data set is categorized in a fuzzy model and distinguished between small, medium and large.

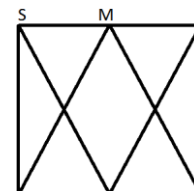


Fig 3: Fuzzy model

b) Testing-

Here we check whether the assumptions and the conclusions we have made on the known data set, now fit a random set of data. Thus by analyzing a new batch of obtained data we find the accuracy that our training set has given us on the random data. Here another fuzzy model is created which follows the same procedure as that of training and shows the results

obtained by the method which distinguishes a criminal from a non-criminal based on rules stated by Cesare Lombroso's theory of Criminology.

• RESULTS AND OBSERVATIONS

The proposed scheme results are divided in three steps namely-

1. Edge Detection Algorithms.
2. Pixel Measurement and calculations.
3. Fuzzy model.

• Edge Detection Algorithm-

Considering the different physical anomalies, the rules to accept the manner of the image, always changes. Here, the side profile of a person is considered to measure the size of his ear and analyze whether or not he is a criminal. The following is a result of a person with canny edge detection algorithm-



Fig 4: Side view, edge detected image of a person

• Pixel measurements and distances-

Pixel co-ordinates are plotted on the necessary physical anomalies and the distance between two endmost pixels is measured to calculate its length, as shown in the image.

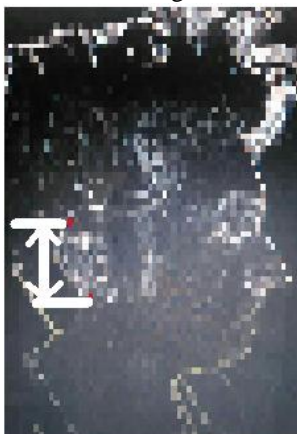


Fig 5 :Pixelized Image

• Fuzzy model-

Similarly 'n' number of other side profiles of criminals and non-criminals is taken. In the training stage of the fuzzy model, firstly the minimum and the maximum values amongst the data are calculated after acquiring all the pixel values of the 'n' number of people. In the figure 6 the length of the ear from fig 5 is plotted. As the lowest and highest value of the dataset is 3 and 10 respectively, the plotted value of 6 is in the zone between small and medium module.

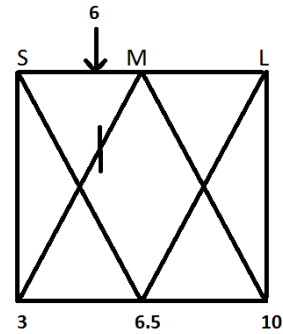


Fig 6: Fuzzy model of noted calculations

In the testing stage, same rules of training data set are applied on the new type of unknown data. Following those rules on the unknown dataset, the authenticity of the results is withdrawn. Thus, concluding the assured results of the model, ranging from 0-1 and stating conclusion in the form of a one line statement, like , "Based on the given data, the probability of a person being a criminal is 0.7", the result is given.

5) CONCLUSION AND FUTURE WORK

In this paper, we propose the idea of treating criminality as a medical condition through Cesare Lombroso's Theory of Criminology with computer aided technologies in domains of Image processing and Fuzzy Logic. If a person is found guilty to become a criminal and detected through this algorithm then it can be notified to the relevant medical experts of individual domains. We identify the probability of the person to be stated as a criminal.

The accuracy of this algorithm can be increased; many other advance techniques can be used replacing the old ones. For example fuzzy logic method can be replaced by more efficient algorithm of neural networks. In future, research horizon of this topic should be expanded around the world. If fuzzy logic is being used then to get more accurate results this is of at most importance that more and finer details must be added in the dataset. This will compel the model into taking the best possible decisions by being familiar with the facts and figures. Medical science should also invest more of its work in this theory. It is a brand new concept introduced in the computer field and hence can be brushed off and worked on by others by finding more accurate answers with brand new theories.

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**Gauri Joshi.** Student studying BE Computer in Cummins College of Engineering.